Enterprise Modelling Framework for Dynamic and Complex Business Environment

Socio-technical Systems Perspective

By

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Abstract

The modern business environment is characterised by dynamism and ambiguity. The causes include global economic change, rapid change requirements, shortened development life cycles and the increasing complexity of information technology and information systems (IT/IS). However, enterprises have been seen as socio-technical systems.

The dynamic complex business environment cannot be understood without intensive modelling and simulation. Nevertheless, there is no single description of reality, which has been seen as relative to its context and point of view. Human perception is considered an important determinant for the subjectivist view of reality. Many scholars working in the socio-technical systems and enterprise modelling domains have conceived the holistic socio-technical systems analysis and design possible using a limited number of procedural and modelling approaches. For instance, the ETHICS and Human-centred design approaches of socio-technical analysis and design, goal-oriented and process-oriented modelling of enterprise modelling perspectives, and the Zachman and DoDAF enterprise architecture frameworks all have limitations that can be improved upon, which have been significantly explained in this thesis. In particular, these approaches face real challenges in their effectiveness and comprehensiveness to analyse and design socio-technical systems. As these previous approaches have been either too technical or too social with limitations in business-IT alignment, many of these approaches usually consider only one mechanism of analysis. The focus of this thesis will be mainly on developing socio-technical systems analysis and design framework, taking into consideration issues related to handling and planning for enterprise aspects and their dynamics, reasoning in decision-making and business-IT alignment through a holistic modelling approach that considers social and technical aspects together.

Using design science research methodologies and the philosophical stance of interpretivism, an exploratory case study was conducted with two companies to understand the current dynamic socio-technical environment and thus inform the design of the prospective framework. Reflection from complexity theory to better understand of the current issues related to change in dynamic socio-technical environment and decision-making influencers helped to define the necessary socio-technical analysis and design requirements. The main output of this exploratory case study came in developing new principles that support and guide the current socio-technical systems analysis and design process toward developing of the hybrid modelling framework suggested in this thesis.

This thesis introduces the development of a novel hybrid-modelling framework to analyse and design socio-technical systems. The embedded capabilities of the framework help to model enterprise aspects in a holistic manner, understanding and planning for various types of change. The developed framework is based on integrating coherent sets of models of enterprise modelling, design rationale and system dynamics in order to offer analysis, simulation and implementation capabilities for activities in which enterprises engage. The Business Motivation Model (BMM) was chosen as a base on which to build the new framework up.

The research has resulted in contributions to knowledge in terms of proposing a structured model-based integrated framework presented as the following deliverables: 1) a metamodel on three abstract levels containing artefacts and separated into a set of views; 2) an implementation process composed of specific steps and specific practices belonging to each goal; and 3) modelling tools consisting of a) Enterprise modelling tools (BPMN, KAOS, SBVR, OSM, UML), b) Design rationale for reasoning c) System dynamic modelling for dynamic simulation. The new framework is called the Reasoning in Dynamic Business Motivation Model (RDBMM).

This thesis also demonstrates how to apply the approach used to increase business insight and alignment through the use of two case studies as example applications. These two case studies are presented to evaluate the RDBMM, and comparison and evaluations from industrial perspectives are presented to support the validation. Lessons learned from the evaluation through the RDBMM applications are discussed; the developed hybrid-modelling framework offers capabilities of reasoning, simulation and IT-business alignment, considering both social and technical aspects for analysing and designing enterprises (current and future planning). The suggested tools used helped to collect enterprise knowledge, understand the enterprise and its environment, and align social, business and technical aspects in systematic manner. Contextual implications, technology adaptation and the agility of the artefacts, process and implemented platform are among the most important issues influencing the success of socio-technical system analysis and design conceptions.

This research opens up new horizons for designing enterprises, integrating different types of model to simulate and implement enterprise ISs. More importantly, it contributes to knowledge in the adaptive information systems requirements towards the full automation of enterprises. The thesis proposes conceptually an enriched modelling and technical concept framework to handle enterprise requirements in run-time.

Keywords: Socio-Technical Systems Analysis and Design, Enterprise Modelling, Business-IT alignment, Reasoning in dynamic business motivation model.

Dedication

This Work Is Dedicated To My Parents

For all their love, care,

Hard work and patience!!!

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Over the last four years, I have been tramping the research path, hoping to achieve my objectives to reach a stage where I can say all is done and a new stage will start. Now I am there, it has been a fabulous experience with hard and tough times and an inspiring and intellectually stimulating joint venture. Writing a thesis is a journey that starts with a mile and ends up with thousands of miles. During this journey, feeling happiness, loneliness, frustration, inspiration, success and loss is just a part. The truth is that I would not have been able to complete this PhD successfully without the encouraging people around me.

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I am indebted for the support extended by the companies who provided me the necessary data to complete my research; Info2cell and Techno-Logic with their collaboration gave their valuable time to assist me during a number of interview phases of the research.

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Acronym List

As-Is: The present/current situation, a representation of the current situation as it is, without incorporating any changes or improvements.

BMM: Business Motivation Model is an OMG specification related to enterprise architecture, and offers a scheme and structure for developing, communicating, and managing business plans in an organized manner.

BPMN: Business Process Management and Notation is a graphical representation for specifying business processes in a business process model. It was previously known as Business Process Modelling Notation.

CSF: A critical success factor is the term for an element that is necessary for an organisation or project to achieve its mission. It is a critical factor or activity required for ensuring the success of a company or an organisation.

e3Value: The e3value is a value driven methodology has been developed by Jaap Gordijn and Hans Akkermans. e3value provide visual model and notation for value flow among systems/enterprises.

FTD-DSRIS: Framework for theory development in design science IS research.

GDP: Gross Domestic Product is the market value of all officially recognized final goods and services produced within a country in a given period of time. GDP per capita is often considered an indicator of a country's standard of living

GQM: Goal/Question/Matrix is an approach to software metrics, to define a measurement model on three levels: Conceptual, Operational and Quantitative.

KAOS: Knowledge Acquisition in automated specification is a goal-oriented software requirements capturing approach in requirements engineering. It is a specific Goal modelling method.

KPI: Key Performance Indicator is a jargon for a type of performance measurement. KPIs are commonly used by an organisation to evaluate its success or the success of a particular activity in which it is engaged.

Metamodel: The model that defines a model, and it has two understanding in the literatures:

1) Generic metamodel, which describe/define the main components and the relations among them in the model, this metamodel called sometimes conceptual model or ontological construct of the model.
2) OMG defined The interoperability metamodel for its specifications, this metamodel mostly build by organisations aiming to automate implementation of their modelling tools, however, OMG have defined the most standards and powerful interoperability metamodels for their standards (UML, BPMN, SBVR,..etc).

OMG: Object Management Group is an international, open membership, not-for-profit computer industry standards consortium. OMG Task Forces develop enterprise integration standards for a wide range of technologies and an even wider range of industries.

RDBMM: Reasoning in Dynamic Business Motivation Model, represent the developed framework that carried out in this thesis built up on BMM specification.

SBVR: The Semantics of Business Vocabulary and Business Rules is an adopted standard of the Object Management Group (OMG) intended to be the basis for formal and detailed natural language declarative description of a complex entity, such as a business.

SME's: Micro, Small and Medium-sized Enterprises (SMEs), according to the revised definition, are made up of enterprise which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million Euros, and/or an annual balance sheet total not exceeding 43 million Euros. European Commission (2005). The new SME definition. Official Journal of the European Union. Brussels, European Commission: 36.

STS: Socio-technical System: in this thesis, STS represents an enterprise

SysML: The Systems Modelling Language is a general modelling language for systems engineering applications. It supports the specification, analysis, design, verification and validation of a broad range of systems and systems-of-systems.

To-Be: Future/Desired situation, a situation that results from incorporating improvements in the current (as-is) situation.

UML: Unified Modelling Language is a standardized general-purpose modelling language in the field of object-oriented software engineering. The Unified Modelling Language includes a set of graphic notation techniques to create visual models of object-oriented software-intensive systems.

VAS: Value Added Services is a popular telecommunication industry term for non-core services. Or briefly, all services beyond standard voice calls and fax transmissions.

"The challenge facing us all as analysts and thinkers is how to move from generalizations about accelerating learning and systems thinking to tools and processes that help us understand complexity, design better operating policies, and guide change in systems from the smallest business to the planet as a whole."

Sterman, 2000

Chapter One: Introduction

1.1 Research Motivation

The world is characterised by dynamism, uncertainty and complexity. After the industrial revolution, humans have relied more upon machines when performing their daily activities (Gershuny, 1979). New mechanical, electrical, technical and information systems have been developed, and human life is now inextricably linked with these systems to form socio-technical systems (Morris, 2009). New paradigms have emerged in all fields of science to aid the understanding of these systems and their relations. In this thesis, a socio-technical system (STS) is seen as any system contain social and technical elements, however the focus is on the enterprise as a socio-technical system: this definition conforms with the understanding presented by Whitworth (2009a), Griffith and Dougherty (2001) and Emery (1959; 1972). Socio-technical systems approaches aim to study and develop human-mechanistic integration in a holistic manner, which means studying soft systems and hard systems together (Whitworth, 2009b), considering social and technical factors in a fused manner. This will contribute to the understanding of social, business and technical systems, and how they work mutually, leading to the better design of organisational structures, business processes and technical systems. Many of the initiatives that are discussed in this thesis promote a better understanding of socio-technical systems. For the most part, these initiatives play a role in the theoretical and conceptual ranges of the problem and solution domains, where these approaches have not yet been widely adopted in terms of aligning social and technical aspects (Morris, 2009) because of a lack of operationalisation details, an absence of practical reference models and a lack of standardisation for industrial use (Baxter and Sommerville, 2011).

Enterprise modelling (EM) and enterprise architecture frameworks (EAFs), techniques and methods are initiatives developed in the early 1990s to provide holistic systematic analysis and design solutions for organisational and technical systems (Loucopoulos and Kavakli, 1995; Zachman, 1987). Based on the literature review conducted in this thesis, these EM and EA frameworks have failed to address the issue of socio-technical systems dynamics and evolution; as well as lacking the inclusion of decision-making reasoning, the expansion of mental models and the consideration of influences/influencers in the socio-technical system and its environment are limited. Many other new initiatives have tried to find a solution to this problem in fields such as requirements engineering, soft systems methodology, IS frameworks and ontology development, and some initiatives have been too technical or too social. However, all are still limited by their particular scope, and improvement is still possible on all scales to advance the holistic analysis.

1.2 Problem Definition

Over the past decade, traditional business practices have become inadequate, and in order to remain competitive, enterprises have been forced to react to change. Many challenges have appeared in the new open economic and business models. The limitations of the current approaches to understanding the evolution of socio-technical concepts leaves enterprises with an insufficient analysis of the context in which they are operating. Sometimes this compels enterprises to rely on technology and ISs to understand the details of how enterprises operate, rather than guiding the technology to enable the strategy: this causes less agility, longer development lifecycles and the failure of IS initiatives. In the IS literature, different initiatives have indicated the new challenges and located them at the boundary of information systems design (Yu et al., 2011; Jarke et al., 2009; Hansen and Lyytinen, 2010).

Baxter and Sommerville (2011) argued that IT projects fail because they do not recognise the social and organisational complexity of the environment. To solve such as issue, tools that help us to recognise such complexity are needed. Sterman (2000) argued that the challenge facing analysts is how to move from generalisations about accelerating learning and systems thinking to developing tools and processes that help to understand complexity, design better operating policies, and guide change in systems from the smallest business to the most complex business systems. However, this requires full alignment to move from understanding the whole environment to designing operations, policies and information systems. Morabito (1999) recommended that organisations should consider several stages of alignment, including dynamic alignment, where incorporating static and dynamic ontology in process dynamics is fundamental for any modelling language (Yu, 2009). To do so, the enterprise architecture (EA) or enterprise model (EM) should be dynamic and agile (Terkelsen, 2013), in order to respond efficiently to such challenges. Finally collaboration, agreement and faithfulness to the language and tools used by stakeholders is important, to facilitate analysis and share knowledge across a project (Yu, 2009).

To overcome such problems, a framework that considers such recommendations becomes crucial for enterprises to succeed in their strategic and IT development initiatives. Enterprises need to understand the dynamic and complex nature of socio-technical systems, and provide sufficient reasoning about design choices, then build enterprise activities that are maturely aligned to software and IT systems. In socio-technical systems development, studies show that the most common challenges facing the development process are related to the social system where people analyse, communicate and design socio-technical systems. Figure 1 summarises a recent survey describing the most current issues that cause insufficient requirements for socio-technical systems analysis and design in the enterprise context.

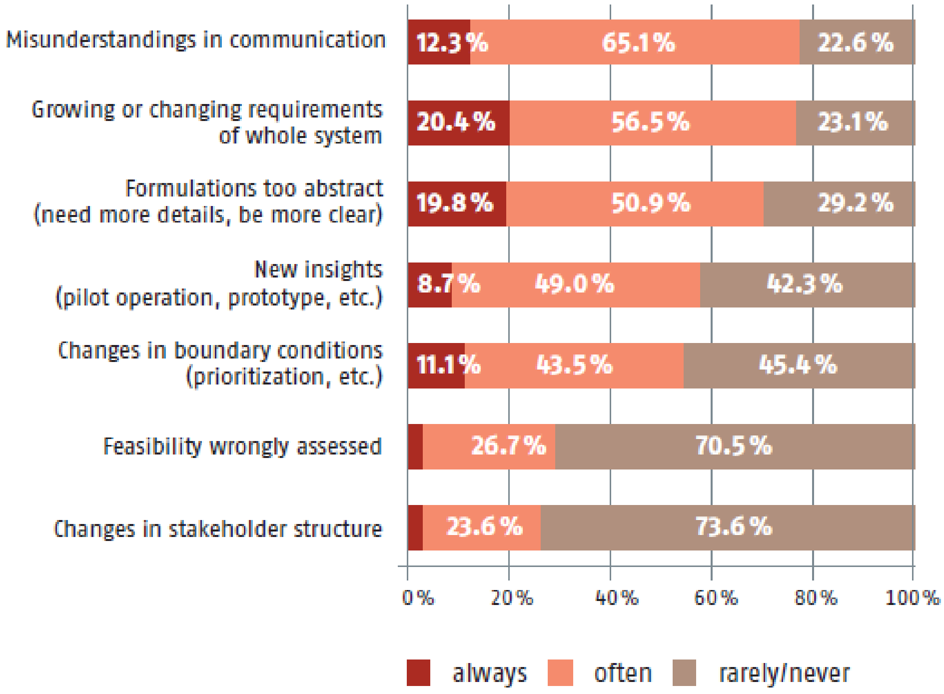


FIGURE 1: REASONS FOR INSUFFICIENT REQUIREMENTS (SWISSQ, 2012)

The survey confirms clearly that the problems are rarely technical, and that a heavy emphasis on social aspects is required. New methodologies, techniques and tools are required so that enterprises can build, react, forecast and change in order to ensure success. In the context of socio-technical systems, the following question has been identified and will be addressed during this research study:

- How can the research syntactically, systematically and systemically[1] address socio-technical systems analysis and design, giving equal attention to social and technical aspects in order to cope with the dynamicity and complexity of STSs?

To address this issue, the socio-technical system that represents an enterprise should be aligned with the high-level social and contextual requirements related to a specific operation and technical details. To be able to do this, from the research point of view, it is important to identify how to break down socio-technical dynamics, complexity and dependences into

[1] Syntax is used to describe the logic/rules of the formation of concepts, tools and languages. Systematic is an adjective used to describe something as consistent, organised and well-arranged, whereas systemic means that something has or can affect the whole system. Source: www.differencebetween.net

different types of artefact to allow full fusion with technology using a hybrid modelling framework that can offer different capabilities to handle such problems. It is not possible to have a comprehensive socio-technical system view using a narrow modelling perspective, and so a multi-perspective framework is required. The main limitation of current methods is that these approaches to analysing and designing socio-technical systems rarely comprehend the social and technical together, and do not identify in detail how to align business and IT strategic and development processes. Enterprise Modelling (EM) perspectives can offer the required capability for business-IT alignment, but one perspective is never enough to provide a holistic view of the enterprise. In addition, Enterprise Architecture Frameworks (EAFs) are neither capable of reasoning about design decisions nor able to understand the dynamic aspects of the socio-technical system.

A successful socio-technical system analysis and design framework requires one to take advantage of all three domains and overcome these limitations

1.3 Aim and Objectives of the Research

This study aims to provide a hybrid modelling framework for analysing and designing socio-technical systems, that should address the limitations of the current socio-technical methodologies and make use of enterprise modelling techniques. These techniques are enhanced using reasoning and dynamics modelling to offer an effective and comprehensive analysis capability. Table 1 lists the research objectives and the chapters which address these objectives:

TABLE 1: RESEARCH OBJECTIVES

Research objective No.	Description	Chapter
1	Review and identify a research gap in the socio-technical literature: Different proposals have been put forward within the socio-technical systems analysis and design field, and pointing out the limitations, challenges and research opportunities is critical for deciding the research design and direction of implementation.	Chapter 2
2	Identification of the limitations and potentials of the EM perspectives and EA frameworks: Enterprise modelling is investigated from many perspectives to gain a more comprehensive view and provide better insight, contributing to overcoming the limitations of current enterprise modelling frameworks, which lack a consideration of dynamics and reasoning modelling.	Chapter 2
3	Increase understanding of change, decision-making and complexity in the socio-technical environment using an exploratory case study: Exploring dynamicity, complexity and decision-making in the socio-technical environment and its impact on information system development.	Chapter 4
4	Develop new principles and a generic supportive model to guide the analysis and design of complex socio-technical systems: A reflection of complexity theory on the findings of the exploratory case study is applied to offer new understanding of analysing and designing dynamic and complex socio-technical systems.	Chapter 4
5	Develop a new modelling framework, "RDBMM", with a supportive implementation process and tools: The Business Motivation Model (BMM) was chosen as an enterprise modelling framework candidate, focusing on enterprise model related aspects to put the research framework into operation. The BMM is detailed and extended, and an implementation process and supportive tools proposed to realise the framework.	Chapter 5
6	Industrial applications using two case studies to test the RDBMM modelling framework: Putting the new framework into operation and execution using two different enterprise settings (as-is and to-be).	Chapter 6 and 7
7	Evaluate the proposed RDBMM and its applications: Industrial implementation, case study comparison and lessons learned are also discussed, followed by proposals for a future extended framework.	Chapter 8

1.4 Research Approach

This research follows the "design science research methodology for IS research". DSRM for IS research (Peffers et al., 2007) is considered to be the main appropriate process for conducting problem-based design research, although there is some overlapping with systems thinking and soft systems methodology. However, it has been argued that soft system methodology is very relevant to design science research (Venable, 2006). The case study strategy will be adopted to demonstrate the methods in a real application to ensure the validity and generalisability of the approach. The main steps of the DSRM for IS research approach are as follows:

- Step one: Problem and Motivation (based on the literature review and analysis)
- Step two: Objective of the solution (literature review analysis)
- Step three: Design and development (literature review, theory development using DSRIS, cross-domain adjustment in exploratory case study with two companies + extending the framework using new artefacts in conceptual modelling)
- Step four: Demonstration (case study: two case studies)
- Step five: Evaluation (enterprise maturity assessment, impact assessment, finding analysis, approach evaluation, discussion with mentors and stakeholders)
- Step six: Communication (attending conferences /discussion , further applications, journal publications and future work)

In brief, the research will use FTD-DSRIS (Kuechler and Vaishnavi, 2012) to reflect principles from complexity science on socio-technical systems in order to offer principles for socio-technical system analysis and design. The Design Rationale (DR) (Tang et al., 2006a; Burge, 2005) will be used for reasoning to inform enterprise design choices and highlight the advantages and disadvantages of each option. Nevertheless, it is not always easy to understand the full impact of making one decision because of the complexity of the relationships; in this case, further investigation will be undertaken using the System Dynamics (SD) (Forrester, 1994; Morecroft, 1983) modelling technique for describing complex and dynamic phenomena and the relationship between artefacts. SD modelling offers capability to simulate changes in artefacts based on their relationships over time (Sterman, 2000; Barlas and Yasarcan, 2008). These all will be integrated with the enterprise modelling techniques based on the motivation model.

The case study will follow another iteration of DSRM for IS research: this iteration will start from the demonstration step as an entry point (Peffers et al., 2007). More emphasis on the case specific process will be discussed in each case study chapter:

1. Step one: Demonstration: demonstrate the RDBMM framework using the modelling techniques and generic process proposed in Chapter 7.
2. Step two: Evaluation: evaluate the applicability and maturity of the enterprise models of the organisation, and measure the effectiveness of the RDBMM in each particular case.
3. Step three: Communication: communicate the results to industrial and academic stakeholders, further presentations and publications.

The case study strategy aims to test a set of techniques, which are part of the DDBMM framework in order to meet the research objectives in a systematic way, mainly using three mechanisms 1) Enterprise modelling 'abstraction' which benefits from Model Driven Engineering (MDE) (OMG, 2003) to help create mature information systems and completely align the development effort from business and social requirements to software and system development in a systematic way. MDE plays a core role in this research, focusing on MDE business modelling specifications. 2) Dynamic modelling that uses system dynamics modelling tools. 3) Design rationale for qualitative reasoning. This strategy will cover the important aspects of enterprise modelling and use reasoning and dynamics to offer the enterprise the insight and agility to be able to fulfil dynamic artefacts. The goal is to provide a better understanding of dynamics and complex aspects in order to offer better socio-technical systems analysis, design and architecture in enterprise context.

The approach followed by this study will bring unique value through:

- Studying the enterprise within its context and extending consideration of the impact of influences/influencers
- Providing reasoning about alternatives and decision-making at the enterprise design stage
- Providing dynamic modelling for simulating current and predict business complex and dynamic aspects
- Providing a flexible approach to moving from high-level organisational goals to IS development to improve alignment (technology implementation suggested as future work)
- Achieving a common understanding and agreement between stakeholders (more collaboration and business insight)

1.5 Research Contributions

The original contribution made by this thesis can be summarised as follows:

1- **Theoretical contribution**

In this thesis, multi-disciplinary theories from several domains (design science, complexity science and socio-technical systems) are applied with the aim of providing a better understanding of the socio-technical emergent phenomena and to design modelling framework that confirm theories from different domains in order to increase the approach robustness, which in turn will improve socio-technical systems analysis and design. New principles offering better understanding in analysing and designing socio-technical systems are proposed in this thesis based on the experience gained from the exploratory study and the reflection of complexity theory concepts on this experience. Moreover, concepts of design artefacts have been considered in the design of the hybrid modelling framework 'The RDDBMM'.

2- **Conceptual contribution**

The RDBMM framework is a set of analysis and design artefacts presented in three levels of abstraction and that incorporates several views. The RDBMM offers a clear and detailed semantics among these artefacts, as well as suggesting a set of modelling tools/languages for using it towards modelling these artefacts. Moreover, the RDBMM framework is followed by an implementation process that presents explicitly the process and modelling methods to be used as part of the proposed framework. Nevertheless, the implementation process could vary from one case to another; this will act as a generic process for the use of the developed framework.

3- **Methodological contribution**

This research contributes in terms of the methodological approach: DSRM for information systems was applied to the whole PhD research process, the DSRM stages are addressed in a unique manner, and mixed methods are used to contribute to fulfilling the research objectives. A systematic literature review, multiple case studies and framework for theory development for design science research in information systems (FTD-DSRIS) contribute in using DSRM in a novel way to fulfil the research needs. For example, FTD-DSRIS was used to understand the dynamics and complexity of socio-technical systems; in addition, FTD-DSRIS helped to conceptualise new principles to guide socio-technical system analysis and design.

4- **Industrial and empirical contribution**

This research examines the techniques proposed in two different case studies, which vary in their modelling processes and details as a result of their organisational position and requirements. Case Study One, Info2Cell company, presents an ‘as-is’ architecture as well as an issues analysis of the data collected using different data collection methods. Case Study Two, Techno-Logic Ltd., is a newcomer to the market, and the modelling focus is on a ‘to-be’ architecture, which focuses on service development and the risk analysis of market issues. The modelling also represents different weights of the modelling lifecycle, as the second case study presents a lighter modelling lifecycle than the first.

1.6 Research Flow and Outline

The research process in this thesis was not straightforward, as it investigated a large number of tools, approaches, frameworks and methods. The purpose of conducting such a wide cross-domain investigation was to identify and adapt the most suitable practical solution from a wide range of domains. The main emphasis was on approaches to socio-technical systems, which have been seen in this research as having various limitations and weaknesses, especially regarding the comprehensiveness their consideration of both social and technical aspects and in the details of their analysis and design for business-IT alignment. It was assumed in this research that the enterprise modelling (EM) domain has made a recognisable effort, which helps to fulfil the analysis and design of enterprises that are considered as socio-technical systems in aligned and systematic manner. Nevertheless, none of the enterprise modelling perspectives were comprehensive enough to cover all of the socio-technical artefacts of modern enterprises (as discussed in Chapter 2). The strengths of the discussed field have been understood and will contribute to building the prospective solution. However, the research leads to an investigation of enterprise architecture frameworks, since these contribute to EM and can offer a comprehensive view of the enterprise as a socio-technical system. Well-known frameworks were discussed and critically evaluated, highlighting several limitations and gaps. The gaps were taken to the next stage of evaluation in the exploratory case study, the exploratory case study aims at understanding the modern socio-technical systems in better way; the findings were interpreted based on the implications of the review of complexity theory in understanding complex dynamic behaviour. This resulted in principles that will be used to describe, analyse and design socio-technical systems. Later in the process, a hybrid modelling framework was developed containing enterprise, reasoning and dynamics modelling techniques to improve the understanding of the complex environment and the impact of dynamic aspects on an enterprise/STS analysis and design.

The framework represented in three levels of abstraction, the detailed level's artefacts is separated to set of views and is supported by an implementation process to guide the modelling activities and set of tools to represent the artefacts in formal models. Overall, the framework was implemented in two case studies with contrasting characteristics, such as modelling ‘as-is’ with social and organisational focused implementation, and modelling ‘to-be' with a technical/software component development, in order to examine its ability to analyse and design different complex and dynamic socio-technical systems. Figure 2 presents a description of the research flow and the storyline of this thesis.

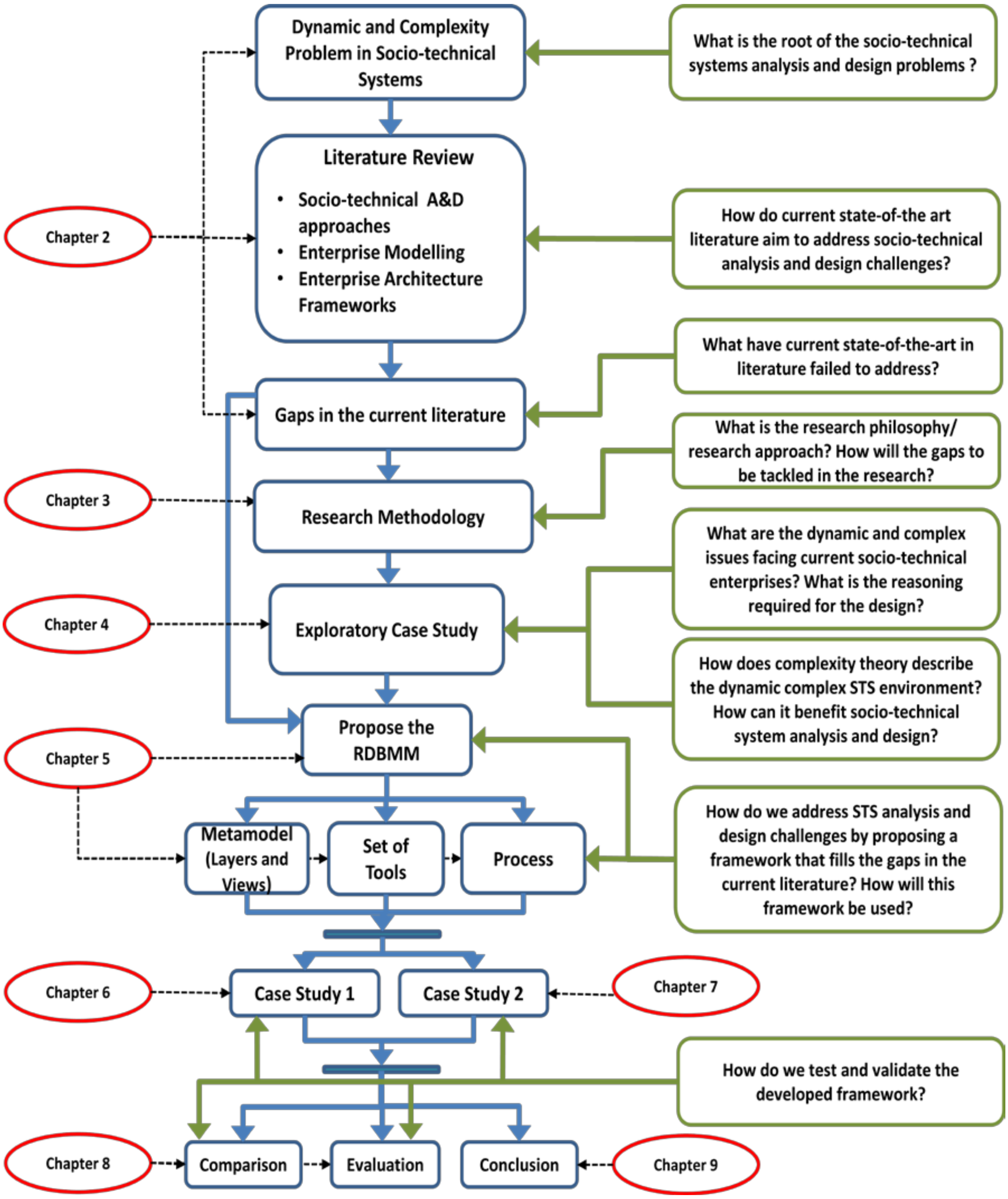


FIGURE 2: RESEARCH FLOW (STORYLINE)

1.7 Structure of the Thesis

The thesis is composed of nine chapters and nine appendices. Chapter 2 reviews the literature on socio-technical systems philosophies and emerging paradigms, enterprise modelling perspectives and new emerging paradigms of enterprise modelling as a systematic approach to analysing and designing socio-technical systems. Enterprise modelling frameworks, which combine sets of enterprise views and layers, are presented and critically reviewed in Chapter 2. The research philosophy, methodology, methods and data collection techniques are presented in Chapter 3. An exploratory case study with SME and enterprise companies is analysed and discussed based on cross-domain theories, and a set of principles to guide socio-technical systems analysis and design are presented in Chapter 4. The research focus, design and modelling framework, the RDBMM, is proposed and presented in Chapter 5, this is based upon the current research gaps in the form of the literature analysis and the findings of the exploratory study. Chapter 6 is a case study of the Info2cell Company to model the ‘as-is’ enterprise and provide managerial and strategic insights. Chapter 7 presents a case study of Techno-Logic Ltd, a new establishment using ‘to-be’ modelling.

Chapter 8 presents an analysis, evaluation and discussion of the developed framework and the case studies with a comparison of the results. Finally, Chapter 9 presents the research conclusions and a discussion of the contribution of the research to knowledge. Future research directions are included in the same chapter. This is followed by a list of references and then appendices containing the enterprise taxonomy, research process model, interviews, and information related to the case studies.

Chapter Two: Literature Review

The main problem which the research aims to investigate is how to provide better analysis, deal with complexity and dynamicity in the rapidly change socio-technical environment and design efficient operation systems, taking into consideration the ease of use and adaptability of the tools that will be used to analyse and design better socio-technical systems for enterprise activities.

Therefore, this chapter reviews literature within the problem domain (the socio-technical system): literature from approaches to socio-technical systems analysis and design have been discussed where challenges and requirements for analysing and designing socio-technical systems were presented. However, since enterprises are seen as socio-technical systems (Emery, 1959; 1972), the chapter will also examine and discuss literature on the current techniques in enterprise modelling (EM) (Loucopoulos and Kavakli, 1995). Enterprise modelling is an abstract representation and description of an enterprise's elements and sub-elements, and scholars in the domain have approached enterprise modelling from different perspectives, sometimes combining more than one perspective to fulfil enterprise needs. This chapter will also discuss the domain of enterprise architecture frameworks (EAFs) (Sessions, 2007; Zachman, 1987), in order to identify the limitations and gaps that the research aims to solve. The approaches to analysing and designing socio-technical systems have some limitations in their comprehensiveness and details, despite the strong consideration of social aspects and the analysis offered by a number of these approaches. To overcome the limitations in these approaches, it was beneficial to use strong techniques that were already well established and detailed in the enterprise modelling domain; the challenges facing enterprise modelling are also related to the comprehensiveness of its perspectives. Advantages were taken from enterprise architecture frameworks to offer multiple perspectives and multi-layer architectures: these are well established and broadly used architectures which use enterprise modelling abstraction techniques to model aspects of enterprises.

The strengths of these three sets of literature have been considered in the prospective solution; gaps have been identified in the three sets of literature and will be addressed through this research. Understanding complexity and dynamicity is a critical issue for successful socio-technical system analysis and it is important to design a framework able to overcome the current challenges; a critical review of the limitations in the current literature are presented at the end of this chapter.

2.1 Introduction to the Problem Domain

The universe is characterised by evolution and uncertainty. Evolution is a phenomenon describe the process of change and occurs in all ecological and non-ecological systems (Bowler, 2003), while uncertainty results from the limitations of the human mind's capability and knowledge to describe or understand certain phenomena, especially those caused by hidden or unnoticeable relationships and dependencies between change influences (influencer and influenced). The environment and the physical universe we live in continuously evolves, and this is also true for all of the sub-entities of the universe, i.e. societies, ecology, technology, theory, science and cognitive stability: all evolve over time in their own context. For a long time, researchers have tried to analyse complex situations occurring in our world, including behaviours, unexpected statuses and many other social and ecological phenomena. The principle aim of social behaviour and choice treatments is to create a platform for a comprehensive investigation of behaviour, decision and choice within business and society. The combination of social actors generate and exchange knowledge, financial capital and other resources in networks of relationships that are embedded in institutional frameworks at local, regional, national and international levels. Sociologists have long believed and argued that psychology alone cannot explain what happens when people work together in either complex modern societies or in the virtual digital society (Sawyer, 2005). In contrast, most psychologists and economists believe that they can explain much about social life with an accurate theory of how individuals make and act on decisions. However, these societies are complex dynamical systems, and thus the best way to resolve the debate is by developing the concept of emergence, paying attention to multiple levels of analysis of individuals, interactions and groups, while the contexts of business performance provide turbulent environments with high ambiguity. For example, business value networks in complex socio-economic systems (Tapscott, 1999; Nohria and Gulati, 1997) typically show characteristics such as multi-scale interactions with high contingency and nonlinearity, emergent behaviour, pattern formation and self-organisation.

Clearly, the new socio-economic and socio-technical systems operate with more efficiency, speed and accuracy, but at the same time have increased in complexity and dynamicity. Thus, in an attempt to manage and control these innovative new systems on the one hand, and increase the number of influencing factors on the other, even the most optimistic ICT design initiatives have found the rhetorical moves unwieldy or struggled with the software tools to express and manage matters as they would like. Complex 'nonlinear; situations entail unfamiliar flow and unexpected sequences and are mostly not visible or understandable. These kinds of complex situations cannot be envisaged by designers or managed by operators without extensive modelling and simulation.

2.2 Socio-technical Systems Literature

2.2.1 Socio-technical Systems: Origin and Evolution

The Socio-technical system (STS) is "a term devised to avoid the rather simplistic technological determinism in much mainstream organisation theory. It was coined in the 1960s by Eric Trist and Fred Emery, who were working as consultants at the Tavistock Institute of Human Relations in England - UK, and used in the theory of organisational choice which guided their program of applied research" (Emery and Trist, 1960). Socio-technical systems theory focuses on social aspects, people and society, and technical aspects related to organisational mechanistic, processes and technology, here, the term ‘technical’ does not necessarily refer to material technology (Ropohl, 1999; Leal et al., 2012). The focus is on procedures and related knowledge, ‘Technical’ is a term used to refer to structure and technicalities in a broader sense. Socio-technical refers to the relationship between the social and technical aspects of an organisation or society as a whole (Sommerville, 2004). In organisational development, a socio-technical system is an approach to complex organisational work design that recognises the interaction between people and technology in workplaces. Therefore, any system that contains social elements and technical elements will be considered to be a socio-technical system. We also see the enterprise as a socio-technical system: this definition conforms with the understanding presented by Appelbaum (1997), Mumford (2000), Griffith and Dougherty (2001). Socio-technical theory, as distinct from socio-technical systems, proposes a number of different ways of achieving joint optimisation. These are usually based on designing different kinds of organisation in which the relationship between social and technical elements leads to the emergence of productivity and well-being. Nowadays, socio-technical systems are more complex, with most people not working for or within a single organisation. Usually, they do business collaboratively across organisational, geographical, cultural and temporal boundaries in a world that has become more ‘flat’. The social requirements in virtual spaces are very similar to those in physical spaces, although geographically distributed organisations are complex, with increasing virtual complexity, since the virtual world becomes an extension of the physical world, with a certain degree of adaptability to cope with technological specifications and capabilities. Unfortunately, virtuality and fuzzy identity make social rules less easy to control or measure (Brown et al., 2007). Human systems are always subject to error. On the other hand, there are more and more technological inventions, and the virtual community is expanding very quickly. It is difficult to apply the same policies used to govern physical spaces to universal communities in cyberspace, yet many countries are still working to develop mature cyberspace regulations. The so-called ‘knowledge society’ is much more advanced than previous societies, since it incorporates a wide diversity of many areas: cultural, physical, environmental, national criminal justice systems and international agreements. Knowledge flow, human learning and advancement have all increased rapidly, and physical and virtual spaces are more greatly fused (Zhang and Jacob, 2011). A few years ago, competition was quite different. An organisation or firm that owned knowledge and skills had an advantage over its competitors. Nowadays, competition is greater, and all of the players have the ability to gain knowledge and skills to some extent when assuming the validity of an 'equal opportunity field'. As social networks expand, communication amongst more players is easier, and the learning process is rapidly accelerating in all types of firms, enterprise, medium, small, government, commercial, services, etc. Moreover, human activities have had a clear impact on the environment and natural resources. Since the current business system is shaped as a global network, any change in one of its nodes will cause an impact on others in this network. The interrelationships between business, economy, ecology and human activities are complex, increasing the complexity of the socio-technical systems.

2.2.2 Approaches to Analysing and Designing Socio-technical Systems

In general, socio-technical systems research considers both the social and technical perspectives of organisational work in order to increase understanding and design comprehensiveness and integrity. The social systems perspective looks into social relations, interaction, skills, problem solving and the management of different situations, while the technical perspective aims to improve reliability, efficiency, control, speed and the accuracy of information flow within the socio-technical aspects by integrating and enhancing knowledge sharing and process management.

Baxter and Sommerville (2011) made considerable investigations and classified the literature on socio-technical systems into four areas: 1) Designers of work and the workplace; for example, Mumford (1983) proposed the ETHICS method, which is an approach to combining user needs within the work environment, participation, organisational structure, and job design into an extension of the socio-technical approach. 2) Information systems; such as the work done in large-scale enterprise systems (Taylor, 1982; Avison et al., 2001; Summerville et al., 2012). 3) Computer-supported Cooperative Work (CSCW) such as the approach presented in Clarke et al. (2003) and Fischer and Hermann (2011) which highlights the importance of communication and collaboration in the socio-technical system. Fischer and Hermann (2011) list different types of communication in the socio-technical environment. They also propose five principles of socio-technical meta-design. These principles primarily fall into the social aspect of the socio-technical system, as follows: a) Cultures of participation; b) Empowerment for adaptation and evolution; c) Seeding, evolution growth and reseeding; d) Underdesign; and e) Structure of communication for 'Designing the in-between'. These encourage the adaptation of knowledge management techniques, collaborative design and work and distributed control as well as improving understanding of emergent behaviour. 4) Cognitive systems engineering: approaches belonging to this classification rely on the investigation of the relation between human and organisational issues (Hollnagel and Woods, 2005; Woods and Hollnagel, 2006). 5) Human-computer interaction; for instance, human-centric concepts can be found in Hendrick (2008), who identifies five main viewpoints in human-system interface technology: a) Human-machine interface technology; b) Human-environment interface technology; c) Human-software interface technology; d) Human-job interface technology; e) Human-organisation interface technology. Finally, 6) Ubiquitous computing. Some other works under this category are related to usability in design (e.g., Mayhew, 1999; Krug, 2005; Fox, 1993) and user-centred design (e.g., Norman and Draper, 1986; Gulliksen et al., 2003).

Some of the problems facing current approaches to socio-technical systems analysis and design are confirmed in Baxter and Sommerville (2011). According to this review, these approaches lack detailed investigation and are inconsistent. The problems are as follows: 1) Fieldwork issues; 2) Inconsistent terminology; 3) Levels of abstraction; 4) Lack of agreed success criteria; 5) Conflicting value systems; 6) Analysis without synthesis; 7) Perceived anachronism; and 8) Multidisciplinary. However, the multi-disciplinarity and level of the analyses of socio-technical researches is acknowledged (Sawyer and Tapia, 2007), but possibly necessary difficulty, because different analytical goals may require different levels of analysis and different focus.

A question raised here is how can an organisation be improved by paying equal attention to the understanding and optimisation of its social system and technical system? Assumptions are merging to form strategic planning pillars that influence business development. An example of such a pillar is the EPISTEL framework (Environment, Political, Informatic, Social, Technological, Economic and Legal) for strategic planning (Clapham and Pestel, 1978). Such as socio-technical approach aims to include social and ecological systems in information systems and technology design to bridge the gap in complex and dynamic systems by increasing situational awareness and making sense of the social environment. Modelling socio-technical systems is important from an engineering perspective in order to bridge the gap between the 'social' perspective and the ‘technical’ perspective. Involving and understanding the social aspect is important for building and generating sustainable information systems in order to serve and interact with social actors. Still, little work have been done in aligning social and technical perspectives together (Morris, 2009).

For instance, trust is one of the key areas investigated by socio-technical scientists, who have studied how it affects the entire organisation and how it flows from humans into the design and configuration of technology. Mayer et al. (1995) and Costigan et al. (1998) have all performed pioneering work in this area, providing an integrative model of organisational trust. First, trust facilitates decentralised decision-making, which in turn improves credibility and response time (reactivity) within the overall system. Second, trust facilitates undistorted communication amongst social actors, which improves the accuracy of information throughout the social system. Third, trust allows different organisations and teams to form smooth partnerships and hold effective negotiations: understanding these aspects will positively influence the enterprise design (Yu and Liu, 2001). The VPEC-T framework (Hunt and Bacon, 2009) is a relatively new enterprise analysis framework based on systems thinking, and integrates trust within the enterprise modelling effort.

Practically, the social system drives the need to generate productivity and develop other supportive activities, such as identifying the sympathetic differences between the descriptive levels in a social system, for example distinguishing between macro-level (e.g.: collective or aggregate phenomena), meso-level (e.g.: social interaction among social agents) and micro-level (e.g.: the belief systems of individual social agents). In this case, there is a tendency to look at the social system as a multi-agent system that allows social parameters to be formulated in formal logic and transferred to technical specifications. There are macro-micro relationships between descriptive levels. The macro levels emerge from the micro levels (the lower level incorporating the higher level), and there is a causality relationship between the macro properties and the micro properties. This is a reflection of the concept of emergence in a complex adaptive system. In return, the interchange between macro and micro levels is usually modelled as nonlinear phenomena. The most significant challenge in this domain is to satisfy the social requirements of human-centric technology and create value from computer software for social needs. Therefore, this will influence the design process for underlying information and technology systems while highlighting the need to focus on interactions within and between complex socio-technical systems. Those interactions involve multiple dimensions of human-technical factors, i.e. physical, cognitive and psychosocial dimensions. This collaborative creativity becomes necessary when designing such a complex system. Critiques have been conducted based on the socio-technical literature to classify the focus perspectives of this literature within the development lifecycle (x =partly support, xx = support) as in Table 2:

TABLE 2: SOCIO-TECHNICAL SYSTEMS DESIGN APPROACHES AND THE DEVELOPMENT PHASES OF THE SYSTEMS ENGINEERING PROCESS

Literature/Reference	Theory	Design Focus	Analysis Process	Assessment & Evaluation
Cherns' (1976, 1987) Principles	XX			
ETHICS (Mumford, 1983, 1995)	X	XX	X	X
Ethnographical Workplace analysis (Hughes et al., 1992)		X	X	
Cognitive Work Analysis (Rasmussen et al., 1994; Vicente, 1999)		XX		
Distributed Cognition (DC) (Hutchins, 1995)	X		XX	
Scandinavian approaches (e.g., Bjerknes and Bratteteig, 1995)		X	X	X
Contextual Design (Beyer & Holtzblatt, 1999)	X	XX	X	
Clegg's (2000) Principles	XX			
Socio-technical method for designing work systems (Waterson, et al., 2002)		X	X	
Cognitive systems engineering (Hollnagel & Woods, 2005)	X	XX	X	X
Human-centred design (International Standards Organisation, 2010)	X	X	X	X
STS a Meta design perspective (Fischer and Herrmann, 2011)	X	XX	X	X
STS levels requirements (Whitworth, 2006, 2009)		X	XX	X

Another analysis of the literature was conducted to understand the focus of the approaches proposed by authors, classifying studies based on their social focus, technical focus or general considerations of technical and social aspects as described in Table 3:

TABLE 3: SOCIO-TECHNICAL SYSTEMS LITERATURE CLASSIFICATION

Social Focus Literature	Both approaches Review and Discussion	Technical Focus Literature
Hughes et al.,(1992)	Damasevieius (2007)	Bryl et al. (2009)
SSM: Checkland (1981); Checkland and Scholes (1999)	Baxter and Sommerville (2011)	Greenwood and Sommerville (2011)
CWA: Rasmussen et al., (1994b); Vicente (1999)	Alter (2010)	Sommerville (2004)
EWA: Hughes et al. (1992)	Ropohl (1999)	Lock (2004)
Hunt and Bacon (2009)	Whitworth (2006)	Dwyer (2011)
Mumford (1983; 1995)	Beyer and Holtzblatt (1999)	Waterson et al. (2002)
Lu and Jing (2009)		Benders et al. (2011)

2.2.3 Reflection on the Socio-technical Systems Literature

The literature on socio-technical systems stresses the need for a comprehensive framework using a systematic process to understand, analyse and design socio-technical system artefacts (Morris, 2009). Two important limitations have been identified:

1- The social and technical aspects are rarely examined together in the socio-technical systems literature.
2- The socio-technical systems literature has failed to provide a clear systematic and detailed analysis and design approach especially for IT-Business alignment.

The limitations of the current methods have driven the research into literature outside the domain. Interesting work has been done in enterprise modelling literature that conforms to the theoretical principles of socio-technical systems analysis and design requirements and helps to better human-machine alignment within their environment. Enterprise Modelling (EM) aims to model both human driven activities and information systems (Loucopoulos and Kavakli, 1995). Although most of the EA effort focuses on the hard aspects of organisational and technical activities, the possibility of addressing the social and soft aspects within EM work is highly desired, and several efforts have been made in this direction (Yu, 2009; Baxter and Sommerville, 2011; Jarke et al., 2011). Moreover, a massive number of modelling languages have also been proposed to fulfil the needs of enterprise modelling that consider human and technical systems as well as different types of real life scenarios. Later, I will recommend a set of selective tools to support the thesis argument.

2.3 Enterprise Modelling

As stated in Section 2.2, socio-technical systems methodologies have several limitations, particularly in that socio-technical literature does not address the semantic alignment among social, business and technical artefacts, since there is no reference metamodel that offers semantics among the concepts in the STS literature. The approaches that belong to the software engineering domain have tried to solve the socio-technical issues practically by using systematic approaches. The goal of these approaches is to help engineers and specialists to understand the environment where the designed system will operate. Enterprise Modelling (EM) scholars took this opportunity to extend the approach to cover the whole work environment, where social aspects attracted considerable attention from practitioners.

2.3.1 Enterprise Modelling: Background

Formerly, organisations sought to avoid information overload by managing knowledge sources efficiently. Gathering too much uninformative information will actually reduce the overall value of the data. An organisation needs only the information or knowledge that it intends to collect. Organisations have to sort the information and remove irrelevant information. To remain competitive, organisations must have quality information that will enable them to produce superior products and services. The end product should be “of consistently high quality throughout the product/service’s life, customised to local market needs, open in that they may be integrated with other products/services, environmentally benign, and technically advanced" (Nagel and Dove, 1991, p. 7).

Enterprise Modelling (EM) is an abstraction representation of the enterprise, aim to offer a simple representation of enterprise`s structured and dynamic aspects. In this thesis, the author adopts the EM definition of Bubenko et al. (1998). EM is motivated by the objectives of the organisation. Enterprise modelling supports the management to externalise knowledge and represent enterprise knowledge in abstract models for strategic planning, organisation and process design, IT/IS planning and requirements management for IS development. There are several reasons why organisations may want to build enterprise models, influenced by their internal and external environments. The internal influences include improving customer satisfaction by meeting their requirements, increasing profitability, improving quality, reducing costs and improving productivity. The external influences include business rivalry and competition, government regulations, the economic situation, social implications, technological progress and changes in industry standards. Other reasons include the intention of the organisation to change its organisational structure and resources, to improve information/communication and to help carry out existing processes in a better manner (Fraser, 1994). Enterprise modelling is a conceptual and computational version of the constitution, performance, procedures, information, assets, human resources, behaviour, goals and constraints of an organisation (Fox and Gruninger, 1997).

The key concepts and terms underpinning this exploratory study of Enterprise Modelling are defined below:

- A model is an artefact[2] that can be defined as a constitution that can be used by a system to simulate or predict the actions of something else (Hoyte, 1992).
- An enterprise is defined as a set of mutually dependent actors, who collaborate or work together for a period in order to achieve goals or results that may be related to all stakeholders. The actors utilise tools, their knowledge and other resources in order to transform raw input into processed output that meets customer's requirements (Christensen et al., 1995, p. 2).

Enterprise modelling is a process of comprehension, which involves the construction of models to appreciate a complex social organisation (Rumbaugh, 1993). The next section will discuss the most popular enterprise modelling perspectives.

[2] In enterprise, an artefact is an object, product or any physical piece of information used or produced by the enterprise, part of the enterprise or of its behaviour.

2.3.2 Enterprise Modelling Perspectives

This section provides a brief discussion of the most well-known and widely accepted enterprise modelling perspectives, although the modelling perspectives found in the literature are not limited to those discussed in this thesis. The following perspectives have a strong link to other less popular perspectives, e.g. service and value perspectives are quite relative. At the same time, these perspectives have a stronger socio-technical sense, potentially better descriptive of socio-technical issues.

2.3.2.1 Goal Oriented Modelling

A goal is defined as an anticipatory internal representation of a state of the world that has the potential for and the function of (eventually) constraining/governing the behaviour of an agent towards its realisation. It is also described as defining function to shape and to direct in a teleological sense the actual behaviour of the system (Castelfranchi and Paglieri, 2007). Goal-oriented actions are actions directed towards the realisation of some specific state of the world. Goal modelling techniques for enterprise and information system modelling have been proposed in several frameworks starting from the early 1990s: these frameworks have different semantics, concepts and notations. The purpose behind adapting goal-oriented modelling aims to provide a top-down analysis to capture requirements from the systems environment in a goal-oriented manner in order to develop a valid information system. GOM is an element that may also be used more widely in business analysis and enterprise modelling. Related elements include scenarios, stakeholder analysis and context analysis, among others.

The ***i**** framework (Yu et al., 2011), KAOS (Dardenne et al., 1993), EKD (Bubenko et al., 1993) and the business motivation model (BMM) are the most used goal-oriented frameworks among researchers and business analysts. BMM focuses on organisational goals mapped to strategy and organisational visions; the ***i**** framework focuses on actors' intentional aspects and stakeholders' goals for early requirements engineering, and was initiated by John Mylopoulos and Eric Yu at Toronto University (Yu and Mylopoulos, 1998).

One of the early and important GOM techniques called Knowledge Acquisition in automated Specification or 'KAOS' (Dardenne et al., 1993), is an IS requirement capturing approach. Its specific goal modelling method allows requirements to be managed, planned and classified starting from goal diagrams. KAOS is also considered as a methodology for requirements engineering, enabling analysts to build requirements models and derive requirements documents from KAOS models, and was developed by cooperation between the University of Oregon and the University of Louvain (Belgium) in 1990. Other goal-oriented modelling techniques have been proposed, such as GBRAM by Anton (1996) and the ESPIRIT CREWS approach by Rolland et al. (1998).

Several researchers (Kavakli and Loucopoulos, 2004; Lapouchnian, 2005; Matulevicius et al., 2006; Matulevicius et al., 2007) present comprehensive critiques of goal oriented requirements engineering (GORE) methods and tools such as KAOS, EKD, and the ***i**** framework. Table 4 offers a list of the most important goal-oriented methods including newly proposed methods such as goal relations description in Techne (Borgida et al., 2009; Jureta et al., 2010) and goal statements and alignment in BMM; and the goal model/metamodel in EKD (Loucopoulos et al., 1997). Rolland et al. (1998) discussed more details related to goal classification and the goals correlation matrix to analyse the conflicts or supportiveness among goals. In addition, some of these methods have execution level or methodological mapping to the underlying technical models/framework.

TABLE 4: GOAL-ORIENTED MODELLING APPROACHES

The Method	Legends	Technical Methodology
KAOS (Lamsweerde et al., 1991)	**Goal -** in hierarchal form **Agent -** active system component **Object -** inactive system component **Operation -** an action an agent takes to achieve a goal **Requirement -** a goal for which an automated component is responsible **Expectation -** a goal for which a human is responsible	KAOS methodology is based on four models; the object model is very close to the development UML object model. KAOS is only a requirements methodology.
EKD (Bubenko, Rolland, Loucopoulos, 1994)	**Goal -** have an issue and actor **Inter-goal Links -** And, or, support, conflict	Requirements management and analysis framework with no specific platform or technical specifications, EKD uses type of data and component/object models to help to identify a mature implementation model
i* framework (Yu and Mylopoulos, 1998).	**Goal**, **Softgoal** **Actor** - Agent, Role, Position **Dependences**: Goal dependence, task dependence, resource dependence, softgoal dependence	***i**** is based on two models for RE and one methodology for implementation. The Tropos methodology bridges the gap between early RE and agent implementation, which is considered to be an implementation methodology.
BMM (Business Rule Group, 2006)	**End -** Vision, organisational goal and objectives **Means -** mission, strategy, tactics, policies, rules **Assessment**, **influence**, **Organisational unit** **Impact value**	BMM implementation as a UML profile for BMM, later to be mapped/integrated to other GOM models in business and technical levels, using model transformation in MDE

TABLE 4: GOAL-ORIENTED MODELLING APPROACHES (CONTINUE)

The Method	Legends	Technical Methodology
Techne (Borgida and Jureta, 2009)	Inference node, Conflict node, Preference node, Optionality node, Domain assumption node, Task node, Goal node, Quality constraint node, Softgoal node	Logical formulation and algorithmic representation only
GSN	**Goal** **Solution** **Strategy** **Context** **Undeveloped Goal (to be developed further).**	A goal-structuring notation (GSN) was developed with which it is possible to express safety requirements as goals. The notation is also rich enough to capture assumptions, justifications, proof in the general sense, and rationale, for presentation to stakeholders so that it can be a bridge between developers and stakeholders
GBRAM (Anton, 1996)	**Goal** **Requirement** **Operationalisation** **Achievement goal** **Maintenance goal** **Agent** **Constraint** **Scenarios** **Goal obstacles**	Modelling notations and scenarios, no real consideration of the technical aspects and not seeming to be implementation driven.

2.3.2.2 Agent-Oriented Modelling

Firstly, we need to distinguish between different perspectives of agent modelling. Usually, the term agent based modelling/simulation is introduced to these types of system, which provide behavioural computational modelling for simulation purposes. This modelling is useful for the large scale simulation of human, organisational, animal or any kind of individual or group that is independent and autonomous: the goal is to assess and understand the effect that the individual agent could have through relations and communications with other agents. This falls into the Artificial Intelligence (AI) research area: methods and techniques from multi-agent systems, genetic and evolutionary algorithms, the swarm approach, game theory, complex systems, emergence, computational sociology and Monte Carlo methods are used in such an approach.

Another related concept is the multi-agent system (MAS), defined as a system composed of multiple interacting intelligent agents. Multi-agent systems can be used to solve problems which are difficult or impossible for an individual agent or monolithic system to solve. Examples of problems that are appropriate for multi-agent systems research include online trading, disaster response and modelling social structures. An Agent is defined as an autonomous software object capable of contributing to the accomplishment of a task by 1)

Accessing domain knowledge, 2) Reasoning about its task. 3) Composing meaningful messages and sending them to another agent or human. 4) Understanding and interpreting these messages. 5) Making decisions based on domain knowledge and collected information, and 6) Acting upon decisions in a meaningful manner (Ferber, 1999).

Methods of agent-oriented analysis and design that have been proposed in the software and requirement engineering field are based on a collection of models and a set of guidelines associated with these models. Some of these methods take their inspiration from object-oriented development for developing agent-oriented software engineering, and others adapt knowledge engineering or similar techniques. The AAII methodology is a technique focusing on identifying the roles in the application domain and assigning responsibilities to these roles, then determining a plan to achieve the role goal, including determining the belief structure of the system. Another methodology is called the Gaia methodology. This methodology is both general, in that it is applicable to a wide range of multi-agent systems, and comprehensive, in that it deals with both the macro-level (societal) and the micro-level (agent) aspects of systems. Gaia systematically adapts approaches starting from statements of requirements to produce a design that is sufficiently detailed that it can be implemented directly (Wooldridge, 2009).

Goals and rationales for the behaviours of agents (Yu et al., 1995; Lamsweerde et al., 1995) of primary importance during requirements engineering are rarely explicitly modelled in object-oriented languages. As presented in the ***i**** framework Tropos approach, Tropos is a software development methodology initiated by the ***i**** consortium, where concepts of the agent paradigm are used alongside the whole software development process. Notions of agent, goal, task and (social) dependency are used to model and analyse early and late software requirements, architectural and detailed design, and possibly to implement the final system. Moreover, certain aspects of real-world agents like non-deterministic behaviour (often characteristic of human agents) are often hard, if not impossible, to express in these languages.

2.3.2.3 Role-Oriented Modelling

Ontology has several types and classification (Steimann, 2000a); role type uniqueness relies on two essential properties of types: existence and semantic rigidity (Guarino et al., 1994). According to this theory, a type is found if one entity belongs to (the extension of) the type: it must stand in some relationship (other than aggregation) to another entity. Based on these characteristics, we can describe the role type as being defined as a found and not semantically rigid type. Equally, a natural type is defined as semantically rigid, but not founded. A reader is a role type; a book is a natural type (Guarino et al., 1994). Therefore, we can define a role as a collection of duties and rights assigned to the role, where the agent/actor who plays that role will inherit those rights and duties during the relation period. Role has been proposed in nearly every modelling framework to answer the "Who"-related questions. In general, any participant in any kind of social related system needs to have a role, which is usually associated with goal and objectives. Most of the literature in business and information systems focuses on the goal that the role is required to achieve, not on the goal that the actor's behaviour shapes: literature from organisational psychology provides more insight into the second part. Organisational structure is completely reliant on roles and responsibilities as key concepts: the role is part of an organisation or organisational unit that aims to fulfil certain tasks and responsibilities, these including collaborating with internal or external roles, and responsibility on the part of the organisational resources. Roles are represented initially in organisational charts, which look like trees of hierarchy describing people in their roles, functional classification and seniority. However, organisational charts are too simple to describe the real complex activities and interaction in the workplace, as Hay (2003, p. 30) said: "Organisational charts are rarely adequate to describe the complexities of human interactions in an enterprise". Organisational charts can tell us more about the formal structure, required behaviour, communication and responsibilities in the form of tasks governed by rules and policies. But, they say nothing about the informal relations and activities that could be shaped by actor behaviour. Social network analysis (SNA) could say more about the runtime activities of social structures (Sharma and Urs, 2008; Egger et al., 2009).

Many other modelling techniques describe the role in the information systems domain, and these techniques describe the abstract level; some other focus on the execution level. Role is presented in EKD in two places 1) actor role model: allocates actors based on their competences, qualifications and skills to suitable roles 2) role activity model: mapping the roles to activities and the way to fulfil them. However, EKD provides a full metamodel for both models and for the enterprise as a whole (Loucopoulos et al., 1998b; Nurcan and Rolland, 1999). In addition, we can find role in ***i**** framework models for early requirements engineering used to describe the enterprise at its higher level represented by social interactions and dependencies among roles. Roles can be modelled efficiently by building models representing the actors and their roles and the dependences/relations among them (Giorgini et al., 2005; Kolp and Mylopoulos, 2001). The concept of role in multi-agent modelling methodologies is crucial, as the agent totally depends on his role in performing tasks; called role-based modelling in multi-agent systems, in the field of artificial intelligence, the agent is autonomous, independent, has relations (with other agents or components), the goal-oriented modelling techniques contain a role (duties and rights) to be fulfilled towards achieving the goal (Yan et al., 2003; Becht et al., 1999; Cabri et al., 2003).

In UML, the role concept presented in the use case model can basically be labelled in the actor notation, while some other initiatives (Riehle and Gross, 1998; Reenskaug et al., 1996) have used UML object notation extension to describe roles, role interaction and specification: these initiatives provide better insight into the semantic relationship among the components in the roles' interactions. In general, UML mainly describes activities and roles related directly to the software system; many other researchers have used UML to describe business activities (Steimann, 2000a; Steimann, 2000b). In BPMN, the swimlane can be used to describe the role, or the pool to describe the actor as a higher-level type of role. The BPMN can efficiently answer who does the activity and where (OMG, 2011). Another notation called the object-role model (ORM) also helps in defining the roles at conceptual level of data and rule modelling as a part of the fact-oriented model. An implemented specification for Role Based Access Control (RBAC) is proposed in the wider technical literature. This is considered an important technique to enforce security policies and control access to technical components. RBAC helps to abstract privacy policies and associate them with roles, and actors will be assigned to these roles (the actor may have one or more roles at the same time). Edwards (1996) has three requirements for building successful access control policy systems: 1) Expressiveness to capture a wide spectrum of policy considerations, 2) Flexibility to handle collaboration, 3) Integration with information from and about the 'real-world' context.

2.3.2.4 Rule-Oriented Modelling

Rule-based modelling started in the 1970s with IBM DB2 (Codd, 1972), which was the basis of relational modelling (database relational modelling) introduced by Codd in 1989. The relational model is also considered as the popular starting point of the conceptual modelling methods. Others argue that rule modelling started earlier within the Artificial Intelligence (AI) domain, but this was related to instructional rules in logic programming more than description of business and domain rules. Literature from the early 1990s described different methods to implement and manage the rules. Integration between a relational approach and decision tables was proposed by Vanthienen and Wets (1995): this integration allowed a relational approach to construct, fill and validate the data in the integrated decision table. Two techniques to store production rules were presented; these techniques later became the basis of rules engines. The first proposal of the PROLOGA system was introduced as a tool to support construction decision tables in an efficient way. Vanthienen et al. (1998) presented inter-tabular anomalies, solving a problem of checking anomalies in chains of rules and checking for circularity. In addition, a proposed enhancement has been made to the

PROLOGA tool. Still, this technique contains several limitations, especially when the tables become larger in terms of visibility and system performance. Knowledge sensing is still difficult for business people to handle among the massive numbers of rows and columns, and checking for missed rules is still not considered as there is no clear link or integration with different business aspects at the enterprise level.

The methods have kept progressing: many methods and techniques focusing on business rules have been proposed, with KPI Company's book *Business Rules Revolution* being released in 2006. The evolution has continued to progress, mainly in the complex rules design area. In 2009, the Decision Model (Halle and Goldberg, 2009) was produced, as shifting the focus from managing business rules to a complex decision model based on business logic aims to provide better agility, manageability, reusability and traceability of the applied rules.

Business rules describe the operations, definitions and constraints that apply to an organisation in achieving its goals and empowering business users. Because of new regulations, competitive threats, and different economic conditions, a business must react fast for all variables. Since traditional IT implementation added delays in time-to-market, we need to manage business rules in a new, different way. Managing rules has taken different phases and shapes. Documenting business rules as a part of requirements took place in Wan Kadir and Loucopoulos (2004) and Fayoumi and Yang (2012), while Rosca et al. (2002) proposed a methodology to handle the whole rule lifecycle. Many other authors have focused on integration between business processes and business rules as a directive to control the process in the organisation (Zoet et al., 2011; Muehlen et al., 2007; Goedertier et al., 2008), and rules models and metamodels aiming to map rules to IS components in business rules-driven object oriented design have been proposed (Kardasis and Loucopoulos, 2004; Loucopoulos and Wan Kadir, 2009; Loucopoulos and Kavakli, 1997) as a schema for business rules integration assessment and implementation. A wide spectrum of rule classifications and categories have been proposed by different researchers (Kardasis and Loucopoulos, 2005; Goedertier et al., 2007; Solomakhin, 2011; Linehan, 2007; Fayoumi and Yang, 2012).

Rules engines development took place after the revolution in business rules techniques and methodologies. The rules engine is a software based system that aims to execute the rules in a runtime production environment. There are many types of rules engine, the most popular being the forward chaining engine, which has two ways to processing the rules:

- Production/inference rules, mostly represented in the form of IF condition THEN action.

- Reaction/event based action, a reactive rules engine reacts to an event or change, needs to be triggered by a different system or event to react automatically.

The second type is the backward chaining, more goal driven rule engine based on fact types to match with a particular goal. Finally, the third type is called a deterministic engine or mixed approach engine: this engine uses both backward and forward chaining and is used to utilise Domain Specific Language (DSL) approaches. This approach is considered more efficient and easier to maintain, implement and manage with high performance capability. Nowadays, rules engines are a part of what is called a Business Rules Management System (BRMS) The BRMS is software that aims to focus on the whole rule cycle, through defining, modelling, deploying and execution. Some BRMSs provide facilities to monitor and maintain the business rules, and are composed of 1) A rules repository to store business rules and logic, 2) A tool, mostly visual, to allow users (technical and business) to define and modify rules and decision logic, 3) A rules engine to execute the rules in the runtime environment. BRMS standards also vary: many have been proposed and they have different quality perspectives. Some of the well-known standards are RuleML, RIF, SBVR, PRR, JSR-94, SWRL and R2ML (Muehlen et al., 2007).

As a result of this, the development of rules has been intertwined between business and IT: some are more business-oriented and some are more technically oriented. Rule-oriented modelling has been presented to offer a structured method to simplify complexity: this rule-oriented modelling has been successful in the business and IT domains.

2.3.2.5 Process-Oriented Modelling

Process oriented modelling has been around for a while; the first formal process-modelling notation was the workflow diagram, which has been used for business and IT purposes. Recently, business process modelling has been noticed in both the business and IT domains as a formal perspective for modelling the enterprise. A business process is defined as a set of defined activities that a business unit performs in response to an event. Within the business process, there is a logical set-of-work performed at a particular point in time. Business process modelling (BPM) is the activity of representing the processes of an enterprise, so that the current (‘as is’) process may be analysed and improved into a future (‘to be’) process. BPM denotes complex relations between artefacts, Who (roles) are doing What (business objects), When (coordination of activities), Why (business logic and rules), How (business activities) and with Which Results (performance indicators). BPM is typically performed by business analysts and managers who are seeking to improve process efficiency and gain greater insight into and quality of business activities. BPM mostly deals with the analysis, design, implantation, execution and optimisation of end-to-end business processes (Bosilj-

Vuksic et al., 2007). Business process management coordinates task flows, resource access and information sharing. Business process modelling can be conducted by using one of a huge number of modelling notations, methods and tools. Enterprise information systems are initially used to support business processes in several ways from modelling to execution and monitoring (Mayer et al., 1995; Huckvale and Ould, 1995).

Business process modelling is a highly recommended approach and integrated into many enterprise frameworks (List and Korherr, 2006); companies today are becoming ever more focused on their business processes, i.e. the set of related activities that create value for the customer. The process view allows organisations to see their business as a chain of activities that has a specific goal and specific inputs and outputs, rather than the functional vertical view of the organisational divisions, which has been shown to require huge administration to handle issues crossing departments; thus, resources are allocated to tasks that do not create value for the customer. Business processes, on the other hand, cross departmental borders and facilitate the company focusing on activities that really fulfil the goal - creating customer value. Also, a focus on business processes puts the customer in the centre, and when customers demand novel products or services, a company can more easily and quickly discover and meet their requirements by adjusting its business processes accordingly. Business processes can be automated easily now. Service-oriented architecture (SOA) and model-driven architecture (MDA) are two important technical and software paradigms where business process modelling plays a central role in aligning business and technology, execution and monitoring. This helps the enterprise to develop an efficient and agile way of doing their business and IT (Muehlen et al., 2007; Muehlen and Recker, 2008).

2.3.2.6 Value-Oriented Modelling

Value-oriented modelling is a perspective focused on value generation, exchange and delivery among actors: the actors could be organisations, IT systems or individuals. Value-oriented modelling emerged from the value based management approach, defined as a method that ensures that corporations are run consistently on value, based on three important elements: 1) Creating value, 2) Managing for value, and 3) Measuring value. The value network is a business analysis perspective that describes social and technical resources within and among businesses (internally and externally). Value networks are considered to be complex and nonlinear with multiple dependences and relations between nodes, and contain heterogeneity, inseparability, perishability and tangible and intangible exchanges as a result of delivering value in the network. There are differences between the two primary types of value: tangible value exchanges involving exchanges of goods, services or revenue, and intangible value exchanges, which include two primary subcategories: knowledge and benefits. Waddell and Khagram (2007) describe network complexity in four dimensions:

- Temporal complexity: referring to the time lags (and variety of length) between taking action and seeing impact;
- Dynamic: referring to the interplay between large numbers of factors/actors/actions with respect to any issue of interest;
- Cultural: referring to ethnic/linguistic/sectoral (business-government-civil society) differences;
- Geographical: referring to local-regional-global interplays.

One of the most important value modelling techniques is the e3value. The e3value methodology models a network of enterprises creating, distributing and consuming things of economic value. Its main focus is on identifying and analysing how value is created, exchanged and consumed within a multi-actor network, hence, taking the economic value perspective and visualising what is exchanged (which kind of economic value) by whom (Waddell and Khagram, 2007). This is particularly useful for validating new business models for networked enterprises.

Nevertheless, e3value has some limitations, mainly in focusing on the business model (in the e-business sense of the word), while leaving out many other concerns, e.g. market analysis. It usually describes the "how" of the business model, but not the "why" (strategic rationale). In general, e3value seems to be particularly suitable for analysing business setups. When companies grow, concerns like competitiveness need more attention. To overcome its limitation, it can be extended or integrated with other modelling frameworks that allow analysts to obtain a more comprehensive view.

2.3.3 Reflection on Enterprise Modelling Literature

Looking back at the enterprise modelling section, I comprehend that each perspective of modelling covers different types of artefact and offers a different quality view of the system. For instance, agent-oriented modelling approaches focus on agent attributes and relations but do not say enough about goal aspects. Goal-oriented modelling provides a quality understanding of the goal and goal composition but not about the processes needed to fulfil these goals. And so on: rule, role and value-oriented modelling cannot say everything about how enterprise operate and generate services; neither can anyone perspective offer all artefact qualities that are required to model the enterprise as a whole, as discussed in Table 5.

TABLE 5: LIMITATIONS OF ENTERPRISE MODELLING PERSPECTIVES

	Goal Perspectives	Agent Perspectives	Role Perspectives	Rule Perspectives	Process Perspectives	Value Perspectives
Networks		xx	x			
Directives				xx	x	
Value	x			x		xx
Responsibility		x	xx		xx	
Operation			x	x	xx	x
Motivation	xx	x				x

This part of the review concludes with understanding that one single viewpoint or perspective on enterprise modelling is not enough; it is important to consider several points of view to end up with a mature and highly robust enterprise architecture. Many other fields related to enterprise modelling have emerged with different quality focuses (requirements, design, architecture, interoperability and integration) and have contributed to enterprise modelling on both the methodological and technical sides. Most importantly, enterprise architecture frameworks have emerged to handle multi-perspective modelling approaches. Still, there is a need to show explicitly how we can tackle the principles to understand complex and dynamic socio-technical contexts using open standard tools. In the next section we will discuss the most important frameworks for enterprise modelling, and discuss the gaps that will be considered in this research for an improvement to satisfy the socio-technical dynamic aspects.

2.4 Enterprise Architecture Frameworks

The study of the EM domain, perspectives and tools helped to conceptualise understanding how the EAFs can offer a more comprehensive enterprise view from different perspectives with a systematic approach to implementing the EM effort. The scope of this section is to provide a comparison of various architecture frameworks and point out the limitations in these frameworks, which will act as a basis for the research focus.

2.4.1 Enterprise Architecture: Background

An enterprise model enables an organisation to identify its basic elements and their breakdown besides specifying the information requirements of these elements. It provides the information needed to define the requirements for integrated information systems and improves the effectiveness and efficiency of the enterprise (ANSI/NEMA, 1994). Architecture is defined as “the grand design or overall concept employed in creating a system, as in the architecture of a city or a customer information system”. It is "an abstraction or design of a system, its structure, components and how they interrelate" (Gartner Group, 2002). Enterprise Architecture is the examination and documentation of the enterprise in its current and future states from an integrated (strategy, business and technology) perspective

(Bernard, 2005). The complexity of systems, the improper alignment of business processes and increasingly expensive Information Technology systems were problems that faced organisations during the 1980s. Very little value was derived from these procedures, and organisations were finding it difficult to manage the complexity of their systems. Organisations aspiring to overcome this challenge “require a disciplined approach to the management of these systems” (Zachman, 1987): this understanding of the challenges helped the emergence of the Enterprise Architecture (EA) discipline. There is an increasing interest in enterprise architecture, a field that not only covers information systems but also encompasses all enterprises (business, operation and IT) for both public and private organisations.

Enterprise architecture is a relatively new field, which had its beginnings a little over twenty years ago. It is still an emergent field of research and therefore there are several definitions produced by a number of research bodies and professionals. Enterprise architecture is primarily an exercise in modelling on a grand scale. The aims of enterprise architecture are: modelling an organisation’s structure, processes and operations; describing the management and changes in the procedures of an organisation; explaining the existing view of the organisation and the ideal view of the organisation; and clarifying how the organisation moves from where it is now to where it wants to be (Nicholls, 2009).

Since enterprise modelling helps organisations to identify and implement appropriate business strategies, in order to identify and implement process improvements, and to plan information technology and information systems, enterprise architecture models present the detailed relationships between business and technology to expose their complexity (Bailey, 2006). Enterprise architecture closes the gap between the strategic, organisational and software engineering disciplines (Bailey, 2006). It also enables the integration of business strategies with technology by developing an information infrastructure that supports the communication of information and knowledge (Fox and Gruninger, 1998). The objectives of enterprise architectures are:

- Defining the strategic context
- Integrating strategy and business process by enabling and leveraging Information Technology
- Creating, updating and managing the evolution of the architecture domains in line with business strategy
- Enabling transparency and interoperability across the enterprise
- Enable communication between the business and IT communities
- Planning and setting targets and securing compliance

- Modelling potential synergies
- Standardising business processes for delivering goods and services to customers
- Supporting scalability and adaptability
- Enabling flexibility to change
- Facilitating completeness and quality assurance
- Facilitating efficient and reliable monitoring (Adapted from Günzel and Rohloff, 2003, p. 424 and Rohloff, 2005)

2.4.2 Enterprise Architecture Frameworks

Enterprise architecture is in itself a tool, technique or methodology that can also be called an approach which uses other tools, methods and techniques. Different tools are widely used for enterprise architecture by vendors and enterprises. These tools vary in their capability, adaptability and scalability (Gartner Group, 2009).

In the last two decades, many enterprise architectural methodologies have arrived on the scene: some of these methodologies are well adopted and widely used, some others kept in the theoretical or academic frame. Four methodologies have had a recognisable academic and industrial impact, the Zachman Framework, the Open Group Architectural Framework (TOGAF), the Federal Enterprise Architecture (FEA) and the Gartner Methodology: these four methodologies are well known and widely used by many practitioners in the field (Sessions, 2007). Other new methodologies such as Archimate, ARIS and MoDAF have also attracted considerable attention while still evolving and being examined by practitioners.

The development of enterprise architecture (EA) using the above-mentioned methodologies is called a framework or an approach, where the implementation could rely on one or a heterogeneous framework. The framework serves as a way to document the enterprise in various levels of detail. Enterprise Architecture Frameworks (EAFs) are becoming significant as they guide the direction of business challenges. The reason for their growth in the last 10 years is the availability of global information networks with increasing complexity in distributed business environments. In Figure 3 a description of EA, where the transformation from as-is to to-be architecture done by using proper methodology or roadmap.

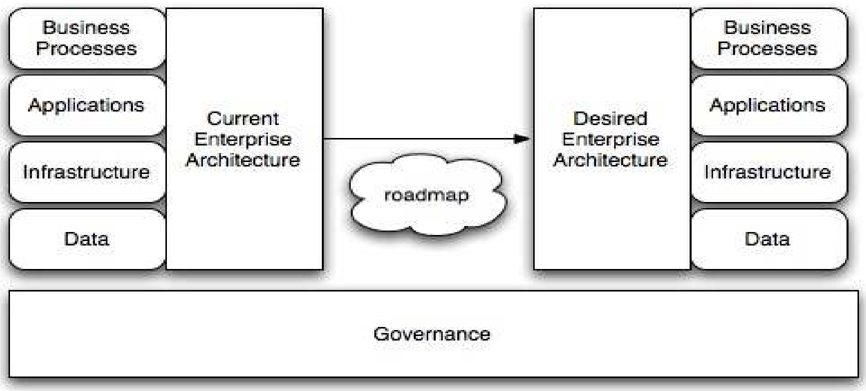


FIGURE 3: ENTERPRISE ARCHITECTURE OVERVIEW (Nicholls (ED), 2009)

2.4.2.1 The Zachman Framework

The Zachman Framework was initially proposed in 1987 by John A. Zachman, an IBM researcher. It is a very popular framework which conceptualises how various architectures created/used in an organisation can be integrated into a comprehensive model. The term ‘architecture’ was taken from the building/construction sector.

Zachman (1987) states that in order to address key issues related to information architecture and its complexity “it is necessary to use some logical construct (or architecture) for defining and controlling the interfaces and the integration of all of the components of the system” (Zachman, 1987). He sums it up by declaring that the key to complexity and change is architecture (Zachman, 2003).

The Zachman Framework is a two-dimensional classification structure for descriptive representation of an enterprise (Zachman, 2003). The vertical dimension or columns describe the perspectives of those who are involved in the cycle. The horizontal dimension or rows are the levels of abstraction involved in the system’s development. The top row symbolises the generic perspective of an organisation. The lower rows are tangible and successively more substantial. The bottom row represents a description of the actual business data, application code, networks, schedule and strategy of the organisation. In short, the rows describe the participant’s perspectives and the columns provide a focus on each dimension while keeping the others constant (Hay and David, 1997).

All of the cells in a column are inter-related and describe the architecture, model, representation or descriptions that are recorded for evidence by an organisation. The cells in the framework can be described independently or ‘normalised’ (Zachman, 1987). All participants are involved in the planning, conception, building, using and maintaining activities of an organisation's systems (Inmon et al., 1997). The vertical columns make up the models of the What, How, Where, Who, When and Why.

2.4.2.2 The Open Group Architectural Framework (TOGAF)

The TOGAF framework was first made available to the general public in 1995 by The Open Group consortium. TOGAF defines a hierarchy by dividing the enterprise architecture into four categories:

I. Business architecture, which gives an account of the processes in a business and its central requirements
II. Data architecture, which gives an account of the structure of information and how data can be organised and accessed
III. Applications architecture, which gives an account of the consistency of data management, how applications are designed and how they are connected
IV. Technology architecture, which gives an account of the hardware and software infrastructure and the reliability of the structure of information systems technology (The Open Group; Sessions, 2011)

TOGAF adopted the Architecture Development Method (ADM) cycle as its implementation methodology. TOGAF 9.1 is the latest version of the TOGAF framework, which includes considerable improvement in developing the semantic metamodel, also it is more business architecture driven to fit with new architectural paradigms such as service-oriented architecture (SOA). TOGAF has showed successful adaptation in industrial sectors.

2.4.2.3 The EA3 Cube

The EA3 Cube was developed in 2004 by Scott Bernard. The framework is built around a cube and implies that "hierarchies are needed to avoid sub-architectures" (Bernard 2004, pp. 104–105). The EA3 cube assists the organisation in defining the scope of their EA documentation process and organising documentation data (Bernard, 2004). It is based on hierarchical levels that relate the different functional areas of the organisation logically to each other by positioning high-level strategic initiatives at the top, general business processes and information flows in the middle, and supporting systems, services and the technological infrastructure at the bottom. The EA3 Cube includes three dimensions that relate to the different functional areas of the organisation (Bernard, 2004). The EA3 is three-dimensional and comprises hierarchical levels, segments and artefacts.

- The hierarchical levels are comprised of goals and initiatives, products and services, data and information, systems and application, and networks and infrastructure.

- The artefacts are the Lines of Business (to produce product or service) which include horizontal components.
- The segments are composed of vertical components and include business activities and allocated resources.
- There are also several common threads that cut across the hierarchal levels, such as Security, Standards and Workforce.

2.4.2.4 Archimate

Archimate is an Enterprise Architecture modelling language, which was initially developed in the Netherlands by the Telematica instituut in 2002. It is now an Open Group Standard. It symbolises end-to-end enterprise architecture in terms of business processes, applications, infrastructure and technology. It provides a coherent framework for designing multiple architecture domains. Archimate also provides IT designers with a potential modelling standard for representing, visualising, communicating and analysing enterprise architecture (The Open Group, 2011).

Archimate notations is not a software development meta language like UML. It is also not a detailed enterprise architecture framework like Zachman or TOGAF, an all-embracing architecture methodology or a framework. It gives a high level of flexibility in design business, applications and technology using simplified structure that fits the rapidly changing business environment. Overall, it plays a limited role by enabling visualisation and solving analytical problems associated with widely accepted architecture frameworks.

2.4.2.5 The Federal Enterprise Architecture Framework (FEAF)

The Federal Enterprise Architecture Framework (FEAF) was created by the US Congress in 1995 and is therefore a government model. The Federal Enterprise Architecture Framework is organised in sets of hierarchies, and the framework is open and very detailed. The main objective of the US government in creating FEAF was to bring together all agencies, departments and functions under one umbrella of enterprise architecture.

The significance of FEAF is to promote Federal interoperability, resource sharing, reducing costs, develop better ability to share information, support IT and related infrastructure, planning investment, etc. The framework is hierarchical and consists of Architecture Drivers (business and design), Strategic Direction (vision, principles, and goals and objectives), Current Architecture (current business and design architectures), Target Architecture (future business and design architectures), Transitional Processes (planning investment, migration, configuration management, and engineering change control), and Architectural Segments (common administrative systems) (FEAF, 1999).

2.4.2.6 Department of Defence Architecture Framework (DODAF)

DoDAF or the Department of Defense Architecture Framework prescribes architectures for war fighting operations, business operations and processes (DoDAF, 2004). The DoDAF framework is used by the American Department of Defense to document IT systems and war fighting capabilities. It consists of three views.

1) Operational View or perspective includes operational elements of the organisation such as the tasks, processes, information needs, user functions, and information exchanges required to accomplish a mission.
2) Systems View includes the functions of systems, interfaces and connections.
3) Technical View includes the standards and technologies used to promote efficiency and interoperability, interaction, interdependency, and forecasting future requirements

The DODAF views were extended in a new version, DODAF 2.0; the terminology has changed from views to viewpoints, and the viewpoints include the following: 1) All viewpoint, 2) Capability viewpoint, 3) Data and information viewpoint, 4) Operational viewpoint, 5) Project viewpoint, 6) Services viewpoint, 7) Standards viewpoint, and 8) Systems viewpoint.

2.4.2.7 The Gartner EA Process Model

The Gartner Model is the enterprise-architecture ‘practice’ of Gartner, a renowned IT research and consulting organisation (Sessions, 2007).

Sessions (2007) sums up the Gartner practice with the phrase: “Architecture is a verb, not a noun” (Sessions, 2007). This refers to the continuous process of creating, maintaining, and influencing enterprise which makes an organisation very energetic. The Gartner framework consists of three components: business owner, information specialists and technology implementers (Sessions, 2007).

2.4.2.8 Architecture for Information Systems (ARIS)

Architecture for Information Systems (ARIS) is a European enterprise architecture framework which is practical and process-centric. Prof. Scheer established the ARIS framework in 1992 (IDS Scheer, 2006). It is similar to TOGAF, as the requirements are a vital part of each domain of the model and at the core are the processes and services, which support and integrate everything.

ARIS differs from other frameworks by not wanting to be identified as IT-centric. The ARIS concept can be identified as one that develops, optimises and describes integrated information systems. It is a framework that focuses on business process analysis and modelling which is evident from the Balanced Scorecard add-on (IDS Scheer, 2006). It is based on a view concept and consists of five views – Function, Organisation, Data, Control (or Process) and Output. It has similar objectives to Zachman (IDS Scheer, 2006).

2.4.2.9 The GERAM Framework

The IFAC/IFIP Task Force developed GERAM (Generalized Enterprise Reference Architecture and Methodology) with the objective of contributing to a single, universally accepted enterprise architecture framework. GERAM is a 'matrix' model, which was built by merging all of the unique characteristics of CIMOSA (see next section).

The new versions of GERAM encompass all of the information required for all types of enterprise engineering/enterprise integration processes. It is based on the life cycle concept and recognises three dimensions or views for describing the scope and content of enterprise modelling. The three dimensions are the Life Cycle dimension, the Genericity dimension and the View dimension.

2.4.2.10 CIMOSA Framework

The Computer Integrated Manufacturing Open System Architecture (CIMOSA) was first introduced in the late 1980s under the framework of the ESPRIT and AMICE Consortium. It is considered to be an all-inclusive open system architecture. It was later modified or adapted as a basis for many other enterprise modelling approaches. It has three dimensions: genericity, model and view (Kosanke, 1995).

The elements in the three dimensions are made up of various levels: instantiation with three levels (generic, partial and particular); modelling with three levels (requirements, design and implementation) and view with four integrated aspects (function, information, resource and organisation). CIMOSA is a process model and comprises views or perspectives which include information, organisation, function and resources (Kosanke, 1995).

2.4.2.11 Enterprise Business Motivation Model (EBMM)

The Enterprise Business Motivation Model was developed in 2009 by Nick Malik, an enterprise architect from Microsoft. This framework captures the central components of business motivation, strategy, functions and operation. The fundamental basis of the EBMM models is the notion of motivation.

The EBMM consists of a variety of elements such as business, business unit, business process, directive, assessment, business model, business capability, data object, influencer, driver, initiative and application (Malik, 2011).

2.4.2.12 Business Motivation Model (BMM)

The Business Motivation Model (BMM) is a Rule Group standard that was adopted later by OMG to become an OMG specification. The BMM requirement aims at supporting enterprise business design and decisions. It contains a set of built-in concepts that define the elements of business plans. They are associated in a structure that is methodology-neutral: it will support a range of approaches for creating and maintaining a Business Motivation Model for an enterprise, and is particularly strong in support of processes that are driven by business change (OMG, 2010a).

BMM is a high-level meta-model for enterprise motivation and governance. It supports change management through elements such as assessments, influencers, ends and means. It enables the management of risk and uses motivation to reward employees based on performance. A cornerstone of any work addressing motivation has to be the enterprise's aspirations, what is called 'vision'. The business model goes beyond an abstract 'vision' statement. It is a specific set of elements in a specific configuration. The action plans for how to realise the vision, called 'mission'. Refinements of the ends and means are also included in the model; Vision into Goals and Objectives, and Mission into Strategies for approaching Goals and Tactics for achieving Objectives. The term 'ends' is used to refer widely to any of the 'aspiration' concepts (Vision, Goal, Objective) and the term 'means' to refer generally to any of the 'action plan' concepts (Mission, Strategy, Tactics). This conjunction of Ends and Means ('being' and 'doing') provides the core concepts of the model. An enterprise, however, cannot operate on this model alone: the business needs to take into account the numerous Influencers that can hinder or assist its operation. These Influencers provide Opportunities that would help the enterprise operate, as well as Threats that would thwart it. Influencers also represent Strengths from within that the enterprise could exploit, or Weaknesses that it should compensate for.

However, the Influencer is inherently a Strength or Weakness: is it always a Threat or Opportunity? That determination is derived from an assessment of the impact of an Influencer on the stated Ends and Means, an assessment such as the one developed in SWOT analysis. In this commonly used technique, internal Influencers are usually assessed to be Strengths and Weaknesses whereas external Influencers are usually assessed to be Opportunities and Threats: both are analysed as a part of the business plan development. Once an assessment has identified relevant Influencers in terms of their impact on Ends and Means, Directives (Business Policies and Rules) can be placed in position to govern and guide the enterprise's Courses of Action. Directives keep the enterprise on course and moving toward its Desired Results. Because of their integral role in guiding Courses of Action, Directives are included in the set of Means concepts. Business Rules are noteworthy in that regard. Business Rules sharpen the Business Tactics because they make Courses of Action concrete at the operational level. Business Rules can also provide specific remedies when a Course of Action fails, and specific resolutions to conflicts that inevitably arise among the Ends. In short, Business Rules provide the leverage needed for building effective, adaptable business solutions and systems.

The Business Motivation Model states that what an enterprise does is driven not by change, but by how the enterprise decides to react to change, and it does not require a specific process for reaction to change. Whatever process is used, the BMM will support traceability. Figure 4 shows the BMM as described in the original specification of OMG (2010a).

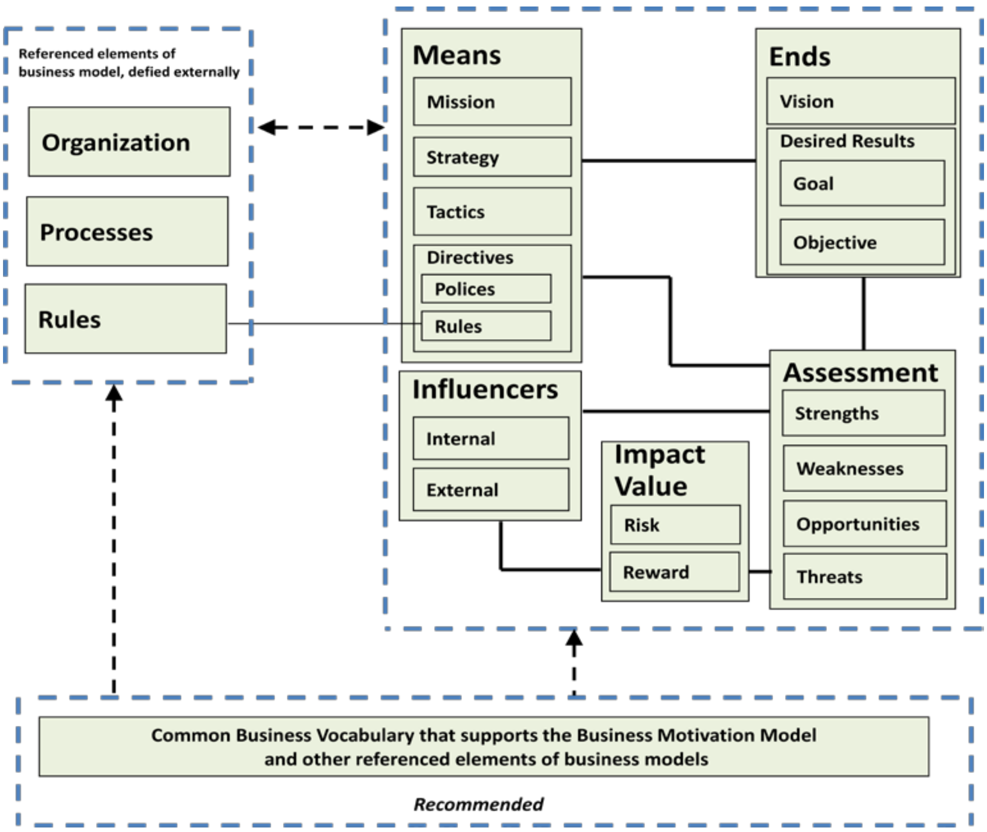


FIGURE 4: BUSINESS MOTIVATION MODEL (OMG, 2010A)

2.4.3 Reflection on EAFs

An examination of the twelve frameworks reveals that all have certain strengths and weaknesses. The comparative analysis of strengths and weaknesses for each framework are presented in Table 6.

TABLE 6: STRENGTHS AND WEAKNESSES OF ENTERPRISE ARCHITECTURE FRAMEWORKS

Framework	Strengths	Weaknesses
Zachman	- Systematic and layered taxonomy - Standard methodology, which can be used as reference by other frameworks - Other systems can map to this methodology and use it as a reference model - Used by private and public sector - Simple, logical model which uses non-technical terminology - Provides good abstraction views	- Does not have a defined methodology or implementation process - Can be used for reference - Over-emphasis on Information Technology - No emphasis on "How" to use it - Not suitable for complex multi-enterprise contexts - Needs to depend on other methodologies - Does not provide clear direction on security
TOGAF	- Greater usability - Fully described open methodology (Architectural Design Methodology) - Hierarchical steps - Linked to business drivers - Focuses more on holistic enterprise change - Output is consistent - Flexible step-by-step process to create a new architecture	- Excessively IT-centric - Little emphasis on people issues - Does not emphasise non-IT-based knowledge - Limited description of business architecture - Over-emphasis on low-level technology architecture
EA3 Cube	- Provides good abstraction - Layered - Understands large, complex enterprises - Components in the cube ideally suit all lines of business - Business and IT focus - Best practices, tools and flexibility (Hawk, 2008)	- Collection of artefacts based on other frameworks - Does not provide strong direction on security - Does not have explicit implementation methodology
Archimate	- Open framework - Non-proprietary - Process oriented - Consistent and integrated modelling of IT and process - Integration with TOGAF	- No explicit methodology - More of an enterprise architecture language than a framework - IT centric - No clear semantics behind the framework - No reference to people or process except in IT context - Does not consider non-IT-based knowledge
ARIS	- Strongly process aware - Useful for product development - Process simulation capability	- Proprietary model and integration is supported only by specific ARIS tools - Based on EPC modelling language

TABLE 6: STRENGTHS AND WEAKNESSES OF ENTERPRISE ARCHITECTURE FRAMEWORKS(CONTINUE)

Framework	Strengths	Weaknesses
DoDAF	- Guarantees output and process uniformity - Documentation of data for assessment - Requirements and architecture elements are universal	- Does not have unique architecture development style - Does not have specialised analysis techniques - Very limited guidance quality attributes (Odongo et al., 2012) - No business aspects focus
FEAF	- Systematic structure of inter-related models - Fully described open methodology - Strongly business focus - Hierarchical	- Exclusively IT-centric - Does not have reference to process and people - Does not recognise non-IT-based knowledge - Ideal for public sector enterprises and not business enterprises - Its implementation has a tendency to be in favour of bureaucracy
Gartner	- Practical framework - Business focus	- Not a complete EA methodology - Does not have a step-by-step process to create a new architecture and will not support implementation - Not widely adopted
BMM/ EBMM	- Strong business focus (business plan, investment case, Return On Investment) - Framework components ideally suit all lines of business - Supports change management by tracking the semantics among the concepts	- The abstract concepts can be disadvantageous as they require more work to specify artefacts - Business focus, integration with MDA technical standards can offer a fully socio-technical implementation
CIMOSA	- Covers all important aspects for process modelling (Zuesongdham, 2007) - IT and business focus - Flexible (Zuesongdham, 2007)	- Manufacturing industry focus - Very complicated - No reference models to design the system (Zuesongdham, 2007)
GERAM	- Technical focus - Offers clear guidance on the different aspects of functional, structural and contextual alignment (Magoulas et al., 2012)	- Lacks a complete implementation methodology - Does not have strong business focus - Does not include time-based progression

The Zachman Framework and TOGAF are considered to be methodologies that are also described as enterprise architectural frameworks. Sessions (2007) argues that the Zachman methodology acts like a taxonomy (study of the principles of scientific classification) and not a framework, as a framework is a structure that supports a system (Sessions, 2007). However, the Zachman Framework is a straightforward framework and very popular among organisations (IDS Scheer, 2006). Some literature also argues that TOGAF does not compete with established architecture frameworks (IDS Scheer, 2006).

DoDAF does not possess any unique characteristics of an ideal architecture model (Odongo et al., 2012), which makes it an advanced framework, and users need experience in how to compose and select the aspects and views and link them together. The EA3 Cube is considered to be an excellent EA Methodology reference as it embodies EA best practices. It is flexible and can be tailored to meet the requirements of any organisation (Hawk, 2008). Both Zachman and the EA3 cube have more layers and recommended artefacts with a comprehensive taxonomy than DoDAF 1.0.

FEAF is a good methodology as it combines the Zachman taxonomy and the TOGAF architectural process (Sessions, 2007). The main concern about FEAF is that it was created for the public sector and therefore may not be suitable for the private sector and medium-sized enterprises. However, it is an ideal reference model. Like TOGAF, FEAF is IT centric knowledge. However better versions are being developed which focuses on 'human capital' and 'other fixed assets'.

The Gartner Architecture model is a 'practice' and not a taxonomy like Zachman, a process focus like TOGAF or a complete methodology like FEAF (Sessions, 2007). Gartner can be considered a good framework like Zachman in terms of driving IT and business value. Unlike Gartner and EA3, GERAM is based on the requirements of IT rather than on business objectives. However, GERAM, like TOGAF, does offer clear direction on aligning the diverse facets of function, structure and context (Magoulas et al., 2012).

The CIMOSA approach cannot be easily understood by practitioners due to its complicated content. It is also not a reference model for designing a system. However, CIMOSA is better known in the manufacturing industry. BMM and EBMM are good motivation models for top-down alignment, which helps to build a mature business architecture and can be federated for other aspects of corporate governance, e.g. risk management, SWOT analysis and quality assurance. BMM and EBMM lack a consideration of technology details.

The existing EAFs are constructed on disparate abstraction mechanisms. The perspectives, viewpoints, architectures and dimensions vary from one framework to another. Most of the frameworks are limited in terms of balancing among functionality, structure and behaviour, in the sense of what is it? What should it be? What might it be? Why do we need to do a particular thing? Why do we consider one option and not another? Frameworks should be developed considering rapidly evolving complex collaborative environments. Besides meeting the challenges of an uncertain and changing environment, enterprises are facing issues such as security breaches and scams in emergent human behaviour. Enterprises have to take strategic initiatives to address risks and issues. These threats have activated a spurt in the number of regulations and the importance of regulatory compliance. It is therefore important that organisations expand the scope of enterprise architectures to alleviate risk, thereby addressing regulatory and security requirements (CISCO, 2009). FEAF has already incorporated updates to IT security, privacy and risk management procedures (CIO, 2010).

Most of the enterprise architecture models examined do not offer reasoning capability. Reasoning allows enterprises to understand the consequences of various scenarios and in the process supports decision-making. Most of the aspects of EAF lack one of clearness, communication, alignment or details (Ganesan, 2011). Several researchers have tried to solve these issues: in view of this, Ganesan (2011) proposed a framework which comprised seven basic components: motivation, governance, architecture, definition and modelling, tool administration, library management, stakeholder management and stakeholder training (Ganesan, 2011). This proposal from Ganesan (2011) suggests that all seven components are not available in their entirety in the current models.

There is an urgent need to structurally and functionally align the constitutional parts of enterprise architectures (Magoulas et al., 2012). According to Sessions (2007), the frameworks, namely the Zachman, TOGAF, FEAF and Gartner methodology, could be merged or blended to suit the requirements of an organisation. A comparative analysis of the twelve frameworks is shown in the table 7 below based on the criteria Scope, Metamodel, Methodology, Layers and abstraction, and other aspects.

TABLE 7: EAFS CRITIQUE

Analysis Aspect	Explanation
Scope	Most EAFs consider the whole enterprise structure (strategic, business and technology). However, the Gartner process model is an iteration process focusing on continually closing the gap between requirements and current architecture. The ARIS model has a process-oriented focus on business operation, alignment, improvement and governance. The BMM and EBMM both have a business architecture focus with the capability to align with technical architecture.
Metamodel	Not all EAFs provide semantic metamodels, and the metamodels fall between the simple and complex. Zachman, EA3 cube, Gartner, ARIS and CIMOSA do not have metamodels. TOGAF, Archimate and FEAF have simple metamodels and frameworks such as DoDAF 2.0, EBMM and BMM have powerful and comprehensive semantic metamodels.

TABLE 7: EAFS CRITIQUE (CONTINUE)

Analysis Aspect	Explanation
Methodology	EAFs mostly do not have detailed implementation methodologies. In most cases, they offer general guidelines or steps for implementation. TOGAF is considered the stronger from this point of view because of its offer, the ADM method for TOGAF initiation and implementation.
Layers and Abstraction	**Non-Layers:** BMM, EBMM, Gartner **Three and Four Layers:** Archimate (3x3 matrix), FEAF (4 layers, DoDAF 1.0 (3 views), ARIS (3 layers x 5 views), CIMOSA (3 layers x 4 views). **Five Layers:** EA3 Cube, GERAM. **Six or more:** Zachman (6x6 matrix), TOGAF (8 models + Requirements model), DoDAF 2.0 (7 views).
Other Aspects	A few frameworks such as Gartner, TOGAF and ARIS focus on changing and maturity of requirements. However, reasoning and dynamic simulation capabilities are not considered. Risks have been discussed briefly in some of these frameworks, but no deep consideration has been provided.

The analysis of the various architecture frameworks reflects the fact that the strengths and weaknesses are evenly distributed. However, most models do not specify metamodels. It is therefore important that the specification of metamodels is made in order to guarantee the consistency of architecture descriptions (Leist and Zellner, 2006). It can therefore be concluded that none of the enterprise architecture frameworks provide a complete solution to the problems facing organisations in term of soft aspects, reasoning and dynamic modelling, while these are important elements to be considered while modelling the enterprises. In the next section, details about these problems and potential issues emerge from the gaps in the current methods.

2.5 Gaps in the Current Literature

In this section, I list a theoretical grounded review of the most important limitations of the reviewed literature. The gaps that the research aims to fulfil and which are to be considered in the analysis and design framework proposed later in this thesis. The following section gives a detailed description of the issues that are poorly considered: 1) Consideration of social aspects when developing the enterprise models, 2) The dynamicity and evolution of the environment, 'dynamics analysis', 3) Reasoning about design choices, 4) External risk consideration through the analysis, 5) Language issues, 6) Complexity and the abstraction level of the enterprise model.

2.5.1 Consideration of Social Aspects

People differ in their understanding, acceptance, agreement and commitment (Hoppenbrouwers, 2005). It is impossible for a human being to be aware of everything in the environment. Human thinking is always influenced by their knowledge acquired, experiences, observation and mood (Sterman, 2000). Many studies in psychology, cognitive science and computer science have tried to draw a mental model describing how the human mind works (thinking, action, feeling and sensing). Belief is changeable, therefore human goals and behaviour are dynamic (Khan and Lespérance, 2010; Ceresia, 2009).

On the other hand, many studies have talked about design theories and how design should be more collaborative to increase the collective intelligence. Possible solutions can be found in the collaborative design framework, allowing stakeholders to negotiate and perform collaborative brainstorming and knowledge sharing which will help to reduce the risk of project failure (Fischer and Hermann, 2011).

However, intentional knowledge is often indirectly suggested, not easily available, not systematically managed, and frequently misplaced (Yu et al., 2006). Yu's (2009) argument declares that goal-oriented RE frameworks (such as the KAOS and NFR frameworks) employ ontology, which is intentional but not completely social. Semantic-based intentional modelling (Yu, 2009) represents the behavioural and intentional aspects of the stakeholders' goals but is still inadequate in presenting social aspects, as social modelling should contain intensive work on cognitive, reasoning, expectation and emergent behaviour mitigation aspects. We can say that 'belief' can only be understood in the current EM tools as either 1) Claims and expectations, or 2) Facts.

As we have seen in the literature review, the approaches of socio-technical systems with intensive social focus better analyse and consider the social aspects, whereas the EM and EAFs represent social aspects in a controlled or engineering manner, which is again limited in its description. Having techniques from both disciplines will make the representation of social aspects more mature. I see social aspects as being distinguished within two groups: 1) social aspects relevant to the design process (e.g. collaboration, thinking and reasoning); 2) social aspects and influencers of enterprise design and operation (e.g. trust, skills, leadership).

2.5.2 Dynamics and Evolving with the Environment

Uncertainty and evolution are two main characteristics of any domain or environment. However, change and evolution are not particularly considered in the current methodologies;

therefore, how can we treat the dynamic nature of the business environment? It is very difficult to find an answer to this question. Change will always occur, whether it is intended or not; whether we know about it or not; and whether we can do something about it or not (Tran and Massacci, 2011). In Jarke et al.'s (2009; 2011) studies, the authors considered the importance of the inter-relationship between requirements and contexts. They also point out the issue of evolving IS design along with ecologies following the requirement to bring through new artefacts from the system environment with the acceptance of this evolution as a fact that occurs in all systems at different rates. Yu (2009) admits the limitation of the current methods in handling evolution and change as well as moving from 'as is' to 'to be' or handling what 'might be'. In addition, there is a limitation in the proposed evolution alignment developed by Samavi et al. (2009) for two reasons: 1) The limitation of the strategic dependency model in describing the operational level of the business; 2) The alignment is not mature enough in terms of technical applicability, choosing among alternatives and automating stakeholders' network creation. The analysis of the twelve EAFs shows that none of these frameworks consider dynamic modelling (Table 7), especially in term of dynamic simulation or re-configurability.

2.5.3 Reasoning

We focus on two kinds of problem: knowledge problems which we need to know, and design problems which we need to do. Reasoning about strategic and operational activities is essential, especially around issues related to the intentional structure. An interactive method with a high degree of human judgement may be best suited to the early stages of requirements engineering, owing to its participatory and informal nature (Yu, 2009). Reasoning about the way in which the risks and opportunities should be handled is crucial to understanding how several solutions affect a wide spectrum of organisational and risk-related issues. Lamsweerde (2009) proposed a method for reasoning about alternative requirements to be considered based on qualitative and quantitative assessment; the author built requirements models based on goal-oriented modelling and evaluated the goals based on the nature of their impact. Tran and Massacci (2011) proposed a reasoning method for the evolutionary model based on prioritising and classifying requirements using a rule-based approach. Nevertheless, the analysis of the twelve EAFs shows that none of these frameworks considers reasoning modelling (Table 7) as part of the framework or part of the analysis techniques used to execute the framework.

2.5.4 Risk Associated with the External Environment

Risk is always associated with change, and most of the enterprise frameworks focus on the internal environment of the enterprise. It is possible that the consideration of risk should be extended to cover wider possible influencers, which might be internal or external. Risk has different levels, and consideration of risk should have several levels of maturity, based on the consideration of multiple levels of influencers, dependences and causal loops. Sometimes it is not easy to identify the risk within a single causal loop, thus the enterprise should define what level of maturity it needs to achieve. A good risk analysis should understand the impact of direct and indirect influencers; the analysis should also provide insight into the level of the impact, alternative scenarios and potential solutions and the speed of the impact's spread on other components, in order to decide the required response time in the case of event-based scenarios. The risk analyst needs to understand the impact on/of ecology, business, technology, and social systems (Jarke et al., 2009). Governance and control should be central and distributed at the same time: central in terms of planning, and design, and distributed in terms of power, privileges and collaborative thinking, for handling emergent events. The literature analysis shows that the previous studied approaches have a lack of consideration of at least one of these external influencers.

2.5.5 Language

Domain terms, concepts and vocabulary are all still issues which must be considered by researchers. Liu et al. (2011) argued that business-IT alignment is difficult because of miscommunication resulting from 'language' differences between the business and IT domains. In Yu (2009), the adoption of a project lexicon or ontology (Breitman and Leite, 2003) is worth considering, to facilitate knowledge sharing and a common understanding among stakeholders. It has also been suggested that lightweight natural language processing may also be helpful (Sawyer et al., 2005). Guarino (2009) confirmed the importance of language in knowledge representation, and outlined a method to represent ontological semantics. Chen (1994) pointed to the issue of the existence of a gap between collaborators in terms of the vocabulary used; it will be based on their fields or environment. It is a challenge for the designers of collaborative systems to overcome this issue. In other research (Lautenbacher et al., 2007), language understanding has been shown to not only affect people's understanding, but to influence machine understanding: a semantic annotation method is the only way to overcome such problems; the author proposed a linguistic modelling method using terms and ontology for requirements engineering. In addition, Hoppenbrouwers (2005) recommended using controlled natural language to overcome ambiguity and misunderstanding in developing business and information systems. The literature analysis in this chapter shows that none of the previous studied approaches has adopted a language facilitating technique.

2.5.6 Complexity and Level of Abstraction

The socio-technical systems are complex by their nature, STS design methodologies and enterprise modelling architectures exhibit considerable variation in the level of detail they describe, and sometimes concepts of the same level describing different ideas have a different 'ontology map'. My understanding is that enterprise activities consist of two levels of enterprise work: the first is detailed analysis to offer robustness to the design of business activities and information systems. The goal of this stage is to set up business activities at a high standard of maturity, agility and quality. During the design process, the designers need to use abstraction techniques to reduce and manage complexity. The second level is related to managing and operating the business and its supportive ISs. At this level, the operation should be working in the abstract and as easily as possible, as business people are looking for ways in which to change, manipulate and control their business in an easy and fast way in order to face the rapidly changing business environment. In socio-technical systems, the responsibility falls partly on people to manage and monitor the unautomated activities: in this case, the requirements focus will be on user/stakeholder needs. The other part falls on the implemented technology, where the focus should be on technology design (Miller et al., 2009). The open community is looking to improve the standard of interoperability of ISs. In general, continuous analysis and adaptation are crucial for successful business implementation (Jarke et al., 2009). Baxter and Sommerville (2011) pointed out clearly that socio-technical systems approaches suffer from the variety of levels of abstractions; likewise the enterprise concept levels can be easily misunderstood, as seen in Table 7.

2.6 Conclusion

This chapter has discussed the approaches of socio-technical systems analysis and design, common perspectives enterprise modelling and the most common EAFs, and pointed out their advantages and limitations. The advantages of each of these sets of literature have been understood and gaps have been identified. Two important analysis and design issues have not been considered in the current EAFs, namely dynamic modelling and reasoning about design decision rationales. The set of problems that have been discussed at the end of this chapter will be considered during this research: a new modelling framework that is able to overcome these problems is crucial. The literature review has been completed, and Table 8 shows the limitations and gaps that the research aims to tackle:

TABLE 8: THE FOCUS AND RESEARCH GAPS

Literature	Research gaps investigated
Approaches for analysing and designing socio-technical systems	1) Approaches to socio-technical systems analysis and design mostly focus on either social aspects or technical aspects, rarely both. 2) Approaches to socio-technical systems analysis and design are limited in terms of details and systematic processes, and the semantics of the approaches which are meant to tackle aligned activities.
Enterprise modelling perspectives	3) In Enterprise Modelling, the single perspective is not enough to model a comprehensive enterprise 'Socio-technical system', resulting in different quality coverage by each perspective
Enterprise architecture frameworks	4) The existing EAFs fail to address reasoning and dynamics modelling. 5) Facilitating complexity, dynamics and decision-making process have not been clearly addressed: factors influencing socio-technical systems need investigation, focusing on issues such as: - Internal influencers - External influencers - Language and issue of common understanding of terms and concepts - Common understanding of levels of complexity and abstraction of enterprise model concepts

Chapter Three: Research Methodology

This chapter describes the work carried out in deciding the appropriate philosophical view to achieve the research objectives of the study. Based on the philosophical views to which this research study adhered, this chapter then discusses the process of adopting a suitable research methodology. An explanation is presented for the selection of suitable techniques to understand and capture the views of the informants, the methodology is aligned with the research objectives. In brief, the research uses the design science research methodology (DSRM) for information systems (IS) (Peffers et al., 2007); other research strategies such as multiple case study and theorisation methodologies such as FTD-DSRIS[3] are used as part of the process of developing and executing a set of research methods, i.e. semi-structured interviews. The method of data analysis is discussed and the chapter concludes by providing a summary of the design of the research in this thesis.

3.1 Methodology Motivation and Philosophical Stance

In the case of this piece of multi-disciplinary research, there must be a way to consider the design of artefacts to overcome the challenges faced when using the traditional paradigms of IS research to analyse and design socio-technical systems. For instance, theory building and testing research may help to explain the centre of gravity for research in systems analysis and design: arguably, while in the dominant engineering research paradigms as in software and requirements engineering they accept design as a valid and they assume people will follow the system rules strictly as designed (Peffers et al., 2007). It has been argued that there is no complete design (Jarke et al., 2011; Mumford, 2006) that allows people to evaluate, apply and interact with new circumstances and scenarios in the work environment. This research aims to design and create artefacts that serve the analyst's purpose in considering the dynamics and complexity of socio-technical systems, so it is very important to adapt and adopt a methodology that allows sophisticated artefacts to be designed in a structured and agile manner. The designed artefacts could be new social innovations or properties and features of social, technical and informational parts of the domain problem; they could be any object in the embedded solution to a well-defined research problem (Peffers et al., 2007). The results should represent a unique approach to solving and improving the handling of dynamic and complex socio-technical design in the applied domain or environment.

[3] Framework for Theory Development in DSRIS (Kuechler and Vaishnavi, 2012)

The research methodology adopted for this research is based on the design science research methodology (DSRM) for information systems (IS) research (Peffers et al., 2007). The DS research methodology has been followed twice in this research, firstly, to conduct the entire PhD research process and secondly, to conduct the case study activities. However, qualitative methods in design theory are used in the case studies, which is valid according to the accounts of Yin (1994), Walsham (1993) and Walsham and Waema (1994). To link the methodology to the philosophical stance of this research, the research adopts the Onion framework (Saunders et al., 2009) to link the hierarchy of the research (philosophy, methodology, strategy, methods, time horizon and data collection techniques). Myers (1997) recommended a number of philosophical backgrounds such as positivism, realism and interpretivism as among the best for performing academic research. Also, research drawing from the discussion of epistemological beliefs of Chua (1986) and Orlikowski and Baroudi (1991) has classified IS research into three main categories: positivist, interpretive, and critical studies.

Design science research can engage in positivism or interpretivism (Hevner et al., 2004) and its applications to information systems should be based on a sound ontology to create useful artefacts (Iivari, 2007): this research emphasises interpretivism, especially in understanding the requirements and drivers of developing a new framework. Interpretivism, which as a philosophy borrows heavily from phenomenology, Saunders et al. (2009) argues that there are different ways of seeing reality and some factors cannot be scientifically measured or generalised; it always associates meanings to things, particularly social aspects/behaviour. Klein and Myers (1999) described the IS interpretivisim philosophy thus: “IS research can be classified as interpretive if it is assumed that our knowledge of reality is gained only through social constructions such as language, consciousness, shared meanings, documents, tools, and other artefacts”. Interpretive research does not set out to test hypotheses (Rowlands, 2005), and it does not predefine dependent and independent variables (Kaplan and Maxwell, 1994). It primarily focuses on the complexity of human sense-making as the situation emerges (Kaplan and Maxwell, 1994). Thus, interpretive researchers attempt to understand phenomena through accessing the meanings that people assign to them (Olesen and Myers, 1999; Rowlands, 2005; Orlikowski and Baroudi, 1991). Interpretive methods used in IS related research are aimed at producing an understanding of the context of the information system and the process whereby the information system influences and is influenced by its context (Walsham, 1993).

Therefore, to draw on the understanding of the research philosophy, the research adopts the DSRMIS to transform our perception of knowledge that can be used to design artefacts. The

DSRMIS implies inductive and deductive approaches[4] at different stages; as a main research strategy to implement and achieve objectives the research considers multi-case studies for this purpose. The choices for the contribution will be in theory building and in designing a framework that contains artefacts. The research analysis choices are conceptual modelling for IS development, design rationale for reasoning and system dynamics for simulation. The methodology choice of time horizon is cross-sectional, which is a kind of 'snap-shot' of the current problem from the perspectives of the literature and the exploratory case study. Figure 5 shows the philosophical stance and the methodology and methods adopted in this research.

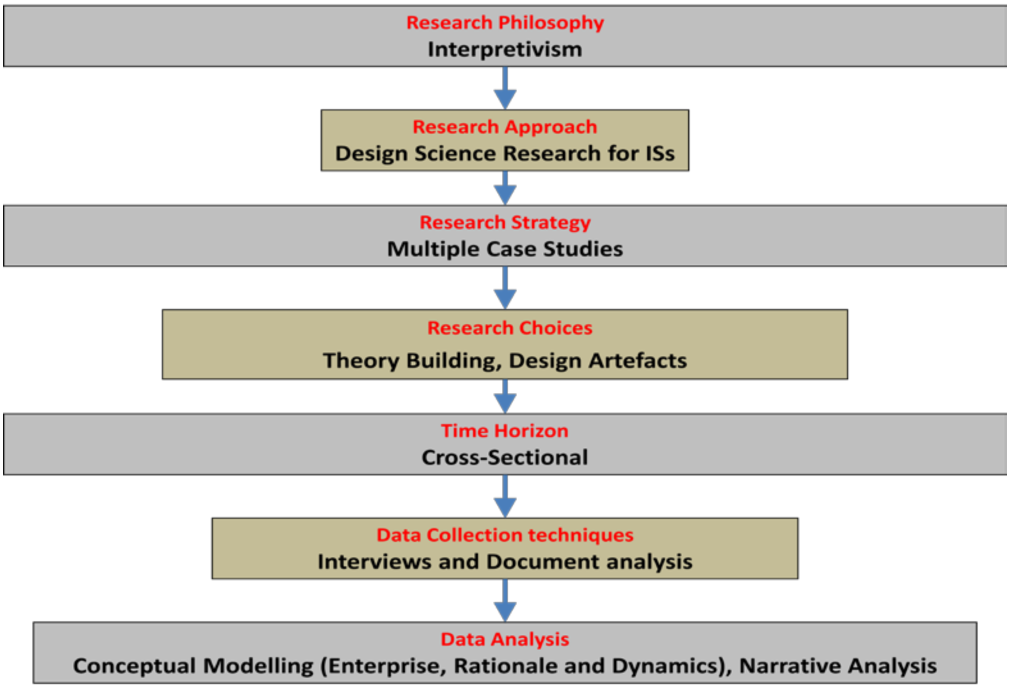


FIGURE 5: RESEARCH METHODOLOGY MAP

3.2 Design Science Research Methodology for IS

The DSRMIS (Peffers et al., 2007) has been chosen to perform the research activities. It is a suitable methodology to be used in such a research environment: the methodology considered the use of interpretive research paradigms, but the resulting research output is still mostly explanatory. DS research is not considered part of the dominant IS research culture, as in the other social sciences, computer science or engineering based approaches. Design science research in IS helps to outline a framework whereby researchers can recognise and evaluate the results of their DS approach research. In contrast to the theory building and testing methodologies, design science research is based on explicit activities. The natural sciences and social sciences try to understand reality and find what is true; design science attempts to

[4] Inductive reasoning works from specific observations to broader generalisations and theories. Informally, it sometimes called a 'bottom up' approach. Deductive reasoning works the other way, moving from the more general to the more specific, sometimes called a 'top-down' approach.

create things that serve human purposes, and create something effective (Hevner et al., 2004). Design science research methodology helps to create and evaluate IT artefacts that are intended to solve identified organisational problems (Peffers et al., 2007). Design science research in IS aims to integrate research methodologies with system development techniques to serve as a mega-methodological approach applicable to social IS research in order to be able to address the problems faced by IS experts.

The methodology provides a commonly accepted framework for successfully carrying out DS research and a mental model[5] for its presentation; it also helps with the recognition and legitimisation of DS research and its objectives, processes and outputs. In addition, it helps researchers to present their research with reference to a commonly understood framework, rather than justifying the research paradigm on an ad hoc basis with each new research effort (Peffers et al., 2007). The DS research methodology comprises six phases as described in Peffers et al. (2007): 1) Problem and motivation, 2) Objective of the solution, 3) Design and development, 4) Demonstration, 5) Evaluation, 6) Communication. Figure 6 below shows the main DSRMIS processes.

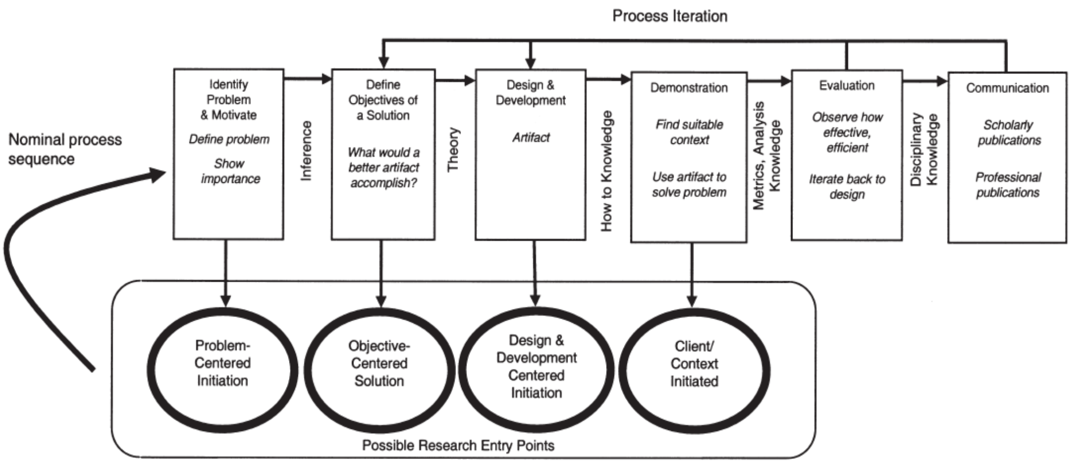


FIGURE 6: DSRM PROCESS MODEL (Peffers et al., 2007)

In this thesis, the literature review (synthesis and integration of information), case study strategy, framework for theory development, descriptive method, interviews and explanatory methods are used to fulfil the stages of the design science methodology. The following section describes how and where these methods will be used within the DSRM for IS main process:

[5] A mental model is a "small-scale [model] of reality . . . [that] can be constructed from perception, imagination, or the comprehension of discourse. [Mental models] are akin to architects' models or to physicists' diagrams in that their structure is analogous to the structure of the situation that they represent, unlike, say, the structure of logical forms used in formal rule theories" (Peffers et al., 2007).

Activity 1: Problem identification and motivation

This stage involved defining the specific research problem and justifying the value of a solution. This is because the problem definition will act as a motivation to develop solution artefacts, which can effectively provide an applicable and practical solution; it may be useful to atomise the problem conceptually so that the solution can capture its complexity. A systematic literature review (described in Section 3.2.1) has been used to tackle this stage; the research questions present the limitations in the current methods/tools to be fulfilled by the research objectives. The literature review in Chapter Two allows problem identification to be performed based on identifying the gaps in the current approaches to analysing and designing socio-technical systems, the EM and EAF literature, which can be summarised as follows:

1) Consideration of dynamic modelling and reasoning is absent in the current methods.
2) There is an absence of detailed artefacts, which should provide the current techniques with the necessary ability to evolve and integrate.
3) There is a need to provide a detailed systematic process for modelling socio-technical systems as a whole with both a technical and social focus.

Activity 2: Define the objectives for a solution

At this point we infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible. The objectives can be quantitative, such as terms under which a desirable solution would be better than current ones, or qualitative, such as a description of how a new artefact is expected to support solutions to problems not hitherto addressed. The objective of the solution is to answer the research questions that have been identified by the literature review; however, the research will consider the current improvements in the EM domain, where hybrid modelling techniques will be used to fill the gaps. Two objectives for the solution have been defined:

1) Understand the complex dynamic socio-technical system environment and develop principles to describe, analyse and design socio-technical systems.
2) Use the principles to develop a hybrid framework for analysing and designing socio-technical systems.

Activity 3: Design and development

This stage involves creating the new artefact in the framework. Such artefacts are potentially constructs, models, methods, or instantiations (each defined broadly) or “new properties of technical, social, and/or informational resources” (Peffers et al., 2007). Conceptually, a design research artefact can be any designed object where a research contribution is embedded in the design. This activity includes determining the artefact's desired functionality and its architecture and then creating the actual artefact. This research takes advantage of complexity science in an exploratory case study using a framework for theory development in design science research for information systems (FTD in DSRIS) (Kuechler and Vaishnavi, 2012), to further build the views and artefacts as an extension of the reused business motivation model (BMM) to build the modelling framework with new artefacts. The design deliverables are as follows:

1) Principles for describing, analysing and designing socio-technical systems
2) Three-level metamodel separated into a set of views and accompanying artefacts
3) Implementation process
4) Set of supportive tools

Activity 4: Demonstration

In this stage we demonstrate the use of the artefact to solve one or more instances of the problem. This could involve its use in experimentation, simulation, case study, proof, or other appropriate activity. Resources required for the demonstration include effective knowledge of how to use the artefact to solve the problem (Peffers et al., 2007). This research will consider a multiple case study strategy to demonstrate examples of how the framework and development process will work; many modelling techniques will be used in the research such as using system dynamic modelling, design rationale, conceptual modelling methods and model driven capabilities. Document analysis and semi-structured interviews will be used to collect the data.

Activity 5: Evaluation

This stage involves observing and measuring how well the artefact supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the artefact in the demonstration (Peffers et al., 2007). It requires knowledge of relevant metrics and analysis techniques. The evaluation is presented by assessing the framework's ability to analyse and design both technical and social aspects of the enterprise. The expressiveness and maturity of the framework will be assessed against the previously developed analysis and design principles. The developed framework will be assessed against the research questions to measure whether the designed solution is filling the gaps in the literature. Moreover, the limitations of the solution will be discussed in the evaluation chapter.

Activity 6: Communication

Here we communicate the problem and its importance, the artefact, its utility and novelty, the rigour of its design, and its effectiveness for researchers and other relevant audiences such as practising professionals, when appropriate (Peffers et al., 2007). In this thesis, the ability to demonstrate and gain the evaluation of academic bodies through conferences, meeting and discussion is the main part of the communication process. Implications for industry will be discussed as well as a design-time evaluation. Further journal publications are planned. It must be presented effectively both to technology-oriented as well as management-oriented audiences (Hevner et al., 2004).

Figure 7 below is a representation of how the research will fulfil each stage of DSRM using different types of methodology, method and technique.

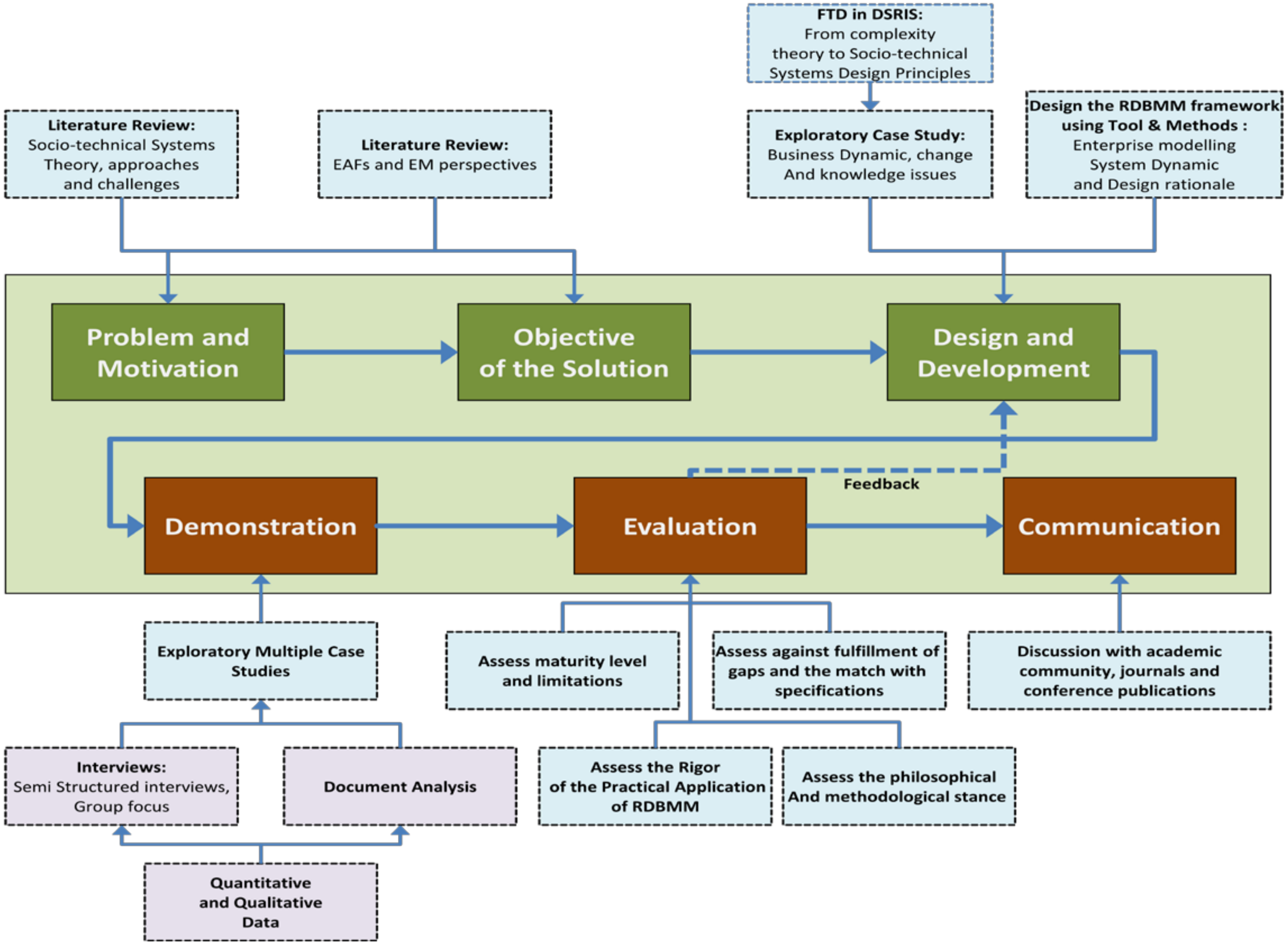


FIGURE 7: RESEARCH METHODOLOGY

3.3 Research Methods

The following sections describe the research methods/strategies used in this thesis in order to fulfil DSRMIS activities:

3.3.1 Literature Review (Synthesis and Integration of Information)

The literature reviews is a one of the most important methods for supporting evidence-based research (Wisker, 2007). The literature synthesis and analysis were important for identifying the problem domain in Chapter Two, which the approaches to socio-technical system analysis and design, the current EM perspectives and EAFs were found to fail to address. The integration of the information coming from several sources (i.e. literature and exploratory study) allowed the author to develop the research framework and decide the tools and techniques to be used, besides the process of implementing the framework. The literature review was based on the published outcomes of the following:

- Research institutes in the relevant domains
- Top professors, scholars and researchers in the domain
- Related conferences, journals and workshops
- Related industrial standards, specifications and frameworks

3.3.2 Case Study Strategy

Case study research is a holistic empirical enquiry to develop a complete and comprehensive understanding of the whole components and sub-components of the system in its context (whether that is an organisation, group, individual, events or regulations) (Wisker, 2007; Yin, 1994). In Walsham and Waema (1994), the use of one or more case studies as a basis for drawing out the interfaces of a particular area of study is actually related to an interpretive epistemological stance. The case study allows the researcher to go through the process of exploration and explanation of the problem. The use of the case study approach helps us to understand the problem, the nature and complexity of these issues and the process of implementation of research framework for socio-technical system, so that valuable insights can be gained into the emergent situation (Yin, 1994). Information must be ascertained from the organisations and then later carefully interpreted. These facts may be gathered from documents, archives, and especially from interviews with any person who has knowledge of the subject area (Benbasat et al., 1987). According to Benbasat et al. (1987), case study research is particularly relevant when the research interest is in organisational rather than technical issues.

A case study strategy includes exploratory activities, this type of method is used if more detailed reasons are required than are possible to gather from the ‘what’ questions of a descriptive method. Exploratory research asks both ‘what’ and ‘why’ questions (Wisker, 2007). When asking ‘why’ questions, the exploratory research method deals with the complex issues of a phenomenon as well. When applied in conjunction with a case study strategy, it explores those situations in which the intervention being evaluated has no clear, single set of outcomes (Yin, 1994). Exploratory methods were expected to be used during the literature review and initial case study work during this research.

3.3.3 Framework for Theory Development in DSRIS

The framework for theory development in design science research in information systems (DSRIS) is a framework developed by Kuechler and Vaishnavi (2012), based on an expansion of both theory for design and action (ISDT: Type V theory[6]) (Gregor, 2006) and design-relevant mid-range explanatory/predictive theory (DREPT) (Kuechler and Vaishnavi, 2012). It proposes a hierarchy of theory in DSRIS arranged according to the level of abstraction of theoretical constructs. The design relevant explanatory-predictive theory (DREPT) is a type of theory that focuses on augmenting the ‘how’ information content of the traditional information systems design theory (ISDT) statement with explanatory information explaining why and how the artefact has the effects it does. The explanatory information may borrow theoretical information from the natural, social or design sciences. DREPT is similar to but more formally stated than the ‘justificatory knowledge’ proposed as an addition to ISDT (Kuechler and Vaishnavi, 2012).

The aims of DREPT and ISDT are to provide high-level definition of the functioning of an artefact to achieve a design goal and direction toward its construction, but they do not describe how the artefact works or by what mechanism(s) the meta requirements and design method achieve the design goal. This provides a logical step that bridges the conceptual distance between kernel theory constructs and artefact features. Thus, it will help in capturing a different sort of design-related knowledge. DREPT acts as a mid-range theory, a conceptual intermediary between the highly abstract space of potential problem solutions suggested by kernel theories or insights and the concrete problem solution of the implemented artefact (Kuechler and Vaishnavi, 2012). The FTD for DSRIS framework is described in Figure 8 below.

[6] An explanatory/predictive theory (Gregor’s (2006) types II-IV) traditionally has the form: “IF A (B, C, . . .) THEN D (E, F, . . .)” (Lee & Hubona, 2009). The output of design science research (following Bunge, 1984) is a technological rule: A chunk of general knowledge, linking an intervention or artefact with a desired outcome of performance in a certain field of application (van Aken, 2004). In DSRIS, we term a specific format for these technological rules an ISDT. The logical format of this technological rule is: “IF YOU WANT TO ACHIEVE Y IN SITUATION Z, THEN SOMETHING LIKE ACTION X WILL HELP”. van Aken (2004) continues, “'Something like action X' means that the prescription is to be used as a design exemplar … The indeterminate nature of a heuristic technological rule makes it impossible to prove its effects conclusively, but it can be tested in context, which in turn can lead to sufficient supporting evidence”.

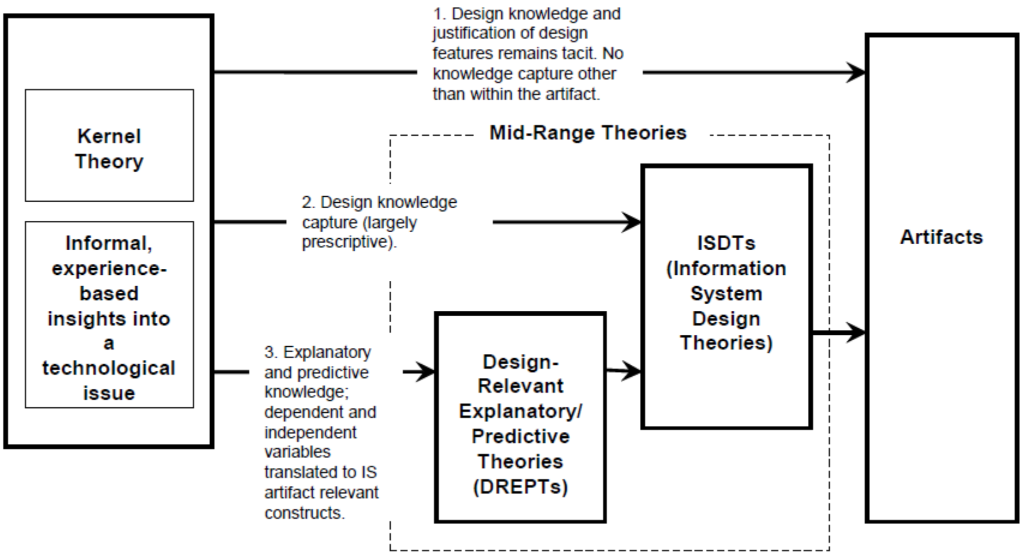


FIGURE 8: ISDTS AND DESIGN-RELEVANT EXPLANATORY/PREDICTIVE THEORIES (DREPT) AS MID-RANGE KNOWLEDGE REPRESENTATIONS IN DESIGN SCIENCE RESEARCH (Kuechler and Vaishnavi, 2012)

In this research method, the aim is to develop and test the concepts/principles and their applicability in the case study configuration. In addition, to help in improving the design of new artefacts and approaches based on the principles resulting from the case study, these artefacts will be explained and detailed then grouped as collective theories in the domain. The artefact development relies mostly on qualitative research, although it is also applicable to quantitative research. The study theory depends on methods that close the gap between research activities and the real world so that the results and findings are grounded in the empirical world, as described in Patton (2002). It is fundamentally realist and objectivist in orientation, emphasising disciplined and procedural ways of getting the researcher's biases out of the way but also adding creativity to the analytical process (Patton, 2002).

In this research, artefact development is based on experience gained from the exploratory case study and the kernel theory represented in complexity theory. In Stage Three, "designing and developing the solution", the DREPT has been used to reflect on the exploratory case study using complexity theory as a kernel theory to rely on for developing principles for understanding, guiding, analysing and designing socio-technical systems. The process contains some elements from discovering artefacts to develop the new guiding principles. Moreover, data analysis techniques considered in this stage are similar to those suggested in grounded theory research (Patton, 2002). Some of these techniques are related to the sense-making process in the socio-technical environment, as we need some other methods to externalise the knowledge (from tacit to explicit and explicit to tacit). However, the following are the main sub-techniques to associate knowledge with meaning to gain insight and experience:

- Comparison
- Classification
- Exploration
- Making relationships
- Decomposition
- Aggregation
- Argumentation
- Information visualising

3.4 Data-gathering Techniques

- Semi-structured interviews
    - Used as explanatory method to ask ‘why’ questions in addition to the ‘what’ questions as in the case of the exploratory method (Wisker, 2007). During this research study, an explanatory method was expected to be utilised in order to explain the application and impact of concepts, developed through descriptive and exploratory case study, and grounded theory strategies, in respect to the modelling and design of future ME.
- Observation
    - Observing employee behaviour during their working day could provide insight into internal issues facing the employees in their daily activities. Issues related to the difficulty of performing tasks, collaboration and communication and unexpected problems could all be discovered through observation techniques.
- Document Analysis
    - Many organisations attempt to document their important information, motivation statements, processes, values, HR, financial performance, services and products and details of these can be found in documents rather than asking too many questions during interviews. Document analysis is highly considered in this research.
- Phone calls
    - To follow up with interviewees, phone calls with specific concerns could be useful to collect the required information that did not have enough attention during the case study interviews.

3.5 Analysis and Representation Mechanism

The research uses specific modelling tools/techniques that respond to the limitations in the current literature; these tools also allow flexibility in response to the philosophical stance of this research. Yu (2009) argued that conceptual modelling is the only way to bring an understanding of complex social phenomena into the system design process. Conceptual modelling has a great ability to be adopted for simulation and for enterprise modelling for technology and information systems development. The abstraction technique is used to simplify complex real artefacts and make it more applicable for simulation, reasoning or development/coding. For instance, using concepts in reasoning to undertake a set of comparative and qualitative evaluations of these concepts, and conceptualising the influencing factors and variables makes the simulation possible by enhancing these concepts with mathematical questions. Conceptual modelling is also the basis of systems and software development, and UML is a well-known formal modelling for object oriented software development. Conceptual modelling is the basis of the modelling tools used in this research. Samavi (2009) stated that strategic reasoning about business models is an important and challengeable part of strategic service design in an enterprise. In addition, reasoning is also important in enterprise requirements processes towards building systems (Lamsweerde, 2009) and in software engineering, particularly in software design (Louridas and Loucopoulos, 2000). Nevertheless, to handle the dynamic features of a complex environment, Sterman (1994; 2000) clarified the importance of supporting decision-making by expanding the boundaries of mental models to understand complex possible behaviours and results: this is not possible without the intensive simulation of dynamic complex behaviours. Where most complex behaviours usually arise from 'feedback' interactions among the components of the system, not from the complexity of the components themselves (Sterman, 2000), dynamics modelling is the answer to this problem. Nevertheless, the combination of the three tools will help to overcome the limitations of each one. The selected analysis tools that aim to fill the limitations in the literature are based on conceptual modelling, as follows:

- Conceptual modelling for qualitative reasoning
- Conceptual modelling for simulation (using mathematical features for each particular concept)
- Conceptual modelling for software implementation and development (transformation of formal models to code)

The following section elaborates the background of Conceptual Modelling.

3.5.1 Conceptual Modelling

Conceptual modelling is about abstracting a model from real life as preserved by the human brain. As stated before, the world is characterised by uncertainty, many things are still unknown for humans and historical patterns can help to predict the future through the learning process. Nevertheless, nothing can be 100% accurate, so the goal for humans is to try to reach a safe level of wisdom. A person describes his understanding of the world via language that is driven by the concept of preservation, and this is exactly what the conceptual model is about; by cognitive argumentation humans create the semantics among these concepts, which is the aim of building the conceptual model towards the formalisation of the semantic model (Gregory, 1993; Yucong and Cruz, 2011). Also, an epistemological model is a type of conceptual model whose proposed scope is modelling things that are known s and believed about the world, where the taxonomy is a classification of these concepts. The simplification of a real world system is a tricky process: simplification should ensure that the important features or characteristics of the real system are reflected in the conceptual model, so that the conceptual model can still be useful and valid. To validate the model for example, method such as GQM can be used to assess the conceptual model against the goal that has been created for it, and to find the matrices required to ensure its validity. The implementation of software systems or simulation is matter of the simplification of reality (Robinson, 2010), however, conceptual models can represent the reality "current situation" or a vision "desired situation" as well. Conceptual modelling can be considered as the first phase of the simulation or of organising the information system life cycle (Rolland and Prakash, 2000) for software and systems development which is described in Figure 9 below.

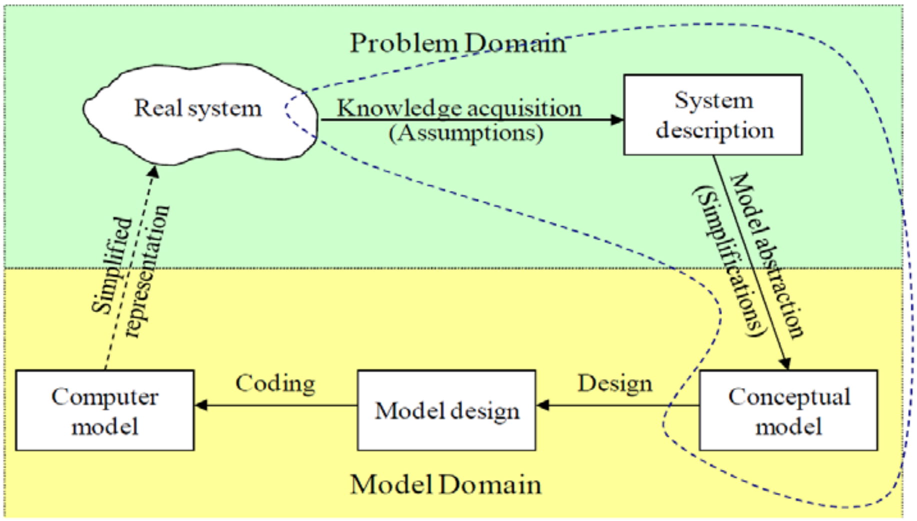


FIGURE 9: CONCEPTUAL MODELLING ARTEFACTS (Robinson, 2010)

For formal development in this research, using formal notations to build detailed conceptual models is a must. A UML object diagram will be used to define the conceptual models where the Causal loop diagram is a formal model for simulation purposes with its main relation of 'cause and effect'. Conceptual modelling is presented as a basis of the simulation process as in Robinson (2008) and as a basis of software design and implementation as in Rolland and Prakash (2000), and for reasoning based on (Lamsweerde, 2009) and (Louridas and Loucopoulos, 2000).

3.6 Methodology and Rationale for Methods

DSRM for IS research has acted as the main research process, and this mega-methodology will uses other methods in order to fulfil each particular stage. For instance, FTD-DSRIS contributes in the design and development stage, particularly in developing the socio-technical systems analysis and design principles. These principles guide the developed framework toward dynamic and complex socio-technical systems analysis and design. The system dynamics, design rationale and conceptual-modelling approaches offer a wide range of modelling capability for modelling different levels of abstraction covering different relational quality perspectives. These models can be extended and integrated in such a way as to incorporate models that are more detailed, which is necessary to satisfy the analysis and design requirements of reducing complexity, reasoning about decisions and simulating the current and future status of the socio-technical system. Humans commonly make errors, and this makes the analysis of social reliability more complex. However, while it is easy to find enough models to describe different levels in the technical system, we found it harder to provide a 'generalised model' for social systems. Because there is still no sufficient perfect description of the human system on one side, and also because of the changing nature of social aspects at the macro level on another side, it is important to work qualitatively in each individual case. To build a successful socio-technical modelling environment, it is necessary to incorporate two aspects of modelling: 1) modelling techniques that should offer a modelling process and modelling language/tool; 2) modelling mechanisms, usually presented by logical formulation and algorithms. The research framework provides a set of views and artefacts as a semantic framework; the tools are required to model these artefacts and a generic modelling process. These all help to better analyse, simulate and implement socio-technical systems.

In a detailed manner, the research will use the design rationale for reasoning about socio-technical system design choices and give insight regarding the advantages and disadvantages of each option. Nevertheless, sometimes it is not easy to understand the full impact of making one decision that results in complex influencing relations; in such circumstances, we engage in further investigation using the system dynamics modelling technique for describing complex and dynamic phenomena and relations among the artefacts in the dynamics model.

This because of the capability of system dynamic modelling to describe the change in artefacts according to their influencing relations during time (Sterman, 1994; 2000). Enterprise modelling, on the other hand, is an ideal model that understands the functions of a socio-technical system. The designer can model and decompose the socio-technical system to a consistent set of modules and hence gain a better understanding of and manage the system complexity (Golnam et al., 2010). System dynamics and enterprise modelling complement each other while drawing inferences (Golnam et al., 2010). These are all incorporated within the modelling effort that aims to model the research framework's views and artefacts. Within the case study, the DSRM process will follow another iteration of the DS research methodology process, but in this case, the process entry point is Step Four, "The Demonstration". However, the process can also be taken from the beginning in the case of independent implementation, in the following description of the steps taken for this research:

- **Step four:** Demonstration (to demonstrate the RDBMM framework using the techniques, methods and tools discussed in this chapter).
- **Step five:** Evaluation (Understanding the impact and the insight offered when RDBMM is implemented as discussed at the end of the case studies chapters and in the evaluation chapter, Chapter 8).
- **Step six:** Communication (using the evaluation interviews and further publications/presentations).

The approach we are following will bring the following unique values:

- Study the enterprise within its context and extend the consideration of the impacts (influences/influencers)
- Provide a mature and systematic approach to move from high-level goals to IS development in real time (methods part of the research: technology development is outside the scope)
- Provide reasoning about alternatives and decision-making in the socio-technical system design process.
- Provide a dynamic modelling capability to simulate the socio-technical system.
- Achieve common understanding and agreement between stakeholders, more collaboration and system insight.

To match the methodology steps with the research objectives, Table 9 shows the processes that should be fulfilled during each phase of the research methodology.

TABLE 9: METHODOLOGY TABLE

Activity No.	Major activities in the research	Philosophical research method(s) adopted	Data Type Involved	Mapping onto methodology step no.
1.	General review of literature on socio-technical challenges and identification of gaps in the socio-technical approaches literature.	Exploratory	Qualitative	1
2.	Identifying the gaps in the EM & EAFs and thinking about a novel model based solution as a hybrid framework to fulfil the gaps.	Exploratory	Qualitative	1, 2
3.	Exploratory case study to understand dynamics, change and decision-making processes in socio-technical systems to feed the framework design.	Exploratory + descriptive	Qualitative	3
4.	Development of principles and a generic supportive framework to guide the analysis and design of complex socio-technical systems as a result of complexity theory adaptation and reflection.	FTD in DSRIS (cross-domain adjustment) + Exploratory, explanatory (descriptive and predictive)	Qualitative	3
5.	Propose a new modelling framework "RDBMM" containing a set of perspectives and new artefacts that aids better consideration of dynamic and reasoning modelling, based on detailed analysis of interviews and literature findings in EA, EM, socio-technical systems approaches and the analysis tools; propose the compensation of tools and the process to help in implementing the framework.	Background Exploratory + DSRIS + Explanatory using DR, SD and EM.	Qualitative	3,4
6.	Case study work with industrial organisation to model the enterprise as a 'socio-technical system', early modelling based on document analysis and exploratory search, to be enhanced with interviews, observation and group focus for detailed analysis.	(Exploratory, Explanatory)	Qualitative and Quantitative	5
7.	Validate and evaluate the framework and approach used with the stakeholders, lessons learned and impact clarification.	Explanatory	Qualitative, Quantitative	6

3.7 Reflection and Conclusions

In this chapter, a description of the research philosophy, methodology and methods has been presented; the chapter offers a review and discussion of the set of methods and techniques that were considered for this research. In brief, because of the subjective nature of the research arguments, where reality has been seen in different ways from different perspectives, an interpretivism philosophical and subjectivist epistemological stance has been adopted. The design science (DS) research methodology for IS research has been chosen as the main research process. The research strategy involves multiple case studies: research methods such as literature review, and FTD for DSRIS will fulfil several stages of the DSRM process. Also, a set of visual conceptual tools will be used for analysis, including system dynamics, design rationale and enterprise modelling. Finally, a set of techniques and data collection methods have been presented which gather and represent the data as the research objectives require. Qualitative and quantitative data types will be considered during implementation/testing of the developed analysis and design framework as appropriate. This chapter has addressed the objective of defining the methodology in detail from the philosophical and empirical dimensions.

Chapter Four: Principles and Model for Socio-technical Systems Analysis and Design

4.1 Motivation of the Exploratory Study

The literature review chapter (Chapter 2) identified that dynamics and complexity in socio-technical systems are increasing; the requirement of analysing, designing and managing these systems is becoming a real challenge. To understand the crucial issues facing modern socio-technical systems, it is necessary to perform a case study analysis to understand how enterprises handle these issues. Which are mainly related to people perception about requirements complexity and dynamics, reasoning process and decision-making, knowledge distribution, management style and planning. Thus to gain a better insight into how best the framework solution can be designed to cope with the current socio-technical challenges. As discussed before, most of the complex issues are embedded in people's interactions in the socio-technical system and its context, where people interact in complex and usually informal relations. Therefore, such issues cannot be discovered unless we understand them directly from the people who are themselves within the situation. This research provides empirical evidence of issues related to the dynamic requirements, knowledge issues and decision-making processes facing enterprises' 'socio-technical systems' adaptation and how they propose to deal with them. The aim of this chapter is to build the theoretical foundation for the socio-technical analysis and design framework.

The interviews were initially conducted in order to identify trends in the key issues facing the modern socio-technical environment in the open business and economic environment and how enterprises handle them, in particular enterprise and small sized IT development companies. Understanding cannot be gained without a deep investigation into the domain in question, where understanding the people involved and the challenges they face in their daily work is a key aspect toward discovering the solution.

The interviews were undertaken with eleven key persons in the IT and IS consulting industry, and were semi-structured, with the goal of understanding the issues related to the decision-making, change and dynamics of business development and delivery, in order to identify the most important issues facing enterprises and the most important tactics they adopt to face the challenges of their highly dynamic and competitive socio-technical environment. The interviews were undertaken with people from a large and a small enterprise. In the two case studies, the key persons interviewed were senior and junior executives belonging to different divisions and roles (strategists, analysts, developers, designers and sales staff). For privacy reasons, the identities of the companies' representatives are concealed. Therefore, in this chapter we will exclude information that could identify the companies and will keep to a general analysis in order to produce an abstract model that will help with understanding current businesses and issues relating to their work processes.

The eleven interviews were coded using special codes, which are described in Appendix D; evidence of the qualitative analysis will be provided in Section 2.

4.2 Findings Regarding Dynamics, Change Requirements and Decision-Making

Two case studies were conducted as part of this research, investigating an enterprise IT company and an SME IT company. The reason behind this separation is the difference in the nature of their business scales and capabilities, which means that the businesses run within different sets of circumstances.

4.2.1 Viewpoint of the Enterprise IT Company

4.2.1.1 Perspectives of Strategic Staff

The interviews conducted with business strategic staff at the enterprise IT company show that several internal and external aspects have influenced the change in requirements from the perspective of the strategic staff: the following aspects were the focus of the interviewees' perceptions:

Customers: Interviewee ESS stated: “The customer’s goal is what the strategy captures”: customers asking for new features of the systems are usually prioritised, especially if the customer is loyal or the company makes a reasonable profit from this customer, or has direct relations with high level strategic people. The satisfaction of this customer is very important to the company for two reasons: 1) The company makes a profit from this customer; 2) The customer’s name/brand reputation is important, as the company wants to use it as a reference to attract more customers. In general, feedback from customers is very important for improving the products. Not only customers, but potential clients can give important feedback.

Senior level strategic staff: it seems that in enterprise IT companies, senior level strategic members make the development decisions based on their understanding and evaluation of the related issues. EBA: "The senior staff have experience about what should be done" - if the strategic members think something should be developed or strategic action should be taken, that will go immediately to the planning and execution phase. ESS: "I decide what should be done": in most cases this involves a meeting with key staff to discuss the issue and end up with a decision. Many decisions are made at a high level where the CEO agrees on deals and development: personal relations help to make deals and patience from both sides is the key to delivering better solutions in the long term. A large margin of freedom is granted to senior strategic level staff to allow them to act in an agile manner during the phase of dynamic requirement changes.

Competitors: Competitor performance is important in driving the enterprise's decisions, as some competitors are trying to gain a large share of the market by implementing unique services and applications to satisfy customer demand, and the enterprise competes in the market by providing their customers with similar services and features, thus gaining further new customers as well as maintaining the current ones. A great deal of research and assessment effort goes into assessing the competitors and their products and services.

Market share: The enterprise would like to maintain and increase its market share, with several acquisitions being made to increase its expectations and a requirement to increase market share in information systems (technology, platforms and applications). Strategic staff understand the important of acquisition for the enterprise to enhance its internal products, increase market share and reduce the competition against its products in the market. This is considered as the organisational goal that guides their strategic decisions and activities: the requirements will change based on the context, performance and capability where the long-term goal is strongly maintained.

Control mechanisms: Staff from lower levels must follow more rules and procedures; higher-level staff have fewer constraints in doing their jobs, as dynamic environments need new decisions to be made continually. Enterprise IT companies have started to understand that they need to be less plutocratic in undertaking their daily work. Someone should decide if they need to do something that should go to the execution phase as quickly as required.

However, the interviewees believe that communication and knowledge-sharing is highly important both horizontally and vertically in the organisational structure in both formal and informal ways.

Besides all of this, enterprise IT companies are continually obtaining feedback from multiple stakeholders such as the following:

Business partners: Enterprise business partners help to identify market trends and market demand. Advice from the business partners is carefully studied and considered when creating the future strategy. Some of the enterprise IT companies does not work in consulting, as they leave this mission to their partners, who consider their company as a strategic technical partner and collaborate to tackle projects together. The partners clearly contributed to the strategic direction of the company; at the same time, the requirements of the business partners are critically considered and discussed within the organisation.

Sales force: One interviewee confirmed that the sales team identify whether the developed products are successful or not highly rated. EBA: "The sales team identify if the developed product is successful or not and discuss this with the strategic team to decide how to respond". During discussion with the strategic team, the next step could be to improve, drop or redevelop the product. Sometimes the enterprise's sales and pre-sales force make an additional effort in analysing and consulting to offer better solutions and increase customer satisfaction. In this circumstance, the sales team know more about the requirements of the market, as they are in close contact with customers. Sharing their concerns with the strategic team is essential to making the correct strategic decision.

Market analysis: The commercial departments in enterprise IT companies perform market analysis to help the company understand their performance and identify trends in customer, product, and reseller performance. This helps to determine how to better forecast business and product directions in order to correctly place investments to maximise ROI. Market analysis plays an important role in providing input, particularly about the external market; at the same time it decentralises knowledge and power about who should decide on the most important strategic consideration to an extent. However, in the end, the planning responsibility will fall under the strategic team's responsibility.

4.2.1.2 Perspectives of Development Staff

The development/technical staff were targeted by the interviews, with a goal of understanding the different perspectives of strategic and technical teams from all levels. Changes in requirements for enterprise IT companies, from the development staff's perspective, are mainly driven by the following:

Staff attitude and awareness: The design and development team in the enterprise IT companies seem used to handling changes in requirements as a fact and part of the nature of the work. Obviously, most of the developers and designers are the highest skilled people in the industry, and try to do their job as well as possible: they bear in mind that working with new requirements every day is part of their responsibilities. Moreover, the development teams in enterprise IT companies know their career path and what skills must be gained to be promoted to the next level. Supported by the agile methodology and iterative approach adopted by many project and product managers, the fusion among analysis, design and development is considered important for better understanding and delivery. Working with an active feedback loop seems to work well for design and development staff. The enterprise IT company's development team is aware of:

- The importance of continuous improvement of the applications and their usability
- The need to adopt new development techniques and new software development life cycles
- The fact that VIP customer satisfaction is a critical factor for an enterprise IT company
- The idea that deadlines can always be challenged (Time vs. Quality)
- The need for a high level of flexibility with no harm to maturity and control (Flexibility vs. Control)

Usually the requirements are checked repetitively; during the development process a document is released at each stage, and this should be signed and approved in order to move to the next level. This tactic aims to improve maturity and control in order to reduce development costs and misunderstandings of specifications. However, misunderstanding of requirements and specifications could happen at any stage; usually companies solve this with informal procedures using phone calls or ad hoc meetings. ESE: "If anything doesn't work, we sit and discuss it and things go well". During the last stage, the quality assurance (QA) team perform the final tests as verification of the functional and non-functional requirements;

the usability team work to identify any usability issues that need to be considered in the design and perform usability tests. This all helps the employees at the operational level to better understand and handle the continuous new requirements.

IS integration: It is obvious that software products and software integration are very important for successfully building information systems in any organisation. When companies try to modularise software, they usually face integration problems. Most of the integration load goes on the customer side to build proper integrated software products. ESS: “we sell it as products or suite products; it is up to you to put effort to integrate it well or not”. This factor contributes in understanding the constraints initiated by sharing the products and technological capability, therefore better conforming to the planned development process.

Project based functionality: In some cases, the enterprise IT company builds specific functionality for specific projects; these functionalities are stored in a functionality catalogue from which customers decide to buy depending on their need. This contributes also in understanding the specific requirements of the customer: processes of localisation and personalisation are highly demanded.

Social and personality issues: In some cases, the personality of the powerful person (either their own characteristics or role based) influences the development and is reflected in the product. When there are several valid options for development direction, lack of analysis and evaluation could result in ambiguous results based on the stakeholder experience. Power factors play a role in the theme of development: in all cases, communication and sharing are the keys to successful development.

Work environment: Companies analyse the issues that could influence products, services and employees; what services and products they offer and competitors offer; what work environment and communication style they have and other companies could have and use to attract other employees. Companies which are trying to maintain their employees still need to know what those who left have in common, and why they left. Analysing the patterns and trends will help better decision-making. Understanding management styles will obviously positively influence the work environment, therefore the results and performance.

4.2.1.3 Business Processes in Practice

We can state that most of the business requirements in enterprise IT companies come from strategic staff and sales staff: the strategic staff are responsible for delivering the requirements documents. EBA: “first of all I have to say that the strategy team are responsible for identifying what the trends are and the gaps are in the market”. The sales staff are usually responsible for commercial issues, customer relations and account management; they look into requirements from a lower scale but they do not make decisions. After the strategic staff makes the decision, the requirements go to the analysis team through the development manager to develop the business processes and functional document which contains the business rules and processes, using business process mapping for analysis and decomposition. Typically, the product manager is responsible for the realisation of the functional and technical specification of a certain product. The analysis staff are very aware of the importance of customisation, localisation and integration issues. The requirements document should be posted and reviewed by stakeholders before the analysis phase. Then all this must be delivered to the design staff to create aspects of the application. After the design phase, the design will be delivered to the development staff for hard coding; this is evaluated and tested by the usability and quality assurance (QA) staff. Any issues arising during the process are posted and discussed, usually informally. ESS: “Processes are hard to change once they are set out, rather than changing the process, staff may set up a face to face meeting and agree on things that could be different”, using phone, email and face-to-face meetings. In the end, someone involved in the strategic staff will decide whether to put it on the catalogue to market, or if it is for a specific customer, the customer will decide whether to accept the developed feature/products or ask for improvements.

4.2.1.4 Causal Relations - Causal Loop Model

The causal factors described in Figure 10 are driven from the analysis of the enterprise process dynamics and probably applicable to most large enterprises from different industries. Strategic decisions are usually influenced by many factors: business partners and the sales team offer a great input to the strategic team regarding what needs to be addressed or changed. To increase market share, decisions to develop products are made; this also influences competitors’ decisions to improve their products and therefore to increase their market share, which has a negative impact on the enterprise’s market share. Customer demands always have a direct relation with market share: increasing market share mean increasing customer demand and requirements. Market analysis will help the enterprise to understand customer requirements and will offer an input to the sales force to offer feedback to the strategic team. Flat control mechanisms positively form staff personality and relations, therefore positively influence the work environment and sales force performance to provide quality feedback to strategic decision-makers.

Nothing can guarantee the applicability at this stage, but in this section, we have tried to abstract the factors and as far as possible draw up a generic model. Also, in many industries certain factors are reported to have increasing rates of change, like those in the enterprise IT company. The result has been a trend towards reduced complexity and a better understanding of influencers. In other words, the causal loop model shown in Figure 10 will today typically act more rapidly than a decade ago. This kind of phenomenon is a key motivator of the research being undertaken to better understand dynamics and change in the business environment.

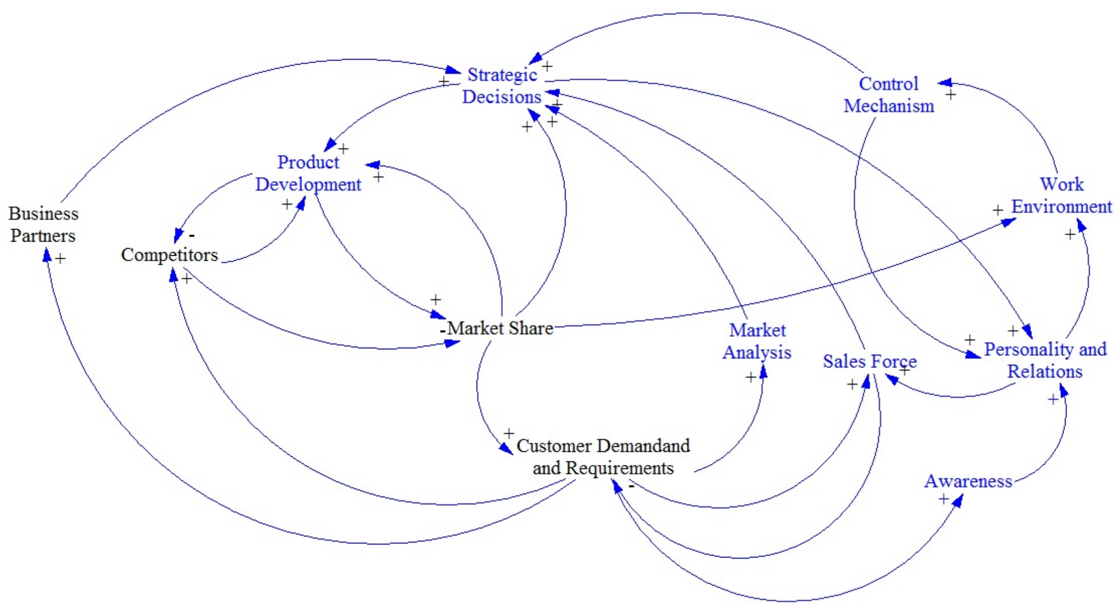


FIGURE 10: CAUSAL RELATIONSHIPS OF INTERNAL AND EXTERNAL INFLUENCERS IN ENTERPRISE IT COMPANY

4.2.2 Viewpoint of Small and Medium Enterprise IT Companies (SME)

4.2.2.1 Perspective of Strategic Staff

During the interviews with staff from the SME company, it appeared that several issues have a major influence on the organisation. The requirements changes in small and medium enterprise (SME) IT companies, from the perspective of the strategic staff, are mainly driven by the following:

Products: Most SME companies rely on their products for making money; they also provide implementation and services for products which could be developed in-house or third party products like SAP, Oracle, and Microsoft. In the case of third party products, the relationship with providers and selling value play an important role in how long the company is keen to keep this product among their offered products. While some other companies do not find it a dilemma to change to a product that has more customer and market demand, most of the SMEs prefer lightweight products to generate money faster. The requirements here are constrained by the product capability: the impact of new/changed products or customer trends on the organisation could be high.

Cost effectiveness: Plug and run is a suitable description of SME strategy: quick and easy money is important for the company's flexibility and freedom in their business model. SMEs offer lower cost solutions and services: although the balance among the triangle of cost, quality and time becomes very difficult, customers are still willing to get solutions that just satisfy their needs. This plays a main role in planning, choosing and adapting the development process.

Limited capability: SMEs cannot accept customers with enterprise projects (large requirements), owing to their limited human resource (skills and technical experience) and budget to tackle these projects. This is considered an important driver for deciding the targeted market segment, solution providers and human resources needed. The planning and development process should conform to the organisation's capability.

4.2.2.2 Perspective of Development Staff

Changes in requirements in SME IT companies from the development staff perspective are mainly driven by the following:

Hierarchy: As with any other organisation, SME IT companies have senior management, mid-management and operational staff. The employees take orders from their direct managers and try to fulfil their requirements; it is rare to see negotiation from employees, who instead work on the requirements while the responsibility for decisions falls on the managers. Unless the employee takes responsibility, they will be very careful in what they are doing and why. In general, small enterprise owners/CEO's act like a "One man band" organisation. SEO: "I usually decide what should be developed, recruitment, negotiate salaries, and build the product catalogue”. In a more traditional style of organisation, but at the same time flexible, a lightweight organisational structure configuration makes it more agile in the phases of market and requirements changes.

Reusability: In SME IT companies, the developers aim to reduce the effort they make by reusing software components from outsourcing or from previous projects. We can state that the development process and results are typically predictable, and the rhythm of development looks similar in most projects, with a low level of learning from experience mostly related to a maximum of 5% improvement in reducing errors and implementation problems. This is not always as radical or enterprising as it should be, taking in consideration the high level of flexibility in small enterprises to adapt themselves quickly to new strategies. This also contributes to their agility in their development processes and ability to handle requirements in a faster manner.

New requirements are always messy: New requirements can create confusing situations for developers in SME IT companies, especially when the requirements present a completely new experience to the development team. SSD: “Sometimes the requirements look like building a space shuttle and sending it to the moon in few weeks” **-** the developer had become used to developing on a small scale with traditional market tools, therefore learning to implement new requirements could create a chaotic situation about what should be developed and how. Sometimes the strategic staff fail to estimate the necessary timeframe to fulfil the new requirements. New requirements in the sense of new for the organisation’s staff to handle can make the organisation unstable: this is the result of lower formality in handling requirements, where having no systematic mature process to treat completely new requirements leaves the organisation in a difficult situation.

4.2.2.3 Business Processes in Practice

Sales and commercial staff initiate the process, starting with the customer signing the order; the project manager locates the resources and calculates the time needed for tasks and project delivery. Depending on the nature of the project, product customisation, configuration, development of integrated components and physical aspects (servers and network specifications) might be required. Product managers follow up with the technical team for any product related issues; the project manager is responsible for delivering and signing the "project completed document". The price and specification are agreed collaboratively among the commercial, technical and project managers; the account manager will discuss technical and functional specification documents with the customer to agree on the plan. Delivering the product is the critical point, where any change or site visits after the signing the document will cost the customer money: usually customers sign support and services contracts for a year, which will commonly be extended for a couple of years more.

4.2.2.4 Causal Relations - Causal Loop Model

As with the previous casual relation description model, the causal factors described in Figure 11 are driven from the analysis and are probably applicable in most SMEs in different industries.

Strategic decisions in SME IT companies are influenced by the availability of the products in the market, since the SMEs usually build solutions based on other large software warehouses' products. This allow more flexibility for changing products based on market trends but the limitation of capability makes it difficult for the SMEs to handle large customer requirements: the cost of the projects might affect the profit, therefore they stick with small and easy projects rather than taking on the risk of a large project. Competitor capability affects prices and affects the SME's ability to attract customers when the competitor can handle large customer requirements. Since control mechanisms in SMEs are more centred around the owner and shareholders, the personal flexibility of employees is high, which has a good impact on productivity, but the ability to influence strategic decisions is much lower.

This generic model is at an abstract level: in many industries such factors are reported to have increasing rates of change like those in the SME IT industry. The result has been a trend towards reduced complexity and better understanding of influencers.

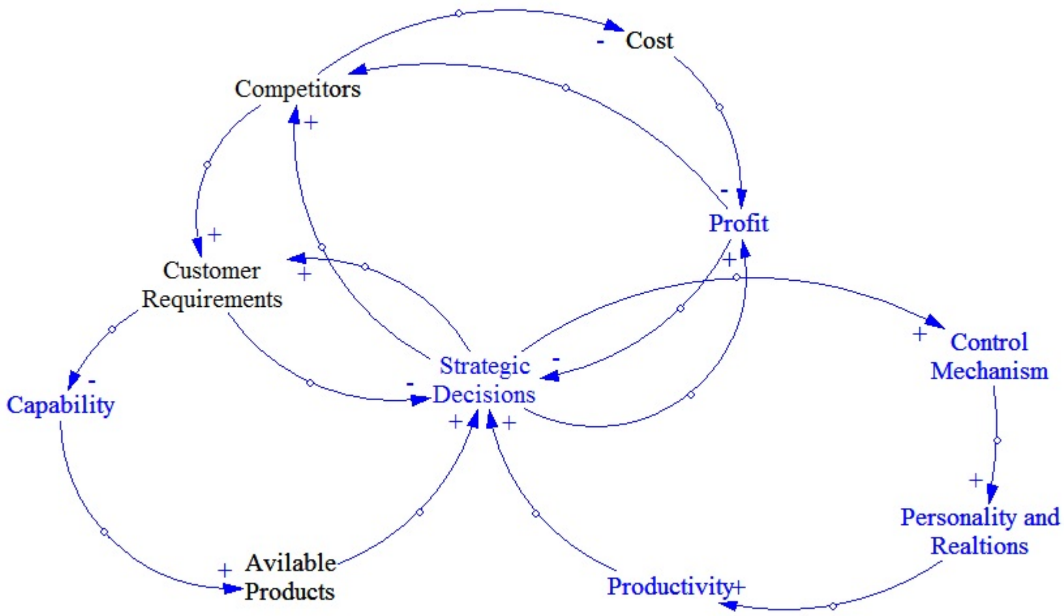


FIGURE 11: CAUSAL RELATIONSHIPS OF INTERNAL AND EXTERNAL INFLUENCERS IN SME IT COMPANY

4.3 Developing New Principles to Guide Socio-Technical Systems Analysis and Design

Based on the case studies analysis, we have seen that an organisation's full context needs to be clearly understood and defined; the story of the enterprise business, value creation, customers, partners and distributors needs to be identified in order to understand the flow of knowledge and artefacts in the complex network. In order to better understand and better govern the activities in the organisation's context, we will now investigate what complexity theory[7] can offer in this context, particularly in describing the complex and dynamic phenomena in the socio-technical environment.

4.3.1 Complexity Perspective on Dynamic Socio-Technical Environments

Social sciences appear to seek improved scientific legitimacy by copying the century-old linear deterministic modelling of classical physics—with economics in the lead (Henrickson

[7] Set of concepts that attempts to explain complex phenomenon not explainable by traditional (mechanistic) theories. It integrates ideas derived from chaos theory, cognitive psychology, computer science, evolutionary biology, general systems theory, fuzzy logic, information theory, and other related fields to deal with natural and artificial systems as they are, and not by simplifying them (breaking them down into their constituent parts). It recognises that complex behaviour emerges from a few simple rules, and that all complex systems are networks of many interdependent parts, which interact according to those rules. Reference: http://www.businessdictionary.com/definition/complexity-theory.html#ixzz2PdbCYQGd

and McKelvey, 2002); at the same time, natural sciences previously strongly rooted in linear determinism are trending toward nonlinear computational formalisms. The postmodernist perspective takes note of the heterogeneous agent ontology of social phenomena, calling for abandoning classical normal science (described by Thomas Kuhn (Hoyningen-Huene, 1993)) epistemology and its assumptions of homogeneous agent behaviour, linear determinism, and equilibrium. Nevertheless, postmodernists seem unaware of the ‘new’ normal science alternatives being unravelled by complexity scientists. These scientists assume, then model, autonomous heterogeneous agent behaviour, and from these models study how supra-agent structures are created. Scrapping the equilibrium and homogeneity assumptions and emphasising instead the role of heterogeneous agents in social order-creation processes is what brings the ontological view of complexity scientists in line with the ontological views of postmodernists. Example, as in spontaneous order creation of the ‘melting’ zone (Kauffman, 1993) which begins when three elements are present:

1) Heterogeneous agents
2) Connections among them
3) Motives to connect – such as mating, improved fitness, performance, learning, etc.

Therefore, from the complexity science point of view, the network structure of the organisation and environment are constructed by autonomous agents, interacting with each other internally and externally, from which evolution in the agent parameters will emerge: this could be reflected in their behaviour and in their impact on environment. These agents interact with a level of freedom for self-organisation and situational confirmation. The agent concept is presented in complexity science as a collection of properties, strategies and capabilities to interact with artefacts and other agents within the context.

The concept of emergence in complexity science has been adapted to many cross-domains in organisational behaviour, leadership, market strategy, risk assessment and mitigation (Ellis, 2004; Henrickson and McKelvey, 2002; McKelvey, 2010a). The concept of emergence was applied for engineering the software part of a system, leading to an agent-oriented software system. Moreover, it can be adapted on a methodological level. Agent-oriented techniques can make a substantial contribution to the implementation of information systems by providing additional functionality and better user interfaces. In software engineering activity, the advantages of the agent concept over other concepts like that of object is not obvious and may depend on the nature of the system to be developed. Conversely, for the requirement’s engineering activity, the concept of the agent seems necessary because of the need to model the environment of the system and because of the natural decomposition of this environment in terms of agents. The concept of object (Meyer, 1988), though resembling that of agent in some respects, lacks some properties that are needed when defining requirements. In classical object-oriented modelling, communication among objects is often simplistic with regards to that occurring among real world entities and is usually limited to message passing or synchronisation among objects. Communication in agent languages is usually far more developed (see e.g. Finin et al., 1997) and allows for communication actions with a higher semantic content and agents with greater autonomy having the capability to decide when they communicate or not.

Furthermore, McKelvey's (2004b) Distributed Intelligence (DI) is an important concept referring to the intelligence of all agents as an evolution in intelligence. The fundamental point of DI is that the intelligence of the collective of agents is not equal to the sum of their individual intelligence; it is usually greater than the sum.

The adaptive tensions (McKelvey, 2010b) created by discrepancies between the requirements in the environment and the actual resources of the organisation may lead to an organisational response in the form of an emergent overall strategic direction that cascades down the organisation in the form of team goals or assigned tasks. For example, when organisation implement new technology, there is always level of tension between this technology and the new environment where it has been implemented, adaptive tension play a role of force to adapt such as technology, this force could be managerial from high-level management to implement such as technology in the environment. To address the complexity of their task environment, agents and their interactions reconfigure themselves by continuously creating new and unpredictable forms of emerging order (Holland, 1998). I argue that the discrepancies not only happen to the resource: the environmental dynamics influence the enterprise system requirements and indirectly influence the resource. As the environment is unpredictably dynamic and the requirements may not feature accuracy and clarity, thus the need arises to make the resources continually evolving for self-organisation and conformation to the new requirements. Figure 12 is a conceptualisation of the complex dynamic interaction in complexity theory.

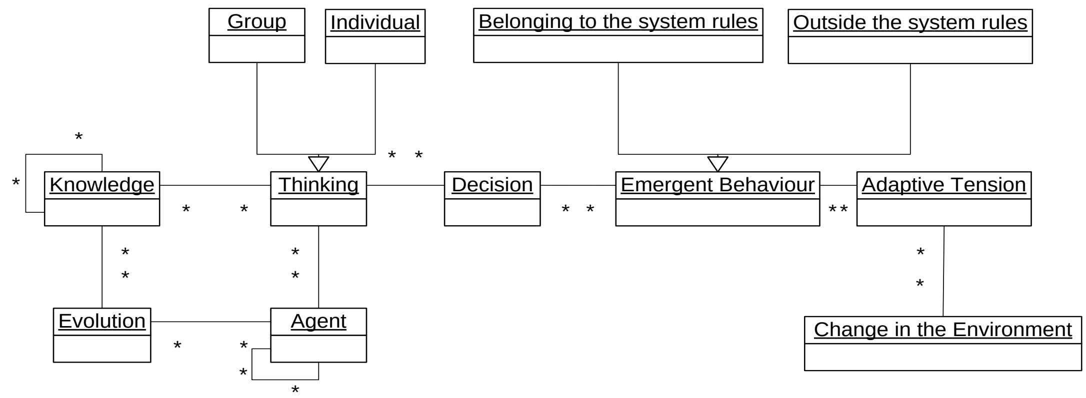


FIGURE 12: COMPLEXITY AND DYNAMIC CONCEPTUAL MODEL

- Interaction among agents causes group thinking: this will speed up learning and cause distributed intelligence, which gives rise to knowledge emergence.
- Agent evolution causes change in the way an agent interacts with other agents: "interaction protocols". This evolution will increase heterogeneity among the agents and will affect the motivation of connection.
- The emergent behaviour of the organisation in response to the pressure of adaptive tension can come in the form of new organisational requirements: these may require new or adapted resources.
- The emergent behaviour of individuals can arise from self-organisation if it follows the rules and conforms to the organisational goals.
- The emergent behaviour could represent a risk if the agent acts outside the rules or against the organisational goals.
- However, the emergent behaviour in return will result in a change that also influences the environment.

Table 10 gives a semantic mapping between complexity theory constructs and socio-technical constructs based on the methodology of framework for theory development (Kuechler and Vaishnavi, 2012) DREPT steps:

TABLE 10: MAPPING COMPLEXITY CONSTRUCTS TO SOCIO-TECHNICAL CONSTRUCTS

Complexity theory construct/proposition	Socio-technical construct/proposition	Semantics
Heterogeneous Agents	Agent/actor	Agents/actors in socio-technical systems have different types, some interact internally and some externally
Agent Motivation	Motivation/Goal	In socio-technical systems, motivation and goals could be for an individual agent or for a group of agent
Self-Organising	Independency and freedom (bottom-up)	Agents have the ability to behave freely either to support or harm the system (need control in terms of human agents, and need intelligence as software agents)
Control Mechanism	Control (Top-down)	Directives required to govern the socio-technical system design and operation, also to direct the agents' behaviour
Adaptive tension	Event based directives and enforcement	The adaptive tension is an event based motivation objective, it is work as an energising device to help in self-organising and can be a negative or positive directive: it can be adapted to socio-technical systems as event based directives
Distributed Intelligence	Collaborative knowledge	Collaboration among agents produces an evolution in knowledge from explicit to tacit which needs to be codified again
Evolving	Evolving	Evolving is a socio-technical system characteristic, and can involve evolving in knowledge, evolving in structure and evolving in the interactions. Evolving can be manual by a human agent, or automatic by a software agent.

The previously adopted principles will help to form new principles for understanding, analysing and designing socio-technical systems. These principles should be considered when developing the prospective modelling framework.

4.3.2 Socio-Technical Systems Dynamics in Practice

In Baxter and Sommerville's (2011) proposal of a generic pragmatic model for socio-technical design, the model is presented as integrated development circles: 1) Organisational change process, the main objective in the organisational change cycle is to understand the behaviour and goals associated with the change activities; every time a new goal is instituted, the organisation should follow a specific process to ensure the quality of mapping and implementation. 2) System engineering process, this shows the activities to be conducted to choose, design and implement the information systems. 3) Socio-technical system engineering, to bridge the two by aligning organisational change to system engineering using sensitisation and constructive engagement (Baxter and Sommerville, 2010). However, this model still lacks interoperability and realisation since it does not propose an explicit detailed implementation process or consider the environment as an input to organisation internal.

I see the socio-technical system in a different way. If we look more closely at the environment, generally, we can distinguish main components: the social system, business and economic system, political and regulatory system and ecological system, which are considered to be the three higher-level components responsible for producing the characteristics of the environment in which the system/enterprise operates. These guidelines and policies represent the top-down approach for imposing facts and obligations that need to be considered in the operative system. The most important fact is that these systems are all highly dynamic, characterised by uncertainty and hard to predict. Thus, the requirements of any operative system emerging from such an environment evolve continually to conform to the dynamic environment.

On the other hand, the resources components should be designed carefully to match requirements. We need the appropriate organisational structure and human capital investment, and the appropriate information and knowledge to help us to advance the work and achieve the goals. Additionally, we need to build a suitable information and technical system structure to support our business model as represented by the business activities. All in the end need financial resource and supportive assets. In general, the business model could take one of two forms: 1) An essential business model; and 2) A comprehensive and domain-based business model. The essential business model is that what enable enterprise to achieve specific purpose, through specific process and under specific circumstances. Therefore, we should look at information systems (ISs) as essential information systems represented by the business motivation, business process system, rule management system, event management system and required services to generate value. For comprehensive domain-based information systems (ISs), we need to decide on the components, configuration and size/capacity of the information systems: do we need ERP, CRM, SCM system applications and so on? Do we need to develop new systems, COTS products, or maybe cloud services? The complexity of the system could be reduced by using techniques that consider structural and behavioural aspects. A system is considered to be complex if it has many changeable components with many dynamic relations/interactions; behavioural aspects could also be the reason for a large, ambiguous number of possible future statuses of the component. As a result, we can distinguish four important analysis points of view: the point of view of the typical agents and their interactions in the business context need to be taken into consideration when designing socio-technical systems to improve contextual sense-making, as follows:

- The agent is outside the enterprise and looks at the service or value that the organisation can deliver to them, and what impact this organisation can bring to environment
- The agent is inside the enterprise and looking outside the organisation: who are the customers, how do we deliver value to them, and influencers of internal processes. (What are the interfaces with the customers, and how do we cope with the market).
- The agent is outside the enterprise and looking at the whole value network, including the influencers (ecology, economy, politics, etc.), and how they work together.
- The agent is inside the enterprise and looking into the details (capabilities, resources, products) that are required in order to fulfil tasks and achieve the organisation's objectives.

The evolution of socio-technical systems should be supported with an abstract model and a reasoning technique to guide the response to changes in the socio-technical system environment and the biddable interactions of its participants, particularly within organisational models and processes, as specified in Hall and Rapanotti (2005). Sterman (2000) argued for the need for an increased understanding of dynamic and complex business problems by expanding mental boundaries; the results will appear in the form of accelerated decision-making and learning about the complex business environment.

Here the proposal of a new model conforms with complexity theory. As suggested previously, three categorised levels are proposed - environment, enterprise and resources; these are intertwined among each other in terms of both action and feedback. Additionally, the major contribution of this framework that it is intended to offer an alternative implementation model that has the ability to systematically and systemically implement socio-technical change using existing open industry standards and tools. Thus, the model offers a way to bridge the gap between the theoretical and practical domains by realising theory operationalisation. In addition, it represents work continuity in each perspective, where knowledge is produced in some stages and diffused and used in another stages. The research will consider feedback mechanisms to describe the dynamics and rationale for reasoning and justification as ways to fulfil a socio-technical design gap. On the IS side, during any activity involving socio-technical systems, humans should handle some of the activities, and some other activities can be fully automated. The concern of implementation is how to define a robust approach that can handle the dynamic requirements of the internal and external configuration. The research suggests that essential information systems are required for efficient business operation management and monitoring that have an agility suitable for handling changes in the environment. From the research point of view, the development will be based on modern approaches to managing information systems through Model Driven Architecture (MDA) and Service Oriented Architecture (SOA). Methods presented in much research (Meijler, 2006; Vidales, 2008; Kim, 2008; Radhakrishnan and Wookey, 2004; Jardim-Goncalves et al., 2006) show the usefulness of this approach in the realisation of research propositions.

The most innovative part of the proposed socio-technical model is the alignment among environment, requirements and actual resources, represented by two important activities in the framework: Sense-making and Constructive Fusion.

- **Sense-making and reasoning:** awareness and sensing around the hypothesis, expectation, design options and alternatives. This activity is concerned with how to make the most sense of the situation and the possible future directions; how we can design a stable socio-technical system by providing a clear justification and argument regarding our choices, which is based on assessing the internal and external issues/influencers. It is important to understand issues of what aspects are under enterprise control and what aspects are out of enterprise decision, however, the enterprise context and the external aspects should be well understood and assessed. Also it is important to understand the interfaces between the enterprise internal and external, and what are the formal and non-formal inputs and values for both. After all, the enterprise needs to test the robustness of its internal system during each phase of organisational design and modelling.
- **Constructive Fusion:** the collaborative visual design process. This starts by understanding all of the related concepts, and shares common understanding among stakeholders, ensuring that the knowledge flows smoothly among all stakeholders in order to build a robust alignment between the designed system components necessary for building a mature, modernised socio-technical system. Not only used for design

alignment, this is also a post-design technique for providing feedback: once a change occurs in a certain component, it alerts the other related components to adapt to the change. This continuous learning through building in a collaborative manner is one of the most important characteristics of constructive fusion. A generic model for these activities is represented in Figure 13.

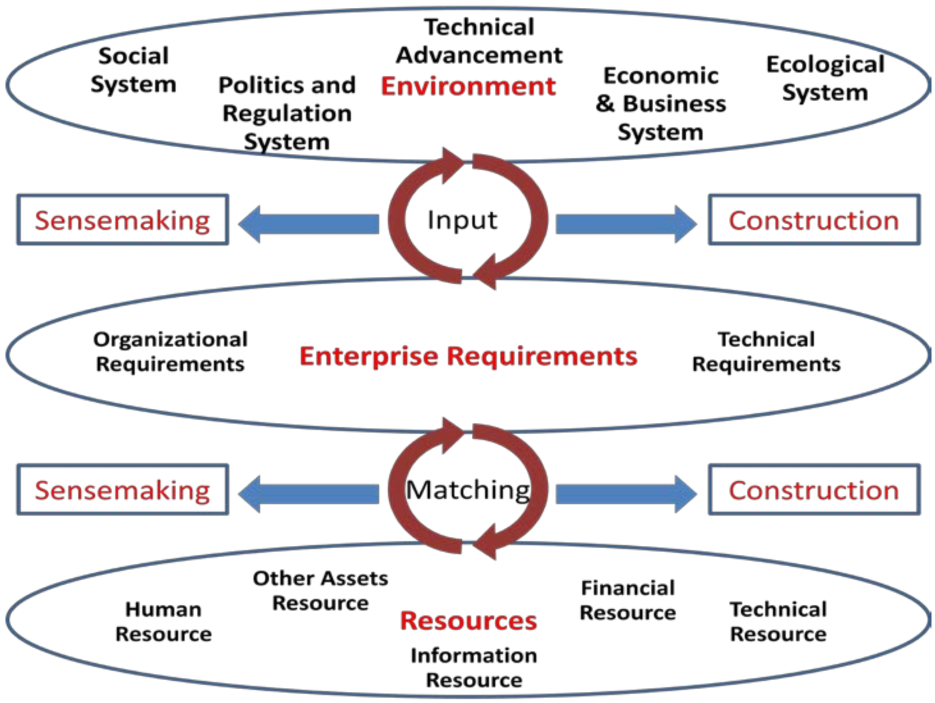


FIGURE 13: GENERIC DYNAMIC SOCIO-TECHNICAL MODEL

In particular, this offers a new conceptual interpretation of the current complex dynamic socio-technical environment by adapting complexity theories; new principles have emerged when complexity theories are reinterpreted to describe a way in which to handle dynamic requirements, analysis and design socio-technical systems. These have emerged from the analysis of the interviewees' answers as follows:

4.3.2.1 Principle 1 - Descriptive: The dynamics of the organisational environment is an input to the organisation's internal aspects

The environment is dynamic and there is an unclear interface between the environment and the internal aspects of the organisation. Therefore, it is essential for sustainable practices that the analyst should understand the change rate of environment artefacts and bridge the gap between these and the internal activities to adjust work practices to match the context requirements. This principle has been derived from aspects of complexity science theory related to the concepts adaptive tension and change rate, which in complexity theory are considered a reflection of ideas of the environmental dynamics where the environment has an interface with the internal activities of the organisation; this interface passes the change from/to the enterprise at different change rates and speeds via so-called strange attractors (Pavard, 2002).

4.3.2.2 Principle 2 - Requirement: Knowledge as a key asset

The enterprise's knowledge, especially in the information era, should be managed carefully, understanding the knowledge life-cycle (creating, codifying, storing, sharing and using) across both tacit and explicit knowledge types and escalating collaborative knowledge for innovation, creativity and maintaining competitive advantage. All enterprise knowledge is based on formal and informal interactions in a dynamic network topology. In other words, human actors should learn in the real timescale; for intelligent systems applications, artificial agents should have the ability to perform a dynamic search in the real timescale, as well. The artificial agent's learning and adaptation will be based on knowledge that will be perceived from input tools (Knowledge Management (KM) tools), and it is the agent's responsibility to extract the required knowledge from the tool repository or database then use it according to its role which will be controlled by governance rules, and the same situation applies with the human actors. This will support McKelvey's (2004b) notion of Distributed Intelligence (DI).

4.3.2.3 Principle 3 – Analysis Requirement: Analysts and designers as evolvers of internal design with context

Understanding the change rate and what needs to be done to evolve with environmental change is mostly the responsibility of analysts and designers, where they need to evaluate, assess and reason about the internal structure in order to cope with changes in its context. Sterman (2000) argues for the need for increased understanding about dynamic complexity by expanding mental boundaries resulting in accelerated decision-making and learning about complex environments. Analysts can use special analysis tools and techniques to do so; intelligent systems can support the fulfilment of some areas in sensing the change in the context. Thinking and creativity are one of the important means of survival for enterprises. Without human sense, it is difficult to cope with changes in the environment. In complexity theory, the concept of modular design is a way of designing independent sub-components and attractors in a structured manner in order to help to facilitate and bring evolution into the internal level; modular designs act as 'Cellular Networks' containing nodes working as adaptive units characterised by high autonomy, with a certain level of control and flexibility.

4.3.2.4 Principle 4 - Analysis and Design: Structure vs. dynamics

A first-time setup needs to be structured, and enterprises should always define their 'as-is' status, where the enterprise needs to clearly define where they stand by modelling the ends and means in order to facilitate the complexity: these will evolve with the context over time. The 'to-be' status can be defined, but by using simulation and dynamic modelling, the organisation can also illustrate the 'to-be' status under different circumstances and conditions. Understanding the emergent and chaotic situation makes the enterprise able to sustain itself during high-tension situations without malfunctioning. In complexity theory, adaptive tension causes several transitions, and it is noticed that critical values such as emergence and chaos could cause disruption. Environmental, organisational and technology change rates should be balanced carefully with defining clear interfaces (adaptive tension) to pass on patterns and map the artefacts.

4.3.2.5 Principle 5 - Design: Strategy and rules as a governance hub

A top-down 'official' and goal orientated approach provides a framework and guidelines for the internal structure. The ends and means of the organisation are not always followed strictly by the employees, nor should they be in some cases. The value lies in building a comprehensive reference model to be followed in the usual work routine and in exceptional scenarios, which are to be continually assessed and re-evaluated. In complexity theory, the heterogeneous agents interact within the environment, agents governed by rules, and the different types of rules required to: 1) govern attributes, 2) govern interaction 3) govern change. However, self-organisation is a characteristic of agents.

4.3.2.6 Principle 6 - Design: Technology architecture as enforcement level

As the documented 'ends' and 'means' do not necessarily really reflect the real situation, and stakeholders' goals might be varied and changeable, implementing technology such as business process management, rules engines, access control policies and performance measurement with dashboards can provide the necessary control and insight about real activities. Commonly, technical systems are characterised by less autonomy and less uncertainty compared to social systems. Governing human behaviour using technology is desirable in order to reduce human error and increase monitoring. The technical architecture can provide real-time feedback that allows the consideration of new requirements once they are needed.

4.3.2.7 Principle 7 - Design: Design vs. architecture

Design is a field of science which needs creativity and talent, whereas architecture needs systematic engineering processes with quantitative and mathematical calculations. Design needs to be more dynamic and adaptive; architecture looks more solid, usually the architecture play the role of incubator or framework for several design aspects, while designs change over time, evolve with new requirements and is shaped in different ways depending on the designer's experience. Linearity and non-linearity, autonomy, intelligence, chaos and socialisation are all concepts contributing to both fields. Design is mostly associated with interfaces, human understanding, reflection, cognitive, mental and sense aspects, where architecture is associated with measurement, skeletons and the tangible value of human use. The activities of design and architecture represent the difference between a mental cognitive task, which has a higher level of flexibility and quality judgement, and a practical/applied task, which is more controlled and structured. In the organisational/IT domain, we first think about architecture as a boundary defining upper and lower limits, then there is a degree of flexibility to decide the design based on criteria of preference.

4.3.2.8 Principle 8 - Design and Operation: Personal goals vs. organisational goals

As the actor, person or agent is autonomous, they are expected to have a personal goal. Everyone sets personal goals as a way to focus their effort and energy, and when working towards these goals, actors form and shape their behaviour to conform with their goals. The goal could be partnership or team shaped as well, therefore the business and organisation can define their goals to work towards an achievement. It is critical for the organisation and employees to match their goals. A negative work impact is caused when the staff of the organisation are working toward goals that contrast with the organisational goals: selection, planning and monitoring the human resources is crucial, while it is obvious that the existence of conflicting personal and organisational goals will harm employees' motivation to achieve the organisational objectives. It appears to be easier and more useful to have artificial agents and smart ISs to do the job, since the system goals are instituted by the enterprise, although it is tricky to obtain good analysis that will reflect the business needs being implemented in their IS infrastructure as required.

4.3.2.9 Principle 9 - Operation and Design: Autonomy vs. control (process)

Individual agents/actors are characterised as autonomous. Putting autonomous entities into an organisational entity contains a risk of emergent behaviour ambiguity unless it is well controlled and governed. Computer science work aims to build more smart systems from dumb components, while organisation management science aims to improve the control of autonomous social entities. Hence, multi-agent systems can be used to make software systems that are more intelligent and autonomous and workflow systems that control people's activities; this is the first step to full high-level socio-technical system integration. Furthermore, rules can govern behaviour, and processes can organise activities in a systematic and structured manner. Quality alerts and dashboards can provide more insight by pointing out misconduct that can be handled in real time. At the same time, emergent behaviour could be necessary to handle completely new and unassessed situations for self-organising towards the organisational goal, so it is important for agents/actors to have an acceptable level of flexibility to solve emergent issues.

4.3.2.10 Principle 10 - Operation: Lower-level activities form the higher image

The activities of the lower-level employees or actors actually shape the enterprise structure. Networking, formal and non-formal relationships and knowledge flow among employees are what really define strategy. Accepting the fact that heterogeneity is natural, and can give the work its unique fingerprint is necessary for innovation and creativity. As stated in complexity theory, the concept of self-organisation aims to offer the agent autonomy and flexibility to change their behaviour to conform to a new status or objectives. Many self-organising agent models have been proposed in complexity science, reflecting social behaviour in society. Since business and IT design usually use the top-down approach, the management and adaptation is bottom-up and needs to emerge from existing factors. Mixture of both in design and operation time can enhance the performance.

4.4 Reflection and Conclusion

Overall, after conducting the interviews with senior and junior technical and strategic staff, from the enterprise IT company and SME, it was clear that the awareness of employees shaped matters in different ways. Most people are clearly looking at the patterns in the business and work environment to shape their own understanding, while others prefer to understand and follow work procedures/rules to construct their professions, and finally others prefer to communicate, interact and share experience and knowledge with their work colleagues to build a comprehensive understanding that is influenced socially. Regarding the influencers and change drivers, the companies are different in their motivation and change drivers. The research shows that the enterprises and SMEs have clear different drivers for change, where change in enterprise companies is mostly pushed from external sources and in SMEs is mostly pushed from internal resources. This is because the enterprise companies have a strong position in the market, and all they need to do is conform and react to external changes in order to maintain this position, whereas SMEs have more limitations in their capabilities and resources. However, companies need to be aware of the risk of relying on trends; trends can help SMEs in approaching customers with a strong market grounding, but it will not help them to understand fully business and market behaviour (e.g. in the case where disruptive technology is introduced) in-depth future forecasting for all possible scenarios is required. Job security, career path clarity and long-term strategy are much lower for SME staff than staff in enterprise companies: staff attitude is basically built based on past experience, and this is how they predict the future, based on their past experience in certain companies. Nevertheless, technical staff are less concerned about decision-making, company position and value generating than strategic staff, who stand on top of their responsibilities. Staff from all levels and organisational types are more likely to use informal communication to resolves issues raised during the work process: easy and fast methods are preferred for communication, discussion of work and the achievement of agreement. In the end, uncertainty does not make people feel comfortable, but, luckily, human nature conforms to self-organisation and means of survival, which make them able to feel optimistic about what will happen to them in the work environment.

Large enterprises consider technology as a strategic capability, where part or all of the business model relies on technology and technology innovation, and some other companies use technology heavily in their business activities to support the primary processes, communication, analysis and reporting. Finally, it is often in small enterprises that the technology has minimum involvement, mainly in office applications, emails and supporting data sheets. Enterprises are aware of competitors' technical capabilities, and always try to adopt something similar (latest technology and practices). The funding theme conforms with the classification of new requirements presented in Miller et al. (2009): this offers a supportive background to the research process and results.

Most importantly, in this chapter new descriptive guiding principles have been presented which enable analysts to understand the current complex and dynamic socio-technical environment. These principles emerged through the application of complexity theory to socio-technical systems in order to interpret information collected from the interviewees based on theoretical assumptions, thus helping to provide a better description of the complex socio-technical systems and provide principles to handle the analysis, design and operation of socio-technical systems (Table 11):

TABLE 11: SOCIO-TECHNICAL SYSTEMS ANALYSIS AND DESIGN GUIDELINES

Principle guideline	Description
The dynamics of the organisational environment is an input to the organisation's internal aspects	Analysts should understand and consider the fact that the environment is dynamics
Knowledge as a key asset	Enterprise must have a holistic knowledge of the enterprise activities and enterprise environment
Analysts and designers as evolvers of internal design with context	The enterprise Analysts and designers should take the initiative to bring external knowledge to internal design continuously
Structure vs. dynamics	Enterprise needs to have both structural and dynamic models in order to help understanding different enterprise settings
Strategy and rules as a governance hub	Enterprise should establish a clear strategy and directives to govern the enterprise activities.
Technology architecture as enforcement level	Technology must enforce the rules and help to fulfil the strategy
Design vs. architecture	Enterprises should take into design consideration the long term scalable architecture, and more flexible designs that mostly will change more frequently
Personal goals vs. organisational goals	Enterprises should be aware about the impact of staff personal goals, and align it to strategic goals as possible
Autonomy vs. control	Staff activities most organized in structured processes with very detailed specific performance measures.
Lower-level activities form the higher image	Enterprises should be aware about the impact of actual activities in the operational level. These practices which actually form the enterprise overall performance and the general image

Chapter Five: Socio-technical Systems Modelling Framework

The main objective of this chapter is to propose a holistic analysis and design framework for socio-technical systems that can deal with dynamicity and complexities by building enterprise models integrated with reasoning and dynamic modelling capabilities in order to support decision-making, increase insight and efficiency and reduce the complexity of socio-technical systems analysis and design. A framework was proposed to meet the socio-technical analysis and design challenges called Reasoning in Dynamic Business Motivation Model (RDBMM). The RDBMM framework will have three contributions: 1) Metamodel levels containing artefacts and separated into different views; 2) Implementation process consisting of a set of steps and practices; and 3) Selecting a set of supportive modelling tools to represent the artefacts as formal models.

5.1 Motivation for Modelling Framework

New principles to guide the current socio-technical systems analysis and design process have been presented in the previous chapter. The research has adopted complexity theory to generate these new principles to offer better understanding, aid analysis and design the current socio-technical system including issues related to understanding the dynamics nature and decision-making for STS analysis and design. To take these principles further for the implementation level, it is necessary to build an appropriate structured, systematic and detailed framework to achieve the analysis and design objectives. The gaps identified in the literature review chapter will be considered in developing the prospective framework, and it is necessary to build a hybrid-modelling framework able to facilitate socio-technical systems` modelling complexity and dynamicity.

However, in order to build such a framework, I need either to build a framework from scratch, relying on integrating concepts from several previous works and frameworks, or adopt/reuse and adapt a solid well-built framework that already exists and is used by practitioners (such as the frameworks discussed in the literature chapter) in order to build the prospective framework around it.

To address this research challenge, the following contributions are undertaken and described in this chapter:

1) A framework metamodel based on three levels of abstraction, the highest level suggest using three modelling techniques to analyse and design socio-technical systems efficiently; 1- Enterprise modelling 2- Reasoning modelling and 3- Dynamic modelling. For enterprise modelling, I have selected the BMM metamodel, which also was enhanced by new artefacts and later was organised into six views. The separation into six views was made to confirm with complexity theory constructs and also in order to separate modelling concerns and to fulfil the requirements of holistic socio-technical system analysis and design. This in order to face challenges of complexity and dynamic environments using particular modelling tool for each view.
2) A systematic sequential process to implement the framework. This process is an enterprise goal oriented sequence in order to design lower levels enterprise components that match exactly the needs of the higher components, the process align strategic, operational and technical levels starting with the enterprise motivation and ends up with technology and operation management and monitoring.
3) Identification of supportive (analysis and design) modelling tools/languages. These tools fall into three modelling techniques as stated before: 1- Enterprise modelling 2- Design rationale for reasoning and 3- System dynamics modelling for simulation. The selection of the tools was based on their open standard nature and their capability to address the metamodel views, which are also based on their potential adoption by industry. These tools helped to facilitate knowledge through formal models.

In summary, the key objectives of this chapter are to develop an analysis and design socio-technical framework that allows consideration and alignment of both social and technical aspects in enterprise context, which also improves the alignment between strategy, operation and technology. It will offer better reasoning about alternatives supporting decision-making in phases of change, and how these aspects are influenced by internal and external factors, particularly by building reasoning and dynamic models to identify the dynamics and impact of any particular artefacts. The framework is also taking into consideration social design artefact principles as a theoretical background of this framework.

The chapter comprises six sections: Section Two discusses a theoretical background to support the framework assumptions from the perspective of the social artefacts and design literature. This discussion will provide theoretical evidence supporting the concepts developed in the prospective framework beside the discussion of complexity theory (Chapter 4). Section Three details a proposal for a hybrid-modelling framework, the Reasoning in Dynamic Business Motivation Model (RDBMM), the levels, views, implementation process and modelling tools are presented. Section Four will discuss how the framework conforms with the principles proposed in Chapter 4 to guide socio-technical systems analysis and design. Finally, section Five presents reflections and conclusions.

5.2 Grounding Theoretical Assumptions to Support Development of the Modelling Framework

Lane (2009) argued that everything we do involves interactions with artefacts that help us to communicate and generate new artefacts. Almost all of our interactions depend on organisations for their settings, purposes and rules, whether they are universities, businesses, government agencies, political parties, law courts, police forces, armies or social networks in real life or even on the internet. Lane also argued that humans did not invent either artefacts or organisations, but rather these arose from and were a feature of biological evolution. Likewise, interpretivist information systems research assumes that the social world (relations, organisations, division of labour) is not ‘given’. Rather, the social world is produced and reinforced by humans through their action and interaction. Organisations, groups and social networks do not exist apart from humans' motivation to communicate and interact, and hence these difficult to be captured, characterised and measured in some objective or general manner.

Since the new design and development methods are concerned with creating and using the artefacts, these artefacts should take into consideration the context of the system. Gero and Kannengiesser (2003a; 2003b; 2003c) argued that structure, behaviour and function parameters can represent different aspects of artefacts design, where multiple agents’ perspectives can offer an accurate view of the design situation. To handle the design issues, the authors built a framework linking these three aspects, in which they assumed that knowledge is grounded in experience and interaction with the environment. This is what gives the environment and agent the dynamic characteristics necessary to continuously improve the design based on the knowledge acquired. Moreover, Lane (2009) argued that the artefacts emerged in circumstances with properties described as the following:

- Artefacts: drive and help to build new components/services
- Artefact settings: the configuration or characteristics
- Purpose: the goal and the underlying intention for creating artefacts
- Rules: needed to govern behaviour to use and produce artefacts
- Roles: roles of the artefacts and their users/agents
- Interaction: among the agents, services or artefacts in their networks

These are applicable to socio-technical systems, where artefact design is knowledge creation, and the settings are related to the technicality and mechanism of creating and using these artefacts. The purpose is the motivation to create and use the artefacts, rules to govern the behaviour and roles to assign responsibilities, and finally the interaction among all of these in their context. However, Jarke et al. (2011) and Mumford (2006) argued that there is no complete design and the requirements keep intertwining within the context, also the design evolves gradually with ecology. Gero and Kannengiesser (2003b; 2003c) present the additional argument that not all of the requirements are known at the outset of a task, so conceptual design involves finding what is needed and modifying it again during the process. This makes the environment within which the processes operate dynamic and uncertain. Since knowledge is grounded in the environment and the agent interacts with the environment by performing tasks, the agent's worldview changes depending on what they do. The potential realisation of these theories relies on the idea that in order to analyse business complexity and dynamic change, consideration needs to be given to the need to decompose business models into smaller components and the need for those components to be at the abstract level. In the most suitable cases, this will be simulated or implemented in ISs or at least have a direct mapping to IT/IS components on the execution level. Since socio-technical systems have emigrant properties for each whole system and depend on the system components as well as the relationship and dependencies between them, this makes the socio-technical properties consistently dynamic and subject to change.

Based on the previous assumptions, the research will map out a facilitated approach covering the perspectives of the parameters mentioned in Gero (2003) and Lane (2009), which can be explained thus: every complex business model can be decomposed into: 1) rules, 2) processes, 3) events, 4) structures, and 5) functions. These five components will give answers regarding: 1) the "where" and "when" as temporal and physical constraints; 2) the "how"; 3) the "what" event cause and "when"; 4) what "thing" and "relations"; and 5) "what" to do. Considering that every autonomous entity has a certain goal and that that goal needs a process to be fulfilled under specific rules, this process needs specific functionality; this could be related to temporal and physical events and could come from outside or inside the system. The enterprise model based approach (Loucopoulos and Kavakli, 1995) integrated with dynamics and reasoning modelling, is a good candidate that can offer a way to build the syntax and semantics of the notions grounded from the literature (Gero, 2003; Lane, 2009; Jarke et al., 2011; Mumford, 2006). Also this helps to satisfy the required analysis and design knowledge towards building a solution for holistic socio-technical analysis and design.

To address the lack of socio-technical system visibility, enterprises must be able to visualise their socio-technical systems through formal architecture models. The suggested framework combines enterprise modelling that aims to provide a structured approach for modelling and offering holistic semantic knowledge in order to offer managers and socio-technical engineers the necessary insight to help them to make better decisions to design socio-technical systems; using dynamic simulation and qualitative reasoning will enhance decision-making capabilities. The insight given should be continuously assessed during the analysis and design process or in an ideal situation to be automatically adaptive to handle change during the operation ‘in the run-time’. The suggested modelling framework will allow smooth transfer from business to IS or build what are called enterprise model driven ISs by linking the social and business artefacts to the necessary IT artefacts. The framework will help analysts to do the following:

- Manage change in the enterprise (visibility and agility)
- Understand systemic implications/risks
- Optimise enterprises for expected outcomes
- Create alignment between strategy, operation and IS implementation
- Provide a foundation for continuous improvement

5.3 Reasoning in the Dynamic Business Motivation Model

The following sections describe the socio-technical analysis and design framework, the Reasoning in Dynamics Business Motivation Model (RDBMM) in terms of metamodel levels, perspectives/views, implementation process and modelling tools.

5.3.1 Metamodel Levels

The RDBMM consists of different levels of abstraction. In enterprise and system modelling, the concept of abstraction[8] helps to improve the flexibility and adaptability and reduce the complexity of the framework based on the enterprise requirements (Floridi and Sanders, 2004). Therefore, it allows practitioners to increase their understanding of the underlying details when they describe the framework components. Also the abstraction mechanism is widely used in enterprise modelling techniques and model driven development, to establish a foundation to implement this framework. Figure 14 is an art sketch of the abstraction mechanisms used in describing the three levels of the RDBMM framework, where the details disappear with the higher level of abstraction.

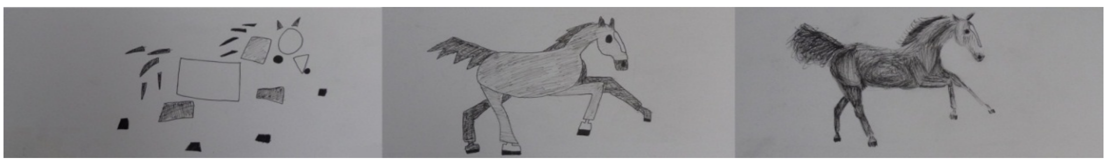


FIGURE 14: ABSTRACTION MECHANISM (NEWGROUNDS.COM, 2010)

The enterprise's modelling is a critical input to IT planning, technology architecture and enterprise solution delivery. At the same time, technology trends and IT capabilities influence enterprise design choices in the realms of capabilities, value chains, processes and channels against criteria such as cost, time of delivery, time of implementation, and time of value realisation. Also, technology innovation can influence an enterprise model partly or completely by changing the way in which enterprise's business is done through new technology. An enterprise model, goals, organisational structure and other constructions need to be considered in terms of how enterprise modelling can become a value-added, business-focused discipline within the organisation.

The robustness of an enterprise design comes from gradually increasing mature insight. When there is no blueprint for the enterprise, there is no corresponding blueprint of how the enterprise relies on and is intertwined with IT. As a result, it is difficult to determine the impact of key decisions, deploy cross-functional initiatives, optimise key resources and funding, and streamline communication and deployments between business and IT. Strategic and tactical requirements drive solutions that are then reflected in the future state 'to-be'

[8] In computer science, abstraction is the process by which data and programs are defined with a representation similar in form to its meaning (semantics), while hiding away the implementation details. Abstraction tries to reduce and factor out details so that the programmer can focus on a few concepts at a time. A system can have several abstraction layers whereby different meanings and amounts of detail are exposed to the programmer. Wikipedia.com

enterprise model. The future state ‘to-be’ enterprise model, in turn, allows IT to more concisely articulate the future state IT model. Enterprise's business and IT can then construct a collaborative approach to keep business and IT synchronised through various business/IT transformations. However, to do this, continual consideration of social and technical aspects is necessary within the stages of modelling, simulation and reasoning, as shown in Figure 15.

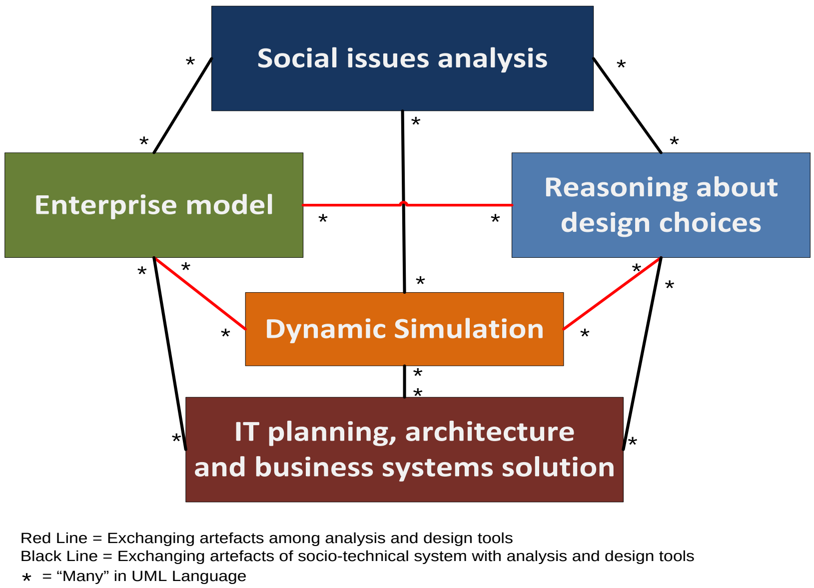


FIGURE 15: LEVEL 0 - FRAMEWORK (HIGH-LEVEL) COMPONENTS

Figure 15 illustrates the high-level components that will be considered in the research, comprising an appropriate enterprise model supported by reasoning and simulation methods to justify and support decision-making during enterprise design. In addition, to help in understanding and rectifying any impact caused by making these strategic decisions, design rationale methods will help look to different alternatives at each stage of the enterprise design as required for reasoning. However, the IT capability influences decision-making related to the enterprise design: balancing controlling and monitoring enterprise activities among business, people and IT is essential and should respond to the boundaries that IT architecture can provide. In enterprise activities driven IT, there is obvious feedback from the enterprise’s environment, capability and motivation to the enterprise design decision; and another important feedback loop from IT architecture to the enterprise design decisions based on the IT capabilities in the ‘design-time’ and based on monitoring activity performance in the ‘run-time’.

The research will consider the BMM to lie at the core of the developed RDBMM framework, particularly for the enterprise model: new artefacts have been considered to extend it. The BMM has a mature metamodel with objectives to integrate it with other OMG specification metamodels, such as BPMN, SBVR and OSM, which are still under development, to ensure interoperability and integration with these specifications. The OMGs have used meta-modelling techniques to allow semantic models to be mapped and to transfer parameters to other models without losing any features that improve the interoperability. The techniques in these specifications act as patterns needing regular change by domain modelling experts, and meta-modelling will also reflect a systematic picture of conceptualising business parameters/variables and their relations in order to use them in enterprise model development and later to build the information systems. It is expected that the BMM specification will be widely adopted as an open standard by industry in the near future.

5.3.1.1 Where Socio-technical Systems Meet the BMM

As seen in Chapter 2, many approaches to analyse and design socio-technical systems were proposed. For example, the socio-technical system engineering approach proposed by Baxter and Summerville (2011) suggests theoretically implementing components to satisfy socio-technical system dynamics and change by integrating organisational change with the effort of system engineering using a set of practices. This generic model does not show the details of the implementation and the practical artefacts required to operationalise this model. At the same time, the BMM covers most aspects suggested in the proposed approach in Baxter and Summerville (2011). Therefore, this research will use the BMM as a detailed and semantically built model to act as a core for the developed RDBMM, particularly to satisfy the enterprise model component and later to add components to support reasoning and dynamic modelling. This way of fulfilment will make the abstract Level-0 in Figure 15 more operationalised. After analysis of the BMM specification based on the OMG work in Chapter 2, a number of identified gaps have still not been taken into consideration: these gaps will be considered in the prospective socio-technical system analysis and design framework.

Therefore, the research will address the following limitations in the BMM OMG specification, which have not been addressed before:

1) Suggest a generic implementation process, later to document the process of implementing the RDBMM and other organisational aspects as followed in the case studies.

2) Provide a quantitative assessment beside the qualitative one proposed by the specification, focusing on dynamic modelling for prediction and risk analysis.

3) Provide a supportive reasoning and sense-making technique to justify and provide the rationale in the decision-making process.

The BMM has advantages as an open community standard, it has great potential to be adopted and integrated into other OMG specifications, also the potential to be implemented within enterprise modelling tools and to be considered by industry. After locating the BMM within the RDBMM framework, it will look more like Figure 16. This is an abstraction of Level-1 of the RDBMM framework. Three sets of components are included in this framework: 1) components that already exist in the BMM model: End, Mean, Assessment, Influencers and Impact value; 2) components that OMG suggests for integration into the BMM model: organisational model, process model, rules model and common business vocabulary; and 3) components suggested in this research: dynamic modelling, reasoning modelling, consideration of social aspects and technical planning, development and management: all together shape more details of the Level-0 abstraction.

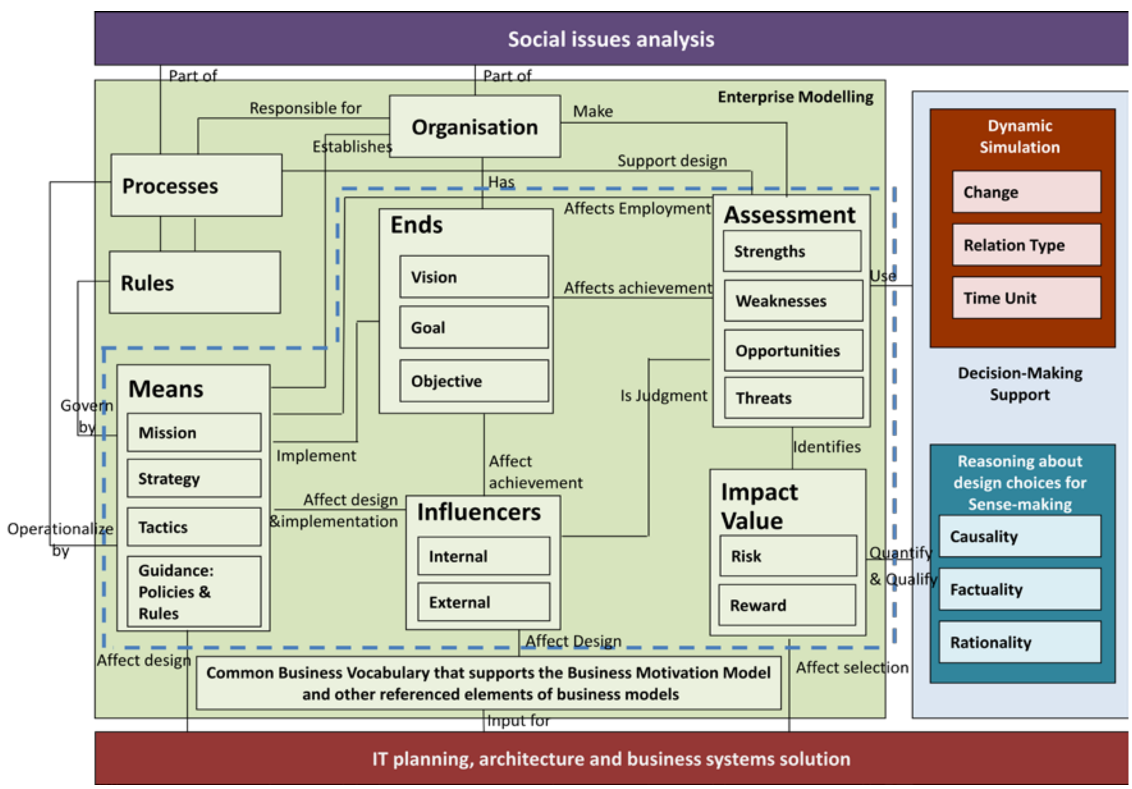


FIGURE 16: LEVEL 1 – REASONING IN DYNAMIC BMM (RDBMM)

The new framework is called the Reasoning in Dynamic Business Motivation Model (RDBMM): this framework is based on a new set of artefacts, tools to model these artefacts and implementation processes. The main components of the RDBMM will be satisfied as follows:

Goals: business goals can be described by natural language, however, in this research the goals will be modelled using formal graphical notation. The KAOS goal-oriented modelling notation is a well-known notation method and very descriptive. Using KAOS notation will provide easy tracking and mapping of the goals for higher and lower levels (from vision to operation). According to BMM, goals are classified to "End" which are "to achieve goals" and "Mean" which are "to do" goals. In the research, we distinguish different types of goal: organisational goals, which should go through an assessment phase to check their suitability for the context and assess alternatives, so that these goals could be subject to a change programme according to external or internal change drivers. The other type of goal is the personal goal; the framework should evaluate changes in personal goals and their impact on work activities. Several assessment models might be required to understand the change and impact levels of personal goals.

Processes: business processes should operationalise strategy, which links to business goals; every process should be linked to the motivation model, particularly to business goals. However, as suggested by OMG, BPMN is the best candidate to model business processes in the inter and intra levels of the enterprise model.

Rules and policies: should be classified according to their source and targets: the motivation model should conform with the policies, rules should also consider the higher-level policies in their formation, and they will be implemented directly in the business processes. OMG proposed the SBVR standard to model business rules and business vocabulary: the standard approach is highly recommended to be used with the motivation model.

Business Vocabulary and Ontology: will also be modelled by using the SBVR as proposed by OMG. SBVR provides a common vocabulary of enterprise business knowledge presented as terms, concepts and facts within the enterprise model across multiple levels of socio-technical system and also between enterprise business and IT aspects. It allows a direct analysis of the information require to perform transformations to support enterprise transformation initiative. Especially, it examines the linkage between strategic, operational and technical decisions and the knowledge that enables them. The vocabulary can also be linked to other aspects of the socio-technical system such as goals, roles, collaboration, business processes, business capabilities, organisation, value chains, and so forth. Such linkages support a more thorough analysis of transformation impact. Therefore, the vocabulary can be linked to IT information systems models, allowing business and IT organisations to jointly plan for change in simple easy to use models, promoting sharing common understanding.

Organisation: we will take advantage of the Organisation Structure Model (OSM) as proposed by OMG to model the organisational aspects that need to be considered and integrated into the motivation model. The organisational structure consists of divisions and employees which participate in enterprise processes and implementation tactics.

Dynamic Simulation, Reasoning and Decision-Support: should consider two types of assessment, qualitative and quantitative. These techniques can support each other for better and comprehensive insight. In this research we will use System Dynamics (SD) Modelling to support quantitative modelling and dynamic continuous time simulation (Sterman, 2000), the dynamic modelling will focus on change in artefacts during time unit and their impacts through relations with each other or the whole system in a specific time frame. Reasoning is a qualitative assessment and can take several forms to provide rationale based on causality and factuality to achieve a specific goal (purpose) of the reasoning model. The concept of a reason has many dimensions. We use the design reasoning to assess decision and alternatives during the enterprise model design and providing a context to the design. The main focus will be on the Design Rationale (DR) approach for reasoning. DR will support reasoning and sense-making activities, which will help to visualise, share argumentation and justify design choices. SD and DR will be discussed in detail in the tools section. Overall, these will all help assessment and decision-making in both the design process and operation. This is considered crucial, since the enterprise model answers the “What” and later the “How”; the sense-making process will answer the “Why”. This will be used in each design step, for example using Design Rationale to decide:

- What Strategy and Tactics to implement
- Whether it would be better to automate the activity or hire a human employee.
- Which action should be taken in reaction to the Impact (negative or positive) of the analysed influencers

The stages may suggest reasoning about the following when appropriate:

- Reasoning about the Mission and it is applicability to the Vision
    - Issues related to applying/not applying the Mission
- Reasoning on the Strategy as a Mission sub-component and its alignment with the goals
- Reasoning about Strategy or Tactic
    - Does it really contribute towards achieving what we want?
    - Is it a realistic choice and achievable?
    - Related issues that could influence its set-up and implementation
- Reasoning about the Goals as shorter and actionable parts of the Vision (sub-visions) and their refinement (sub-goals)
    - Goal - Questions - Options - Criteria (new alignment idea based on Design Rationale QOC)
    - Considering the goal setting criteria will help in early stage assessment.
- Reasoning about the processes that aligned to Tactics which are already aligned to Objectives
- Reasoning about how the Rules and Polices support and govern the course of action (Strategy and Tactics).
- Reasoning about technology design, development and procurement

Potentially, beneficial matrices can be used: the research might conduct an analysis of more detailed artefacts as sets of matrices, for example: situated goals and their implementation influence and influencers by building Goal x Goal matrices, Goal x External and Internal Influencers matrices or Goal, Role, Resource matrices

Social Issues Analysis: also important, as the enterprise is built upon social goals, run by social entities and services social needs. Here the representation of social analysis serves as an input for the enterprise design and continuous improvement. Narrative analysis could be considered to analyse data collected during the interviews: action research, ethnographical research and observation can serve such a purpose too. Understanding social issues such as trust, satisfaction, personal goals, culture, relationships, commitments and language should offer insight for planning, designing or re-engineering business practices (strategic, tactical and operational) and thus for designing suitable ISs. Design Rationale (DR) supports social reasoning and collaborative thinking, and System Dynamics (SD) modelling can also help in some cases in modelling some quantified social aspects to represent their impact overall system.

Information Systems and IT Planning, Design and Management: respond to the enterprise modelling requirements of designing ISs and help to serve the purpose of its development. Another equally important aspect is the IT design choices and decisions, as the IS is aligned to the EM, and its design is assessed against the directives, capabilities and resource availability. The management and operation of IS and IT are based on two objectives: 1) monitoring the performance of business activities; and 2) reducing IT complexity and improving IS usability. IS design and development responds to the enterprise model, which in turn conforms to social needs. IS are best designed using the open standards UML family modelling languages. For instance, SysML (OMG, 2012b) can be used to model broad systems types, and SoaML (OMG, 2012) used to develop ISs for service oriented architecture platforms.

5.3.1.2 Detailed RDBMM

The RDBMM framework describes the detailed level of the artefacts (abstraction Level-2): this level shows the artefacts and the semantics among them, and is considered mature for operationalisation. Reasoning and dynamics modelling are represented here as two types of assessment for decision support analysis. Assessment has different categories and assessment can be performed on everything/all artefacts in the enterprise modelling, e.g. End, Mean, Influencers, social and technical aspects, to understand better the impact value and make decision about the suitable design option.

The core of this level is based on the BMM metamodel: the End actually has two parts, firstly Vision, which represents the future state the enterprise wants to accomplish but in a high level and long-term setting. The desired results are more specific, where Goals should be attainable and directed to a specific business issue/problem. Usually Vision is made operative by Missions and it is amplified by Goals (OMG, 2010a). Regarding the desired results, a Goal is qualitative and tends to be longer term compared to Objectives, but at the same time it is focused enough to be quantified by Objectives. Objectives need to be more quantitative and specific rather than general, and bounded by a time frame, Objectives should be consistent with the industry`s popular ‘SMART’ criteria. The desired results are supported by Courses of action where Goals are maintained by Strategies and Objectives braced by Tactics, and distinguishing between Strategy and Tactic usually done by either a) prioritising and effort/time involved b) planning horizon (short and longer term practices). Tactics implement Strategies (OMG, 2010a). Mission indicates the on-going operational activity of the enterprise and describes what the business does or will do on day-to-day basis. Mission should include three different artefacts: 1) action, 2) service/value delivered as a result of this action, 3) consumer for this service. Course of Action is a configuration or setting of the enterprise involving different artefacts (things, processes, locations, people, motivations and time frames): these need to be undertaken to achieve the Desired Results. Courses of Action are governed by Directives and include Strategies and Tactics. Courses of Action can be realised by Business Processes, which engage a number of resources and assets to contribute in delivering the expected value. Strategy is a component of the plan for Mission, and it includes the essential Courses of Action to achieve the Ends (Goals in particular); it also represents the appropriate approach that enterprises rely on to achieve the goals, given the environmental issues and risks. Tactics implement Strategies and part of the detailing of Strategy. Directives usually indicate how the Course of Action should or should not be carried out; they govern Courses of Action and define constraints or liberate some aspect of an enterprise. Every Directive must be explicit and recorded in an official manner (OMG, 2010a). Business Policy, Business Rules and Regulations are elements of Directives. Business Policy is not directly enforceable and offers a basis for Business Rules, while Business Rules are directly enforceable and control, govern and influence business behaviour. Regulations are outer organisational Directives that are enforced on lower level organisations e.g. government policies. Policy design usually responds to one or more assessment, where Business Rule are derived from Business Policy. Business rules always present obligation or necessity. Influencers in BMM can be anything that is able to affect the enterprise without the direct exercise of command, sometimes without making effort or intent.

The impact of influencers is judged in assessment. Influencers have two types, internal and external; sometimes specific external influencers are recognised as organisations and called Influencing Organisations. Assessment involves judgement about Impact or potential Impact. Assessment has different categories: it can be qualitative as in design rationale reasoning or quantitative as in systems dynamic modelling. The impact of Influencers should be assessed against the End and Mean; however, assessment can also use other assessments as. SWOT (Strength, Weakness, Opportunity, and Threat) analysis is a very common way to assess the impact of influencers and can use KPIs that are more specific. A Potential Impact significant to an Assessment can provide the impetus for Directives that govern Courses of Action or support the achievement of Ends. Potential Impact can be a Risk to avoid which has several types, or a Reward to exploit. The Organisational Unit answers the Who is responsible for or owns the End or Mean. The Mean is lined to the placeholder, own assets that might be fixed assets, or resources such as human and financial resources. Assets include Technology and ISs, which are also aligned to business design (OMG, 2010a). However, sets of Business vocabulary, Concepts/Terms and Facts provide a basis for understanding, sharing and agreeing on definitions of enterprise concepts, to be used in Ends, Means, Directives, Processes and therefore ISs (Fayoumi and Yang, 2012).

The level of detail shown in Figure 17 will be separated into a set of views/perspectives that show all of the artefacts, because space limitations do not allow us to show all of the artefacts in one single model. More details have been added to this metamodel, and it has been separated into a set of views/perspectives to make implementation easier using a set of tools that aim to satisfy different perspectives.

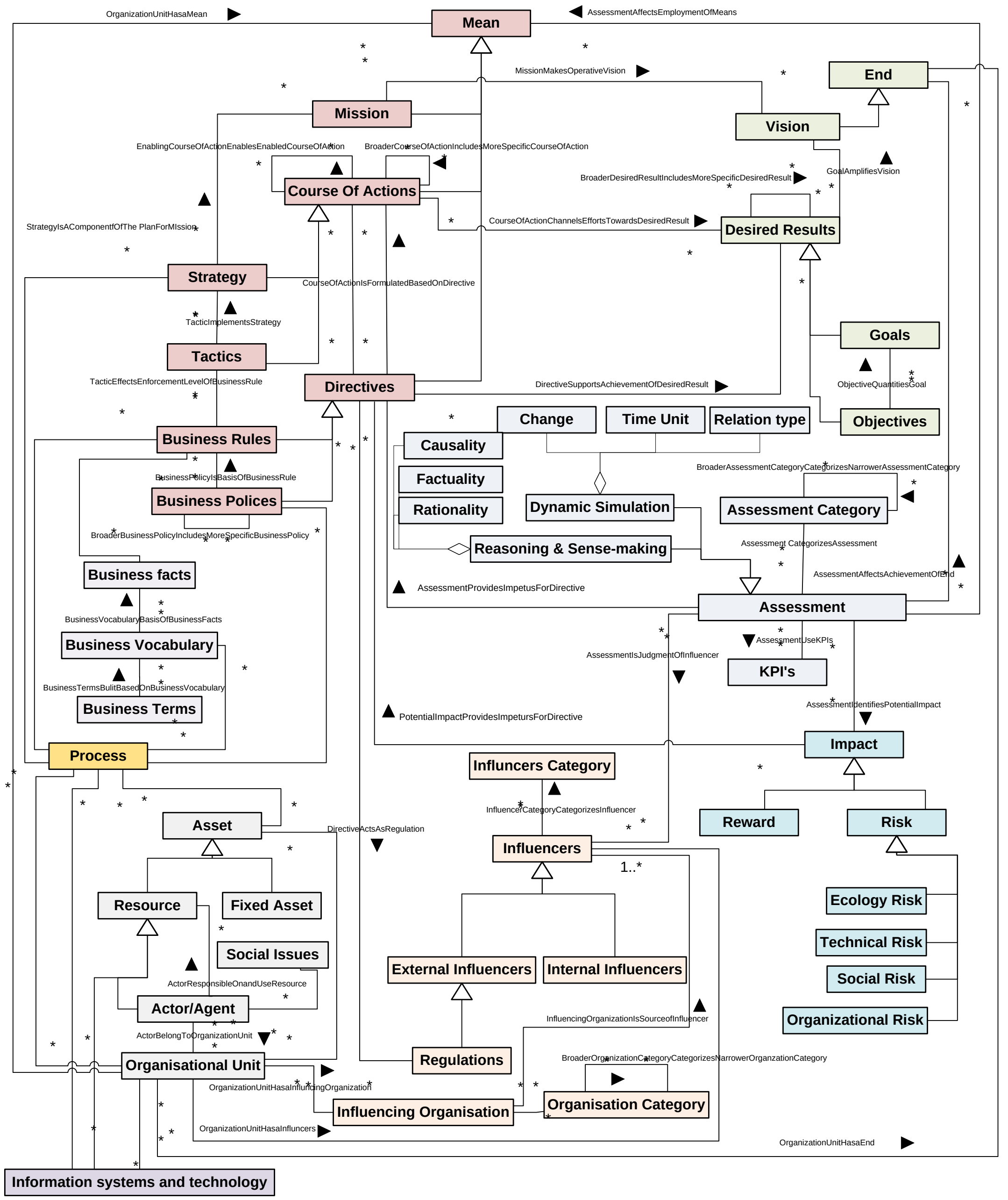


FIGURE 17: LEVEL 2- DETAILED RDBMM

The reason for creating a framework with different levels of abstraction is to comply with the metamodelling and abstraction mechanism to reduce complexity and improve interoperability. The higher level is simple and easy to understand and can be implemented in several ways (in this thesis, the BMM is the suggested framework for implementing the RDBMM level-0), where analysts can make use of any preferred enterprise modelling metamodel to build their work on. In addition, this applied approach, which has been followed to create the 'lower' levels of the RDBMM framework, also depends on the approach used to model the case studies: it all depends on the case study requirements. The three modelling and representation techniques, enterprise modelling, rationale modelling and dynamics modelling, support the abstraction mechanism, which means that they can be used to abstract either domain problems or solutions to bring understanding of complex issues, they have the ability to represent reality and visions, general as well as very specific and detailed problems. Levels of abstraction have been defined in the RDBMM framework and semantically linked.

5.3.2 Metamodel Views/Perspectives

The focus will be on separating the details of six views/perspectives that respond to the propositions of complexity theory on complex dynamic environments (discussed in Chapter 4). These perspectives are linked through the semantics provided in the model of the Level-2 RDBMM in Figure 17. The views consider social and technical features as well as internal and external factors, and the perspectives are mapped to the original complexity theory propositions described in Chapter 4. Each agent has a goal, and agents use knowledge represented by ontology that helps them to communicate and evolve. Decisions are made also based on the knowledge acquired, the agent usually belongs to a social or organisational group and is participating in a controlled process governed by rules to deliver a value. The mapping between these views and the original complexity propositions are described in Table 12:

TABLE 12: LINKING VIEWS TO COMPLEXITY PROPOSITIONS

View/Perspective	Response to complexity proposition[9]
Goal View	Motivation
Agent/Actor View	Agent
Decision View	Autonomous, sensing and selection according to their motivation
Concepts/Ontology view	Shared Knowledge that support distributed intelligence
Process View	Control mechanism of self-organised agents
Organisation view	Communication and coaching structure, roles and tasks

The semantic mapping among these perspectives is highly important: these are linked through at least one artefact from each perspective, as described in the semantics of Level-2

[9] Refer to Chapter 4 where complexity theory is defined and discussed.

RDBMM. The details provided will contribute in RDBMM for complex and dynamic socio-technical systems as well as opening new horizons for building adaptive intelligent system development by mapping instances from these perspectives to IS development.

5.3.2.1 Goal View

5.3.2.1.1 Goal-Objective model

The enterprise goal is the main organisational, divisional or departmental goal: this goal usually represents the End, and is composed of several sub-goals, where achieving these sub-goals results in the achievement of the main goal; the more the goals are operationalised the more they represent the "Mean". The enterprise goal has two types: long-term goals represent the vision, and short-term goals the mission statement. The sub-goal is a refinement of the main goal and operationalised by tasks; there is at least one task to execute each sub-goal operation. The sequence of tasks combined together can be represented as a business process, and the business process should refer to a goal to clarify the End of this process. The relations among the goals can be defined from different perspectives. First, the goal could be a target or 'hard' type or a through or 'soft' type: a target goal is a goal that aims to be achieved with alignment to the top strategy, and should be short or long term, while a through goal is a goal that supports and satisfies different aspects of internal or external polices, legal issues and standards which relate to delivering or achieving the goal. Any goals related to security, quality, safety and privacy are considered to be through goals assigned to target operational goals. A through goal is a non-functional capability goal. It is not actionable but supports the hard goals, and usually the actionable goal is achieved through it: it is different from a sub-goal, which is functional. The organisation is still required to define the level of maturity of the through goal, although they need to specify whether it is obligatory or optional. As an example, security goals need to be defined clearly: what do we mean by security and what level of security do we need to achieve? What is the necessary level and what is the optional level?

In terms of influencing, the goal could be supportive to another goal, or conflicting with another goal; in some cases, the effect of the goal is not clear enough to decide the level of influence and impact until the process has been tried, while in other cases the influence depends on the situation and environment. Goal influencing relations usually have two types: 1) formal relation within the boundaries of the organisational design; 2) Informal influencing relation outside the design boundaries and considerations. Other factors proved by the literature that have a direct influence on the situated goal are described below based on Ordóñez et al. (2009):

- **Specificity:** valuing how much the goal is specific; taking into consideration the fact that the goal should not be narrow or wide, specific and aligned to the wider picture to ensure higher goal achievement.
- **Time horizon:** the period is an important aspect, as the goal should be within optimum suitable time and should be assessed against the enterprise capacity and capability, risk and opportunities assigned to set it up over a short or long period.
- **Difficulty:** the difficulty of goal achievement should be evaluated against the time, quality and resources (capabilities).
- **Ethicality:** this is a critical issue, as achieving the goal should conform with ethical behaviour and standards. What is the impact of violating the ethicality?
- **Learning:** each goal achieving an activity has an expected learning scale and experience to be gained during and after the process. What do we expect to invest in order to gain knowledge related to achieving the task (‘knowledge as input’)? What do we expect to gain (‘knowledge as output’)? Learning will gradually improve actions towards the goal.
- **Accuracy:** are we defining the right goal? This is an important question to asked immediately after goal definition. However, refinement and quantifying the goals helps to improve accuracy.
- **Any other side effects:** usually goal activities will influence other activities, goals and resources used. How could the goal achievement process affect related issues in the environment?
- **Issues:** On top of the EKD framework assumptions (Bubenko et al., 1993) discussed in Chapter 2, that goals are set up as a result of issues, challenges, SWOT analysis should be performed before goal confirmation as the goal may drive new issues. It is necessary to assess the challenges associated with a particular goal, and how to overcome them. What is the SWOT analysis for the goal, and how can we use it in an efficient way to support the business plan?

Figure 18 semantically presents a description of the goal and goal relations.

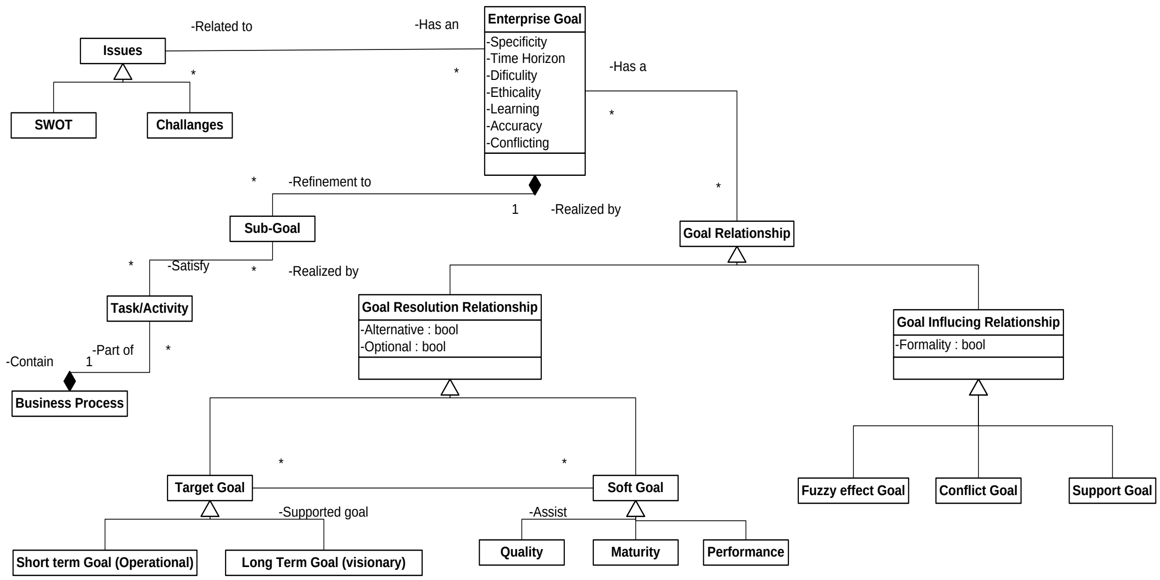


FIGURE 18: GOAL VIEW

5.3.2.1.5 Goal Setting

In the goal setting literature, hypotheses have been proved stating that setting challenging goals for workers, after a clear and detailed explanation of the objectives, positively influences their performance. The specificity and difficulty of set goals positively affects workers' performance, and this enhances the workers' satisfaction with their performance and rewards. The more the workers' satisfaction increases, the more they will commit to new challenging goals. A high level of goal commitment helps workers to intensify their dedication and persistence to work and better their performance (Hollenbeck and Klein, 1987).

Goal setting also intertwines between organisational context and human psychology, making it a complex process: the feedback control mechanism offers rationale monitoring for the effectiveness of the actions engaged with goal fulfilment. In addition, this feeds forward to lead humans to set greater and more advanced goals as a result of increasing confidence and trust in their capabilities (Bandura, 1989). The feedback mechanism in goal achievement has proved its functionality in goal setting research (Locke et al., 1981; Tubbs, 1986). The general notion is that people need to understand whether the direction of action engaged and initial results correspond to the general work mission (Locke and Latham, 2006).

Goal setting criteria, as discussed earlier, can significantly improve the goal planning and design, in particular, any situated goal needs to tell you where you are heading. The make-up of effective goal setting is generally agreed to involve the use of standard SMART goals (Reynolds, 2010; OMG, 2010a): 1) Specific, 2) Measurable, 3) Attainable, 4) Relevant, 5) Time-Limited.

1) Specific

The goal should be focused to direct the effort on achieving a specific thing. This will answer what exactly to achieve. Possible questions include what is the enterprise going to do? Why does the enterprise need to do this at this time? How is the enterprise going to achieve this goal? The goal should be specific but not too specific, so as not to disregard the relation with the higher-level goal and overall vision, or forget the impact of the goal on the environment and related aspects.

2) Measurable

If the enterprise cannot measure the goal, it will not be possible to manage it. In the broadest sense, the whole map is a measure of what the enterprise would like to achieve. The goal should be identified with measurable progress, so change can be seen to occur, and the whole map should be measured by achieving the goal. Setting up progress points with very specific measures will help the measurement process: the measure is more likely to be quantitative but could be qualitative in order to measure some intangible aspects.

3) Attainable

Attainable, in the map, means ‘do-able’. This means that the learning curve is not a vertical slope and the plan includes all the factors that are needed to achieve the goal, including progress goals (short-term goals). This answers how to achieve the goal in the goal map by achieving those short-term goals. If they are too difficult, it sets the stage for failure, but setting them too low sends a negative message that the performer is not capable. It is recommended to set challenging goals for satisfying achievement which should be realistic at the same time.

4) Relevant

The goal to be accomplished needs to be relevant to the actor’s context: relevant goals make it possible to perform an action to change the current state of ‘as is’ to the desired ‘to be’ state. Enterprise stakeholders need to develop their belief and use their abilities, skills and knowledge to reach them. Although they may start with the best of intentions, the knowledge that it is too much means that the subconscious will keep reminding them of this fact and discourage them from achieving the goal. Therefore, they need to understand what they need to know and how to execute the task. Every progress point they achieve increases their motivation and commitment to completing the task and reaching the goal. Before starting an activity, they should make sure that the activity is the right one among the alternatives, and the best way to achieve the goal.

5) Time-limited

Setting a timeframe for the goal is important: for instance, the goal and progress points should be limited and measured against time as well. Putting an end point on the goal gives a clear target to work towards. Without time boundaries, the commitment will be vague. Without a time limit, there is no urgency to start taking immediate action. Time must be attainable and realistic.

Overall, after defining any goal, it is necessary to perform an internal assessment, to understand the goal's dynamics, impact and appropriateness. The assessment will answer many questions such as: Are we defining the right goal? Is the time frame correct? Do we understand the impact of this goal on learning and progress? The impact on the organisational achievement? The relation of the goal with other goals? The relation against the internal and external policies and rules? The ethicality of the goal and the process of achieving the goal ? The difficulty against the capability? The integration with the vision and long-term impact? Finally, and most importantly, the relation with the actor/agent's cognitive skills and capability?

5.3.2.2 Agent/Actor View

An organisational unit is usually set up to support achieving a goal, by assigning some responsibilities to this unit. The responsibilities could be primary or secondary, presented as target goals and through goals. These goals or sub-goals need resources to make them complete, and the organisational unit organises their resources in terms of roles and assets. Assets can be different kinds of resource (finance, tools, software, equipment, knowledge and information). Roles have several types of relation: 1) role to role, represented as a hierarchy and collaboration between the roles; 2) role to goal, which is intentional, assigning goals to a particular role; 3) role to resource dependency, using a particular resource to fulfil the role's responsibilities.

In the case of knowledge resource dependency, the relation could be assigning work to another actor/role which will be considered as a resource for that role. Sometimes, in the case of software agent role dependency on knowledge, the knowledge base from where the knowledge will be acquired is the source in the general case, thus must be specified for each particular case. The roles need to be fulfilled by actors, using the resources based on their role privileges to fulfil the role efficiently.

We can use different perspectives to look at the actors: each perspective defines different kinds of actor. We can look at the actors as individuals or a group, i.e. the actor is Smith who fulfils the role of sales representative, alternatively, the role is the sales team who all have similar responsibilities. The other perspective is to look at the actor as human actor or software agent actor, since advanced technology aims at developing intelligent autonomous artificial agents to fulfil particular jobs and perform specific tasks. At a particular stage of the analysis it is necessary to decide whether it is better to build an artificial agent to fulfil this role, or whether it can only be handled by a human actor. The actors (agents or human) will take the same relation types as the roles; for instance, agents have particular roles and the relations they have should conform with the role relations model. The agent model is strongly related to the goal model and their semantic relations are described in Figure 19.

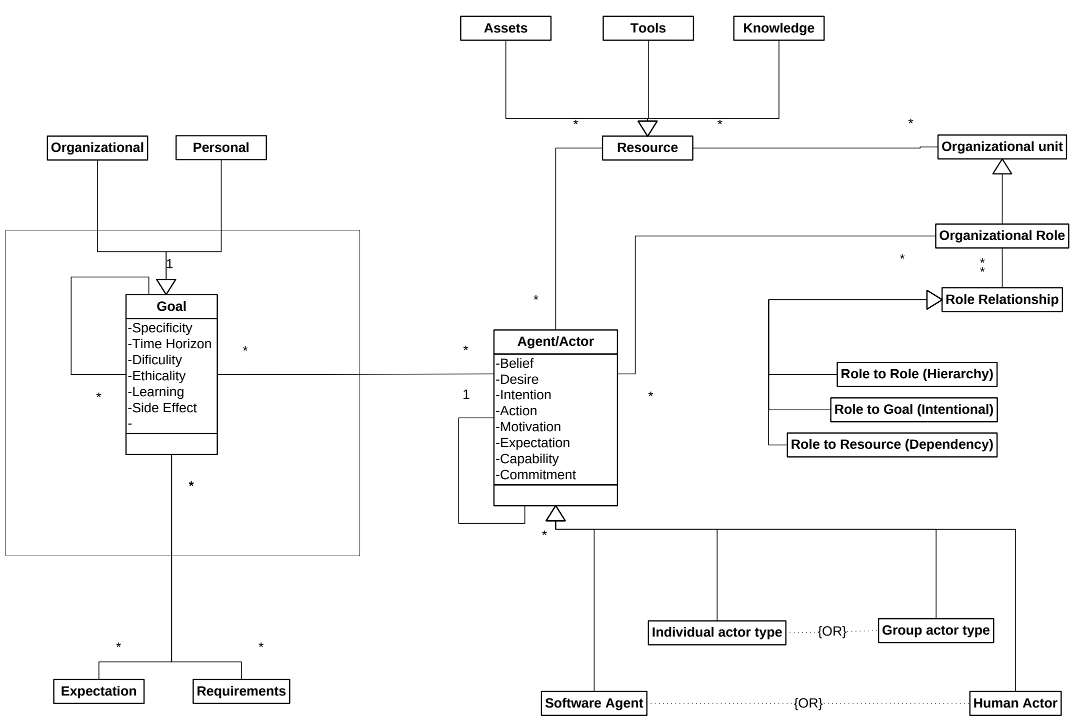


FIGURE 19: AGENT/ACTOR VIEW

5.3.2.3 Decision View

Organisations need to be keen to make the right decision: to do so, they need to consider a wide spectrum of artefacts and the ways these artefacts connect. Business forecasting is a critical practice but is unlikely to always be accurate. The methods used in decision-making should be comprehensive and consider the ripple effect of the internal or external environment artefacts. The model proposal distinguishes between two important activities: the input and the output of the assessment. The assessment should consider internal and external factors, some of which are influencers, and the others those influences that should be assessed against the drivers of making assessment. Usually the drivers of the enterprise are the goals, objectives or strategy. Key Performance Indicators (KPIs) are the measurement elements to assess against the designed business, where the assessment should measure the influences and influencers of the End, Mean, Processes or any of the enterprise aspects. Assessment in the research will focus on using two types of assessment: 1) Design rationale for qualitative assessment, two of the most used form of reasoning are Goal/Options/Criteria and Issue/Position/Argument (Louridas and Loucopoulos, 2000). And 2) System Dynamics for quantitative assessment based on stock and flows model. Examples of internal influencers/influences are resources, infrastructure, habits, management style, assumptions, corporate value, while external influencers/influences could be and are not limited to customers, government, the economy, partners, competitors, environment, suppliers, technology and ecology. The assessment output will show the strengths and weaknesses of the enterprise: it could also show the impact in terms of rewards/opportunities that the enterprise could experience by going in a certain direction. Alternatively, this could be a risk/threat that it needs to avoid and take into consideration (types of risk that socio-technical systems might face are described in Appendix F). The assessment could also show up issues related to specific directions or option; thus, the enterprise will end up with a recommendation as to how to make the decision. The assessment could be qualitative or quantitative, based on the nature of the assessed artefact itself. The decision model is shown in Figure 20.

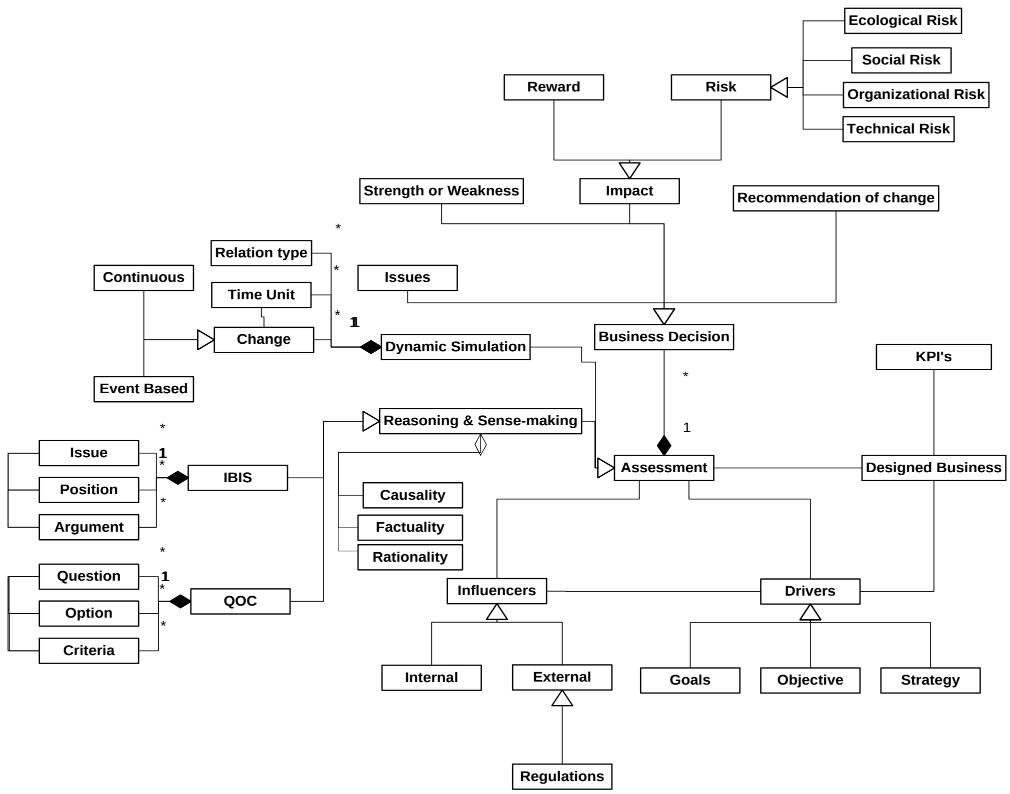


FIGURE 20: DECISION VIEW

Success criteria are usually associated with an organisational vision. For instance, OMG have adopted the BMM for organisational modelling. The model allows enterprises to map their mission to their vision, assigns courses of action to the mission, allocates resources to the processes and finally defines the KPIs and the assessment model according to the map between these levels, which can be achieved using the SBVR model (Fayoumi, 2011).

5.3.2.4 Ontology and Terms View

Most of human knowledge is represented and communicated by language; natural language is a basis for requirement gathering, and all business concepts documented by natural language as 'explicit knowledge', or in the human mind 'tacit knowledge', can also be communicated verbally using natural language. Thus, research in business and computer studies has focused on natural language as a key part of understanding business and the environment. The business research area has mainly focused on business taxonomy, concepts and definitions. Work in computer science has covered ontology development, natural language processing, fact based modelling, textual models and semantics of business vocabulary and business rules. We are aiming at a simple structure of linguistic requirements in order to improve communications and planning. To achieve this, business has many concepts and concepts that need to be defined: these concepts consist of vocabulary and connecting the concepts using ontological relations (Karpovic and Nemuraite, 2011), and these factors can be used to describe business rules and policies using quantifiers, logical operations and logical models to provide what are called business facts (Malik, 2011; OMG, 2008b). The concepts and facts will also help to define services and describe sets of activities used in the business process model. The aim of this model is to link the higher-level description of the rules that could influence the lower levels and vice versa; for example, the internal rules imposed from inside the system, and external rules imposed by other systems, e.g. government, ecology, cultural norms, etc., how they are semantically linked and how they influence each other. What can an enterprise do to mitigate the risk of change? Figure 21 shows the ontological view of business concepts, vocabulary and facts.

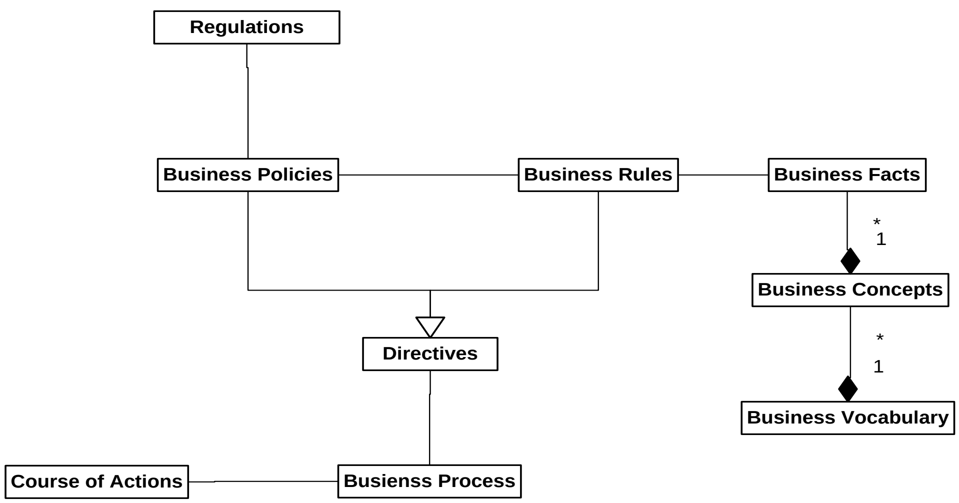


FIGURE 21: ONTOLOGY AND CONCEPTS VIEW

5.3.2.5 Organisational View

Much work done in the organisational-oriented approach relies on conceptual modelling in software engineering, role/group orientation in AI and organisational structure aspects in organisational science: these are the most important areas where the organisational structure model is shaped. Organisations vary in their structure, therefore in their capability and agility; organisational structure should be decided based on a high-level assessment of the End, where organisational structure is part of the Means aligned with the End. Most of the focus in the organisational view is on the attributes of the role, matching capabilities with qualifications and putting behaviour under the constraints of rules. Organisational structures and topologies (as in OMG, 2010a; Fowler, 1996) are not a premier focus of this view:

organisations can decide to choose the right internal configuration that is suitable for their business activities. Therefore, the emphasis will be on the Role characteristics and attributes that belong to the organisational unit. The organisational model is presented in Figure 22.

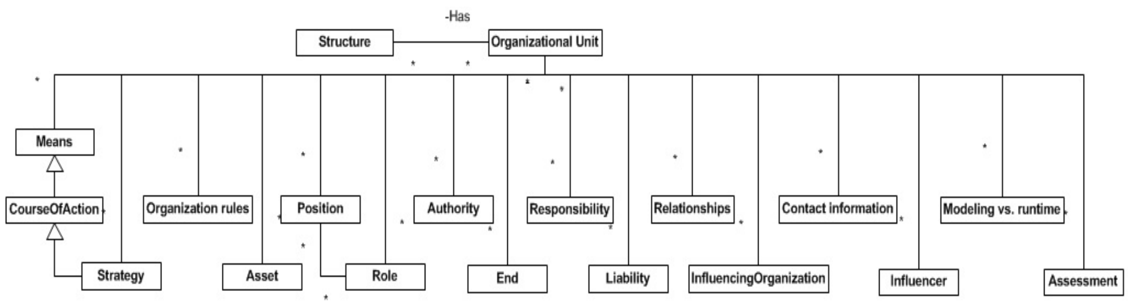


FIGURE 22: ORGANISATIONAL VIEW

5.3.2.6 Process View

The process view has been widely considered for rationale understanding and analysis of inter and intra organisational work. Since business tasks/activities flow in sequence and parallel, the business view provides an easy and rational description of what is going on in the organisation, and answers the “what”, “who”, “when”, and “where” to do the tasks. In our understanding of the business processes, each organisational unit is responsible for a set of processes related to its core responsibilities and this will be labelled by the process owner. The process owner designs and develops processes according to the specific goals or End, and the process is the ‘detailed Mean’, as a refinement of the business tactics or ‘high-level Mean’; objectives quantify the goal and can also provide a basis for the KPIs. The process is designed under specific rules derived from business polices, whether internal, such as company policies, or external, such as industrial policies and regulations. Overall, the business process needs to identify the resources, whether human or assets, required for executing the process in an efficient manner. Figure 23 shows the process model in relation to the other artefacts.

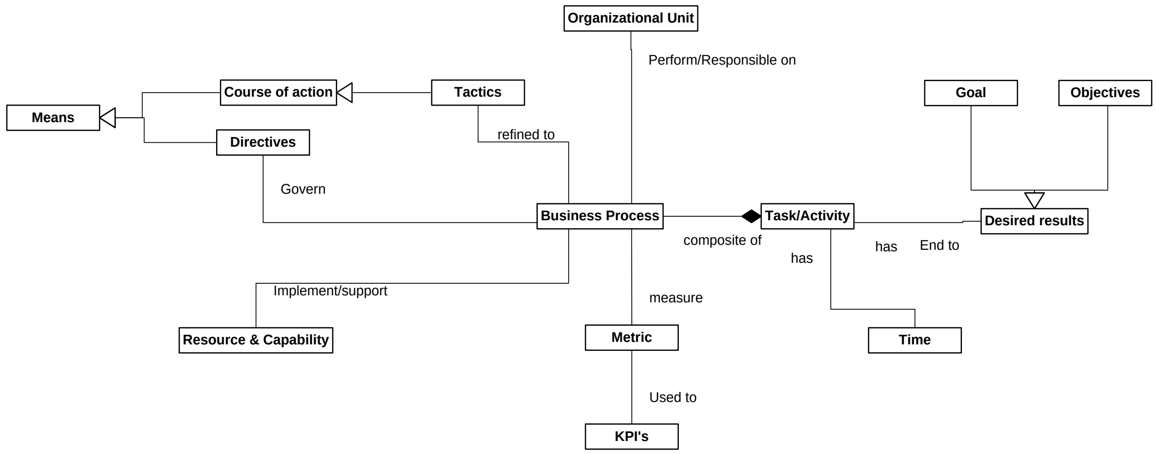


FIGURE 23: PROCESS VIEW

5.3.3 Implementation Process

The implementation process is the logical steps that need to be followed to implement the RDBMM framework, I argue that the implementation process is not a set of fixed static steps, but varies from one case to another, flexible to be adapted to the organisational work style, which can be very controlled, as in the Rational Unified Process (RUP) and Capability Maturity Model Integration (CMMI), or flexible, such as the agile methodologies. Proposing the steps as a rationale process is the aim of specifying the priority and hierarchy of the approach. The feedback and iterations follow the main methodology which the organisation is willing to adopt: for example, the waterfall is different to the RUP and the RUP is different to the agile in term of feedback mechanisms, control and lifecycle size. Another factor that influences the implementation methodology is the view of the architecture itself: the approach we follow is an enterprise goal oriented modelling-driven IT.

The implementation processes are varied, and there is no one ideal implementation process. The motivation model specification (OMG, 2010a) does not provide explicit methodological steps for implementation. However, this enterprise goal oriented-driven IT approach can be implemented in agile, mature and highly aligned manner. The analysis, design and implementation process of the case studies are to be documented. Thus there is a need to adopt an agile and mature approach to developing business services and their underlying technology with a continuous analysis of internal and external impacts. Generic approach to satisfy these principles is needed, and this approach can be used in several ways, for instance:

1) Change management: set up new goal involving interpretation and assessment of many aspects through the goal life cycle.

2) Requirements management: managing customers' requirements through a goal-oriented development life cycle.

In the logical process of the enterprise goal orientated analysis starting with goal identification `top-down process`, in the RDBMM, the End is considered as an aim result targeted by the enterprise: the Mean then operationalises this End, where further assessment of both is required which can be done using qualitative reasoning or quantitative dynamic simulation. Afterwards, the capabilities, resources, structure and detailed processes are linked to the Means toward fulfilling the End. Implementation options and continuous adaptation and response to new requirements usually comes when the enterprise has a solid architecture, where changes are proposed in response to contextual or strategic change, and change is sometimes required to improve quality and performance. Table 13 proposes a generic process and main stages to be fulfilled by the modelling tools/techniques; the modelling tools are based on open enterprise modelling standards in addition to dynamic and reasoning models. The process has been divided into a sequential set of steps and each specific step (SS) includes specific practices (SP).

TABLE 13: IMPLEMENTATION PROCESS

Steps and Practices of the Implementation Process	**Potential Supportive Tools**
SS1 Setup Motivation Model (End then Mean) • SP 1.1 Define the goal and refine the goal to sub-goals (Goal Model) • SP 1.2 Define the objectives of the goal based on goal-setting criteria or SMART criteria • SP 1.3 Assess against goal-setting guidelines (using reasoning or dynamic modelling) • SP 1.4 Capture and define general polices and directives (Rule Model) • SP 1.5 Assess Motivation model against influencers • SP 1.6 Continuously define business concepts and facts	KAOS Modelling Framework (Respect-IT, 2007) Business Motivation Model (OMG, 2010a)
SS2 Process Design (Operation) • SP 2.1 Build the logical activities to fulfil the goal (Process Model) • SP 2.2 Process benchmarking (Design processes based on best practices e.g. ITIL when possible) • SP 2.3 Assess against objectives (using narrative, reasoning or dynamic modelling) • SP 2.4 Assess process against resources (using narrative, reasoning or dynamic modelling)	BPMN (OMG, 2011) BPMM (BPMM, 2008) BMM (OMG, 2010a)

TABLE 13: IMPLEMENTATION PROCESS (ONTINUE)

Steps and Practices of the Process	Potential Supportive Tools
SS3 Process Detailed Assessment and Development (Operation assessment and Design) • SP 3.1 Define operational KPIs • SP 3.2 Define the boundaries and quality limits • SP 3.3 Define specific rules and constraints (Rule Model) • SP 3.4 Analyse requirements of implementing the process (Staff responsibility and technology) • SP 3.5 Confirm the process	SBVR (OMG, 2008b) BMM (OMG, 2010a) Simulation (Ren et al., 2008; Hall and Harmon, 2007) SD (Sterman, 2000) DR (Selvin, 2010) OSM (OMG, 2009b)
SS4 Procurement, implementation and deployment • SP 4.1 Decide whether the components will be developed or purchased: 'COTS' • SP 4.2 Specify the technology and capacity • SP 4.3 Decide the architecture topology	DR (Burge and Brown, 1998) SysML (Friedenthal, 2011) UML (OMG, 2007) SoaML (OMG, 2012)
SS5 Operation and Management • SP 5.1 Evaluating results against objectives • SP 5.2 Monitoring system health • SP 5.3 Monitoring performance of business activities • SP 5.4 Continuous evaluation and adaptation	BPM, SOA and MDA (Del Rosso, 2006) SHM (Kothamasu et al., 2006) BAM (Kung et al., 2005)

5.3.4 Modelling Tools

No one specific modelling technique covers all RDBMM framework aspects; many tool providers produce tools supporting a combination of modelling techniques, but none of these tools satisfy the research view, since the current tools lack support for the three main perspectives of the framework (enterprise modelling, reasoning and dynamic modelling). Alternatively, by using the modelling methods in a semantic manner, I will be able to offer open and dynamic modelling capabilities in the latest generation of the enterprise (IS) modelling as suggested in Castro et al. (2002) and Wahid et al. (2008) by instantiating the concepts and relationships provided in the enterprise model. These models will allow the analysis to represent:

- Modelling business motivation.
- Modelling the organisational structure, business processes and business policies/rules.
- Evaluating and assessing the alternative organisational process and structures.
- Achieving common understanding and agreement between stakeholders.
- Designing an agile technical framework satisfying current and future business and IT challenges.

The research uses the following modelling languages (Figure 24), as they describe the different aspects of RDBMM that ensure full requirements elaboration and analysis to help in designing a modern socio-technical system platform. Analysing the system from the perspective of the agent, goal, process, ontology/knowledge, organisation and rules are required; the models cover these perspectives and the refinements of their semantics. The SBVR helps to share common understanding among business and IT people while considering social capabilities that are technically executable: the process of defining the business vocabulary and business rules aims to bridge the gap between social knowledge and IS development where that knowledge is represented for technical use. The SBVR has a great potential for developing information systems with a higher level of representation (Fayoumi and Yang, 2012). OSM will model the organisational units, hierarchy, ownership and responsibilities. KAOS is a well-known goal-oriented approach: the goal model will be used to model the goals and goals refinement. BPMN will be used to model business processes for inter and intra enterprise activities.

Design Rationale (DR) offers lightweight qualitative reasoning enabling social collaboration for decision making, however Systems Dynamics (SD) modelling still has a lack of implementation and can only help in quantitative discrete and continuous time simulation in a way that aids visualising the mathematics.

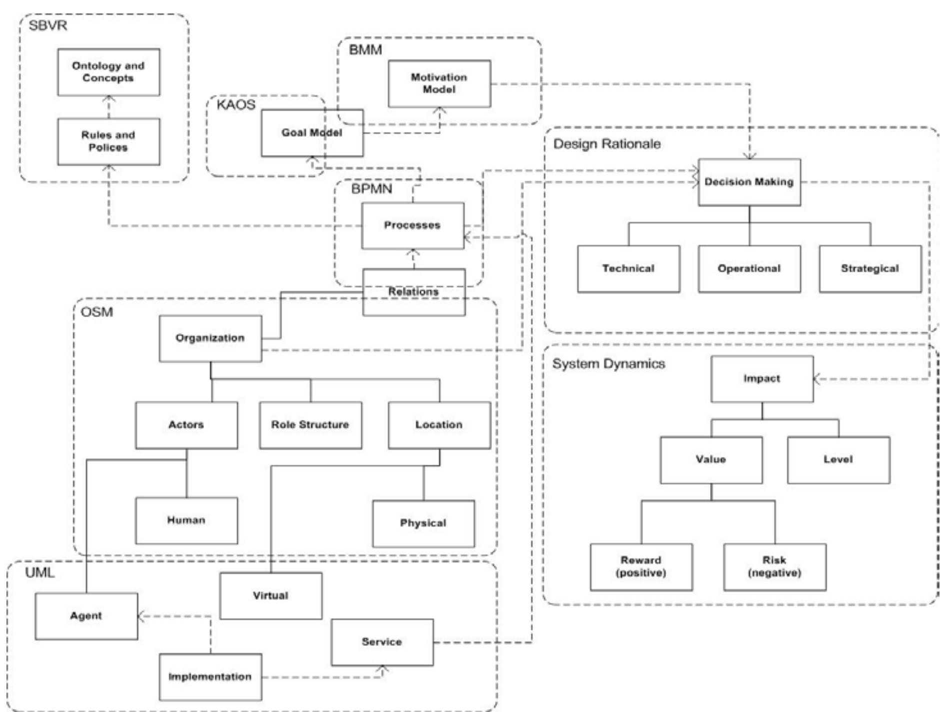


FIGURE 24: RDBMM AND SUPPORTIVE MODELLING LANGUAGES

As stated before, Design Rationale will be used for lightweight qualitative reasoning and System Dynamics modelling will be used for dynamics simulation. The Unified Modelling Language (UML) (Rumbaugh et al., 1999; OMG, 2007) is a well-known object oriented modelling specification that might not be used fully in this research, alternatively UML family specifications will be used to satisfy specific needs, such as in Chapter 7 when SoaML (OMG, 2012) is used for modelling services for SOA architecture. The case studies in Chapters 6 and 7 will show how the suggested modelling tools can be used in real life examples.

5.3.4.1 System Dynamics Modelling

In organisations, managers have to make quick decisions, which require excellent cognitive abilities. Any limitation in understanding and addressing dynamic and structural complexities will result in problems. System Dynamics, developed by Jay Forrester during the 1950s and formally introduced to the scientific community in Forrester's (1961) book entitled *Urban Dynamics*, is an ideal methodology for framing, understanding and discussing complex issues and problems (Golnam et al., 2010).

System dynamics is a computer-aided approach. These computer models are excellent tools for studying problems, as they are built around a particular problem over time. System Dynamics includes conceptual tools to analyse systems and is a tool for investigating and modelling complex dynamic problems in terms of stocks (the accumulation of things), flows (the motion of things), and feedback loops at any level of aggregation (European Commission, 2007). The modelling tool candidates are iThink, Vensim and Powersim.

System dynamics is a methodology for studying and managing complex feedback (business and social) systems. It can identify high leverage variables in a system at a quick pace (Vail, 2002). It traces the cause and effect of relationships between systems of related variables (Vail, 2002).

The design of a system dynamics model consists of several steps:

a) Listing the factors that contribute to the problem
b) Sketching the structural relationships and characterising them as levels and rates that feed or drain them
c) Quantifying the factors and the assumptions associated with them

d) Running computer simulations to test the validity of the model (European Commission, 2007)

A system dynamics approach provides "essential insight into situations of dynamic complexity", particularly when testing whether real systems are viable (Sterman, 2000). However, this approach does not imply how the system elements should be reconfigured to produce a desired result.

System dynamic modelling is concerned about the representation and modelling of dynamic behavioural aspects of system components by presenting a simulation of the evolution of behavioural aspects over time. System dynamic modelling aims to develop an in-depth understanding of the targeted system's reflexive behaviour by delivering a reflective system based on mental model expansion, using systems thinking mechanisms including feedback loops among system components and representing system behaviour patterns over time. What makes using system dynamics different from other approaches to studying complex systems is the use of feedback loops and stocks and flows. These elements help to describe how even seemingly simple systems display baffling nonlinearity. Among the various research methods for analysing the dynamics of goals in organisations, simulation modelling – more specifically system dynamics modelling, which is particularly suitable for modelling the qualitative, intangible and 'soft' variables involved in human and social systems (Forrester, 1961; Forrester 1994; Morecroft and Sterman, 1994; Sterman, 2000; Spector et al., 2001), is important. System dynamic modelling is expected to be optimal for that part of the modelling research which is mainly exploratory and quantitative.

5.3.4.2 Design Rationale

Organisations depend on communication and coordination. However, organisations also have to depend on the capabilities of their employees to exchange information or ideas and to coordinate activities effectively. Design rationale systems have been created to enable organisations to create and manage their knowledge assets so that there is effective communication and coordination; this was initially developed by Kunz and Rittel (1970). Design Rationale is an explicit documentation of the reasons behind decisions made when designing a system or artefact. As artefacts or instantiations of documents increase in complexity, the need to capture the fundamental design rationale increases. The goal of the design rationale approach is to minimise this dilemma. The aim of the design rationale is to justify why an artefact, or a part of an artefact, is designed the way it is (Lee and Lai, 1991;

Regli et al., 2000). Design is a decisive activity. It is “a goal-oriented, constrained, decision-making, exploration and learning activity that operates within a situation that depends on the designers perception of the situation and results in the description of a future engineering system” (Gero, 2000). Therefore, documenting the design rationale is a crucial practice in order to understand designers’ perceptions.

Design rationale is the documentation of the reasoning and rationale that provides support to the activities that take place during the design process. It is an effective tool for reflection, communication and analysis (Horner and Atwood, 2006). Design rationale acquires the knowledge and reasoning justifying the final design. Figure 25 demonstrates an example of the issue-based argument for design rationale.

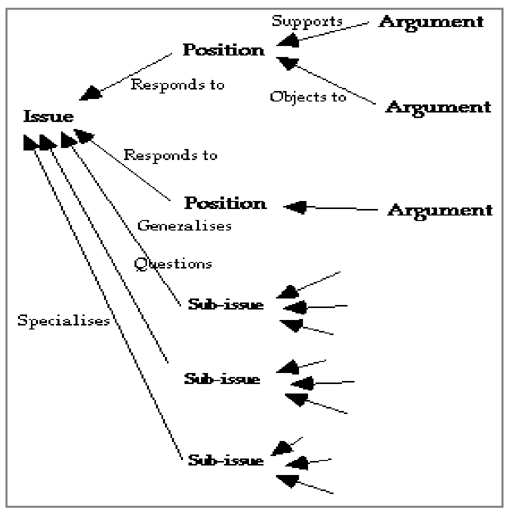


FIGURE 25: DESIGN RATIONALE (GRIFFITHS, 2000)

Designs are selected based on functional and quality requirements. Nevertheless, there is a growing concern that the design rationale is not always entirely documented, and that employees regularly need substantial amounts of communication in order to understand work done by others (Klein, 1993; Regli et al, 2000). Design rationale is based on arguments; these arguments consist of issues and sub-issues raised, and arguments for and against each alternative (Burge and Brown, 1998). From the figure shown above it is evident that the system starts from a root issue, and expands to generate sub-issues as it develops (Griffiths, 2000).

Some design rationale tools that can be used effectively within enterprise architecture are: An Intelligent Design Evolution Management System (AIDEMS), Process Technology Transfer

Tool (PTT), Design Rationale Capture System (DRCS), Active Design Documents (ADD), Reconstructive Derivational Analogy (RDA), IBIS (Issue Based Information Systems), JANUS, Design Recommendation and Intent Model (DRIM), Hyper-Object Substrate (HOS), PHIDAS, M-LAP (machine-learning apprentice system), and SIBYL (Burge and Brown, 1998). The advantages of using design rationale include:

I. It enables design teams to communicate past critical decisions, what alternatives were investigated, and the reason for the chosen alternative.
II. It transfers design knowledge between activities or assignments with similar rationales.
III. It encourages deliberation and the explicit consideration of alternatives. (Dix et al., 1998)

Technical challenges include: the requirement for a large number of trained employees, which is an expensive proposition in small organisations; making all employees aware of all of the relevant resources available to them; and design rationale technologies have to be specifically designed to suit the needs of the organisation. Design challenges include building systems which are beneficial to the user; being flexible so that broad content types are supported; and retaining a human-centred approach (Regli et al., 2000). If designers can establish greater visibility of design rationale, they can clearly determine design constraints that are incompatible. If the decision process is clear and transparent, designers will be able to focus on their efforts at creating better design rather than spending time on explanatory and descriptive tasks (Whelton et al., 2007).

Design rationale seeks to provide an argumentation-based structure to the political, collaborative process of addressing wicked problems. Some articles in creativity issues argue for or against the notion that design rationale techniques can spur creativity in the design process.

Design rationale techniques are used in this thesis as a method for justifying and reasoning about every design step, to be sure the decision made is the most suitable one. Well-known design rationale styles include the following:

- **Issue-Based Information System (IBIS)** contains Issue, Position and Argument.
    - Procedural Hierarchy of Issues (PHI)
- **Questions, Options and Criteria (QOC)**

- **Design Rationale Language (DRL)** contains Goal, Alternative, Claim, Question, Group, View point, Procedure and Status.

5.3.4.3 Organisation Structure Metamodel (OSM)

The Organisation Structure Metamodel (OSM) is intended to provide a definitive vocabulary, rules and interchange metamodel for specifying the authority, responsibility and accountability structure of an organisation (OMG, 2009b). OSM is a business-level specification that provides the potential for BPM suites and other IT systems to leverage a common, extensible set of data related to organisational units as resources. OSM will enable the business level documentation of virtually any sort of organisational form, the organisational units that go to make it up, information about those organisational units, and their relationships to other organisational units. It also includes the ability to identify and contact individuals, document the skills they possess, assign these individuals to organisational positions and roles, specify organisational unit capabilities and assign resources to organisational units. The specification will include at least one mapping to a production directory schema (such as LDAP), OMG (2009b).

5.3.4.4 KAOS for Goal-Oriented Modelling (GOM)

In this research we will use KAOS as graphical goal model notation. The BMM does not provide a specific goal modelling graphical notation, thus we will support the goal modelling by using KAOS to improve alignment and refinement.

Goal-oriented specifications provide assistance in the correct design of adaptive systems. Knowledge Acquisition in Automated Specification of Software Systems (KAOS) is a goal-driven methodology (Lamsweerde, 2001), based on a rich framework for requirement elicitation, analysis and management; this methodology is supported by two tools, Objectiver and FAUST (Delor et al., 2003). KAOS is also a methodology for requirements engineering. It was developed in the early 1990s as the first major teleological requirement modelling language. It has been applied to a number of industrial case studies.

Goals can be specified at various abstraction levels in an Enterprise Architecture Framework. Analysts use KAOS to build motivation models and to derive requirements documents. KAOS focuses on goal elaboration, which defines an initial set of high-level goals and objects as well as agents and actions. KAOS is iterative and refines goals using decomposition. It identifies obstacles to goals and goal conflicts, and operationalises goals into constraints that can be assigned to individual agents. It is expressible in terms of conditions that can be monitored and controlled (Letier and Lamsweerde, 2002).

This research will make use of the KAOS goal model approach, integrating it as part of the developed RDBMM framework to provide a graphical hierarchy of goal decomposition.

5.3.4.5 Semantics of Business Vocabulary and Business Rules (SBVR)

Semantics of Business Vocabulary and Rules (SBVR) is a standard from the OMG adopted in 2005 and combining different facets of ontologies and rule formation. It combines ideas from multiple topics, including modelling, ontologies, mathematics, philosophy and linguistics (Linehan, 2008). SBVR is a business vocabulary or a special purpose language tool; it is a meta-model for developing semantic models of business vocabularies and business rules that govern organisational actions. It assists organisations to easily understand totally unambiguous statements that define a procedure or function, raising the abstraction level of business solutions and capturing business requirements.

SBVR is used to describe businesses, not the IT systems that serve them. It does this using a language which is understandable by business people (Linehan, 2008). A business rule is a category of elements of guidance (OMG, 2008b). A vocabulary is drawn from one natural language that can be shared. The terminology is specialised, like the structured language used by lawyers or engineers. A vocabulary includes terms and names for noun concepts and ‘readings’ for verb concepts (OMG, 2008b).

Figure 26 presents the components or perspectives of SBVR: domain-level models, levels of abstraction and concept-oriented and fact-oriented views.

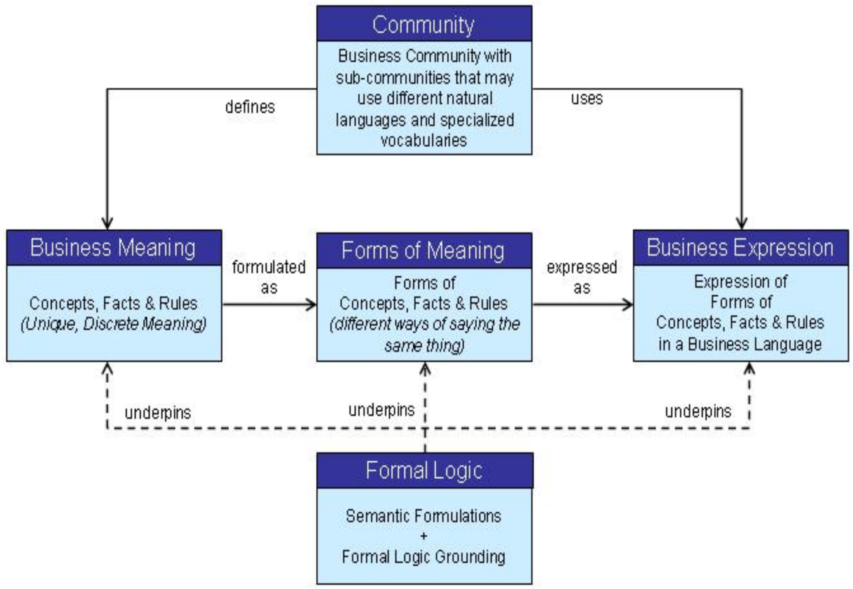


FIGURE 26: COMPONENTS OF THE SBVR MODEL (OMG, 2008B)

SBVR can define different kind of knowledge and vocabulary classification methods in an information system's usage which may contain several vocabulary repositories classified based on business and IT system requirements, as SBVR uses controlled natural language and is intended to be the basis for formal and detailed declarative natural language description of a complex entity, and for business rules. SBVR has the ability to describe different kinds of requirement:

- Business and domain ontology
- Business vocabulary and facts
- Business rules/polices
- System rules/polices

SBVR's formal logic can be machine-processed. It includes two specialised vocabularies:

- Vocabulary for defining business vocabularies, which can deal with all kinds of term and meaning.
- Vocabulary for defining business rules which deals with the specification of the meaning of business rules, and builds on the previous vocabulary.

SBVR is suggested to be a part of the BMM interoperability framework where business rules are integrated with processes and organisational structure aligned to strategy and organisational vision. This will increase the fusion with model-driven architecture (MDA) to document, develop and implement requirements.

Nevertheless, we are going to use the Semantics of Business Vocabulary and Business Rules (SBVR) to define terms and to share common understanding among stakeholders. The standard is recommended by many practitioners and uses controlled natural language and semantic formulation, thus allowing definition of the terms at business level and use at implementation level for underlying information systems (Fayoumi et al., 2009). One expressive technique used by SBVR structured English is font styles to designate statements with formal meaning. In particular,

- The term font is used to designate a noun concept
- The name font designates an individual concept
- The verb font is used to designate a verb concept
- The keyword font is used for linguistic particles used to construct statements

5.3.4.6 Business Process Modelling and Notation (BPMN)

Business Process Modelling and Notation (BPMN) is intended to be a non-methodological approach to allow business analysts to model a process in as simple or as complex an amount of detail as they believe suitable for the application. BPMN is an OMG specification providing a graphical notation that describes the main steps in a business process as a process-based pattern (OMG, 2011). BPMN illustrates the end-to-end flow of a business process. The notation has been specifically designed to coordinate the sequence of processes and the messages that flow between several process participants in a related set of activities. While it appears different in use and meaning from the UML activity diagram, the unified modelling language (UML) adopts an object-oriented approach to the modelling of applications, while BPMN considers a process-oriented approach to modelling business. A business process model does not necessarily have to be implemented as an automated business process using a process execution language. Where this is the case, business processes and participants can be mapped to constructs such as use cases and behavioural models in the UML. Many studies have been published discussing mapping between these techniques. Figure 27 shows the BPMN notations.

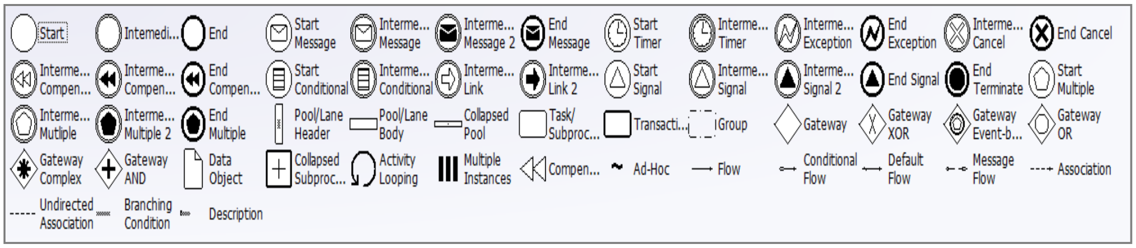


FIGURE 27: BPMN NOTATIONS

5.4 Confirmation of RDBMM to Socio-technical Analysis and Design Principles

As suggested in Chapter 4, the RDBMM takes into consideration socio-technical system analysis and design principles as the following:

Principle 1 The dynamics of the organisational environment is an input into the organisation’s internal aspects: the RDBMM offers a holistic knowledge blueprint for what is required to analyse influencers internally and externally. Analysts need to understand the enterprise context, identify and classify the influencers factors such as (stakeholders, competitors, regulatory body, customers, culture, economical and ecological issues might affect the enterprise activities).

Principle 2 Knowledge as a key asset: RDBMM is a knowledge framework which considers knowledge as a key asset. As the RDBMM framework promises to offer a holistic knowledge blueprint, the framework with its six views is able to cover most of the enterprise knowledge required to gain the visibility, and therefore better agility and fast-reacting decision-making of enterprise activities. Business ontology, concepts and facts are the main elements in constructing the enterprise’s knowledge. RDBMM’s holistic visibility offers the ability to optimise processes, to alter unnecessary policies or rules and to utilise resources. The RDBMM offers a solid foundation for continuous improvement. For example, the system dynamics model can be used as a basis for resource allocation, risk assessment and investment decision support. In the same model, changing some of the influencing factors or the way the factors influence the whole system can offer an insight based on different scenarios.

Principle 3 Analysts and designers as evolvers of internal design with context: In the same way, since all models decode a set of knowledge. The analyst/consultant should understand the dynamics of the enterprise context where it is considered an input to the enterprise’s internal aspects, and continuously assess performance and system sustainability. The responsibility falls on the strategic staff and socio-technical analysts to understand and analyse critical issues. The design rationale and systems dynamic modelling allow analysts to consider the dynamic factors of the external environment and visualise thinking and arguments about the best choices to be made and the consequences of each choice.

Principle 4 Structure vs. dynamics: The RDBMM is composed of a set of structural, behavioural and dynamics models. The capabilities that the enterprise possesses are taken into consideration when designing services, while objectives and capabilities are aligned in a way that does not over-promise or over-expect. The decision-makers will visualise objectives as an ‘end’ and capabilities as part of the ‘means’ and match them. The decision-makers in this case will be able to understand their choices by using the knowledge presented in RDBMM within the margin of freedom that the capability can offer.

Principle 5 Strategy and rules as a governance hub: As presented in the RDBMM, strategy, policies and rules form an enterprise governance hub, where they play a major role in aligning and directing the enterprise’s activities. These should be implemented in business systems with sufficient constraints to also govern user behaviour.

Principle 6 Technology architecture as enforcement level: The technical specifications are not fully developed in this research, although a conceptual and logical architecture are presented in chapter 7 and chapter 8. Nevertheless, the alignment between operation and ISs will satisfy the conformability, and it will depend on the implemented technology that the enterprise is willing to consider. Regarding automating activities, the technical platform should provide a level of enforcement derived from polices and rules toward achieving the strategy.

Principle 7 Design vs. architecture, the RDBMM offers a framework that can be implemented using several design concepts. Thanks to the three levels of abstraction which allows an analysts/consultant to implement the RDBMM architecture in the way they think it is more suitable to each particular business case. In addition, thanks to the separation between metamodel, tools and implementation process, which also offered more agility, customisability to the framework, analysts who are happy to design the models with different modelling languages/tools are able to do so without affecting the RDBMM architecture capability.

Principle 8 Personal goals vs. organisational goals: The RDBMM encourages the micro analysis of stakeholders, and goals should be described in levels of enterprise, groups and individuals, all of which need to work in harmony within their context. The enterprise analysts need to take into consideration the staff's personal objectives, welfare and insure continuous learning and promotion. They should be organised within a set of structural activities or ‘business processes’ with specific performance indicators. In the end, the RDBMM offers a framework for essential capabilities that allows the design of different cases, views and scenarios based on the main goal and objectives.

Principle 9 Autonomy vs. control: People are autonomous entities therefore to make sure that enterprise should monitor these autonomous entities, it need to organize their activities/tasks into clear defined processes, which are monitored by senior members within the organization’s structure, and govern their behaviour using set of policies and rules. All these aspects have been considered in RDBMM, using process model, rule model and organization structure.

Principle 10 Lower-level activities form the higher image: In the run-time, the flexibility offered to the operation staff in the way they performed their tasks or in best scenarios to engage them in designing the enterprise activities they are going to perform. Compliance to rules and to the designed activities is actually what is going to form the real enterprise image. This principle could not be tested in the design level. Therefore, RDBMM does not really reflect this principle but analysts/managers should be aware of it during implementation.

5.5 Reflection and Conclusion

This chapter has presented a new hybrid framework, the Reasoning in Dynamic Business Motivation Model (RDBMM), built upon the findings in Chapters 2, 3 and 4: the challenge addressed is how to design better socio-technical systems taking advantage of the capability of the current open standards of business and technology's analysis and modelling tools to improve the analysis and design process, which in return will increase enterprise agility and maintain control over the whole enterprise. In this chapter, to operationalise the socio-technical system analysis and design, a high-level RDBMM framework (Level-0) was proposed to present the essential and general components of the RDBMM framework; this high-level framework was operationalised using the BMM. A set of artefacts and the semantics among them have been proposed and situated within the BMM metamodel in order to expand the framework. The detailed RDBMM metamodel has been presented in Level-2, and this shows the real implementation artefacts. Reasoning and dynamics modelling were integrated in assessment types and played a major role in decision-making activities.

Furthermore, the detailed level Level-2 activities have been separated into a set of views conforming to complexity theory constructs. The need for separation lay in reducing the complexity and separation of modelling concerns which make it easier to adapt a particular modelling tool to model each specific view. Afterwards, the implementation process and the candidate tools to support the aim of this research have followed the proposed metamodels. The Design Rationale's qualitative analysis will help to offer better reasoning during the design process and support decision-making using argument visualisation. The System Dynamics modelling quantitative analysis can help to model discrete events and continuous time simulation: this tool helps to visualise mathematical formulas in enterprise settings. However, these methods also help to identify risks impact qualitatively and quantitatively. In this research, it was decided to use OSM, SBVR and BPMN, the OMG specifications and KAOS for modelling enterprise-related aspects of enterprise models beside the BMM, also to support model-driven development for future implementation of the socio-technical system.

The RDBMM framework offers full alignment among enterprise concepts: it will be able to align change in the environment with the enterprise strategy, then the operation and finally information system development. RDBMM offers the ability for successful alignment among all enterprise levels while considering both social and technical aspects.

Chapter Six: Info2cell Case Study

6.1 Motivation and Introduction

The main aim of this case study is to demonstrate that the RDBMM for socio-technical enterprise modelling in an SME is applicable in a service SME. To accomplish this aim, the RDBMM is applied in this case study; the objectives of the case study include understanding the reasoning behind Info2cell's strategic decisions, providing insight regarding future potential states and understanding risks. This case does not show all of the components of Info2cell's Enterprise models, but it shows that all the RDBMM aspects as proposed in Chapter 5 have been implemented with a minimum of one example for each artefact.

Table 14 shows the response of this case study developed models to the RDBMM views and artefacts:

TABLE 14: INFO2CELL CASE STUDY MODELS

RDBMM Views/Perspective	**Info2cell Models Response To RDBMM Views**
Goal view and motivation artefacts (End, Mean Influencers, Assessment, Potential Impact, Strategy, Tactics and Policies)	Motivation Model
Terms, Facts, Concepts and Ontology view	Business Vocabulary
Facts, Rules view and Decision view	Rule Sets
Process view	Process Model
Decision view, Influencers, Assessment and Potential impacts	Rationale Model
Dynamic impact of influencers, assessment and impact prediction	Dynamic Model
Agent/Actor view	Organisation Model
Analysis of Social aspects	Issues analysis

The modelling process started with understanding the context and the business model, later the RDBMM was implemented as described in Figure 28:

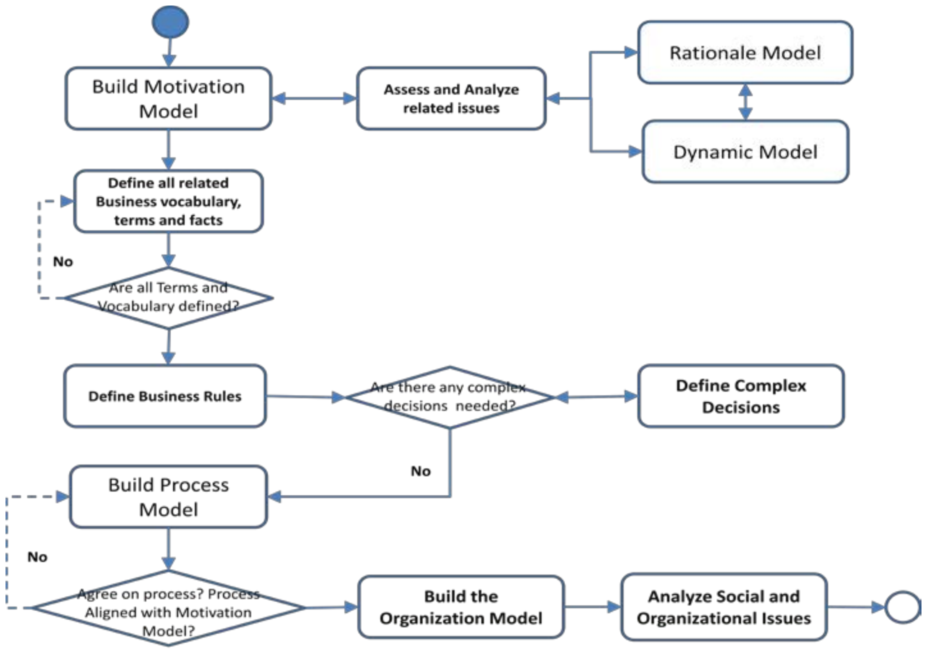


FIGURE 28: INFO2CELL CASE STUDY MODELLING PROCESS

6.1.1 Info2cell - Overall Context

Most of the companies in the world are classified as SMEs; for instance, in the 25-member EU there were approximately 23 million SMEs representing 99% of all EU companies and employing around 75 million people (European Commission, 2005). Globally SMEs account for 99% of business numbers and 40%-50% of gross domestic product (GDP). SMEs are prone to face more challenges with respect to dynamics and chaos. Researchers (Gunasekaran et al., 2000; Oduoza et al., 2009; Wahid et al., 2008) have stated clearly that the rapid response to change in customer demand and trends, a lack of formal documented procedures and resource allocation, and particularly job allocation in real time are the most challenging problems facing SMEs. Therefore, the developed RDBMM is a good candidate to overcome such challenges.

Info2cell is a leading mobile Value Added Services (VAS) company serving the Middle East and North Africa (MENA) region. Mobile carriers abound in this region and statistics published in January 2009 (Shaykhoun, 2009) confirm that there is a growing relationship between new carriers and increased competition. In early 2008, the number of new mobile subscribers reached 194,533 million; the market in 2009 for mobile value-added services in the Middle East is estimated at US$ 350 million. This market value is distributed across the various players along the value chain - mobile operators, content providers, and applications developers. The VAS market is expected to grow at a strong compound annual growth rate of around 22% and to be generating revenues of over US$ 11.5 billion by 2014. The most popular VAS services delivered in the MENA area are mobile entertainment, financial, learning, data and social services.

Figure 29 shows the abstract description of Info2cell's business model.

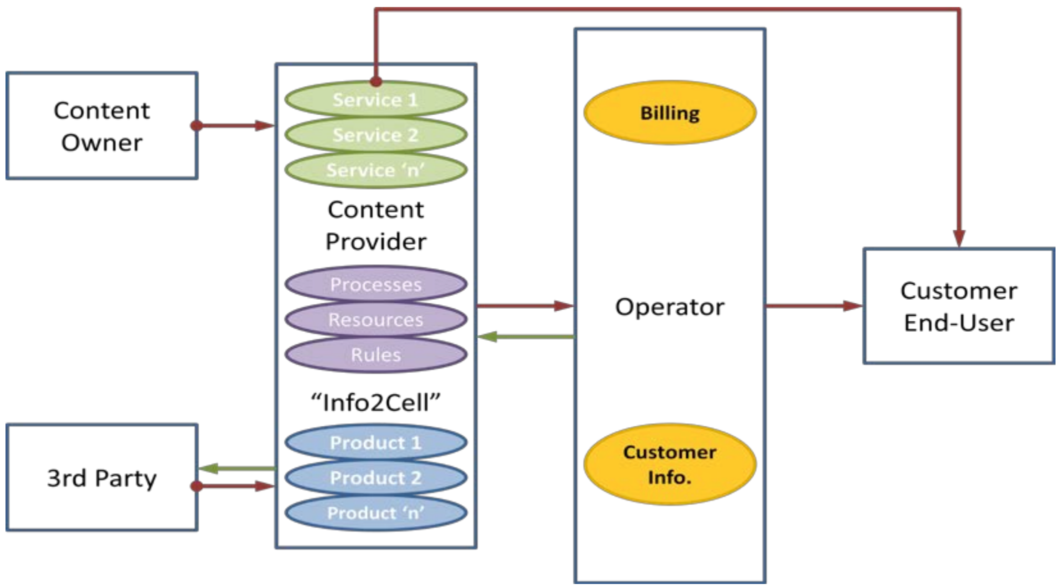


FIGURE 29: CASE STUDY CONTEXT

6.1.2 Info2cell Case Background

In Middle East, the concept of wireless portal services were introduced initially by the pioneer company Info2cell, with the vision of Bashar Dahabra, the founder and CEO of Info2cell; Info2cell was established in 1998 and has been at the lead of mobile service delivery since then. Info2cell started out as a specialist in non-voice mobile data communications. Currently Info2cell draws on the experience of Acotel group of Italy, which in 2000 acquired 33% of Info2cell and supported it with a US$ 2.5 million comprehensive top-of-the-range adaptable wireless platform. In 2003, Info2cell became 100% owned by the Acotel Group. Today, Info2cell is the leading and largest wireless applications service provider in the MENA region with 57 employees, providing direct access to more than 40 operators across the MENA region including STC, Etisalat, Zain Group, Qatar Telecom, Batelco, Mobinil and Orange.

Info2cell products and services include SMS, MMS, WAP, WAP Push, and Web content in the News, Islamic, Entertainment and Sports categories. Furthermore, Info2cell partners with major local, regional and international content providers/owners to aggregate their content to mobile operators in the region including to BBC, CNN, MBC, Al-Arabiya, Rotana, Future TV, Al-Majd TV along with other major players in the industry.

The main delivery processes involved in Info2cell's service provision are:

- Services pushed by 3rd parties that could include development or delivery only
- Services developed and pushed by Info2cell (VAS, Mobile applications, Web portal)
- 3rd party content agreements pushed by Info2cell.

Info2cell aims to improve the quality of services, therefore the quality of its business processes. So Info2cell has started lately to adopt several industry standards to improve its development and delivery processes, for example, following the PMP approach for project management, recently adopting ITIL for support services, and implementing a ticketing system to handle internal and external technical issues. Also, one line of RDBMM modelling for 'Quality of Services' presented and documented in Appendix D to demonstrate how RDBMM can be used for one goal alignment of enterprise modelling.

6.1.3 Application of the RDBMM in Info2cell

In a competitive open market, Info2cell is looking for more market insight to increase its competitive advantage. More future technology, products and services awareness are required and strategic thinking fitting the requirements of an open dynamic market is highly necessary. Moreover, Info2cell is interested in investigating internal issues, mainly employees' perspective and issues of control and leadership. During the interviews, a number of issues were investigated in order to improve institutional awareness from this side, and also to facilitate understanding of dynamic market patterns. A set of modelling tools, narrative analysis and simulation methods was used to understand the problem domain and to help gain more socio-technical insight as suggested by the RDBMM framework. The enterprise modelling was performed from the perspective of the Info2cell community. Documents were analysed to gain more insight and information about the company.

6.2 Business Motivation Model

The BMM is the core of the RDBMM, so modelling started with End, Mean and Guidelines, and moved on to look at Assessment, Impact, and Influencers. The other aspects of modelling followed the BMM model.

6.2.1 Motivation Model

This contains all of motivation elements of the Info2cell case study, the motivation model as proposed by OMG presented in the following model (Figure 30).

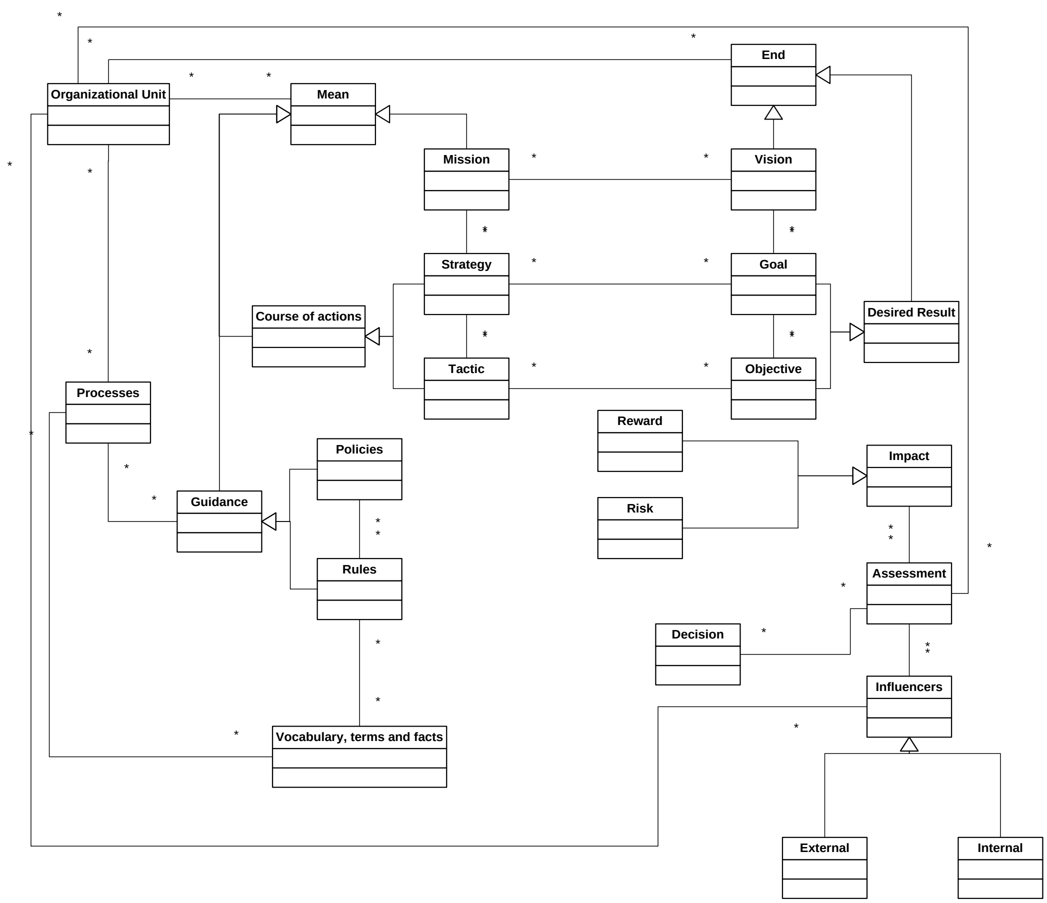


FIGURE 30: BUSINESS MOTIVATION MODEL (BMM)

6.2.1.1 Info2cell strategy

Figure 31 represents the rationale of Info2cell's goal hierarchy focus strategy, this hierarchy conforms with the BMM End and Mean components and the relations among them.

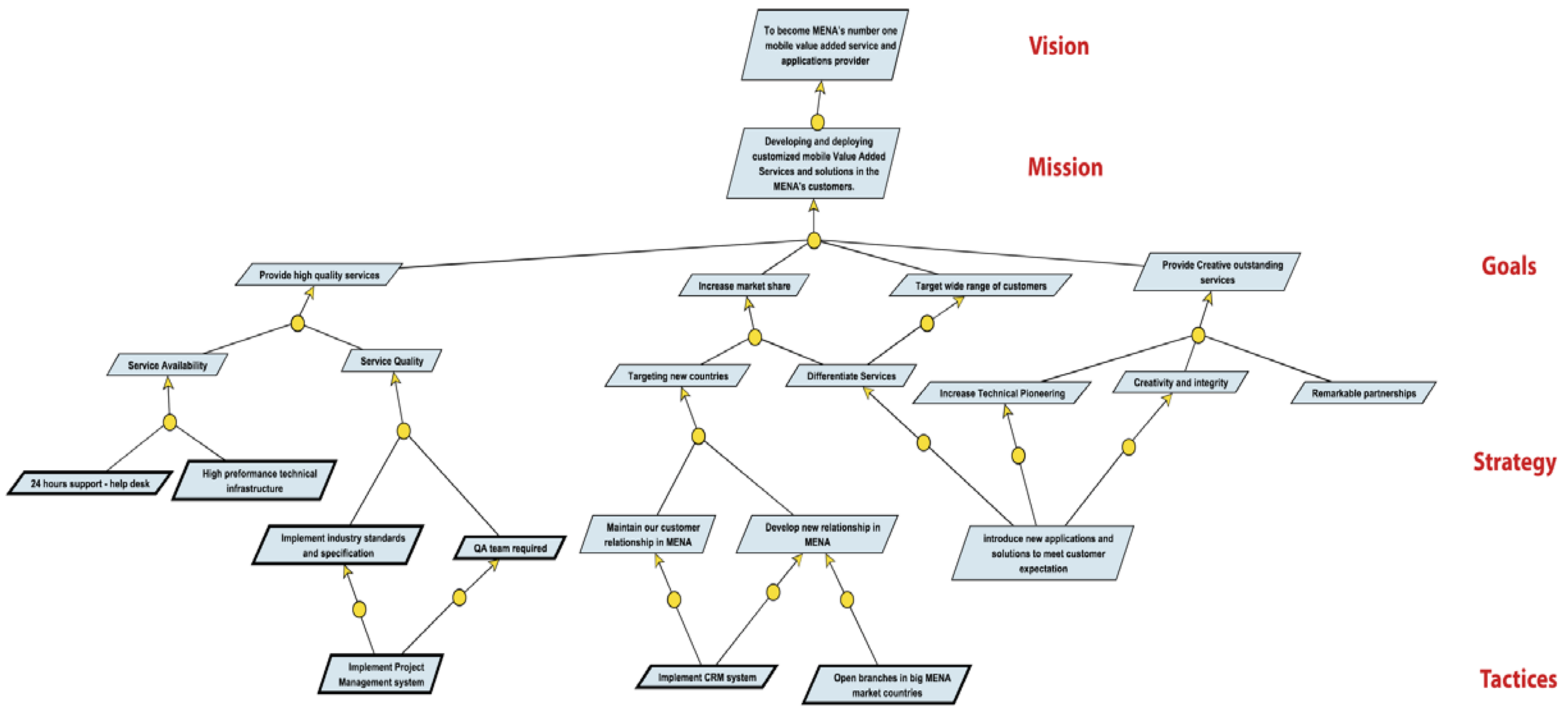


FIGURE 31: INFO2CELL GOAL HIERARCHY MODEL (KAOS GOAL MODEL)

6.2.1.1.1 Vision

This section describes the **Vision** section of the Info2cell goal hierarchy model (Figure 31)

TABLE 15: INFO2CELL VISION PATTERN

Info2cell Vision	
Description	To become MENA's number one mobile Value Added Service and applications provider
CATWOE Customer	Individuals (B2C) , Companies (B2B)
CATWOE Transformation	Provide VAS to subscribers and customers
CATWOE Owner	ACOTEL GROUP, Shareholders
CATWOE Environment	**-** Laws in countries where we operate - Industry rules and service level agreement (SLA)
CATWOE Actor	Info2cell branches
Owner	Info2cell
Status	Commercial operational
Amplified by goal	Customer demand, long-term subscribers
Made operative by mission	Info2cell Mission

6.2.1.1.2 Mission

This section describes the **Mission** section of the Info2cell goal hierarchy model (Figure 31)

TABLE 16: INFO2CELL MISSION PATTERN

Info2cell Mission	
Description	Developing and deploying customised mobile Value Added Services and solutions for MENA customers
Owner	Info2cell
Status	Operational
Makes vision operative	Info2cell Vision
Planned by means of strategy	MENA focus, VAS development and delivery

6.2.1.1.3 Goals

This section describes the **Goals** section of the Info2cell goal hierarchy model (Figure 31)

TABLE 17: INFO2CELL GOAL 1 PATTERN

Goal 1: Provide high quality services	
Description	Develop and provide high quality services meeting customer expectations
Priority	High
Owner	Info2cell
Status	Operational
Amplifies vision	Info2cell Vision
Composed of goal	Customer focus, technology and creativity

Quantified by Objective	Objective 1
Ethicality	QoS considered ethical practice; all practices should conform to regulator and ethical work report
Difficulty	Difficulty associated with timeframe, technology and materials used to deliver the service and size of the project QA team responsible for service quality standards
Aligned to	Info2cell mission
History	Info2cell has previously faced some issues related to quality: - Operator mobile bandwidth does not support high quality - Mobile application bugs - Material source is of low quality Info2cell is keen to learn from past experiences: issues to be clarified to the customer when required

TABLE 18: INFO2CELL GOAL 2 PATTERN

Goal 2: Increase market share	
Description	Increase market share in competition with other VAS providers
Priority	High
Owner	Info2cell
Status	Operational
Amplifies vision	Info2cell Vision
Composed of	Targeting new countries and differentiating services
Justified in	Leadership reasoning
Quantified by Objective	Objective 2
Ethicality	The processes and procedures to be followed all conformed with ethical practices standards
Difficulty	Difficulty is high due to the keen competition in the market
Aligned to	Info2cell mission
History	- Info2cell as first mover in the market had a great market share in 1998, at almost 80% - This number reduced gradually until it reached 40% in 2008

TABLE 19: INFO2CELL GOAL 3 PATTERN

Goal 3: Creative outstanding services	
Description	Develop services using state of the art technology and creative media refined by a human touch
Priority	Medium
Owner	Info2cell
Status	Operational
Amplifies vision	Info2cell Vision
Composed of goals	Technical pioneering, remarkable partnership, creativity and integrity
Quantified by Objective	Objective 3
Ethicality	The developer services should conform with country regulations and culture, and with industry and service delivery regulations
Difficulty	Nowadays, there is an increasing in technology services providers.

	Bringing new and creative ideas to lead the market become a real challenge.
Aligned to	Info2cell mission
History	- Info2cell is the first VAS provider in Jordan and the Middle East - Creative content has been always delivered. However, the new creative services are continually under evaluation.

TABLE 20: INFO2CELL GOAL 4 PATTERN

Goal 4: Target wide range of customers	
Description	Provide mobile services for both business and personal customers in three forms. - Business to Consumer (B2C) - Business to Business (B2B) - Machine to Machine (M2M)
Priority	Medium
Owner	Info2cell
Status	Operational
Amplifies vision	Info2cell Vision
Composed of goal	Differentiate services, target different market segmentations
Considered in assessment	In assessment of Influencer 1
Quantified by Objective	Objective 4
Ethicality	- Conform to country regulator policies - Conform to business policies - Conform to country culture - Conform to children/underage safety and security
Difficulty	Different kinds of service and application need to be developed to match the needs of different customers. Medium difficulty due to the need for creative ideas, skills and resources
Aligned to	Info2cell mission
History	Most of Info2cell's experience falls under the area of end user services. where Info2cell is well-known and successful.

6.2.1.1.4 Objectives

This section describes the **Objectives** section of the Info2cell goal hierarchy model (Figure 31).

TABLE 21: INFO2CELL OBJECTIVE 1 PATTERN

Objective 1: Service quality	
Description	During the 4th quarter of the current year (2011), Info2cell planned to reduce customer enquiries related to service quality by 20% compared to the 3rd quarter.
Priority	Medium
Criterion	Percentage of customer quality issues enquiries
Timeframe	End of year (from October to December)
Target value	30%
Actual value	50%
Percent Achieved	20%

Last Update	14/10/2012
Owner	Info2cell
Status	Operational
Quantifies goal	Goal 1: Provide high quality services
Part of objective	Customer and market share

TABLE 22: INFO2CELL OBJECTIVE 2 PATTERN

Objective 2: Market share	
Description	In the next financial year, Info2cell planned to increase their market share
Priority	Medium
Criterion	Percent of market share in the end of the financial year
Timeframe	End of next year
Target value	40%
Actual value	35%
Percent Achieved	-20%
Last Update	14/6/2012
Owner	Info2cell
Status	Operational
Quantifies goal	Goal 2:Increase market share
Part of objective	Customer

TABLE 23: INFO2CELL OBJECTIVE 3 PATTERN

Objective 3: Service creativity	
Description	Info2cell aims at increasing the new outstanding and creative services provided to customers
Priority	High
Criterion	Number of patents, number of first time established services in MENA
Timeframe	During the next financial year
Target value	Ten services yearly
Actual value	Two services yearly
Percent Achieved	40%
Last Update	14/6/2012
Owner	Info2cell
Status	Operational
Quantifies goal	Goal 3: Creative outstanding services
Part of objective	Customer

TABLE 24: INFO2CELL OBJECTIVE 4 PATTERN

Objective 4: Customer	
Description	This represents the ‘customer’, which is also a perspective of the Balanced Scorecard.
Priority	Medium

Timeframe	End of next year
Percent Achieved	35%
Last Update	14/6/2012
Owner	Info2cell
Status	Operational
Quantifies goal	Goal 4: Target wide range of customers
Part of objective	Final achievement

6.2.1.1.5 Influencers

This section describes the influencers of diagram "Info2cell BMM".

TABLE 25: INFO2CELL INFLUENCER 1 PATTERN

Influencer 1: Mobile market increased by more than 30% last year in MENA	
Description	Expansion of the mobile market increases the number of potential customers
Influencer Source	External
Influencer Type	Environment
Owner	Info2cell
Status	Strategic/Operational
Judge by assessment	Assessment 1

TABLE 26: INFO2CELL INFLUENCER 2 PATTERN

Influencer 2: Smart phone market increases by around 11% annually in MENA	
Description	Increased use of Smart phones offers a plentiful environment for customers to request a whole spectrum of VAS products
Influencer Source	External
Influencer Type	Customer
Owner	Info2cell
Status	Strategic/Operational
Judge by assessment	Assessment 2

TABLE 27: INFO2CELL INFLUENCER 3 PATTERN

Influencer 3: Number and services of competitors	
Description	Increasing number of competitors to around 500 VAS providers in MENA area increases the challenges of maintaining market share: competitors could provide similar services with competitive prices
Influencer Source	External
Influencer Type	Competitor
Owner	Info2cell
Status	Operational
Judge by assessment	Assessment 3

TABLE 28: INFO2CELL INFLUENCER 4 PATTERN

Influencer 4: Country regulations	
Description	Country regulations affect business in terms of: - The content that can be delivered - Physically having branches located and registered in the country
Influencer Source	External
Influencer Type	Regulation
Owner	Info2cell
Status	Operational
Judge by assessment	Assessment 4

TABLE 29: INFO2CELL INFLUENCER 5 PATTERN

Influencer 5: Operator policies and trends	
Description	Operators can control content and data in several ways: - Content does not match operator trends or could be satiated by other competitors. - Operator controls customer data and market statistics.
Influencer Source	External
Influencer Type	Partner/Regulation
Owner	Info2cell
Status	Operational
Judge by assessment	Assessment 5

TABLE 30: INFO2CELL INFLUENCER 6 PATTERN

Influencer 6: Info2cell Annual budget	
Description	Annual budget allocated by owner could limit Info2cell's activities, limiting its: - Ability to buy important resources or hire new experts - Ability to spend on training and development and employee rewards - Ability to target more markets and customers due to travel and follow-up expenses - Ability to adapt to changing technology and attend technical and services conferences or consortiums
Influencer Source	Internal
Influencer Type	Resource
Owner	Acotel
Status	Strategic/Operational
Judge by assessment	Assessment 6

TABLE 31: INFO2CELL INFLUENCER 7 PATTERN

Influencer 7: Customer Demand	
Description	Customer demand is rapidly increasing, resulting in: - Global trends and emergence of personal need (customising and

	personalising services) - Increasing bandwidth and speed of data transfer with a great decrease in mobile data package prices
Influencer Source	External
Influencer Type	Customer
Owner	Info2cell
Status	Operational
Judge by assessment	Assessment 7

TABLE 32: INFO2CELL INFLUENCER 8 PATTERN

Influencer 8: Content Owner/Partner	
Description	- Content partner could set up minimum grounds before providing Info2cell with the right to distribute content. - Content owner could ask Info2cell to distribute poor content
Influencer Source	External
Influencer Type	Supplier
Owner	Info2cell
Status	Operational
Judge by assessment	Assessment 8

TABLE 33: INFO2CELL INFLUENCER 9 PATTERN

Influencer 9: Info2cell Human resources	
Description	Info2cell's employees play an important role in the organisation's activities towards its goals: - employee skills and experience - employee retention and loyalty
Influencer Source	Internal
Influencer Type	Resource
Owner	Info2cell
Status	Operational
Judge by assessment	Assessment 9

6.2.1.1.6 Assessments

This section describes the assessments of diagram "Info2cell BMM".

TABLE 34: INFO2CELL ASSESSMENT 1 PATTERN

Assessment of Influencer 1:	
Description	Increasing the number of mobile owners means increasing potential customers of value added services: the diversity of users should be taken into consideration.
Assessment Type	Opportunity
Motivation	As a VAS and mobile applications providers it is very crucial to understand the potential market size for the services.
Owner	Info2cell
Status	Strategic and operational

Judges influencer	Mobile market increased by more than 30% last year in MENA
Assesses effect on desired result	Increase market share
Causes employment of means	Target wide range of customers
Identifies potential impact	Gaining more customers
Undertaken	Commercial

TABLE 35: INFO2CELL ASSESSMENT 2 PATTERN

Assessment of Influencer 2:	
Description	The increasing number of smart phone owners means that we need to target the demand of those customers with suitable services for their smart phones.
Assessment Type	Opportunity
Motivation	The smart phone opens up a wide range of potential delivered services, therefore newer technology and innovated services are highly desired to match customer demand.
Owner	Info2cell
Status	Operational
Judge Influencer	Smart phone users increase by around 11% yearly in MENA
Assesses effect on desired result	Increase market share
Causes employment of means	Service availability, creativity and integrity
Identifies potential impact	Gain more customers
Undertaken	Commercial

TABLE 36: INFO2CELL ASSESSMENT 3 PATTERN

Assessment of Influencer 3:	
Description	Increasing number and services of competitors with competitive prices.
Assessment Type	Threat
Motivation	As a VAS and mobile applications provider it is important to know the competitors in the market to know how to differentiate the company's services in order to increase competitive advantage.
Owner	Info2cell
Status	Operational
Judge Influencer	Number and services of competitors
Assesses effect on desired result	Increase market share
Causes employment of means	Target wide range of customers, quality of services, service availability, creativity and integrity.
Identifies potential impact	Losing customers
Undertaken	Strategy, Commercial

TABLE 37: INFO2CELL ASSESSMENT 4 PATTERN

Assessment of Influencer 4:	
Description	Different countries in MENA have different sets of regulations: some require having an office in the country and others that there is a joint venture with a local partner.
Assessment Type	Threat - Opportunity?
Motivation	Need to make sure that country regulations are well understood in order to best conform with delivery polices applied in the country.
Owner	Info2cell
Status	Operational
Judge Influencer	Country regulation
Assesses effect on desired result	Increase market share
Causes employment of means	Target wide range of customers, service availability
Identifies potential impact	Longer supply chain, share revenue
Undertaken	Commercial

TABLE 38: INFO2CELL ASSESSMENT 5 PATTERN

Assessment of Influencer 5:	
Description	Operators have always fit their strategy to specific trends and directions related to VAS, however, many aspects influence the operator's direction: - Increasing number of competitors and their VAS - Countries' cultures and social systems - Regulators' rules
Assessment Type	Threat
Motivation	Most of our customers come through mobile operators; mobile operator play a gateway role in reaching customers
Owner	Info2cell
Status	Operational
Judge Influencer	Operator policies and trends
Assesses effect on desired result	Service availability, service diversity
Causes employment of means	Target wide range of customers
Identifies potential impact	Effect on type and volume of service delivery
Undertaken	Commercial

TABLE 39: INFO2CELL ASSESSMENT 6 PATTERN

Assessment of Influencer 6:	
Description	Annual budget set by owner could limit Info2cell activities by:

	- Reducing the cost of development and updating services and assets - Reducing the ability to target more customers in new countries. - Reducing the ability to hire new skills and capability
Assessment Type	Weakness
Motivation	Info2cell should be able to perform its activities to achieve its vision without worrying about the size of the annual budget
Owner	Info2cell
Status	Strategic and operational
Judge Influencer	Annual budget
Assesses effect on desired result	Increase market share
Causes employment of means	Target wide range of customers, deliver innovative services
Identifies potential impact	Lose competitive advantage
Undertaken	Strategy

TABLE 40: INFO2CELL ASSESSMENT 7 PATTERN

Assessment of Influencer 7:	
Description	Customer demand has increased for several reasons: understanding trends in customers and products will help to increase revenue
Assessment Type	Opportunity
Motivation	As a VAS and mobile applications provider it is crucial to understand customer needs and market direction
Owner	Info2cell
Status	Strategic and operational
Judge Influencer	Customer demand
Assesses effect on desired result	Increase market share
Causes employment of means	Target wide range of customers, unique services
Identifies potential impact	Gaining more customers
Undertaken	Commercial

TABLE 41: INFO2CELL ASSESSMENT 8 PATTERN

Assessment of Influencer 8:	
Description	Content owner is an Info2cell business partner, however, the content providers might increase the minimum grant which may diminish Info2cell profit
Assessment Type	Threat
Motivation	It is necessary to understand the minimum acceptable grant that make reasonable profit and Info2cell can accept.
Owner	Info2cell
Status	Operational

Judge Influencer	Content Acquisition and Product application Department
Assesses effect on desired result	Deliver innovative services, high quality services
Causes employment of means	Increase market share , Target wide range of customers
Identifies potential impact	- Reduced profit - Reducing Customers
Undertaken	Content and product development manager

TABLE 42: INFO2CELL ASSESSMENT 9 PATTERN

Assessment of Influencer9:	
Description	Employees are subject to many influences that may change the direction of the work and should be planned right: - Mismatch between organisational and personal goals - Employees could have low motivation - Employees could leave the organisation - Employees may need training and to gain more skills
Assessment Type	Weakness
Motivation	Understand employees' needs, plan their careers, assess their performance and offer them the necessary action to sustain and improve their performance.
Owner	Info2cell
Status	Operational
Judge Influencer	Info2cell Human Resources
Assesses effect on desired result	Deliver innovative services, high quality services
Causes employment of means	Target wide range of customers
Identifies potential impact	Lose competitive advantage
Undertaken	Human Resources

6.2.1.1.7 Potential Impacts

This section describes the potential impact of diagram "Info2cell BMM."

TABLE 43: INFO2CELL IMPACT 1 PATTERN

Impact 1: Winning customers	
Description	Getting new customers and increasing market share
Impact type	Reward
Owner	Info2cell
Status	Operational
Significant to assessment	Assessment of Influencer 1

TABLE 44: INFO2CELL IMPACT 2 PATTERN

Impact 2: Increasing potential customers	
Description	Targeting smart phone owners will increase market share
Impact type	Reward
Owner	Info2cell - Development
Status	Operational
Significant to assessment	Assessment of Influencer 2

TABLE 45: INFO2CELL IMPACT 3 PATTERN

Impact 3: Losing customers/decreasing market share	
Description	Potential customers are moving to other competitors
Impact type	Risk
Owner	Info2cell
Status	Strategic
Significant to assessment	Assessment of Influencer 3

TABLE 46: INFO2CELL IMPACT 4A PATTERN

Impact 4a: Reduced profit/longer supply chain	
Description	Having local partners will lengthen the delivery life cycle and reduce the profit
Impact type	Risk
Owner	Info2cell
Status	Operational
Significant to assessment	Assessment of Influencer 4

TABLE 47: INFO2CELL IMPACT 4B PATTERN

Impact 4b: Closer to customer location - increase customers	
Description	Being closer to the customer and fulfilling their needs
Impact type	Reward
Owner	Info2cell
Status	Operational
Significant to assessment	Assessment of Influencer 4

TABLE 48: INFO2CELL IMPACT 5 PATTERN

Impact 5: Minimise number of potential services	
Description	Potential and targeted services could be blocked
Impact type	Risk
Owner	Info2cell
Status	Operational
Significant to assessment	Assessment of Influencer 5

TABLE 49: INFO2CELL IMPACT 6 PATTERN

Impact 6: Limited resources	
Description	Could lose customers or potential development
Impact type	Risk
Owner	Info2cell
Status	Operational
Significant to assessment	Assessment of Influencer 6

TABLE 50: INFO2CELL IMPACT 7 PATTERN

Impact 7: Market analysis	
Description	Market research and analysis could create a great opportunity to increase customer satisfaction
Impact type	Reward
Owner	Info2cell - Commercial
Status	Operational
Significant to assessment	Assessment of Influencer 7

TABLE 51: INFO2CELL IMPACT 8 PATTERN

Impact 8: Losing profit/ Losing Customer	
Description	The income may become less, increasing the service price might cause losing customers
Impact type	Risk
Owner	Info2cell
Status	Operational
Significant to assessment	Assessment of Influencer 8

TABLE 52: INFO2CELL IMPACT 9 PATTERN

Impact 9: Staff goal dynamics	
Description	Social resources are very dynamic: difficult to predict their behaviour
Impact type	Risk
Owner	Info2cell
Status	Operational
Significant to assessment	Assessment of Influencer 9

6.2.1.1.8 Strategies

This section describes the **Strategies** section of the Info2cell goal hierarchy model (Figure 31).

TABLE 53: INFO2CELL STRATEGY 1 PATTERN

Strategy 1: Maintain and develop new relationships in MENA	
Description	Operate region-wide in each country of operation, focusing on major cities, competing head-to-head in each city with other

	premium VAS providers companies
Owner	Commercial department of Info2cell
Status	Operational
A component of the plan for mission	Info2cell mission
Implemented by tactic	Tactics 1 and 6
Assessed in	N/A
Realised by business process	N/A, this strategy is assigned to tactics

TABLE 54: INFO2CELL STRATEGY 2 PATTERN

Strategy 2: Introduce new applications and solutions to meet customer expectations	
Description	Being customer focused means understanding different customers; needs: developing services and applications meeting their expectations is essential for success
Owner	Technical department of Info2cell
Status	Operational
A component of the plan for mission	Info2cell mission
Implemented by tactic	Tactics 4 and 5
Assessed in	Innovation and new service development reasoning
Realised by business process	N/A, this strategy is assigned to tactics where further details are required to develop related processes

TABLE 55: INFO2CELL STRATEGY 3 PATTERN

Strategy 3: Ensure Service Availability	
Description	Service availability is required at anytime and anywhere the customer exists and the main aspects related to service availability are: 1- Service delivery is on time and ensured by high quality infrastructure and media 2- Services are available for subscribers through different channels.
Owner	Info2cell – multiple divisions
Status	Operational
A component of the plan for mission	Info2cell mission
Implemented by tactic	Tactics 3 and 4
Assessed in	Market leadership reasoning
Realised by business process	N/A, this strategy is assigned to tactics

TABLE 56: INFO2CELL STRATEGY 4 PATTERN

Strategy 4: Ensure Service Quality	
Description	Service quality has two different aspects: 1- Quality of delivery and application should be bug-free and

	efficient 2- Content quality must fit several types of devices
Owner	Technical, editorial, operation and content departments of Info2cell
Status	Operational
A component of the plan for mission	Info2cell mission
Implemented by tactic	Tactics 2, 4 and 5
Assessed in	Leadership reasoning
Realised by business process	N/A, this strategy is assigned to tactics

TABLE 57: INFO2CELL STRATEGY 5 PATTERN

Strategy 5: Remarkable partnerships	
Description	Partners sometimes play a role as a success factor for the organisation, so choosing partners that are able to support and provide high reputation services is important: selection of partners should be based on a value creation assessment that considers tangible and intangible values
Owner	Strategic and commercial departments of Info2cell
Status	Operational
A component of the plan for mission	Info2cell mission
Implemented by tactic	N/A
Assessed in	N/A
Realised by business process	Business process can be developed to guide partner selection

TABLE 58: INFO2CELL STRATEGY 6 PATTERN

Strategy 6: Technical pioneering	
Description	Technical adaptation and innovative usage needs to consider several factors: - Understanding changes in community and social trends - Researching new developments related to the VAS industry - Evaluating and adapting new technology - Developing upstream services
Owner	Technical department of Info2cell
Status	Operational
A component of the plan for mission	Info2cell mission
Implemented by tactic	Tactics 4, 5 and 7
Assessed in	Service development and innovation reasoning
Realised by business process	Business processes and polices can be developed to impose pioneering requirements

TABLE 59: INFO2CELL STRATEGY 7 PATTERN

Strategy 7: Creativity and integrity	
Description	A creative culture needs outside-the-box individual thinking, collaboration and practices
Owner	Technical, editorial and content departments of Info2cell
Status	Operational
A component of the plan for mission	Info2cell mission
Implemented by tactic	Tactics 4 and 7
Assessed in	Service development and innovation reasoning
Realised by business process	Business guidelines can be developed to support creativity and integrity practices

6.2.1.3.3 Tactics

This section describes the **tactics** section of the Info2cell goal hierarchy model (Figure 31).

TABLE 60: INFO2CELL TACTIC 1 PATTERN

Tactic 1: Implement CRM system	
Description	Implementing a CRM system to help in storing, retrieving and updating customer information, thus helping to retain and maintain relationship with customers, and gaining new ones
Owner	Commercial department - owner Support department - implementer
Status	Operational
Implements strategy	Strategies 1 and 2

TABLE 61: INFO2CELL TACTIC 2 PATTERN

Tactic 2: Implement Project Management system	
Description	Project management system
Owner	Project management team (PMO) - owner Support team - implementer
Status	Operational
Implements strategy	Strategy 5

TABLE 62: INFO2CELL TACTIC 3 PATTERN

Tactic 3: 24 hour support/Help desk	
Description	Help desk to operate 24 hours to ensure that services are running efficiently
Owner	Support team
Status	Operational
Implements strategy	Strategy 4

TABLE 63: INFO2CELL TACTIC 4 PATTERN

Tactic 4: High performance technical infrastructure	
Description	Implement and install high performance technical infrastructure (servers, PCs, network, internet)
Owner	Technical department
Status	Operational
Implements strategy	Strategy 4

TABLE 64: INFO2CELL TACTIC 5 PATTERN

Tactic 5: Implement industry standards and specifications	
Description	Industrial standards and specifications to be followed such as ISO, PMP, ITIL, etc.
Owner	Quality team, Technical department
Status	Operational
Implements strategy	Strategy 5

TABLE 65: INFO2CELL TACTIC 6 PATTERN

Tactic 6: Open branches in the major markets in MENA region	
Description	Physical offices with full-time employees in the major markets of MENA countries
Owner	Strategic department
Status	Operational
Implements strategy	Strategies 1 and 2

TABLE 66: INFO2CELL TACTIC 7 PATTERN

Tactic 7: Recruit high skills	
Description	Highly skilled people are required to deliver Info2cell's mission
Owner	HR department
Status	Operational
Implements strategy	Strategies 7 and 8

This section describes the exceptional strategy and tactics of diagram "Info2cell BMM".

TABLE 67: INFO2CELL EXCEPTIONAL STRATEGY PATTERN

Exceptional Strategy: Cutting expenses	
Description	Cutting expenses to reduce money spent
Owner	Strategic department
Status	Strategic/Operational
A component of the plan for mission	Exceptional mission
Implemented by tactic	Exceptional tactics
Assessed in	N/A

TABLE 68: INFO2CELL EXCEPTIONAL TACTIC 1 PATTERN

Exceptional Tactic 1: Reduce salaries	
Description	Cut salaries to reduce expenses
Owner	Strategic department - owner Finance and accounting - execution
Status	Operational
Implements strategy	Cutting expenses

TABLE 69: INFO2CELL EXCEPTIONAL TACTIC 2 PATTERN

Exceptional Tactic 2: Restructuring and job termination	
Description	Organisational restructuring and laying off employees
Owner	Strategic department
Status	Strategic/Operational
Implements strategy	Cutting expenses

TABLE 70: INFO2CELL EXCEPTIONAL TACTIC 3 PATTERN

Exceptional Tactic 3: Reduce purchasing	
Description	Reduce company purchasing in all divisions
Owner	Finance and administration
Status	Strategic/Operational
Implements strategy	Cutting expenses

6.2.1.5.5 Business Policies

This section describes the business policies of diagram "Info2cell BMM".

TABLE 71: INFO2CELL BUSINESS POLICY 1 PATTERN

Business Policy 1: The account manager is responsible for contacting customers and operators	
Description	Account managers will contact operators and discuss requirements and scope of services
Enforcement Level	Pre-justified
Volatility	Fixed
Motivation	The commercial team should look into customer needs and market demand, then transfer requirements to the internal strategic and development team
Owner	Info2cell - commercial
Status	Operational
Basis for business rule	Sales rules 1
Motivated by assessment	Assessment 2
Governs business process	Project delivery business process
Exceptions	In case of account manager absent, a product manager can handle his urgent responsibilities.

TABLE 72: INFO2CELL BUSINESS POLICY 2 PATTERN

Business Policy 2: Service prices should be competitive	
Description	The total service price should be set based on market analysis and competitors' prices to maintain competitive advantage
Enforcement Level	Pre-justified
Volatility	Quarterly
Motivation	Competitors are increasing, therefore the service price should be suitable and match the market scale.
Owner	Info2cell - commercial
Status	Operational
Basis for business rule	Sales Rule 2
Motivated by assessment	Assessment 3
Governs business process	Project delivery business process, calculate price
Exceptions	- Service cost is very high - Service is pioneer and the only one in the market

TABLE 73: INFO2CELL BUSINESS POLICY 3 PATTERN

Business Policy 3: Services must comply with the relevant laws and regulations of all countries we serve	
Description	No service to be delivered before checking eligibility in the distributed country
Enforcement Level	Pre-justified
Volatility	Yearly - once regulation/law changes
Motivation	Law confirmation
Owner	Info2cell
Status	Operational
Basis for business rule	N/A
Motivated by assessment	Assessment 5
Governs business process	Project delivery business process

TABLE 74: INFO2CELL BUSINESS POLICY 4 PATTERN

Business Policy 4: Account manager should contact customers to notify them of results	
Description	Account manager should contact customers to inform them of the reason for rejecting them for a service
Enforcement Level	Post-justified
Volatility	Fixed with some exceptional cases
Motivation	Transparency and advices are required to maintain customer trust
Owner	Info2cell - Commercial
Status	Operational
Basis for business rule	N/A
Motivated by assessment	Assessments 4, 5 and 6
Governs business process	Project delivery business process

TABLE 75: INFO2CELL BUSINESS POLICY 5 PATTERN

Business Policy 5: Service should be the core strategic direction of Info2cell	
Description	The provided services should be at the core of the strategic delivered services
Enforcement Level	Pre-justified
Volatility	Assessed every 6 months
Motivation	Services should be: - Within the budget capability of Info2cell - Within the expertise of Info2cell - Profitable
Owner	Info2cell
Status	Operational
Basis for business rule	OR001: Service request
Motivated by assessment	Assessment 7
Governs business process	Project delivery business process

6.3 Vocabulary and Facts Model

6.3.1 Vocabulary Model

The following model (Figure 32) represents the main concepts in Info2cell

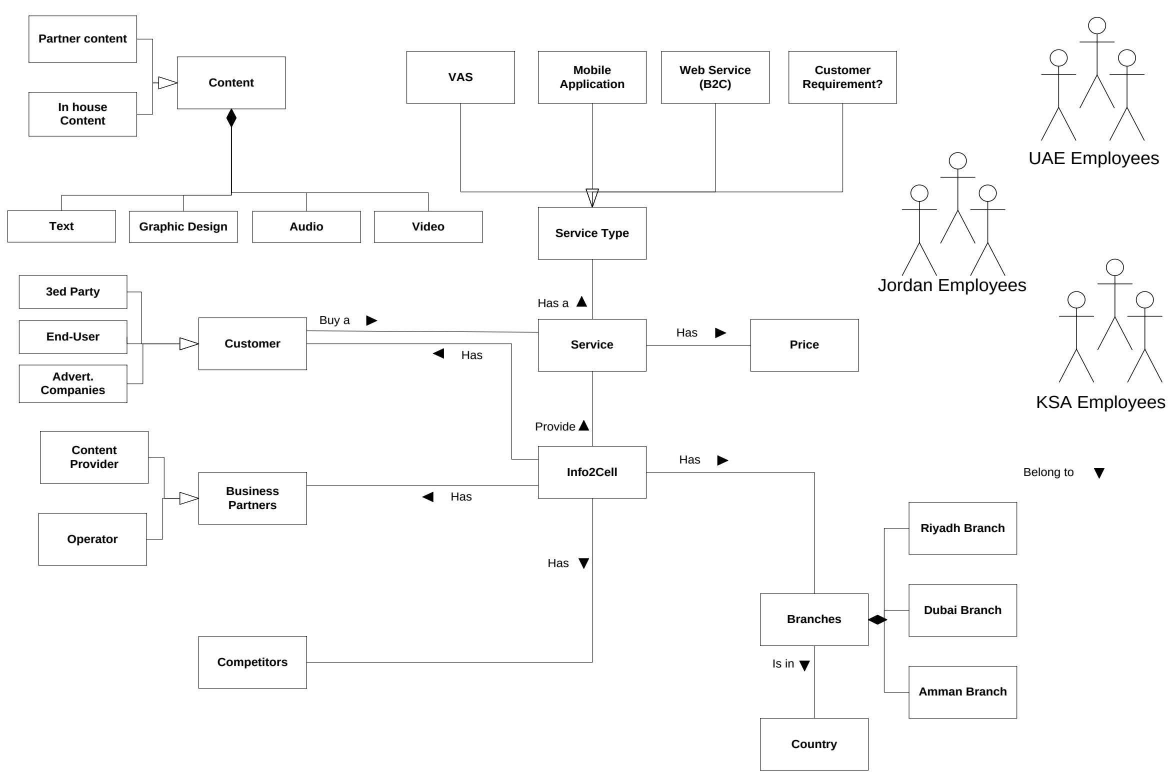


FIGURE 32: VOCABULARY AND FACT MODEL

6.3.2 Vocabularies and Facts Definitions

This section describes the business vocabulary and facts definitions used by Info2cell

TABLE 76: INFO2CELL BRANCH TERM PATTERN

Branch	
Description	An organisational unit that has customer responsibility. Specific: Info2cell organisation unit where they have three branches (Amman, Dubai, Riyadh).
Plural	Branches
Gender	Neutral
Source	Logistics
Owner	Logistics
Status	Operational
In Vocabulary	Core Concepts
Used in operative rules	OR002, OR003
Fact statement	- Employees work in branch - Customers buy from branch - Branch is in country

TABLE 77: INFO2CELL COUNTRY TERM PATTERN

Country	
Description	A politically organised body of people under a single government.
Plural	Countries
Gender	Neutral
Source	Logistics
Owner	Logistics
Status	Operational
In Vocabulary	Core Concepts
Used in operative rules	OR002, OR003
Fact statement	- Branch is in country - Customer is in country - Operator is in country

TABLE 78: INFO2CELL CUSTOMER TERM PATTERN

Customer	
Description	General: Someone who pays for goods or services. Specific: Individual or company who pays Info2cell for the services.
Plural	Customers
Gender	Neutral
Source	WrdNet
Owner	Info2cell
Status	Operational

In Vocabulary	General Vocabulary set
Used in operative rules	OR001, OR002, OR003
Fact statement	- Customers buy from branch - Supplier delivers to customer - Customer pays for service - Customer has record

TABLE 79: INFO2CELL SERVICE TERM PATTERN

Service	
Description	General: Work done by one person or group that benefits another "budget separately for goods and services" Specific: the products and service provided by Info2cell to customers, services are in mobile portal or value added services.
Plural	Services
Gender	Neutral
Source	WrdNet
Owner	Info2cell
Status	Operational
In Vocabulary	General Vocabulary set
Used in operative rules	OR001, OR002, OR003
Fact statement	- Service offered to customers - Service had a price - Service has type, Subscribing service has starting and ending date - Service develop either internally or collaboratively with business partner

TABLE 80: INFO2CELL BUSINESS PARTNER TERM PATTERN

Business Partner	
Description	General: An individual or company who has some degree of involvement with another entity's business dealings.
Plural	Partners
Gender	Neutral
Source	businessdictionary
Owner	Info2cell
Status	Operational
In Vocabulary	Operational Vocabulary set
Used in operative rules	N/A
Fact statement	- Info2cell have business partners - Business partners offer value - Business partner has experience in at least one of Info2cell services - Info2cell have a contract with business partners

TABLE 81: INFO2CELL PRICE TERM PATTERN

Price	
Description	General: A value that will purchase a finite quantity, weight, or other measure of a good or service.
Plural	Prices
Gender	Neutral
Source	businessdictionary
Owner	Info2cell
Status	Operational
In Vocabulary	Operational Vocabulary set
Used in rules	Sales rules set
Fact statement	- Price assigned to service - Price have a value - Price is essential part in each quotation. - Price can be changed

TABLE 82: COMPETITOR TERM PATTERN

Competitor	
Description	General: Any person or entity which is a rival against another. In business, a company in the same industry or a similar industry which offers a similar product or service.
Plural	Competitors
Gender	Neutral
Source	businessdictionary
Owner	Info2cell
Status	Operational
In Vocabulary	Operational Vocabulary set
Used in rules set	Sales rules set, External rules set
Fact statement	- Info2cell has competitors - Competitors attract customers - Competitors provide similar services

6.4 Rule Model

6.4.1 Business Rule Sketch

This diagram summarises the results of the rule elicitation undertaken through the interviews held in April 20012. The rules represent using SBVR specification and a sample of Info2cell rules is shown in Figure 33.

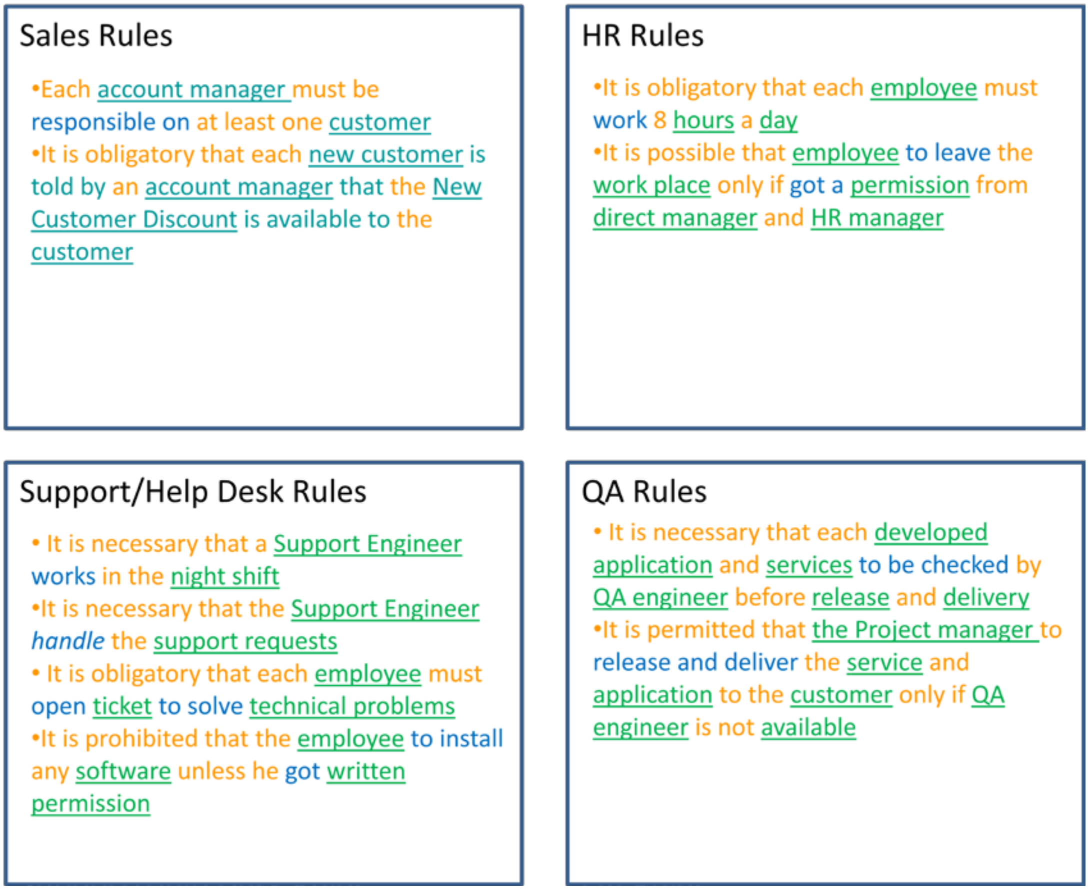


FIGURE 33: SAMPLE OF RULES

6.4.2 Rule Map

Figure 34 shows the vocabulary roots of all of the sets of rules

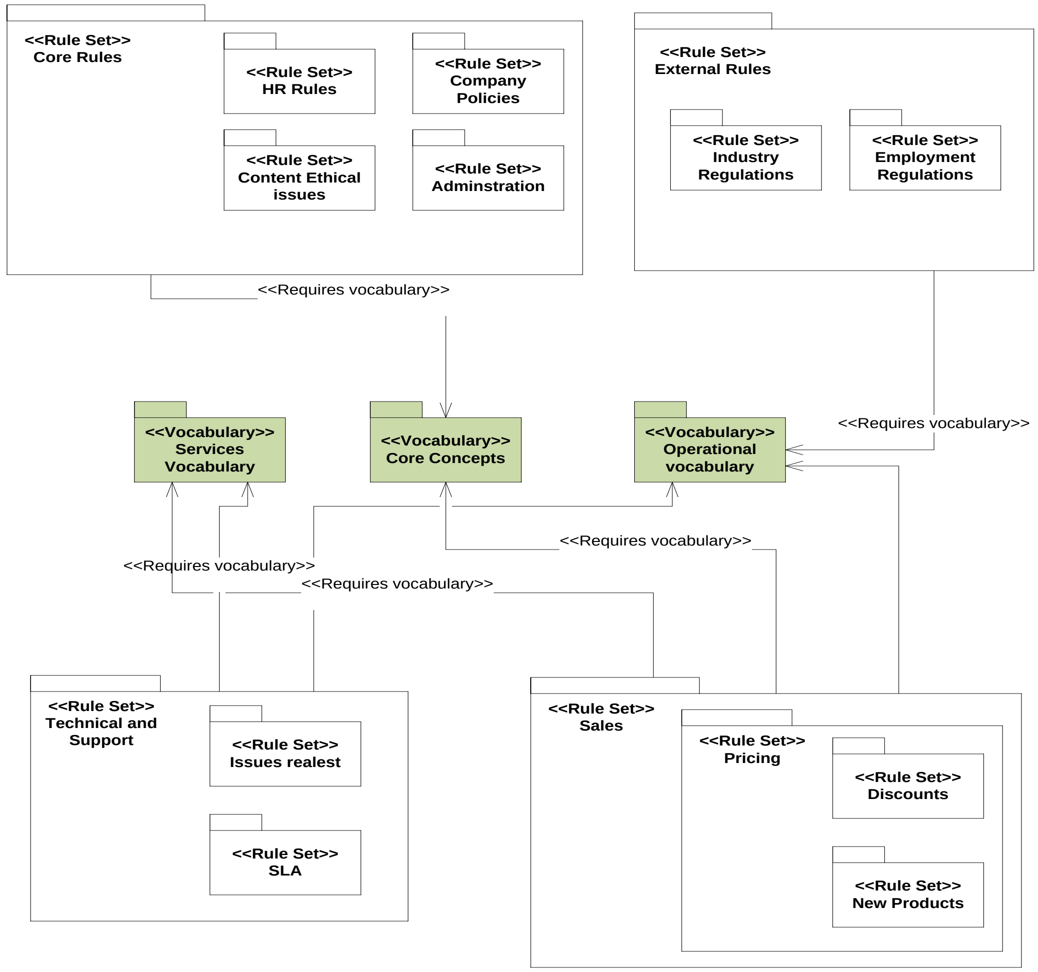


FIGURE 34: RULES MAP

6.4.3 Structural Rules

6.4.3.1 "Customer Vocabulary" Rules

This contains example vocabulary elements for the Info2cell case study.

TABLE 83: INFO2CELL CUSTMER RULES 1 PATTERN

R1: Customer & Service	
Rule Statement	**It is necessary that** each **customer** is signs up for **at least one** **service**.
Rule Language	SBVR
Rule Modality	Necessity
Volatility	Yearly
Effective form	01-JAN-2011
Source	Sales
Owner	Sales
Status	Change requested
Referenced noun concepts	Customer, Service
References vocabularies	Service Vocabulary and Core Concepts

TABLE 84: INFO2CELL CUSTOMER RULE 2 PATTERN

R2: Customer and Service Type	
Rule Statement	It is necessary that each customer signs up for at least one service type
Rule Language	SBVR
Rule Modality	Necessity
Volatility	Yearly
Effective form	01-JAN-20011
Source	Sales
Owner	Sales
Status	Change requested
Referenced noun concepts	Customer, Service
References vocabularies	Service Vocabulary and Core Concepts

TABLE 85: INFO2CELL CUSTOMER RULE 3 PATTERN

R3: Customer Type and Service	
Rule Statement	It is possible that customer has more than customer type and has more than one service and services have different service types.
Rule Language	SBVR
Rule Modality	Necessity
Volatility	Yearly
Effective form	01-JAN-2011
Source	Sales
Owner	Sales
Status	Agreed
Referenced noun concepts	Customer, Service
References vocabularies	Service Vocabulary and Core Concepts

6.4.3.2 Sales

This section contains some sample sales rules: this rule set is part of Sales Rule Sets in Figure 34.

TABLE 86: INFO2CELL SALES RULE 1 PATTERN

SR001: Order Pre-processing Payment	
Rule Statement	It is obligatory that the sales staff to receive 50% payment before processing the customer order.
Rule Language	SBVR
Rule Modality	Obligation
Volatility	Yearly
Effective form	01-JAN-20011
Source	Sales
Owner	Sales
Status	Operational

Referenced noun concepts	Customer, Payment, Service, Order, Sales staff
References vocabularies	Service Vocabulary and Operational Vocabulary

TABLE 87: INFO2CELL SALES RULE 2 PATTERN

SR002: Initial amount	
Rule Statement	It is necessary that the **initial amount** of each **customer** is sum of the **total price** of each **service** that is signed by the **customer**.
Rule Language	SBVR
Rule Modality	Necessity
Volatility	Yearly
Effective form	01-JAN-20011
Source	Sales
Owner	Sales
Status	Operational
Referenced noun concepts	Customer, Service, Initial Amount, Total Price
References vocabularies	Service Vocabulary and Operational Vocabulary

6.4.4 Operative Rules

6.4.4.1 Service delivery

This section contains rules on how to accept and deliver service: this rule set is part of Sales Rule Set in Figure 34.

TABLE 88: INFO2CELL OPERATIVE RULE 1 PATTERN

OR001: Service request	
Rule Statement	It is obligatory that the **customer** buy/subscribe for a **service** that is available, that **customer request** the **service type**, that **service** is an instance of that **service type**, and that **service** has reference **catalogue** that is confirmed by **strategic department**.
Rule Language	SBVR
Rule Modality	Obligation
Enforcement Level	Post-Justified
Volatility	Quarterly
Effective form	01-JAN-20011
Source	Commercial
Owner	Commercial
Status	Operational
Referenced noun concepts	Customer, Service, Service Type, Catalogue, Strategic Department
References vocabularies	Service Vocabulary, Core Concepts and Operational Vocabulary

TABLE 89: INFO2CELL OPERATIVE RULE 2 PATTERN

OR002: Subscription service - unsubscribe	
Rule Statement	For each **subscription customer** all of the following conditions must always be met: 1. If all the following conditions are met: - **Service** subscription is less than 7 days - **Notification** sent before month of **subscription due** - **Unsubscribe** from the **branch** where request was made - **Branch** is in **owning country** - **Current location** is same as **owning country** Then, all of the following conditions must be met as well: - **Customer** to **branch** in customer location, if no **branch** in **customer location**, **customer** to responsible **account manager** - **Subscribing branch** is in owning **country**
Rule Language	SBVR
Rule Modality	Obligation
Enforcement Level	Pre-authorised
Volatility	Quarterly
Effective form	01-JAN-20011
Source	Commercial
Owner	Commercial
Status	Operational
Referenced noun concepts	Customer, Service, Service Type, Catalogue, Strategic Department
References vocabularies	Service Vocabulary, Core Concepts and Operational Vocabulary

TABLE 90: INFO2CELL OPERATIVE RULE 3 PATTERN

OR003: Development service - unsubscribe	
Rule Statement	For each **development customer** all of the following conditions must always be met: 1. If all the following conditions are met: - The **down payment** is unreturnable - **Unsubscribing notification** should be sent within the first stage of the development as agreed - Unsubscribe from the **branch** where request made - **Branch** is in owning **country** - **Current location** is same as **owning country** Then, all of the following conditions must be met as well: - **Customer** to **branch** in **customer location**, if no **branch** in **customer location**, **customer** to responsible **account manager** - **Service** request branch is in **owning country**
Rule Language	SBVR
Rule Modality	Obligation
Enforcement Level	Pre-authorised
Volatility	Quarterly
Effective form	01-JAN-20011
Source	Commercial
Owner	Commercial

Status	Operational
Referenced noun concepts	Customer, Service, Service Type, Catalogue, Strategic Department
References vocabularies	Service Vocabulary, Core Concepts and Operational Vocabulary

6.4.5 Decision Tables

In this section, decision tables have been created to handle multiple-input decisions.

6.4.5.1 Service Request Decision

This is a sample of a decision table of specific SBVR rule statements related to service request decisions.

If The Service type is Development Service the legality of each customer must be registered in a served country as commercial entity

The Requested Service must be part of Service Catalogue of Info2cell

TABLE 91: INFO2CELL SERVICE REQUEST DECISION TABLE PATTERN

DT001: Service Request verification	
Description	This rule set is a decision table that is maintained via decision tables as a formal decision method
Volatility	Every six months
Notes	
Owner	Info2cell
Status	Under review
Rule set inputs	Service type, customer status, the service
Rule set outputs	Accept order, Reject order with reason why
Referenced Vocabularies	Service Vocabulary, Core Concepts and Operational Vocabulary
Referenced noun concepts	Customer, Service, Service Type, Catalogue, Customer Status

Notes:

The Service request is a development service	Customer is registered as commercial entity?	The Requested Service is in Service catalogue	Accept Order?
No		Yes	Yes
No		No	No
Yes	No	Yes	No
Yes	Yes	No	No
Yes	Yes	Yes	Yes

6.4.5.2 Service Release Decision

This is a sample of a decision table of specific SBVR rule statements related to service release decisions

- PMO must confirm the **completion** of the service project

- Quality Assurance should check the developed service **quality** before service been released

- It is obligatory that each Acceptance letter signed by customer received before service released

TABLE 92: INFO2CELL SERVICE RELEASE DECISION TABLE PATTERN

<table>
<tr><th colspan="2">DT002: Service release</th></tr>
<tr><td>Description</td><td>This rule set is a decision table that is maintained via decision tables as a formal decision method</td></tr>
<tr><td>Volatility</td><td>Every six months</td></tr>
<tr><td>Notes</td><td>
<table>
<tr><th>PMO confirm the completion?</th><th>Quality Assurance check the developed service quality?</th><th>Acceptance letter signed by customer?</th><th>Release Service?</th></tr>
<tr><td>No</td><td></td><td></td><td>No</td></tr>
<tr><td>Yes</td><td>No</td><td></td><td>No</td></tr>
<tr><td>Yes</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Yes</td><td>No</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Yes</td><td>No</td><td>No</td><td>No</td></tr>
</table>
</td></tr>
<tr><td>Owner</td><td>Info2cell</td></tr>
<tr><td>Status</td><td>Under review</td></tr>
<tr><td>Rule set inputs</td><td>Project status, Quality status, Customer feedback</td></tr>
<tr><td>Rule set outputs</td><td>Release service, Don't release Service with reason why</td></tr>
<tr><td>Referenced Vocabularies</td><td>Service Vocabulary, Core Concepts and Operational Vocabulary</td></tr>
<tr><td>Referenced noun concepts</td><td>Customer, Service, Quality Assurance, PMO, Acceptance Letter</td></tr>
</table>

6.5 Business Processes Model

6.5.1 Business Processes

Describes the business processes of Info2cell: an example is provided below of a business process that was followed in Info2cell and considered a primary business process.

6.5.1.1 Project Delivery Business Process

This project delivery process is the main operational business process and value delivery stream in Info2cell, the BPMN model is presented in Figure 35.

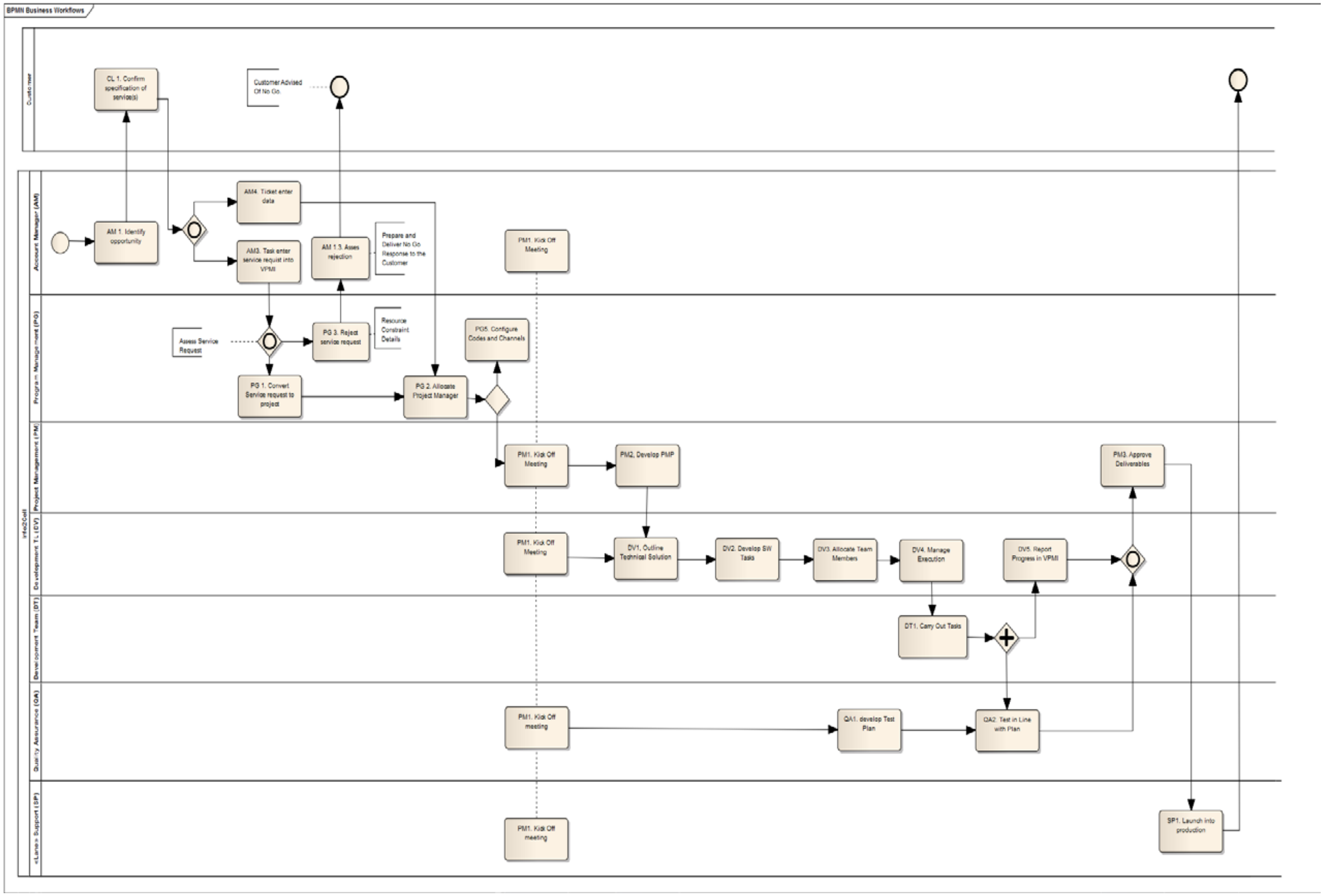


FIGURE 35: PROJECT DELIVERY PROCESS

6.5.1.1.1 Business Events

This section describes the business events of the diagram "Project delivery process".

TABLE 93: INFO2CELL BUSINESS EVENT 1 PATTERN

Customer wants to buy a service "Service request"	
Description	A customer requests a particular service from Info2cell
Occurrence	Often - triggered by new customer or led by existing customer
Frequency	50 to 100 per year
Owner	Customer
Status	Operational

TABLE 94: INFO2CELL BUSINESS EVENT 2 PATTERN

Support required	
Description	Support information is requested by customer
Occurrence	Often - triggered by customer
Frequency	300 to 500 per year
Owner	Customer
Status	Operational

TABLE 95: INFO2CELL BUSINESS EVENT 3 PATTERN

Service/content ready to deliver	
Description	The information that a particular service is ready for a customer
Occurrence	triggered with project plan
Frequency	Up to 2,000 per year
Owner	Info2cell - several divisions
Status	Operational

TABLE 96: INFO2CELL BUSINESS EVENT 4 PATTERN

Service/content delivery delayed	
Description	The information that the requested service delivery has been delayed in being handed over to the customer
Occurrence	20%
Owner	Technical department
Status	Operational

TABLE 97: INFO2CELL BUSINESS EVENT 5 PATTERN

Customer request rejected/ No go project	
Description	The information that a service requested by a customer has been rejected by Info2cell
Occurrence	Sporadic - not often
Owner	Commercial
Status	Operational/Strategic

TABLE 98: INFO2CELL BUSINESS EVENT 6 PATTERN

Customer not interested	
Description	The fact or state that a customer is no longer interested in a service.
Occurrence	Episodic - Rarely
Owner	Customer

6.5.1.1.2 Business Activities

This section describes the business activities of diagram "Project delivery process".

TABLE 99: INFO2CELL BUSINESS ACTIVITY 1 PATTERN

Identify opportunities	
Description	Commercial team to identify opportunities in the market for potential customers
Post-condition	Market analysis/study
Goal	To target suitable customers most likely to buy services
IT support	Supported - CRM system
Owner	Commercial
Resource	Account Manager
Supported by use case	Create, update, delete and retrieve customer information
Status	Operational/strategic

TABLE 100: INFO2CELL BUSINESS ACTIVITY 2 PATTERN

Customer confirms specifications	
Description	Customer should confirm the specification and price before a project goes to plan and execution
Post-condition	Commercial team prepares and sends proposal/specification document with quotation to the customer
Goal	To document the purchase order and agree on project
Estimated duration	From 1 to 5 working days estimated
IT support	Supported, confirmation is documented in archive
Owner	Customer
Resource	Interaction with account manager
Status	Operational
Supported by use case	Confirmation should be identified by commercial team

TABLE 101: INFO2CELL BUSINESS ACTIVITY 3 PATTERN

Enter service request into VPMI	
Description	The service request should be entered into the VPMI system, to allow the Technical department to gain insight about the required service
Post-condition	Confirmation received from customer
Goal	To inform project planning about the request to help assess the

	case
Estimated duration	15 min
IT support	Supported
Owner	Commercial
Resource	Account Manager
Status	Operational
Supported by use case	Enter, modify and retrieve data

TABLE 102: INFO2CELL BUSINESS ACTIVITY 4 PATTERN

Enter data into RT queue	
Description	Enter information into RT to give Finance and Administration department insight about the upcoming project and to assess the case
Post-condition	Confirmation received from customer
Goal	To inform and initiate RT
Estimated duration	15 min
IT support	Supported
Owner	Commercial
Resource	Account Manager
Status	Operational
Supported by use case	Enter, modify and retrieve data

TABLE 103: INFO2CELL BUSINESS ACTIVITY 5 PATTERN

Reject request	
Description	Service request could be rejected for several reasons e.g. low feasibility, limited resources or capabilities
Post-condition	The service request should be assessed by several divisions
Goal	To close the lead
Estimated duration	2 to 4 working days
IT support	NA
Owner	Programme manager
Resource	Programme manager
Status	Operational
Supported by use case	N/A

TABLE 104: INFO2CELL BUSINESS ACTIVITY 6 PATTERN

Assess rejection	
Description	Assessment of rejection reasons and causes
Post-condition	Rejection received by programme manager
Goal	To identify the issues influencing the rejection, and provide insight to customer about decision
Estimated duration	2 hr
IT support	Support - assessment identified and service status updated to closed in the CRM

Owner	Programme manager
Resource	Programme manager
Status	Operational
Supported by use case	N/A

TABLE 105: INFO2CELL BUSINESS ACTIVITY 7 PATTERN

Convert service request into project	
Description	Once the project has been approved, the service request status will be changed to project
Post-condition	Approving the project
Goal	Clarify the status of the service request and transfer it to the project plan
Estimated duration	1 hr
IT support	Yes
Owner	Programme manager
Resource	Programme manager
Status	Operational
Supported by use case	Yes

TABLE 106: INFO2CELL BUSINESS ACTIVITY 8 PATTERN

Allocate project manager	
Description	Project manager to be identified to manage the project activities, time and resources
Post-condition	Service request transferred to a project after approval
Goal	To manage and deliver the project
Estimated duration	1 day
IT support	Yes
Owner	Programme manager
Resource	Programme manager to identify project manager
Status	Operational
Supported by use case	Yes

TABLE 107: INFO2CELL BUSINESS ACTIVITY 9 PATTERN

Kick-off meeting	
Description	Meeting to include various stakeholders from several Info2cell divisions.
Post-condition	Project manager allocated
Goal	To agree on plan and objectives
Estimated duration	2 hr
IT support	Yes
Owner	Project management / other project stakeholders participate
Resource	Project, programme and account managers
Status	Operational
Supported by use case	N/A

TABLE 108: INFO2CELL BUSINESS ACTIVITY 10 PATTERN

Configure codes and channels	
Description	The codes and channels that will be used in the project should be ready before the meeting
Post-condition	Project manager allocated
Goal	Preparation to initiate the project
Estimated duration	2 days
IT support	Yes
Owner	Programme manager
Resource	Programme manager
Status	Operational
Supported by use case	N/A

TABLE 109: INFO2CELL BUSINESS ACTIVITY 11 PATTERN

Develop test plan	
Description	Quality assurance develops test plan suitable for the project type and technology
Post-condition	Codes and channels have been configured
Goal	QA planning
Estimated duration	3 days
IT support	Yes
Owner	Quality assurance
Resource	Quality assurance engineer
Status	Operational
Supported by use case	N/A

TABLE 110: INFO2CELL BUSINESS ACTIVITY 12 PATTERN

Develop PMP	
Description	Developing a project management plan, dividing tasks, time duration and cost
Post-condition	Kick-off meeting completed
Goal	Manage the project activities and deliver the service
Estimated duration	5 days
IT support	Yes
Owner	Project Management
Resource	Project Manager
Status	Operational
Supported by use case	N/A

TABLE 111: INFO2CELL BUSINESS ACTIVITY 13 PATTERN

Outline technical solution	
Description	Technical solution to be outlined in terms of technology, development tools, hardware required, final deliverable and capability
Post-condition	Kick-off meeting completed
Goal	Technical planning
Estimated duration	2 days
IT support	Yes
Owner	Development team leader
Resource	Team leader
Status	Operational
Supported by use case	N/A

TABLE 112: INFO2CELL BUSINESS ACTIVITY 14 PATTERN

Allocate team members	
Description	Identify team that will carry out project tasks
Post-condition	Project approved
Goal	Better project planning and management to meet the time schedule
Estimated duration	3 hours
IT support	Supported
Owner	Project manager/ Development team leader
Resource	Project manager/ Development team leader
Status	Operational
Supported by use case	N/A

TABLE 113: INFO2CELL BUSINESS ACTIVITY 15 PATTERN

Develop software tasks	
Description	The software projects need to be defined and divided to decide the number and quality of the development team
Post-condition	Technical solutions outlined
Goal	To better allocate resources and deliver project
Estimated duration	4 days
IT support	Yes
Owner	Development team
Resource	Allocated developers (decision made early by PM)
Status	Operational
Supported by use case	N/A

TABLE 114: INFO2CELL BUSINESS ACTIVITY 16 PATTERN

Manage execution	
Description	Managing project execution and tasks to meet the time schedule
Post-condition	Project started

Goal	To make sure that activities performed as planed
Estimated duration	The whole project life cycle
IT support	N/A
Owner	Development team leader
Resource	Team leader
Status	Operational
Supported by use case	N/A

TABLE 115: INFO2CELL BUSINESS ACTIVITY 17 PATTERN

Carry out tasks	
Description	The development team starts to carry out the project tasks to deliver the specification
Post-condition	Project approved, project starting time due and resources allocated
Goal	To deliver the project
Estimated duration	The project life cycle - task specific period
IT support	Supported - for development
Owner	Development team
Resource	Allocated developers
Status	Operational
Supported by use case	Yes - Various

TABLE 116: INFO2CELL BUSINESS ACTIVITY 18 PATTERN

Report progress in VPMI	
Description	Development team leader should update progress in the VPMI system
Post-condition	Tasks started and carried out
Goal	To keep all the internal stakeholders informed about progress
Estimated duration	30 min
IT support	Supported
Owner	Development team leader
Resource	Team leader
Status	Operational
Supported by use case	Yes

TABLE 117: INFO2CELL BUSINESS ACTIVITY 19 PATTERN

Test in line with plan	
Description	The test is performed when the components are ready (validation and verification) according to the test plan
Post-condition	Components ready for test
Goal	Ensure quality of deliverables
Estimated duration	Depends on ready components
IT support	Supported - for testing
Owner	Quality assurance

Resource	Quality assurance engineer
Status	Operational
Supported by use case	N/A

TABLE 118: INFO2CELL BUSINESS ACTIVITY 20 PATTERN

Approve deliverables	
Description	The information that the project manager has approved the deliverables
Post-condition	Testing has been completed by QA
Goal	To make sure that the deliverables meet the specification before delivery to the customer
Estimated duration	2 days
IT support	N/A
Owner	Project management
Resource	Project manager
Status	Operational
Supported by use case	N/A

TABLE 119: INFO2CELL BUSINESS ACTIVITY 21 PATTERN

Launch into production and delivery	
Description	The information that the deliverables are being handed to the customer through a suitable medium.
Post-condition	Deliverables approved by project manager
Estimated duration	2 hr
IT support	Supported
Owner	Support
Resource	Support engineer
Status	Operational
Supported by use case	N/A

6.5.1.1.3 Business Artefacts

This section describes the artefacts of diagram "Project delivery process".

TABLE 120: INFO2CELL BUSINESS ARTEFACT 1 PATTERN

Request Letter	
Description	This is a document sent by a customer to request a service
Artefact type	Document
Owner	Commercial
Status	Operational

TABLE 121: INFO2CELL BUSINESS ARTEFACT 2 PATTERN

Acceptance Letter	
Description	This is a signed document showing that the customer has

	agreed the specification of service and service delivery
Artefact type	Document
Owner	Commercial
Status	Operational

TABLE 122: INFO2CELL BUSINESS ARTEFACT 3 PATTERN

Subscribing Agreement	
Description	This is the signed document that defines the conditions for a customer
Artefact type	Document
Owner	Commercial
Status	Operational

TABLE 123: INFO2CELL BUSINESS ARTEFACT 4 PATTERN

Quotation	
Description	This is a document showing the service project price, specification and duration prepared by the sales team and sent to the customer
Artefact type	Document
Owner	Commercial
Status	Operational

TABLE 124: INFO2CELL BUSINESS ARTEFACT 5 PATTERN

Payment	
Description	This is the money transferred by the customer to pay for a service
Artefact type	Value - money
Owner	Accounting and finance
Status	Operational

TABLE 125: INFO2CELL BUSINESS ARTEFACT 6 PATTERN

Subscribing Fees	
Description	This is the money transferred by operators, paid by a service subscriber to pay for a service.
Artefact type	Value - Money
Owner	Accounting and finance
Status	Operational

TABLE 126: INFO2CELL BUSINESS ARTEFACT 7 PATTERN

Invoice	
Description	This is the document sent to the customer to request payment

	for a service
Artefact type	Document
Owner	Accounting and finance
Status	Operational

TABLE 127: INFO2CELL BUSINESS ARTEFACT 8 PATTERN

Service	
Description	This is the actual service to be paid for
Artefact type	Service type
Owner	Info2cell - Several divisions
Status	Operational

6.6 Organisational Structure Model

6.6.1 Organisation

The following section describes the organisational structure of Info2cell. This section shows the divisions and departments required to execute the organisational strategy.

6.6.1.1 Organisational Structure

This is Info2cell's current organisational ownership structure. The Acotel Group is the owner of Info2cell, where Info2cell is composed of two branches, branch in Amman formally registered as Etico LLC. In addition, Info2cell owns 51% of Rawafed in Riyadh - KSA. Figure 36 shows the organisational ownership structure.

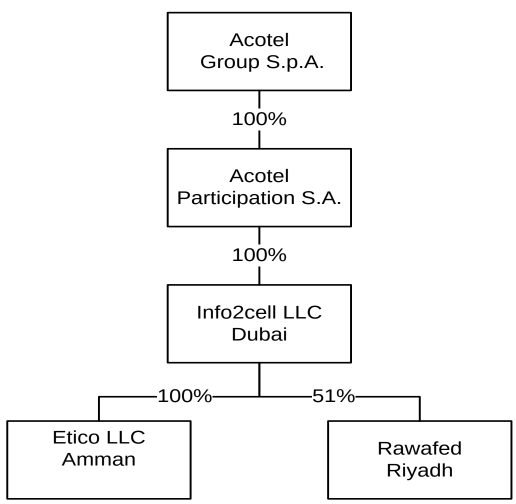


FIGURE 36: OWNERSHIP STRUCUTRE

The following model (Figure 37) represents Info2cell's current organisational structure and staffing.

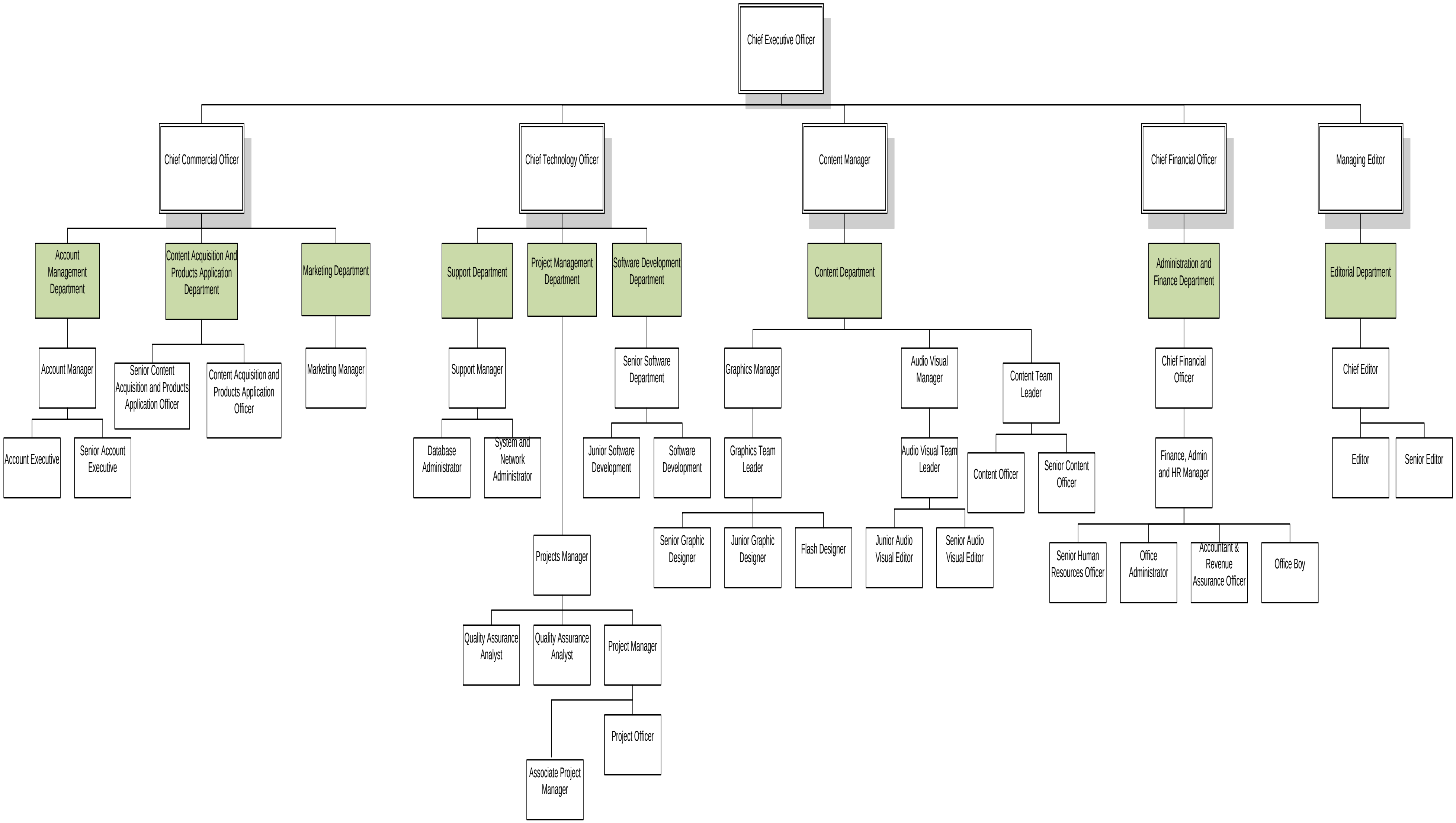


FIGURE 37: INFO2CELL ORGANISATIONAL STRUCTURE

6.6.1.1.1 Organisations

This section describes the organisations of the diagram "ownership structure".

TABLE 128: INFO2CELL ORGANISATION OWNER PATTERN

Acotel Participation	
Head	Claudio Carnevale
Owner	Acotel Group
Status	Consortium management
Responsibilities	- Set up Info2cell budget - Decide the auditor and auditing system - Visionary and strategic advice based on market and industry analysis

TABLE 129: INFO2CELL ORGANISATION PATTERN

Info2cell LLC	
Head	Bashar Dahabrah
Owner	Acotel Participation
Status	Operational
Responsibilities	Strategic management, commercial activities

TABLE 130: INFO2CELL ORGANISATION SHAREHOLDER PATTERN

Rawafed Technology Company	
Head	Bashar Dahabrah
Owner	Info2cell LLC 51% , Rawafed Information LLC 49%
Status	Operational
Responsibilities	- Manage key accounts in the KSA - Open new market opportunities within the KSA
Community-Specific terms	Info2cell Riyadh "Rawafed" Arabic: روافد

TABLE 131: INFO2CELL ORGANISATION BRANCH PATTERN

Info2cell Etico LLC	
Head	Bashar Dahabrah
Owner	Acotel Participation
Status	Operational
Community-Specific terms	Info2cell Amman
Responsibilities	Development, content management, project management, HR and accounting, editorial work, commercial activities

6.6.1.1.2 Organisational Units

This section describes the organisational units of each of the Info2cell organisations.

TABLE 132: INFO2CELL COMMERCIAL UNIT PATTERN

Commercial	
Head	Vacant
Owner	Info2cell
Status	Operational
Is located in	Info2cell Etico LLC
Unit specific rules	Inherit organisational rules. Account managers may be required to travel
Authority	- Negotiate and agree with customers and operators about finance according to the organisational working rules - Negotiate with customers and operators about developing new services/applications with involvement of technical department - Business development activities
Liability	Liability onus on Info2cell, commercial department responsible for commercial contracts, customer agreements, provision and delivery, support contracts
Goals and Responsibility	- Prepare, update and provide the service catalogue to customers - Reply to RFP and RFI documents, prepare quotations and proposals - Acting as customer relationship unit - Follow-up customer requirements - Part responsibility for pricing and new product development - Arrange with project managers to deliver the projects
Influencing relationships	Customers and operators, strategic department, development departments, content department and finance department

TABLE 133: INFO2CELL EDITORIAL UNIT PATTERN

Editorial	
Head	Hanin Abu AlRub
Owner	Info2cell
Status	Operational
Is located in	Info2cell Etico LLC
Unit specific rules	- Inherit organisational rules. - Editorial department can take days off during the week to be able to work during weekends
Authority	Approve content and negotiate content and format with customers and operators
Liability	Liability for content editorial activities
Goals and Responsibility	- Publishing, editing, updating and testing content for the Web, WAP and smart phone using editorial software - Linguistic and format responsibilities
Influencing relationships	Content department, operators and third parties

TABLE 134: INFO2CELL TECHNICAL UNIT PATTERN

Technical	
Head	Yaman Saqqa
Owner	Info2cell
Status	Operational
Is located in	Info2cell Etico LLC
Unit specific rules	Inherit organisational rules. Support team may work on day or night shift
Authority	Technical and technical support decisions issues
Liability	Liability for performance and quality of developed services - Project managers have liability for handling and delivering projects successfully on time
Goals and Responsibility	- Technical and software development - Project management and coordination - Quality assurance - Technical support (internal and external)
Influencing relationships	Strategic department, commercial department, customer and operators requirements

TABLE 135: INFO2CELL CONTENT MANAGEMENT UNIT PATTERN

Content Management	
Head	Hanin Abu AlRub
Owner	Info2cell
Status	Operational
Is located in	Info2cell Etico LLC
Unit specific rules	Inherit organisational rules, and for specific purposes related to live publishing and updating content, employees are required to work overtime.
Authority	Developing, auditing and publishing different kinds of content in different forms; other authority related to communication with customers and operators.
Liability	Liability for the developed content. However, customers and content providers are responsible for their own content. Verifies and tests the applicability of the content before publishing
Goals and Responsibility	- Textual, web, WAP, graphic design and audio/video content - Communication and coordination with other departments and with operators regarding content issues
Influencing relationships	Operators' requirements, technical department and editorial department

TABLE 136: INFO2CELL FINANCE AND ADMIN UNIT PATTERN

Finance and Administration	
Head	Mohammad Zawati
Owner	Info2cell
Status	Administrational/Operational
Is located in	Info2cell Etico LLC

Unit specific rules	Inherit organisational rules
Authority	- Partial authority on finance and accounting decision-making - HR actions, contracts, suppliers according to the work policies of the organisation - Organisation's administration services
Liability	Activities conducted and approved by the authorised staff in the department, other liability onus on staff activities
Goals and Responsibility	All finance and accounting activities in the organisation HR related activities Organisation administration services
Influencing relationships	Involved in cross-organisation departments' primary and secondary activities.

6.6.1.1.3 Positions

This section describes sample positions from the diagram "Organisational Structure".

TABLE 137: INFO2CELL HR POSITION PATTERN

HR Manager	
Staff	Hanan Albitar
Telephone	241
Owner	Info2cell
Status	Strategic/Operational
Role	- Acting HR Manager - Administration related to staff payroll, insurance and evaluation
Assets	- CCTV - One PC - Printer - HR documents and employees profiles/contracts
Authority	Salary deductions and warnings relating to discipline and commitment
Goals and Responsibility	- Handling all activities related to staff employment - Recruitment, evaluation and training requirements and criteria - Developing policies and rules related to work environment (penalties, bonuses, benefits) - Administering payroll, advising on employment legislation and implementing disciplinary procedures
Community-Specific terms	Position Arabic: مدير شؤون الموظفين Staff Arabic: حنان البيطار

TABLE 138: INFO2CELL MEDIA TEAM LEADER POSITION PATTERN

A/V media Team Leader	
Staff	Lutfi Jaber
Telephone	666
Owner	Info2cell
Status	Operational
Role	- Responsible for audio projects

	- Responsible for video projects - Managing team of two A/V staff
Belonging assets	- Studio with its full recording assets - Receiver - Three PCs - TV tuner
Authority	- Main responsibility for A/V section work including full accountability for produced work, training A/V section staff - Accountable for daily services - Reports directly to Content manager
Goals and Responsibility	- Audio mixing and mastering - Audio editing and sound composing - Sound tracking and design - Video/visual editing and effect - Graphic design (motion, logos, pictures and posters)
Community-Specific terms	Position Arabic: مسؤول فريق (صوتيات/مرئيات) Staff Arabic: لطفي جابر

6.7 Geographical Distribution

6.7.1 Sites

This section describes the sites if Info2cell. Figure 38 illustrates the geographical distribution of Info2cell.

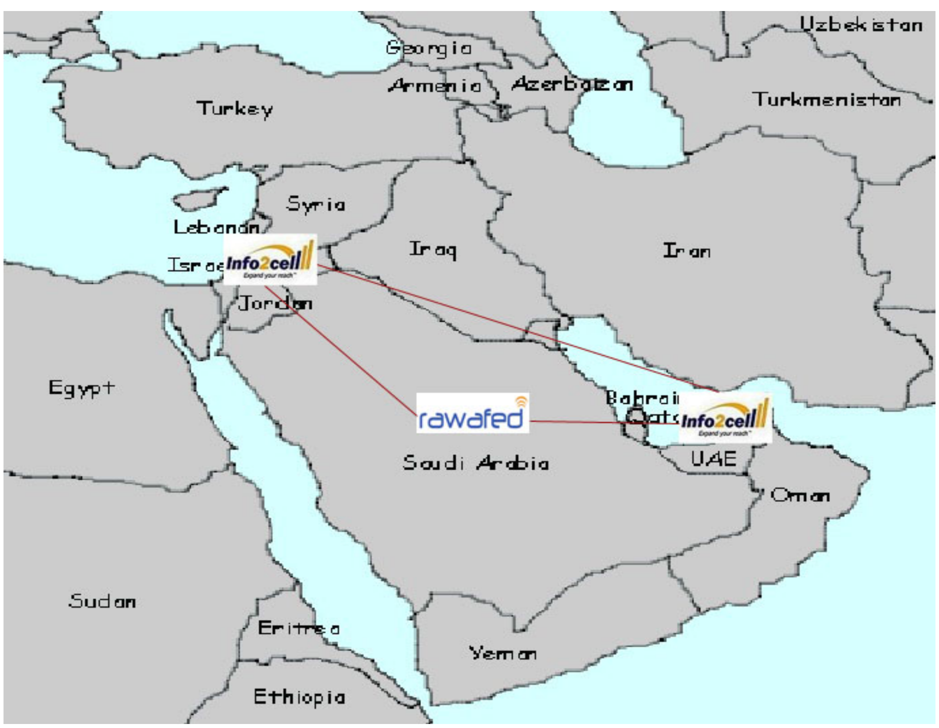


FIGURE 38: SITE MAP

6.7.1.1 Sites
This section describes the sites of the "Site Map" Diagram.

TABLE 139: INFO2CELL SITE 1 PATTERN

Info2cell Dubai	
Address	Dubai
Country	UAE
Owner	Info2cell FZ-LLC
Status	Head Office
Business Units	Strategic Management, Finance, Sales and Marketing
Community-Specific terms	English: Info2cell Arabic: إنفو تو سيل دبي

TABLE 140: INFO2CELL SITE 2 PATTERN

Info2cell Amman	
Address	Amman
Country	Jordan
Owner	Info2cell Etico
Status	Operational
Business Units	Creative work, Development, Sales, Project Management, Accounting
Community-Specific terms	English: Info2cell Arabic: إنفو تو سيل الأردن

TABLE 141: INFO2CELL SITE 3 PATTERN

Rawafed	
Address	Riyadh
Country	Saudi Arabia
Owner	Info2cell 51%, Rawafed Information LLC 49%
Status	Operational
Business Units	KSA Sales and Marketing, Services
Community-Specific terms	English: Rawafed Arabic: روافد

6.8 Reasoning Model - Design Rationale

6.8.1 Info2cell Mission Reasoning
This reasoning model shows the reasoning map of the mission achievement as well as the issues that need to be considered toward achieving the mission represented in Figure 39.

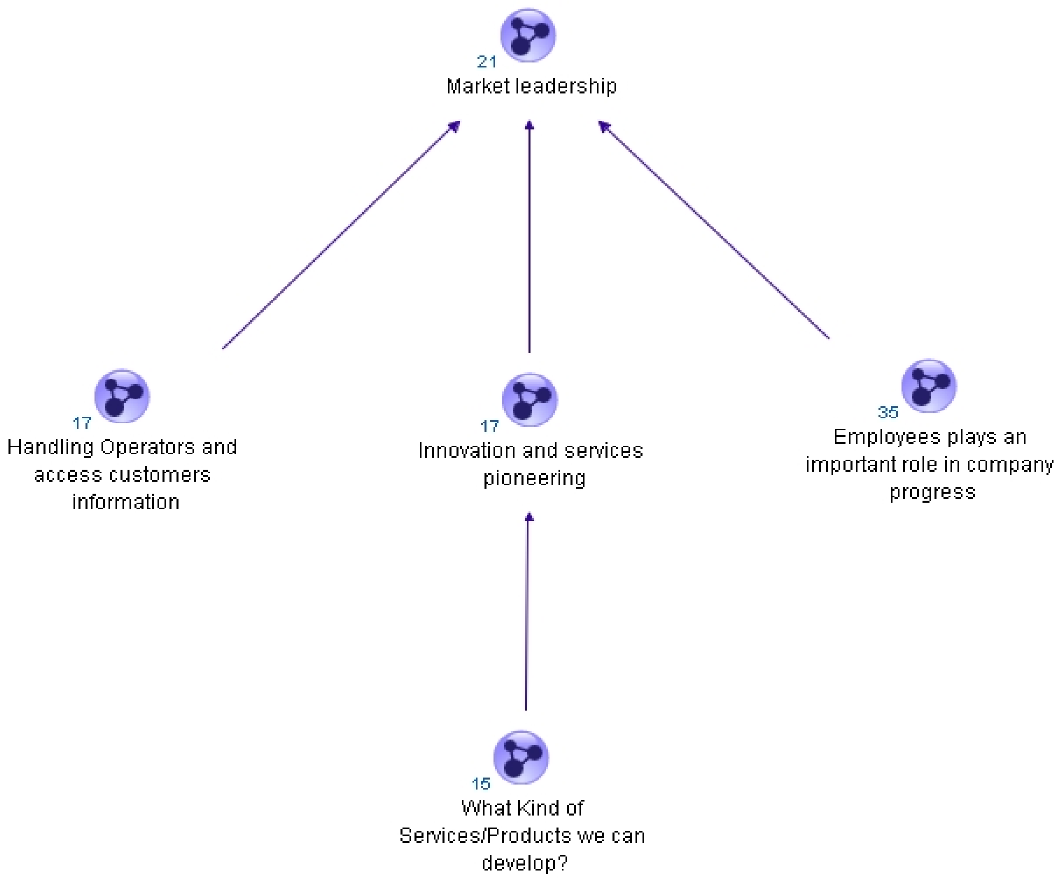


FIGURE 39: MISSION REASONING

6.8.2 Info2cell Leadership Reasoning

The following reasoning model (Figure 40) describes the leadership issues that Info2cell will consider towards achieving this goal; potential answers and assessment through argumentation are included.

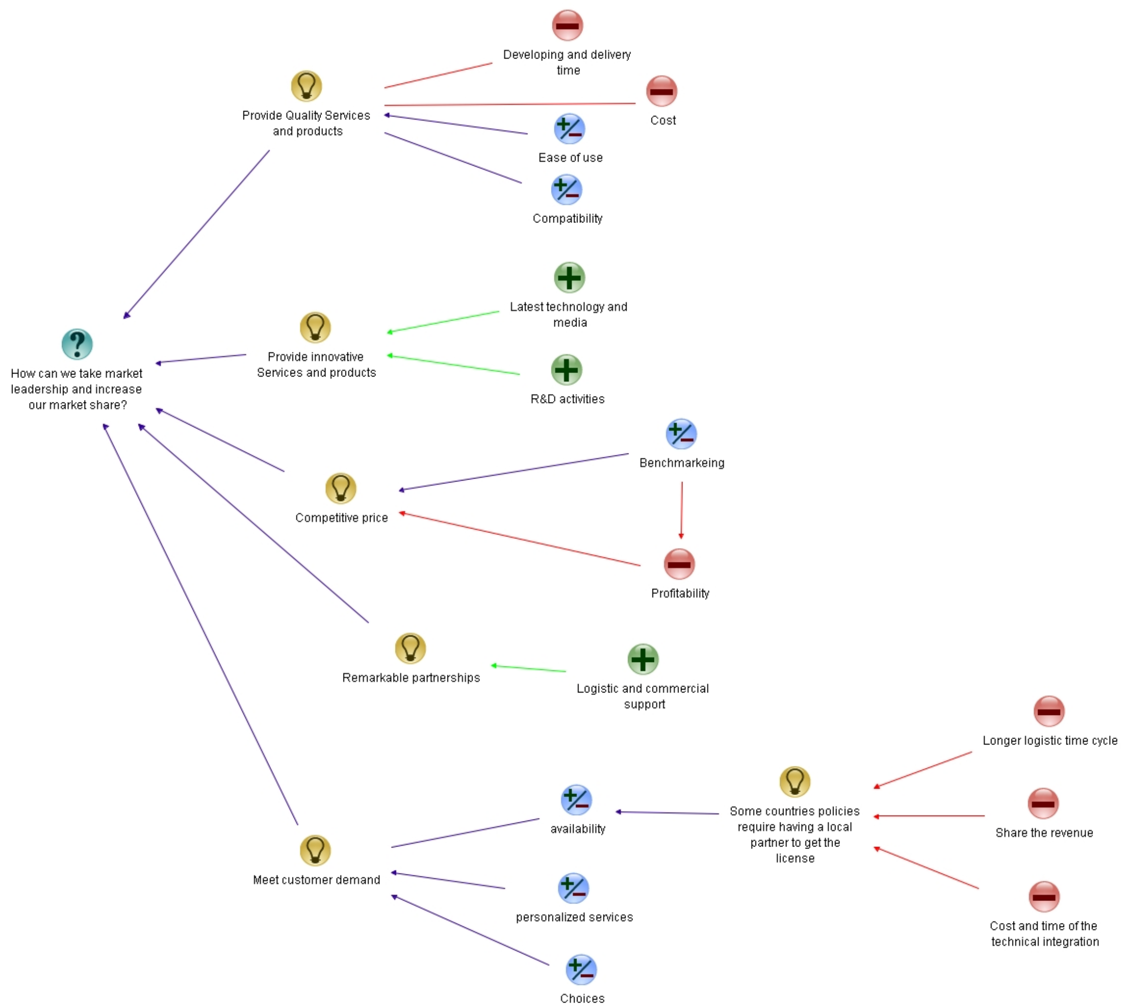


FIGURE 40: LEADERSHIP REASONING

6.8.3 Info2cell Handling Operator Regulations Reasoning

The operators have a powerful position that may affect Info2cell and their endeavour toward market leadership immediately: reasoning about potential scenarios is shown in the following reasoning model (Figure 41).

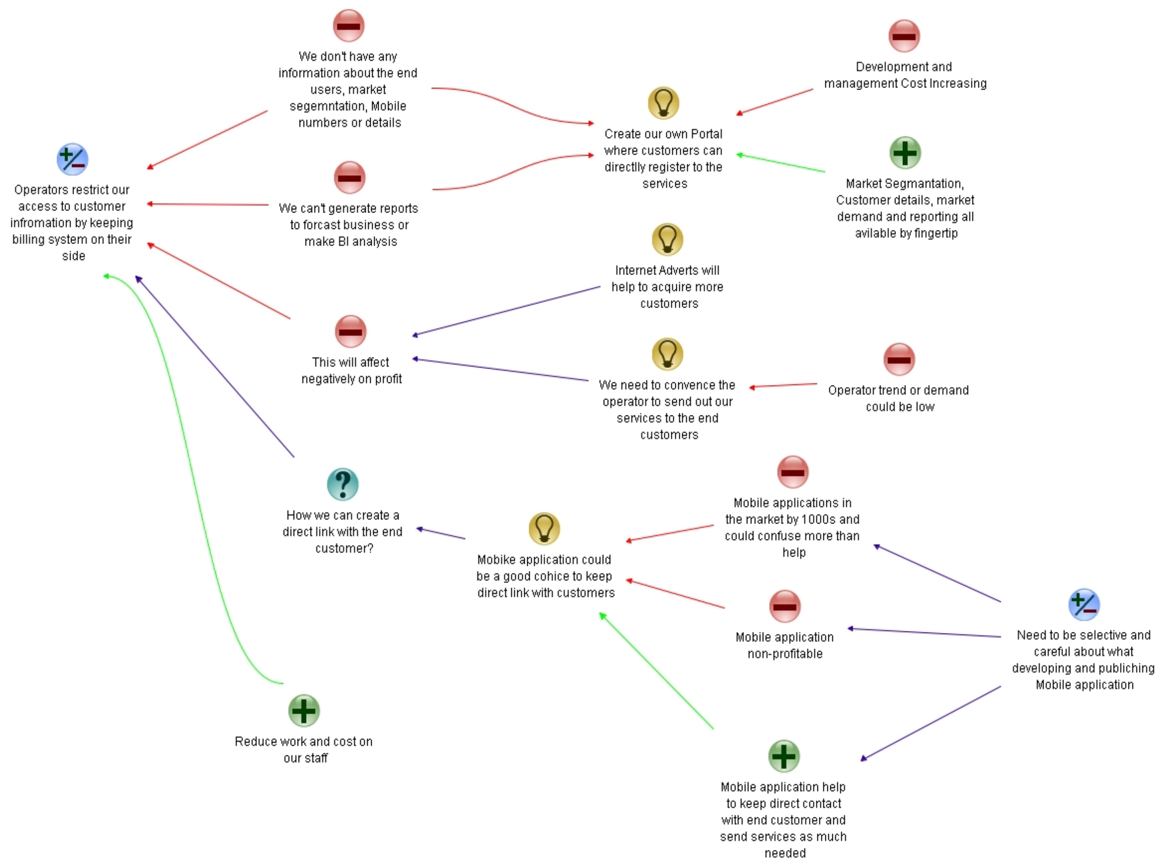


FIGURE 41: OPERATOR REGULATIONS REASONING

6.8.4 Services Development Reasoning

New services are always required to gain and retain customers; potential new services have been assessed briefly in the following reasoning model (Figure 42).

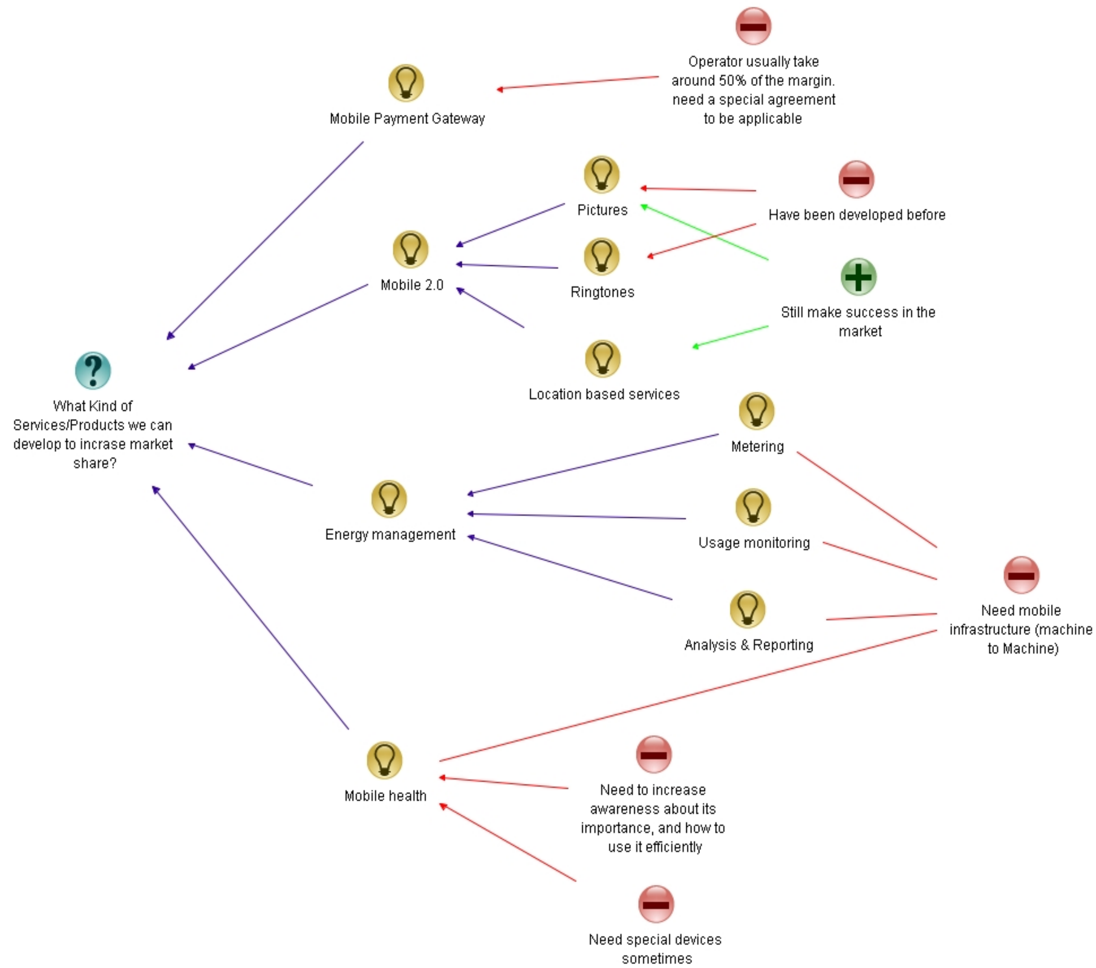


FIGURE 42: SERVICES DEVELOPMENT REASONING

6.8.5 Innovation Reasoning

Innovation and new product development process is crucial, several options are available to tackle this process. The reasoning model below (Figure 43) describes the potential options for Info2cell to tackle the innovation process.

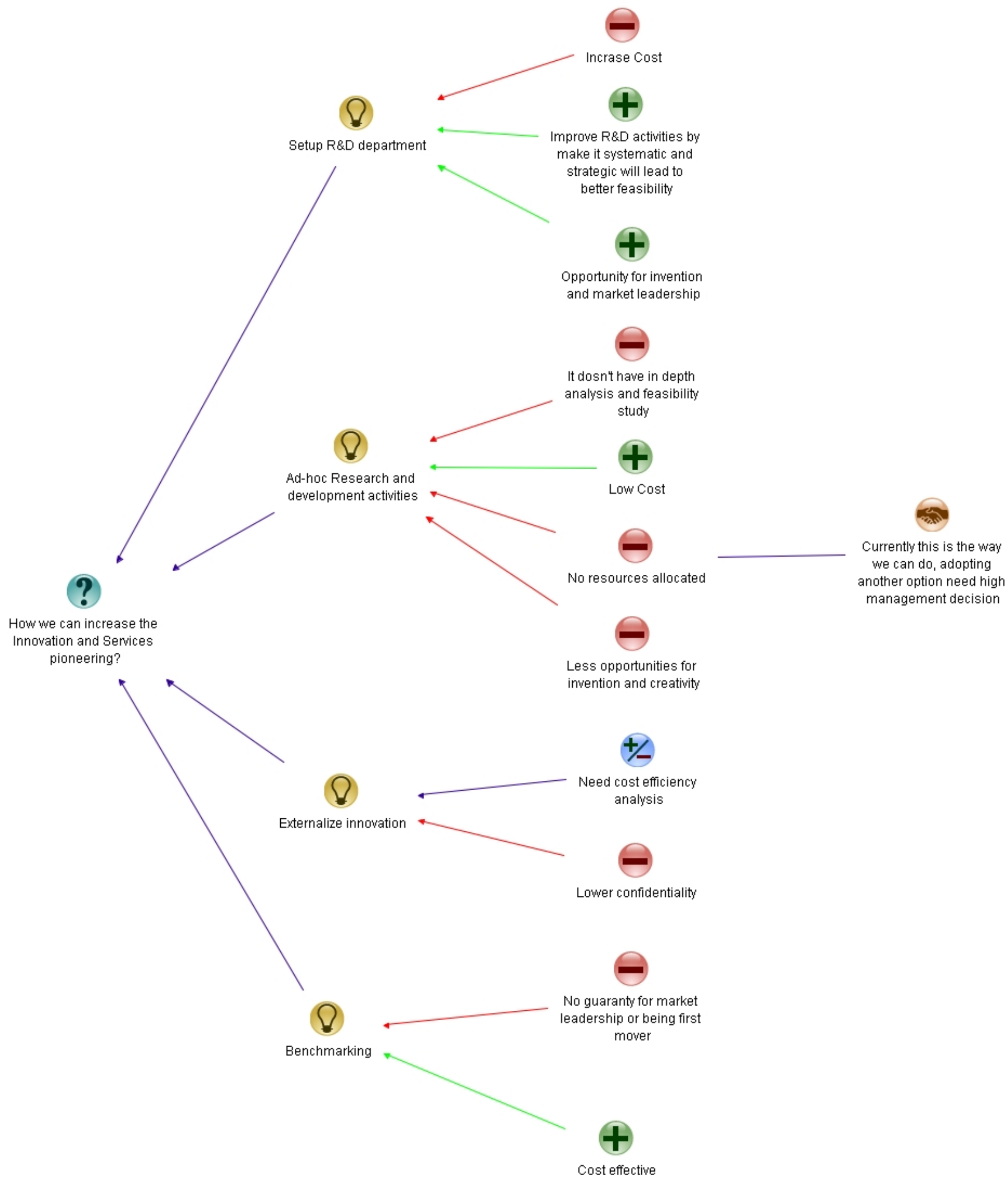


FIGURE 43: INNOVATION REASONING

6.8.6 Employees Issues Reasoning

Info2cell staff have been always a key component of the success achieved during the last two decades. However, during the analysis issues appeared that might be critical for Info2cell management: reasoning about potential practices is shown in the reasoning model below (Figure 44).

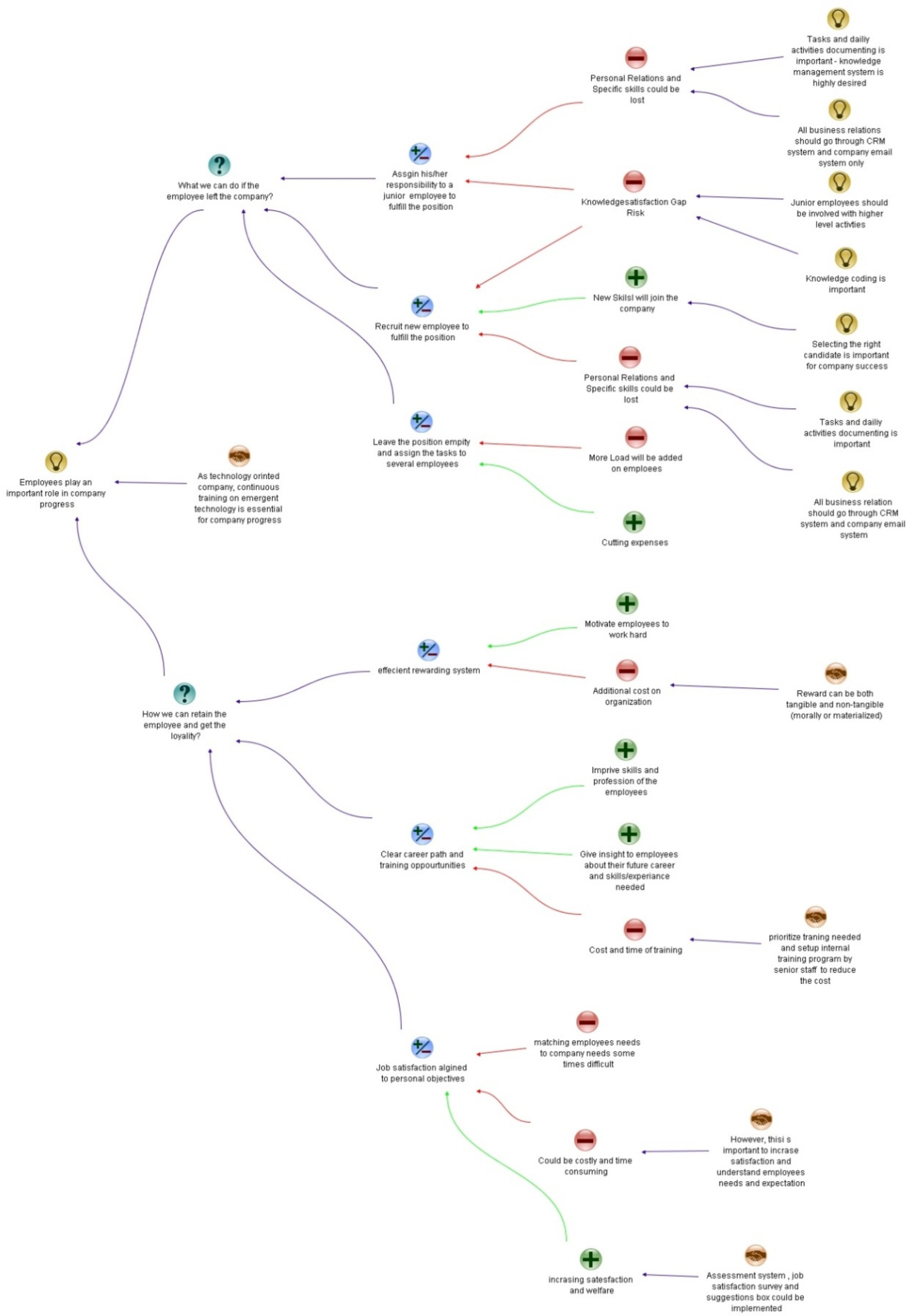


FIGURE 44: EMPLOYEE ISSUES REASONING

6.9 Dynamic Model

One of the main objectives of this research is to incorporate dynamic capability with an enterprise model; this section will demonstrate an example of a revenue dynamic model as one of several dynamic models for a particular issue that could be shown.

6.9.1 Revenue Dynamic Model

The case study analysis shows that several factors that influence Info2cell revenue:

- **Third parties:** Third party companies contribute up to 20% of Info2cell revenue. In 2010, third parties companies purchasing reached only 7% of total revenue, a 60% reduction in the usual purchasing rate of third party customers.
- **Operators**: Services delivered through operators equals 75% of the total revenue of Info2cell: any change in operator trends, polices or delivery may directly influence revenue.
- **Competitors**: Competitors have increasing in the last three years by a steady rate of 4%; this increase might also influence revenue.
- **Content providers:** These usually ask for a yearly minimum grant to provide content to Info2cell. This minimum grant could be changed year on year.
- **Customers**: VAS customers are increasing gradually, this can be presented as a formal growth rate of 7% yearly.

TABLE 142: REVENUE TABLE

Year	**Third parties**	**Operators**	**Content providers**	**Customers**	**Total**
2007	25	70	7	14	124
2008	27	77	8	16.5	136.5
2009	29.5	82	6	18.5	143
2010	14	83	6	21	130
2011	30	87	5.5	23	151

The iThink® model consists of stocks, flows, converters and connectors and these general modelling constructs were used to represent different sections of the Info2cell revenue model. The iThink® continuous simulation tool transforms standard modelling constructs into a set of differential equations, which are solved using a numerical integration technique.

The results produced from executing the stock and flow model (as shown in Figure 45) are presented in Figure 46.

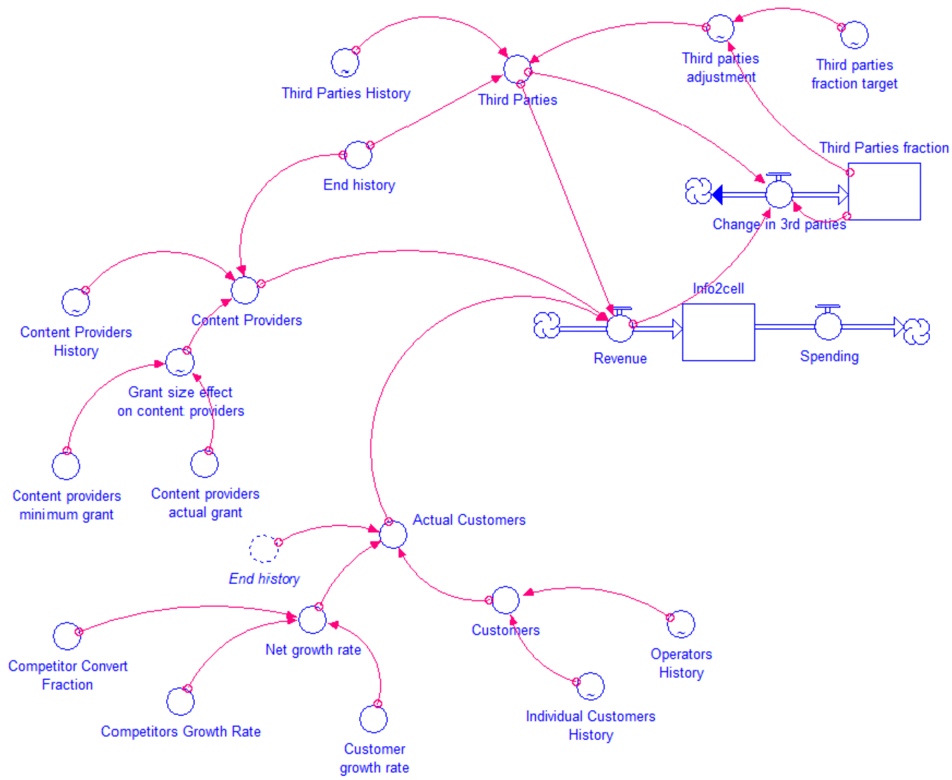


FIGURE 45: REVENUE DYNAMIC MODEL

As shown in Figure 46, the data was imported into the model and presents the change in Info2cell's revenue. Changing the input values or discovering more influencing factors will obviously give more insight into potential future scenarios and encourage strategic (causal loop) thinking.

Here, the behaviour was tied to what is operationally driving the changing values, e.g., customer growth and third party decline. We often want to set these values so as to closely replicate the history. Here, instead, we are using the history and then using the 2011 values as a springboard for later years, based on the values provided.

The model has a structure that drives third party revenue down to 7% of total revenue by 2017 (the end of 2016). Since it cannot change instantaneously, it only falls to 8% by then. This is controlled by the graphical function 'third parties fraction target', which sets the target over time.

The model has a structure to deal with grants for content providers: if we change 'content providers actual grant', we will see a change in the simulation result. The model shows the structure for competitors taking away some of the new business. We modify the value of the ‘competitors convert fraction’ to change how much new business the competitors are taking away from Info2call's new business.

It should be noted that this model does not include a structure for influences on operators from changes in operator trends, polices or delivery, because such information requires a longer period of data gathering and analysis than was possible within the constraints of this study.

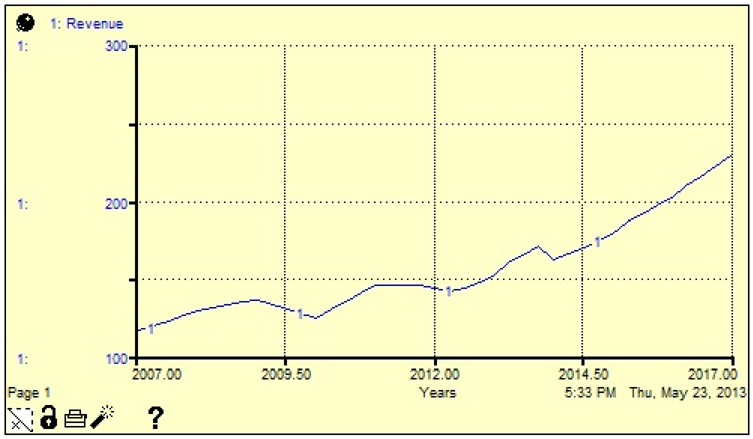


FIGURE 46: INFO2CELL REVENUE

As promised, the RDBMM will offer a foundation for continuous improvement: the previous simulation of Info2cell’s revenue model shows the possibility to identify problems based on recognised factors such as the following:

Problem: In Table 142 we see that the revenue coming from content providers is decreasing, so spending resources on building services may cost Info2cell a loss. If Info2cell spends 3,000 yearly on resources related to content provider services, and we assume that the profit decreases by 10% yearly on average, what is the minimum share that could be acceptable and profitable for Info2cell? Execution of the model Figure 47 results shown in Figure 48 as the following:

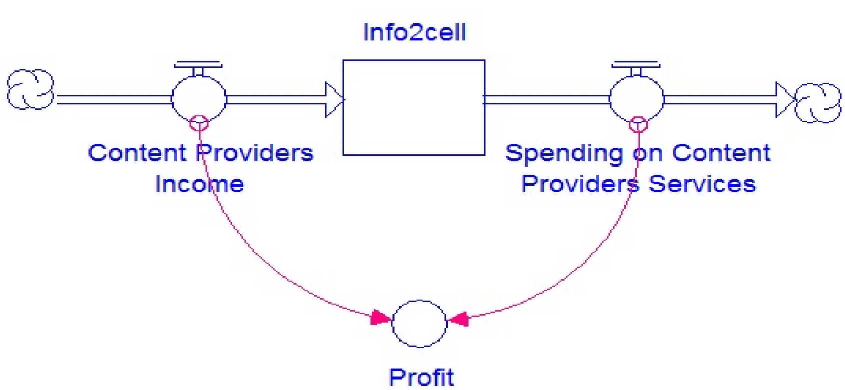


FIGURE 47: CONTENT PROVIDER SERVICES COST AND PROFIT

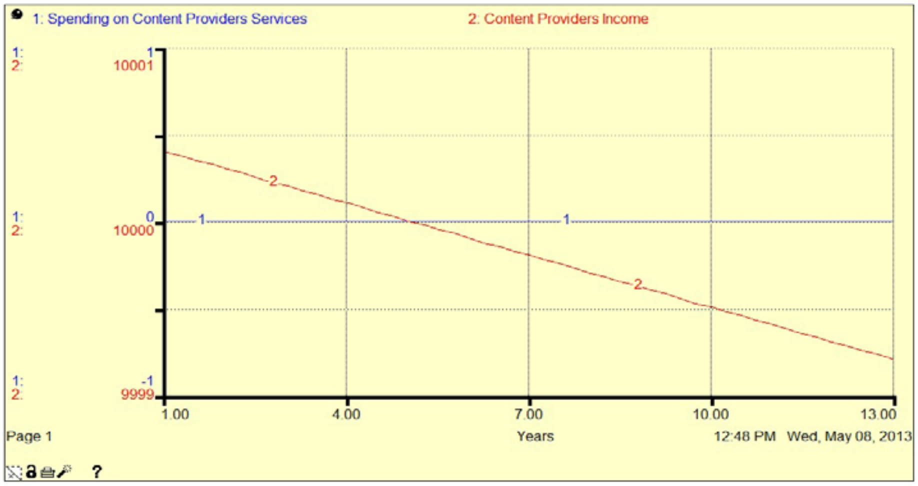


FIGURE 48: SIMULATION RESULT

Figure 48 shows that, after 5 years the content provider's services will not be profitable anymore forInfo2cell. Investment in these services after 5 years will cause a loss. Changing agreements and types of services or stopping investment in this direction are some options to be considered by strategic staff.

6.10 Info2cell – Organisation and Social Issues Analysis

During the interviews with Info2cell staff members, critical issues were observed, discussed and analysed. The following sections will discuss the analysis and suggest some recommended practices related to these challenges.

6.10.2 Management and Leadership

It is obvious that managing a team requires more than distributing tasks and putting pressure on the employees to finish them within the time set. The literature shows that setting challenging goals, sharing objectives, clarifying direction and guidelines and motivating the employees will bring better results and better work performance (Heslin, 2008; Ordóñez et al., 2009). Still, employees need appreciation and reward, at least in some verbal form: e.g., "thank you for your effort, this is a great effort, keep up the hard work; your work was outstanding! I know you are under pressure, don't panic this will help in your evaluation". Such words will not cost the managers anything, but will help the employees to recharge their motivation and keep the performance levels high. Also, as people are never identical, it is very important to make an effort to understand individuals, what motivates them and the best ways to achieve the organisational goals through those employees. The employees need to know where the company, and they along with it, are heading. Good results will never be gained if the employees get no inspiration: they need to know and feel that their contribution is important for the organisation and for delivering business.

Based on the interviews conducted with the Info2cell staff, it was clear that the section and division managers suffer from a lack of leadership abilities, where they are not able to guide, motivate or inspire their employees appropriately; at the same time they are not able to identify the capabilities, skills and goals of their employees. Although some managers make an effort to understand the individual employees on a minimal scale, the situation will remain the same as long as the managers keep focusing on fulfilling the tasks and forget about the soft aspects of the organisation.

Social awareness (staff and self), organisational awareness, emotional intelligence, conflict management and collaborative teamwork are important factors for successful leadership. Successful leaders know when they should be an ordinary colleague for their employees and when they need to use their authority and make hard decisions. Some practices to increase distributed intelligence can be suggested, as follows:

- Sharing the organisational goal with employees
- Sharing a common understanding of goals and objectives
- Involving all employees at all levels in strategic design and implementation
- Understanding employees' needs and aligning them with organisational strategic goals
- Incorporating individual employees' intelligence in strategy improvement
- Rewarding employees by attempting to meet their goals

6.10.3 Administration, Human Resources and Supportive Activities

Human Resources (HR) departments are usually responsible for hiring employees, welfare, employment schemes, salaries, evaluations, penalties, inducements, employee benefits and training. In the modern HR work, many companies have started to focus on knowledge management, skills development and communication. At Info2cell:

- The recruitment process as shown in the flowchart[10] appears to be reasonable: during the interviews, several staff pointed out clearly the several vacant positions in the company, and wondered why such positions had been vacant for a long time, some for nearly a year. Searching for employees and talent acquisition is suffering at Info2cell. The organisation can use well-known job sites to hunt for talents, and candidates should go through intensive interviews with clear criteria to assess their motivation to learn, collaborate and contribute, besides their qualifications and expertise in the subject matter. The company should make sure that the hired employees' goals match the organisational goals and can be incorporated within the mission statements.
- The HR department created an "Employee of the month" award. However, a number of employees believe that this reward system does not reflect the real situation and is not fair to most. This questions the evaluation criteria of the organisation.
- Regarding the performance appraisal forms, the interviews identified a number of good factors, but the document does not state how the evaluation will be performed, and whether it is supported by quantitative data regarding the number of tasks fulfilled or not completed, misconduct and time spent on learning and fulfilling tasks. The reasons behind the evaluation and the necessary action to be taken need to be clear, as well as the kinds of skills and qualifications the employee needs to acquire to improve their productivity and performance. Furthermore, the company is advised to include factors such as relevance, confidence and satisfaction factors in their appraisal.
- The company has an email address called "The employee's voice" for suggestions and feedback: employees can directly send an anonymous email to the CEO. The employees are not keen to send email through this anonymous system; the reason could be the absent of trust, where they believe that the value of sending the email might negatively affect their position in the organisation.
- An online questionnaire could be implemented on a quarterly basis to understand employees' needs, feelings, motivation and suggestions; this could bring a good feedback mechanism to senior managers to allow them to handle resources in efficient manner. This is a method of bottom-up organisation performance evaluation and could help to measure satisfaction and help in collaborative organisational development.
- Since several employees complained about the slowness of HR and administration activities, it is necessary to set up clear timescales and deadlines of which employees, HR

[10] Flowcharts have been developed within Info2cell, and handed to the author as part of the documents required for analysis

and Admin staff are aware. For example, to obtain a salary slip or employment status, the requirements (purpose, the employee name and number) should be submitted by the requester and time limits should be clear (this letter is to be ready in three days' maximum from the time of submitting the request). All activities should be bound by set deadlines to preserve employee and support staff rights. HR staffs should keep the employees in the centre of their focus and think about them as customers.

- New rules, policies or third party involvement could affect employees directly; all rules and policies should be explained and made explicit to the employees to avoid misunderstanding and misconduct, so as not to put the employees in an awkward situation. It is the HR staff's responsibility to explain all of the general rules of the organisation, benefits, employment and evaluation. The department managers could also be in charge of explaining the rules, the position and department mission and specific evaluation criteria.

6.10.4 Standards and Processes

Recently Info2cell decided to adopt several industry standards to improve work practices in different areas. For example, ITIL has been adopted to deliver technical support and IT services for internal and external users; before this, Info2cell was using ad hoc practices to deliver IT support and services. Quality assurance teams have made a recognisable effort to model and optimise Info2cell's processes, yet the quality system still confuses a number of quality standards and needs to decide on a quality reference model for each particular issue. Some procedures and testing programmes have been adopted to better guide the testing of mobile applications.

Moreover, six months ago an operational management group was established to act as a central hub to better connect internal entities and to connect the company with the external environment: this positive initiative will help to improve knowledge sharing, conflict management and transparency. A number of industry standards and tools can be used to enrich this experience toward its goals.

6.10.5 Suggested Practices

A number of practices will be suggested to Info2cell to improve its organisational work: these practices fall into the social and procedural area as follows:

Gap Analysis: To understand the gap between design and operations and between the current state and future state, gap analysis should be performed. Activities, responsibilities and tools should be continually evaluated. To understand performance, companies usually need to look at patterns in their historical performance and try to predict future performance based on the history and the change in factors that influence performance. For example, it has been noticed that job descriptions need to provide a form of responsibilities, tasks and qualification and compare them with the designed job description. Therefore, the current operations will be studied to decide which future operations are to be implemented which can bring the required results.

Knowledge Management is a set of strategies and practices that enable organisations to manage, create, identify, share, store and represent insight and experiences as knowledge; this knowledge could be in tacit or explicit form and embedded in individuals and organisational practices. Info2cell needs to manage the knowledge and expertise within the company to mitigate the risk of losing knowledge. The records show that almost ten employees have left the company in the last year, and a number of interviewees admitted that losing skills to competitors is a major issue facing the company. Efforts have to be made to document processes, daily tasks and project deliverables. Also, it is very important to document experienced gained during and after performing tasks and whither the goal have been achieved or not. Many practices can help, such as establishing an internal portal, wikis and blogs, communication analysis and email archiving. Employees' profiles need continuous updating; tools and skills obtained by employees to fulfil certain tasks should be noted.

Innovation is not a single-aspect practice: several factors play a role in innovation in products and services. One option is to set up a partnership with a research entity, university or individual with particular aims of development. Other options that could work well include establishing a partnership with a public entity to support innovation, e.g. a partnership with a tourism development initiative to develop location-based services for tourist sites in Jordan, or partnership with universities to deliver mobile learning services. These kinds of project will ensure mutual benefits for both sides in the partnership. Spreading the culture of innovation is very important internally: Info2cell could allow their employees to dedicate a day to doing something they like, and then to present and discuss the idea in a group meeting; reasonable ideas could go through assessment and a feasibility study for developing the idea.

6.11 Reflections and Conclusion

The following conclusions can be made based on the Info2cell case study, the overall aim of which was to show the useful application of the RDBMM presented in Chapter 5.

1) The proposed RDBMM was successfully applied to Info2cell as a socio-technical system. During testing, it proved useful in visualising and aligning the enterprise model with continuous reasoning and dynamic modelling used to identify risk and design choices and make decisions about them.

2) An ‘as-is’ model of the enterprise is presented in this chapter which can act as a basis for any future enterprise modelling effort with the aim of improving alignment, forecasting and maturity.

3) Info2cell started to adopt industry best practices such as ITIL to provide IT services in a quality standard manner. Info2cell made an effort to design and map business processes in the organisation within a centralised operations management hub.

4) It was identified that social aspects are a critical measure for understanding organisational performance.

5) Data availability was one of the main limitations of this case study:

a) Only a limited number of interviews lasting an average of 1 hour were made. Further data gathering is necessary in order to gain a clearer picture. In this case, it is recommended that at least one full year of data is gathered and analysed, over different periods, so that all critical issues become visible, especially those created seasonally or by economic or political factors. Therefore, further observation and monitoring are required to understand the alignment, dynamics and effectiveness of the reasoning modelling.

b) No detailed data were available related to the variation of the complexity level of the jobs involved; this should also be evaluated against years of experience and years of experience in Info2cell. Such data could significantly help to understand performance and satisfaction, and their impact on motivation and performance. The analysis should aid in understanding the context at the country and regional levels.

Based on the result of implementing RDBMM, the maturity of the enterprise insight, alignment and visualisation has been considerably improved. Figure 49 shows the results of RDBMM implementation using the maturity assessment standard used in this research to evaluate the RDBMM application (Appendix E):

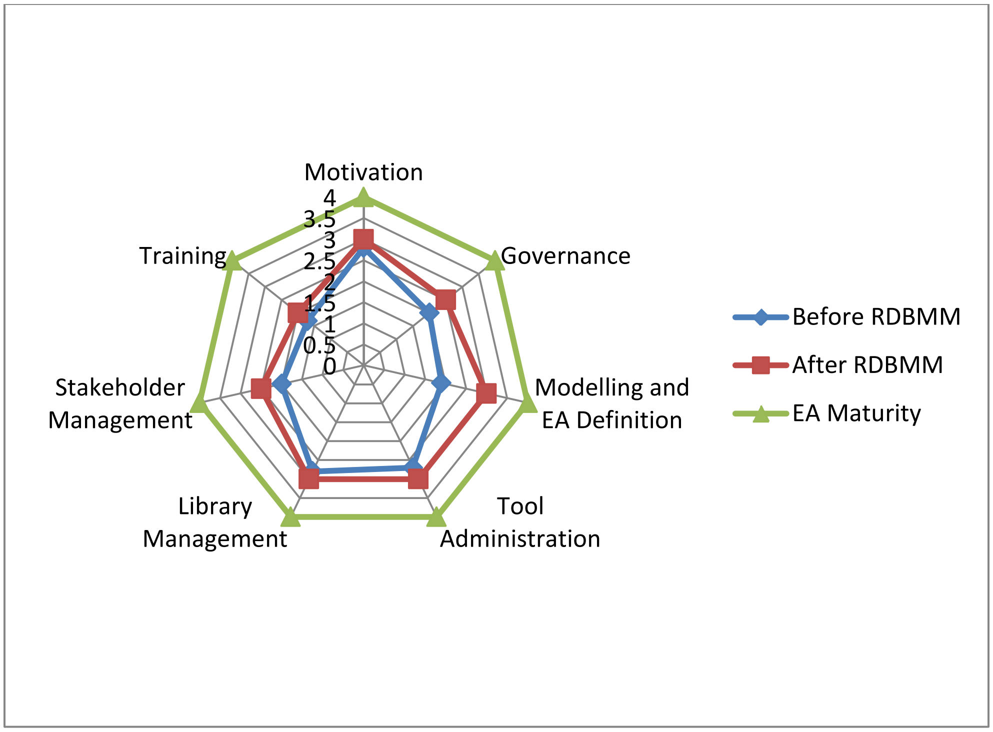


FIGURE 49: INFO2CELL EA MATURITY

Chapter Seven: Techno-Logic Case Study

7.1 Motivation and Introduction

After examining the Info2cell case study, the following research questions were raised: (1) How can RDBMM be implemented in a lightweight development life cycle to improve business agility; and (2) is the proposed RDBMM applicable for developing 'to-be' architecture from scratch in business activity design? Keeping in mind these research questions, the case of Techno-Logic as a newly established company required more focus on market analysis and decision-making. The case study presented in this chapter was designed to test the application of RDBMM through a systematic process focusing on different aspects of analysis as the case required. Besides this, the case study also demonstrates how to move in aligned manner from business design to technical service design in implementing business applications. At the end of this chapter, an analysis and discussion of the results of the case study application is presented. In the following Table 143 shows the response of Techno-Logic models to the RDBMM views and artefacts:

TABLE 143: INFO2CELL CASE STUDY MODELS

RDBMM Views/Perspective	Models Response To RDBMM Views
Goal view and motivation artefacts (End, Mean, Influencers, Strategy, Tactics)	Motivation - Goal Model
Decision view, Influencers, Assessment and Potential impacts	Reasoning Model (Goal Assessment)
Dynamic impact of influencers, assessment and impact prediction	Dynamic Model
Terms, Facts, Concepts and Ontology view	Business Vocabulary, Terms and Facts
Facts, Rules view and Decision view	Rule and Decision Sets
Process view	Process Model
Decision and Assessment view	Process Selection
Decisions about social, financial and technical resources	Resource Allocation
IS design and management	Process Development

7.1.1 Techno-Logic - Overall Context

In Saudi Arabia, the IT market reached $7.2 billion in size in 2012. E-learning products and online courses are increasing in number every day, and many universities and corporations are investing significant capital in e-learning programmes and initiatives. This growth is also reflected by Ambient Insight's report published in 2010, showing that the e-learning market had already arrived at the $27.1 billion mark in the year 2009 and is expected to surpass $49.6 billion by the year 2014 (Adkins, 2011). Therefore in order for the Kingdom of Saudi Arabia to take this global direction and be one of the leading countries in introducing innovation to education, many initiatives on different levels are required. The Saudi Arabia market has attracted competitors from all over the world: enterprise IT companies as well as small/medium enterprises looking to the Saudi market as a potential fruitful market for their products; competition will be tough for new entrants like Techno-Logic, but some other factors related to maturity of planning and deep market understanding could play a role towards securing their success.

7.1.2 Techno-Logic Case Background

Techno-Logic is a newly established company, looking to develop enterprise architecture and the underlying IT components. The strategy will initially be implemented in one location; the locations will be increased based on the business and market demand. Techno-Logic will specialise in e-education and e-learning services. Their services include a wide spectrum across developing e-learning solutions; providing equipment for classes and labs; technical support, consultancy and training. Techno-Logic is a small entrepreneurship with no in-house developed solution or products: it will rely mainly on vendors' technology. A network of partnerships should be established, systems customisation and localisation could be offered to customers, which requires a technical team. The most important part of the services that Techno-Logic is looking to provide is consulting and training, from which most of the revenue is expected to come. This chapter aims to analyse and design Techno-Logic's strategic plan based on the RDBMM framework. The implementation process will be described in the following section to track the activities contributing to the architecture design of the Techno-Logic company.

7.1.3 Application of the RDBMM at Techno-Logic

As mentioned before, the objectives of this case study are to provide a flexible and short implementation life cycle for the RDBMM. It is very important to provide such an approach to fit the capabilities, resources and timescale of SMEs. The application of RDBMM at Techno-Logic will follow an enterprise goal oriented approach for enterprise modelling-driven IT (from goal to SOA). This case study will also suggest an operations and management implementation style for ease of adaptation of the architecture to fit the rapidly changing business environment. The RDBMM will offer to the mangers in Techno-Logic the ability to plan and design their business activities, understand market dynamics using simulation. It will allow them to develop IT/IS capabilities that fit their needs and allocate resources more efficiently. Figure 50 presents a proposal for a process to be followed in the Techno-Logic case study:

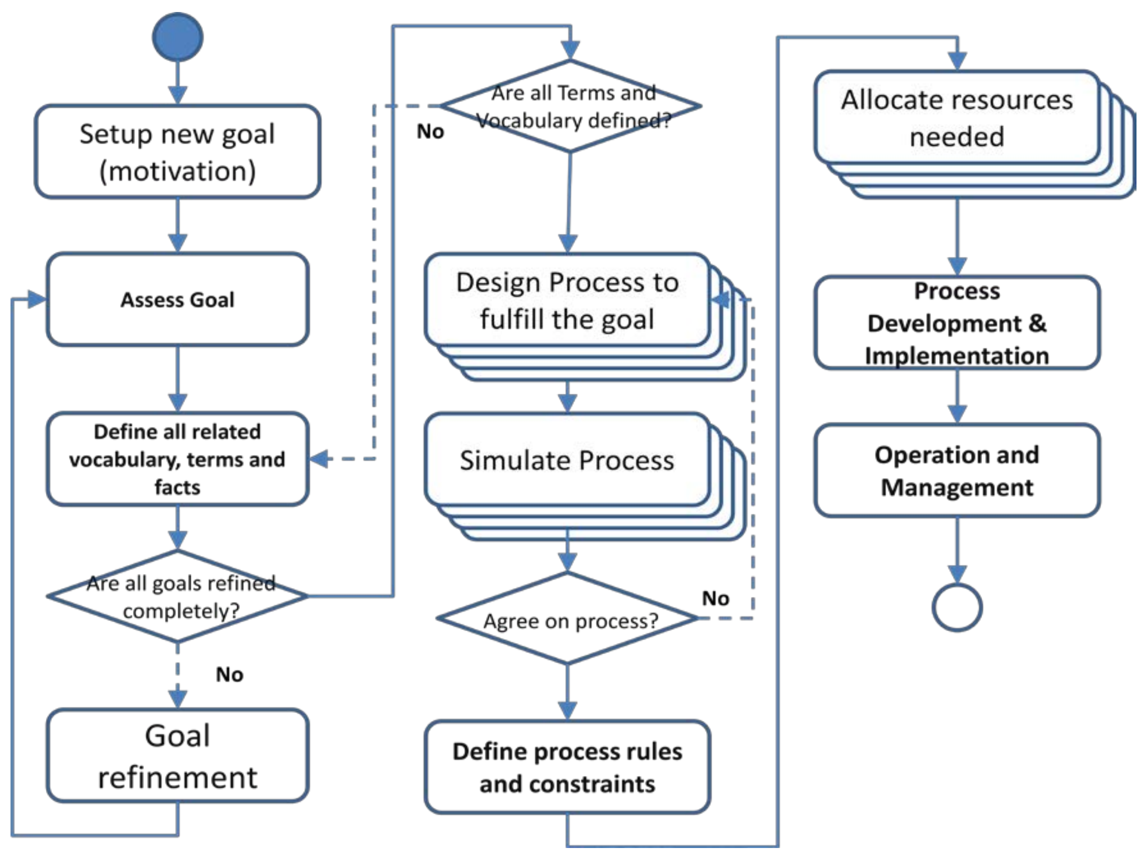


FIGURE 50: TECHNO-LOGIC MODELING PROCESS

7.2 RDBMM for Techno-Logic Analysis and Design

A profile to store Techno-Logic models and artefacts has been built using the Sparx© EA tool as shown in Figure 51. This UML profile can be used for future work in implementing integration among different tools to exchange, store and retrieve models data from Design Rationale and Systems Dynamics modelling tools to the Enterprise Modelling environment to support model driven interoperability.

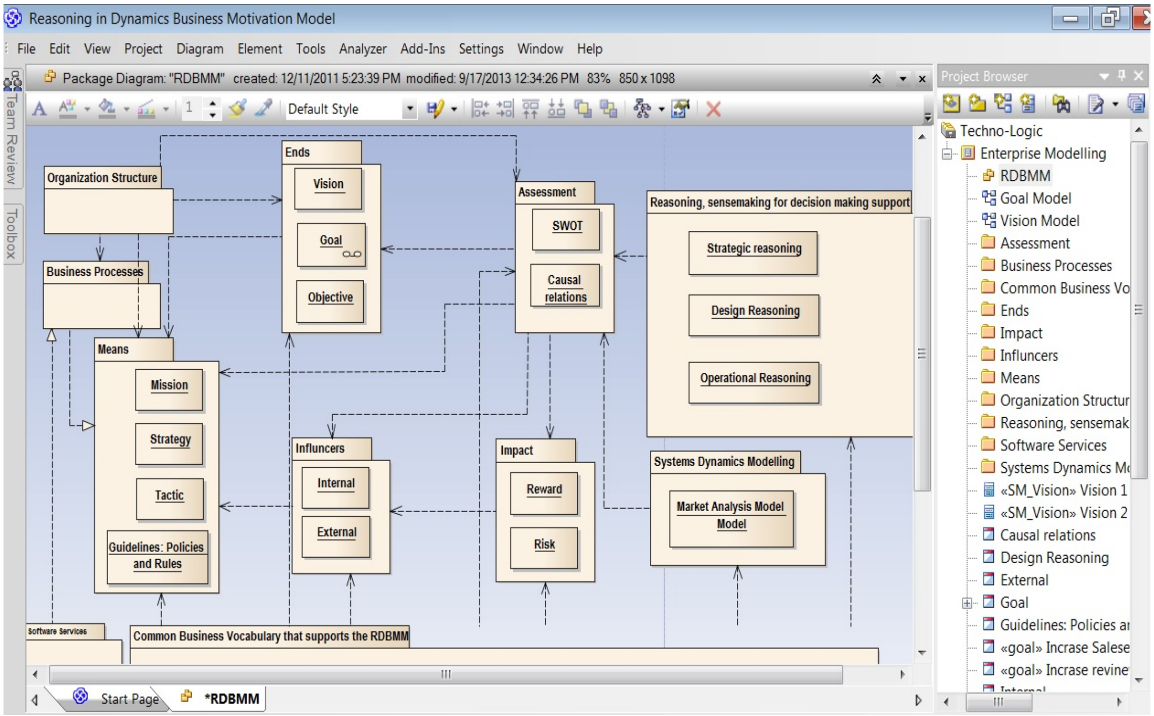


FIGURE 51: RDBMM PROFILE

7.2.1 Motivation - Goal Model (Setup Goals)

This is the motivation and goal model and goal refinement model for Techno-Logic, and is followed by detailed descriptions of each of the goals presented in this model (Figure 52).

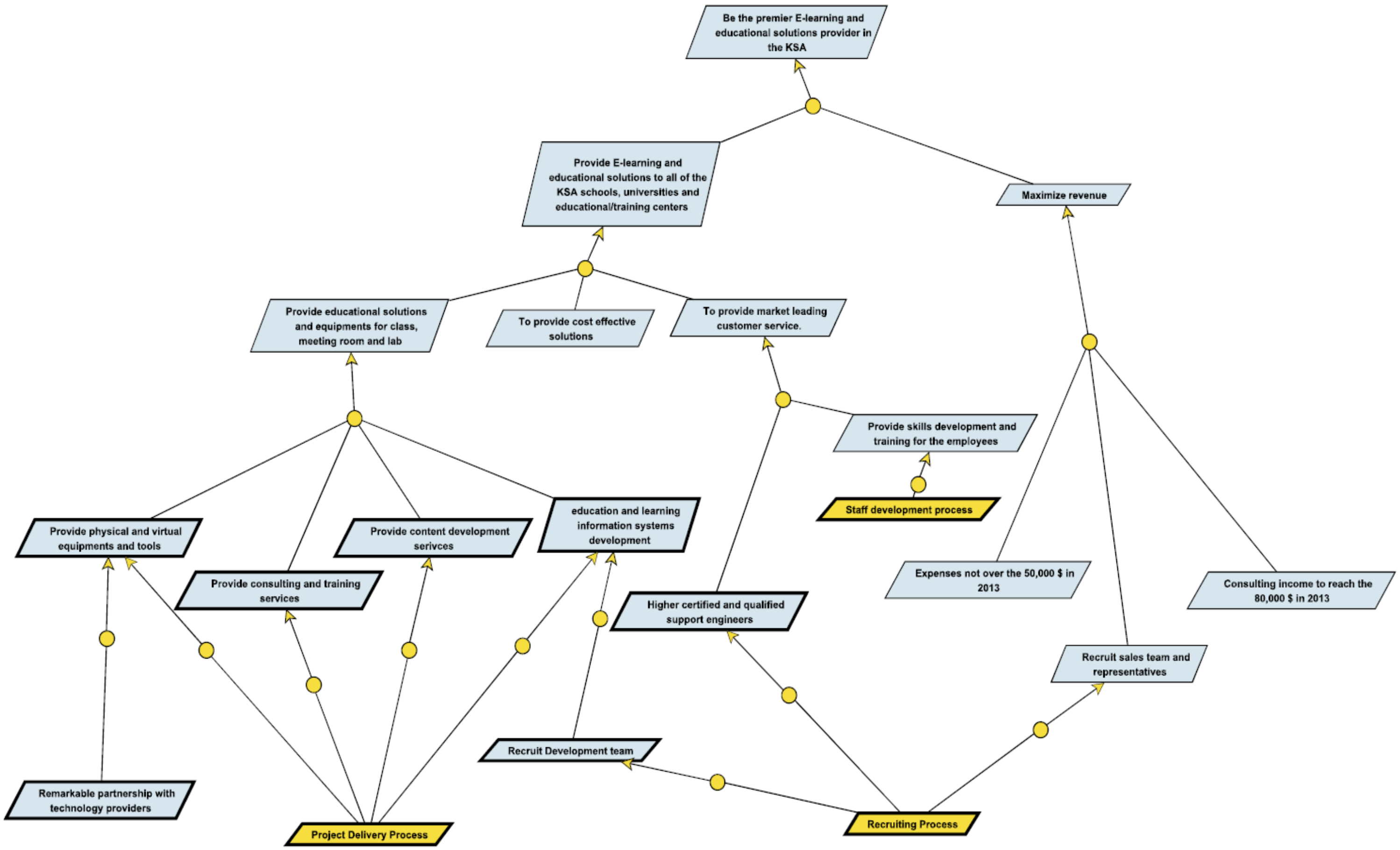


FIGURE 52: GOAL MODEL

7.2.1.1 Goal Description

This section describes the **goals** and their types in the Techno-Logic goal model (Figure 52)

TABLE 144: T-LOGIC GOAL 1 PATTERN

Goal 1: Be the premier E-learning and educational solutions provider in the KSA	
Priority	Medium
Owner	Techno-Logic
Status	Strategic
Type	Vision
Composed of	Goal 2: Techno-Logic mission
Justified in	Assessment 1
Ethicality	- Operate according to the laws in the countries in which it operates - Conform to ethical procedures and practices in the industry
Difficulty	Medium: Techno-Logic's capabilities play a major role in achieving the desired results.
History	None of the shareholders/owners have prior experience in leading an e-learning organisation.
Criteria	- Percentage of market share after 5 years - Intangible value of the company - Brand recognition - Number, name and size of the customers
Timeframe	Long term - 5 years
Target value	10% of e-learning market share in Saudi
Actual value	0.2%
Percent Achieved	5%
Last Update	7/9/2012

TABLE 145: T-LOGIC GOAL 2 PATTERN

Goal 2: Provide E-learning and educational solutions to all KSA schools, universities and educational/training centres	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Mission
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	Goals 3, 4, 5, 6
Justified in	Assessment 2
Ethicality	Companies have the right to compete in the market without rule violation.
Difficulty	Medium: Techno-Logic's capabilities play a major role in achieving the desired results
Aligned to	Goal 1: Techno-Logic Vision
History	Techno-Logic has no previous experience in working towards such a goal
Criteria	- Number of targeted leads - Number of accepted requests
Timeframe	Long-term frame: 5 years Short-term frame: Yearly evaluation
Target value	Target 300 leads in the next year

	Rejected deals to not exceed 20% of total requests
Actual value	3%
Percent Achieved	5%
Last Update	7/9/2012

TABLE 146: T-LOGIC GOAL 3 PATTERN

Goal 3: Maximise revenue	
Priority	High
Owner	Techno-Logic
Status	Operational
Type	Mission
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	Goals 7, 8, 9
Justified in	Assessment 5
Ethicality	Belong to competition rules and regulations in the country and for the specific domain (IT and consulting services)
Difficulty	Medium
Aligned to	Goal 1: Techno-Logic Vision
History	Last year revenue was $25,000 based on ad-hoc consulting services
Criterion	Revenue volume by $
Timeframe	Long term: 5 years Short term measure: End of the financial year 2013
Target value	$200,000
Actual value	$25,000
Percent Achieved	12.5%
Last Update	7/9/2012

TABLE 147: T-LOGIC GOAL 4 PATTERN

Goal 4: To provide market-leading customer service	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Goal
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	Goals 10, 11
Justified in	Assessment 4
Ethicality	Follow service level agreements that conform to industry standards and law in the country operated in
Difficulty	Advanced: skills, capability and customer relationship strategy play a major role in achieving the goal
Aligned to	Goal 2: Techno-Logic Mission
History	None
Criteria	- Number of issues resolved within timeframe - Number of complaints - Level of customer satisfaction
Timeframe	1 year from beginning to the end of next year
Target value	- More than 90% of issues resolved on time - Number of complaints not to exceed 30

	- Customer satisfaction to reach 80% of total customers
Percent Achieved	10%
Last Update	7/9/2012

TABLE 148: T-LOGIC GOAL 5 PATTERN

Goal 5: Provide educational solutions and equipment for class, meeting room and lab	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Goal
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	Goals 12, 13, 14, 15
Justified in	Assessment 4
Ethicality	Conform to educational law in the country Conform with any specific policy requirements of the customer Conform to quality standards and code of ethics
Difficulty	Medium
Aligned to	Goal 2: Techno-Logic Mission
History	None
Criteria	- Targeted market segments and customers - Number of successful equipment/tools deals
Timeframe	End of 2014
Target value	- Market segments (universities, schools, education and training centres, government sectors, hospitals and enterprise level companies) - To reach $120,000 for the next year
Actual value	0
Percent Achieved	0%
Last Update	7/9/2012

TABLE 149: T-LOGIC GOAL 6 PATTERN

Goal 6: To provide cost effective solutions	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Goal
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	None
Justified in	Assessment 2
Ethicality	Solutions delivery under the terms of service level agreements
Difficulty	Easy: depends on technology providers/"partners"
Aligned to	Goal 2: Techno-Logic Mission
History	None
Criteria	Comparison to competitors in the market. Number of successful bidding deals
Timeframe	End of next year
Target value	To be within top 3 providers that offer price worthy products (ROI) To win more than 70% of customers bid for
Actual value	0%

Percent Achieved	Price comparison to be communicated 0%
Last Update	7/9/2012

TABLE 150: T-LOGIC GOAL 7 PATTERN

Goal 7: Recruit marketing/sales team and representatives	
Priority	High
Owner	Techno-Logic
Status	Operational
Type	Strategy
Amplifies vision	Goal 1: Techno-Logic Vision
Achieved by	Process 1: Recruitment process
Justified in	Assessment 6
Ethicality	Should conform with employment terms and conditions in the country
Difficulty	Medium: The 2013 budget plays an important role, besides skills availability in the market
Aligned to	Goal 3: Maximise revenue
History	None
Criterion	Number of marketing and sales staff
Timeframe	End of next year 2013
Target value	7 staff
Actual value	0
Percent Achieved	0%
Last Update	7/9/2012

TABLE 151: T-LOGIC GOAL 8 PATTERN

Goal 8: Consulting income to reach $80,000 in 2013	
Priority	High
Owner	Techno-Logic
Status	Operational
Type	Strategy
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	N/A
Justified in	Assessment 4
Ethicality	Consulting services should follow international standards and take into account local culture and regulations
Difficulty	Medium
Aligned to	Goal 3: Maximise revenue
History	- Owners have successful experience in consulting services - Owners believe consulting could bring in a good amount of money with minimum project management effort and risk taken
Criterion	The revenue amount of the consulting services
Timeframe	End of next year
Target value	$80,000
Actual value	$5,000
Percent Achieved	6.2%
Last Update	7/9/2012

TABLE 152: T-LOGIC GOAL 9 PATTERN

Goal 9: Expenses not over $50,000 in 2013	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Strategy
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	N/A
Justified in	Assessment 5
Ethicality	Ideally, companies set up their budget and expenses at the beginning of every financial year; companies have liability for controlling their expenses
Difficulty	Medium
Aligned to	Goal 3: Maximise revenue
History	None
Criterion	Amount of money spent
Timeframe	During the complete financial year
Target value	Upper limit $50,000
Actual value	Spent until present $10,000
Percent Achieved	100%
Last Update	7/9/2012

TABLE 153: T-LOGIC GOAL 10 PATTERN

Goal 10: Provide skills development and training for employees	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Strategy
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	Staff development process
Justified in	Assessment 2
Ethicality	Techno-Logic is very committed to staff development and training to maintain and increase its competitive capabilities
Difficulty	Medium: The training and development budget plays the main role in achieving this goal, beside market/technology understanding and staff motivation and willingness to learn
Aligned to	Goal 4: To provide market leading customer service
History	None
Criterion	Number of training courses provided to staff
Timeframe	End of next year
Target value	Two training courses for every staff member per year
Actual value	0
Percent Achieved	0%
Last Update	7/9/2012

TABLE 154: T-LOGIC GOAL 11 PATTERN

Goal 11: Hire certified and qualified support engineers	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Tactic
Amplifies vision	Goal 1: Techno-Logic Vision
Achieved by	Process 1: Recruiting process
Justified in	Assessment 2
Ethicality	Recruitment procedure and job requirements identify the level of skills and experience required for a particular position
Difficulty	High: two concerns: 1) Hard to find high skilled people not engaged with multi-national enterprises; 2) Salary required could be too high
Aligned to	Goal 4: To provide market-leading customer service
History	None
Criterion	Number of position-related certificates held by recruited employees
Timeframe	End of next year
Target value	Two specialised certificates related to the position requirements to be obtained by each employee
Actual value	0
Percent Achieved	0%
Last Update	7/9/2012

TABLE 155: T-LOGIC GOAL 12 PATTERN

Goal 12: Provide e-learning content development services	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Tactic
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	N/A
Justified in	Assessment 4
Ethicality	Developed content should conform with the legal specifications for learning and published materials in the country
Difficulty	Medium
Aligned to	Goal 5: Provide educational solutions and equipment for classrooms, meeting rooms and labs
History	None
Criteria	- Number of content development project proposals sent - Number of agreed content development projects
Timeframe	End of next year
Target value	Lower limit of sale to be achieved: $40,000
Actual value	$0
Percent Achieved	0%
Last Update	7/9/2012

TABLE 156: T-LOGIC GOAL 13 PATTERN

Goal 13: Education and learning information systems development	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Tactic
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	Setup and recruit development team
Justified in	Assessment 4
Ethicality	Development should follow QA standards
Difficulty	Medium
Aligned to	Goal 5: Provide educational solutions and equipment for classrooms, meeting rooms and labs
History	None
Criteria	- Profit from developed applications - Profit and number from successful development projects (tangible and intangible)
Timeframe	End of next year 2013
Target value	Lower limit of sales to be achieved : $40,000
Actual value	$0
Percent Achieved	0%
Last Update	7/9/2012

TABLE 157: T-LOGIC GOAL 14 PATTERN

Goal 14: Provide consulting and training services	
Priority	High
Owner	Techno-Logic
Status	Operational
Type	Tactic
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	N/A
Justified in	Assessment 4
Ethicality	Consulting and training should take into consideration the following: - Customer requirements - International and subject related standards and specifications - Country law and culture
Difficulty	Medium
Aligned to	Goal 5: Provide educational solutions and equipment for classrooms, meeting rooms and labs
History	None
Criteria	Profit and number of consulting projects (tangible and intangible) Profit and number of training sessions provided (tangible and intangible)
Timeframe	End of next year
Target value	100,000$
Actual value	$5,000
Percent Achieved	5%
Last Update	7/9/2012

TABLE 158: T-LOGIC GOAL 15 PATTERN

Goal 15: Provide physical and virtual equipment and tools	
Priority	Medium
Owner	Techno-Logic
Status	Operational
Type	Tactic
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	Goal 16: Remarkable partnership with technology providers
Justified in	Assessment 4
Ethicality	Equipment and tools provided should be fully understood and Techno-Logic staff should be aware of all features, limitations and usage policies
Difficulty	Medium
Aligned to	Goal 5: Provide educational solutions and equipment for classrooms, meeting rooms and labs
History	None
Criteria	- Number and types of equipment/tools that Techno-Logic can provide (intangible measured by number of accepted POs) - Profit and number of projects where equipment fully or partly delivered within the project (tangible and intangible)
Timeframe	End of next year
Target value	$40,000
Actual value	$0
Percent Achieved	0%
Last Update	7/9/2012

TABLE 159: T-LOGIC GOAL 16 PATTERN

Goal 16: Remarkable partnership with technology providers	
Priority	High
Owner	Techno-Logic
Status	Operational
Type	Tactic
Amplifies vision	Goal 1: Techno-Logic Vision
Composed of	N/A
Justified in	Assessment 5
Ethicality	Business partners and alliances are usual business practice in the current open business environment where technology and expertise are distributed
Difficulty	Medium
Aligned to	Goal 5: Provide educational solutions and equipment for classrooms, meeting rooms and labs
Criteria	- Number of partners (intangible measure required to calculate the value) - Reputation of partners (Market statistics required) - Special deals/prices from partners - Support and collaboration of the partner for each case
Timeframe	End of next year 2013
Target value	One partner for each solution/service provided by the company
Actual value	0
Percent Achieved	0%
Last Update	7/9/2012

7.2.2 Goal Assessment

7.2.2.1 Assessment 1 - The Strategy Reasoning 'map'

Figure 53 describes the reasoning map towards Techno-Logic's long-term goals.

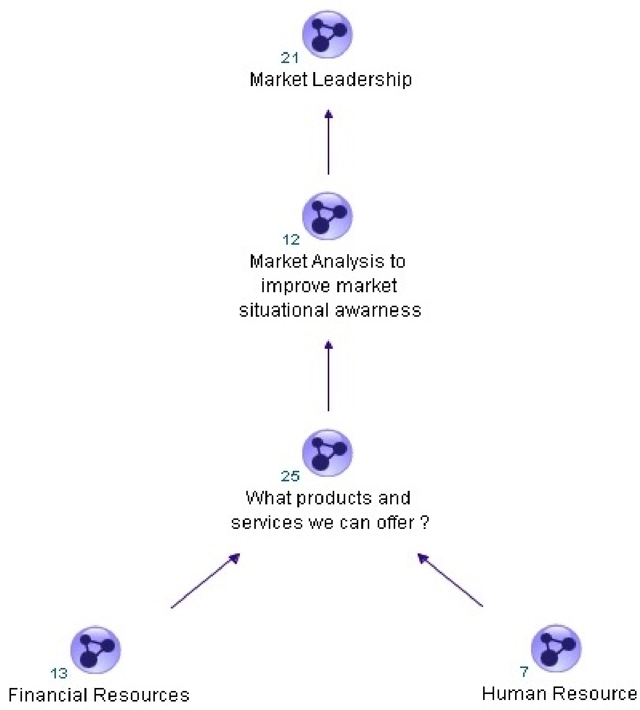


FIGURE 53: STRATEGY REASONING MAP

7.2.2.2 Assessment 2 - Market Leadership Reasoning

Figure 54 shows the model describing the reasoning for the market leadership objective, requirements and related issues.

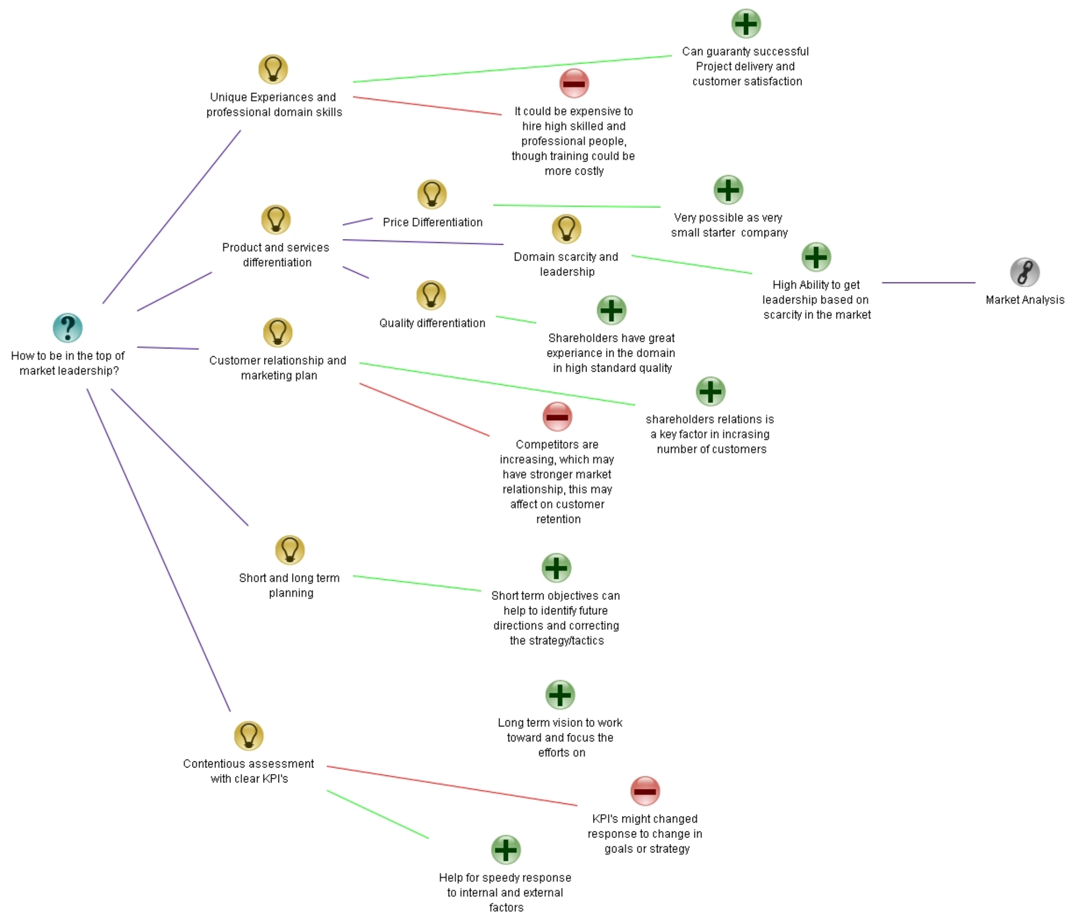


FIGURE 54: MARKET LEADERSHIP REASONING

7.2.2.3 Assessment 3 - Market Analysis Reasoning

Figure 55 describes the model of the reasoning for the market analysis.

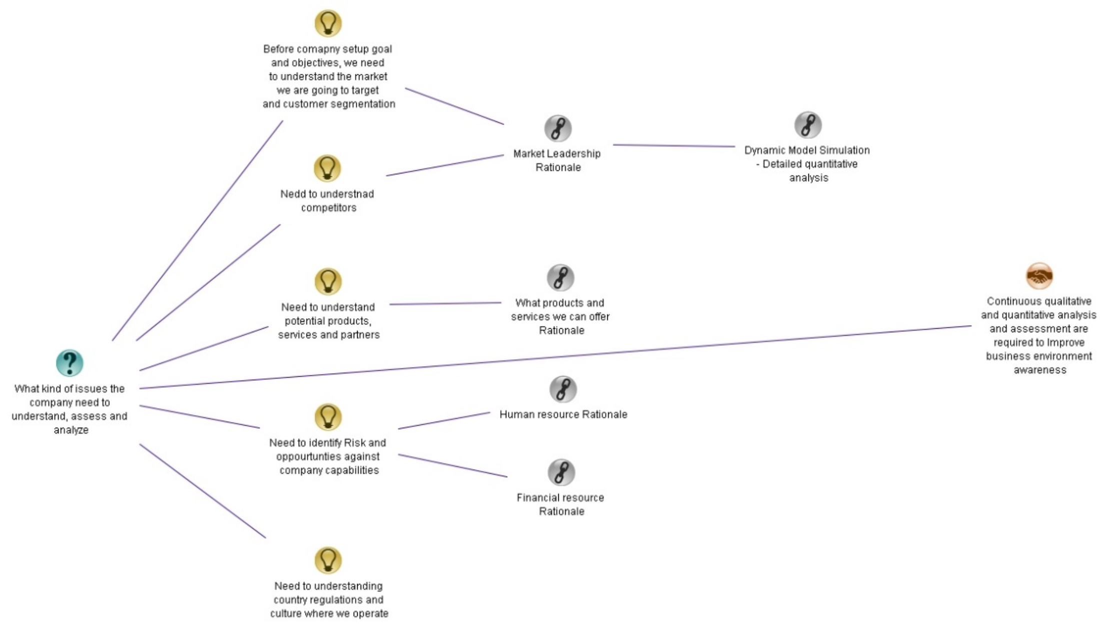


FIGURE 55: MARKET ANALYSIS REASONING

7.2.2.4 Assessment 4 – Products and Services Reasoning

Figure 56 describes the model for the reasoning regarding products and services that could be adopted/developed by Techno-Logic.

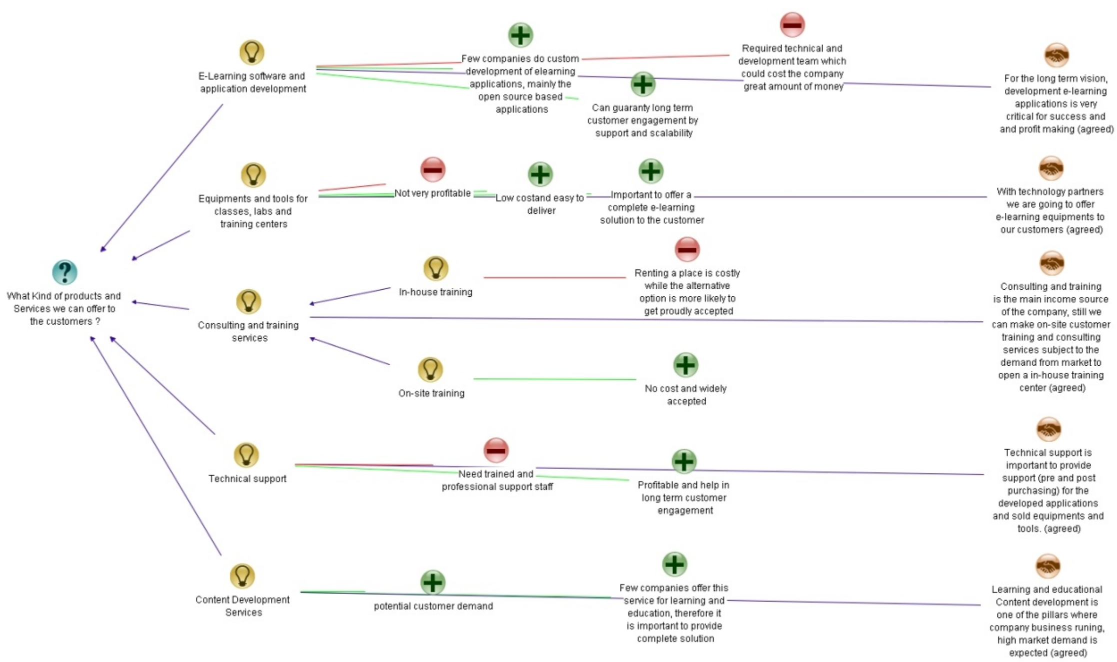


FIGURE 56: PRODUCTS AND SERVICES REASONING

7.2.2.5 Assessment 5 - Financial Resources Reasoning

Figure 57 describes the model for the reasoning regarding financial resources and related issues.

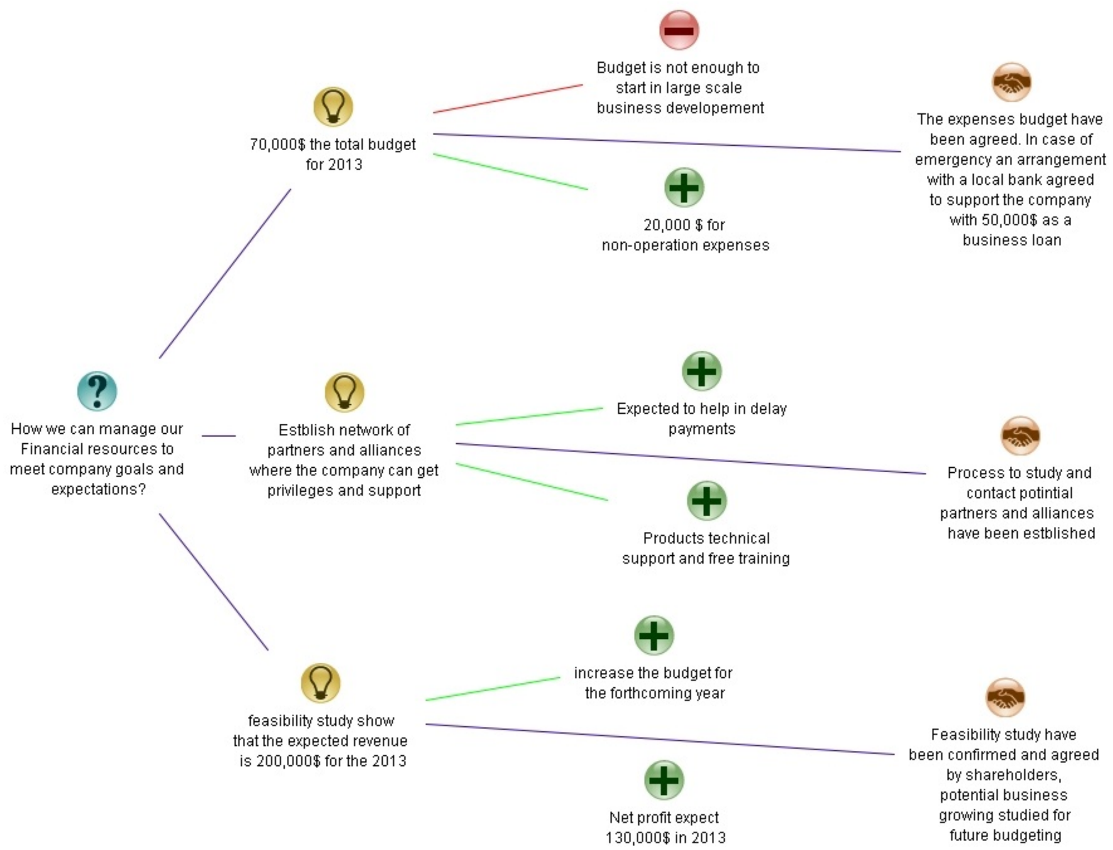


FIGURE 57: FINANCIAL RESOURCES REASONING

7.2.2.6 Assessment 6 - Human Resources Reasoning

Figure 58 describes the model for reasoning about human resources recruitment and needs.

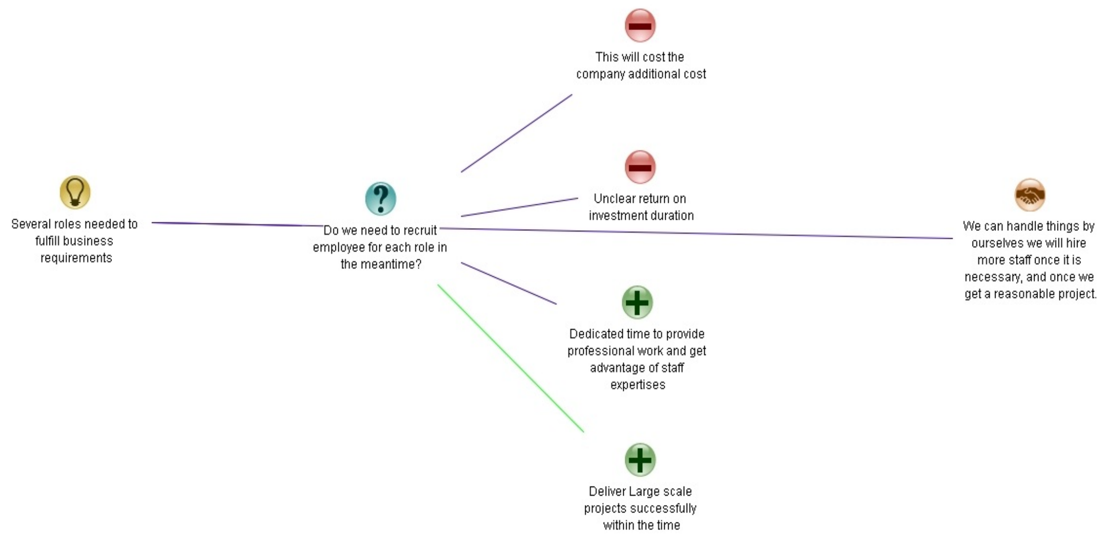


FIGURE 58: HUMAN RESOURCE REASONING

7.2.2.7 System Dynamic Model - Detailed Market Analysis

To offer a quantitative assessment that supports the decision-making required in market analysis reasoning we built a simulation dynamic model. To run the dynamic simulation model, a set of influencing factors were identified with T-Logic stakeholders in Table 160. The factors' impact value might change, therefore continuous evaluation is required.

TABLE 160 INFLUENCING FACTORS

Market Growth Rate	The e-learning market in Saudi Arabia grew by 6% in 2012, and is expected to increase by 8% in 2013
Competitor Increase Rate	12 new SMEs company were registered in 2012, in which e-learning services are among their offered services, increasing by 20%
Customer Profile	Market studies have proved that the customer profile has an impact on their decision to pay for company services. However, the customer profile here will be valued as increasing purchasing expectation by 7% out of the total leads. In contrast, a poor customer profile will influence loss of potential customers by 14%.
Relationships	Good market and customer relationships will increase the potential purchasing by 5%

TABLE 160 INFLUENCING FACTORS (CONTINUE)

Partners' Products	Product quality, price, warranty and features will play a role in market leadership; the influence rate goes to 25% if a competitor is able to give a better offer
Partner Support	Level of sales support, implementation support, training and promotion all help to advertise the brand
Marketing Spending	The company cannot rely on "word of mouth" to advertise their products. We assume marketing spend with a k$ increase acquires customers by fractions: .0001 for each k$.
Business Capabilities	Internal business capabilities, mainly the ability to lead enterprise projects successfully (employee number and skills, financial stability and technical ability), will increase the possibility of winning more deals

Figure 59 shows a model describing market dynamics and the factors influencing sales amount and customers gained. The results shown in Figure 60 are based on the simulation run of this model, which assumes that the effort that T-Logic makes in term of relationships and partner value is higher than the average competitor's values.

The market influencing factors were identified with Techno-Logic managers during the interviews. Figure 61 shows the dynamic of the market, available customers in the country, and customers acquired by T-Logic under certain circumstances in comparison to the average competitor. Four positions are captured to show change during time in the market where T-Logic is performing better than the average competitor. In order to understand how T-Logic will perform against all of the competitors, the value of the average competitor should be multiplies by the number of competitors in the market.

In this model, each competitor can be assigned specific values for their influencing factors, which can also vary as the simulation progresses based on market position, marketing strategy or product/service attractiveness. When the competitor spends half as much on marketing as T-Logic does, T-Logic wins more market share.

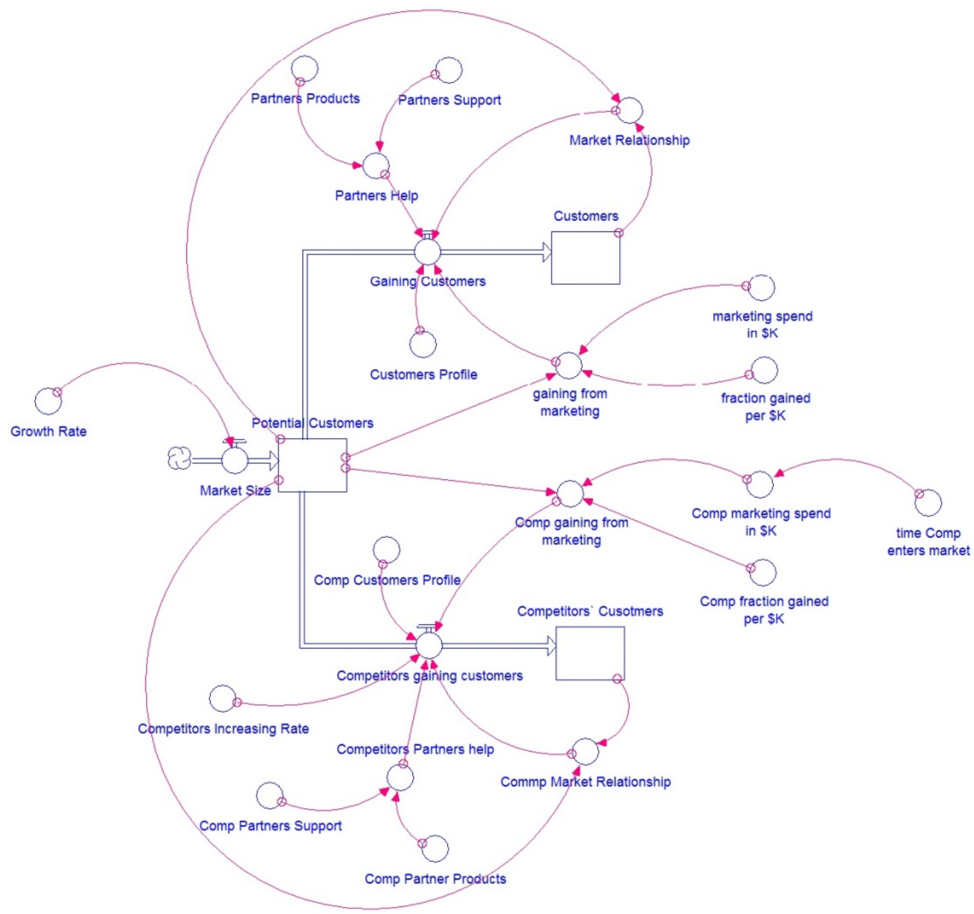


FIGURE 59: MARKET ANALYSIS DYNAMIC MODEL

In this simulation, we assume that the competitor enters the market at the same time as T-Logic, and we assume that the available potential customers are 100. This is not usually the case in the real world. If all variable values are the same for both companies, but the competitor company enters the market one year later, the end result will be vary and different values should be given to many influencing factors such as market position and market relations. Here the model includes a variable for competitor increase rate: this can be used if we are looking to understand T-Logic's market position in comparison to a group of competitors.

This model does not include the factors that influence the development of a market for a specific product/service, nor does it model competitors, potential customers or customers leaving the market. For an entirely new product/service, the potential market will likely grow more than the average market growth, so we may want to include this influencing factor as well at a later stage. However, when modelling a developing market (e.g. Saudi Arabia), it is unlikely for us to be interested in the shrinking of the market that occurs after maturation at this point in time.

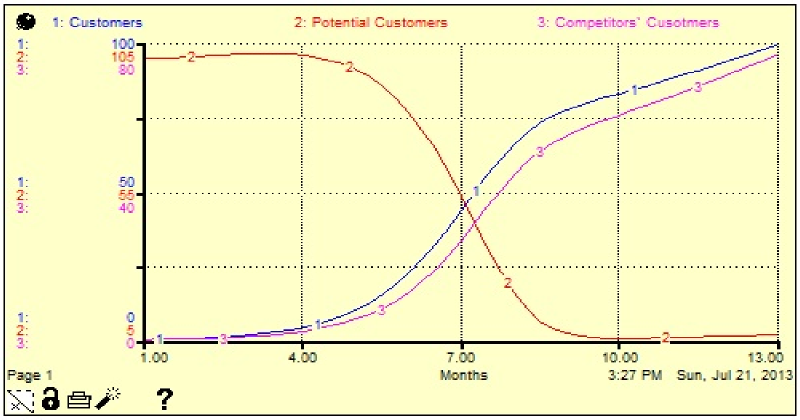


FIGURE 60: SIMULATION RESULT

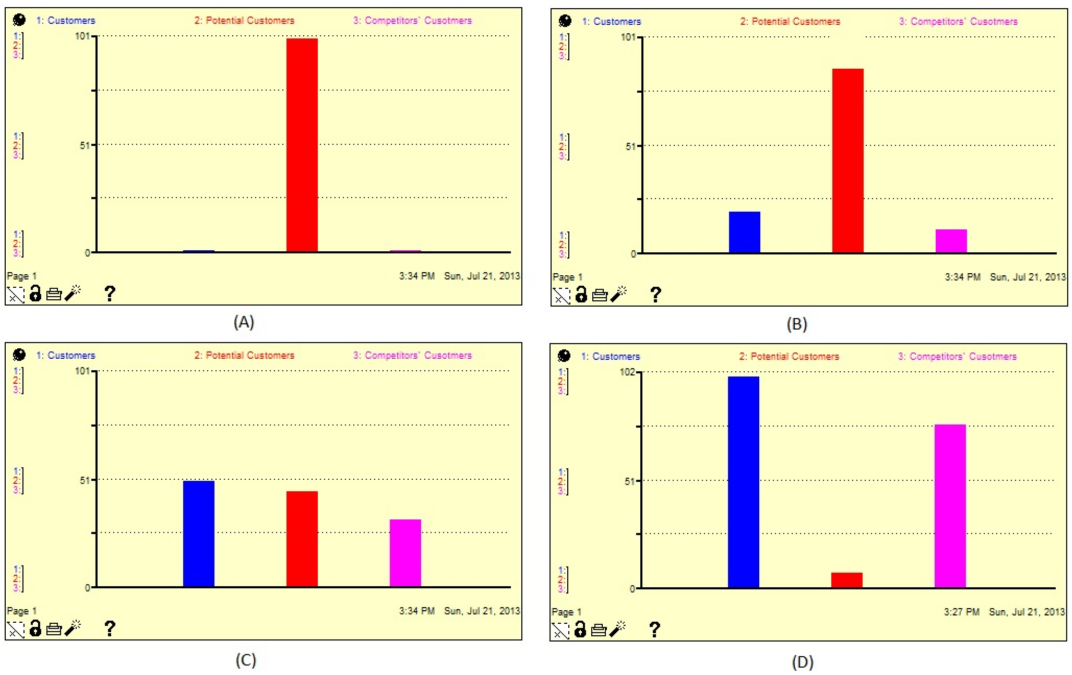


FIGURE 61: SIMULATION RESULT DURING TIME (BAR GRAPH)

7.2.3 Goal x Goal Matrix

A systematic approach to revealing goal correlations is to use matrices to ensure that all possible interactions are revealed and presented in Table 161, making the pattern of goal relationships clear. present this relation using four qualitative values of the goal correlation matrix, Break (--), Hurt (-), Support (+) and Make (++). Definitions of these relations are presented in (Appendix B).

In such circumstances where the hierarchy of the goals is based upon one tree, it is difficult to find conflicted goals in a 'break' setting; it is usually more likely for conflicts of interest to appear with complex organisational motivation design.

TABLE 161: GOAL CORRELATION MATRIX

	Goal 4	Goal 5	Goal 6	Goal 7	Goal 8	Goal 9	Goal 10	Goal 11	Goal 12	Goal 13	Goal 14	Goal 15	Goal 16
Goal 4		+	+			-							
Goal 5													
Goal 6													
Goal 7						-							
Goal 8											+		
Goal 9				-				-	-	-		-	
Goal 10						-							
Goal 11		+				-							
Goal 12		+	+			-							
Goal 13		+	+			-							
Goal 14		+	+		++		+						
Goal 15		+	+										
Goal 16	+	+	+				+					++	

7.2.4 Defining Terms and Vocabulary

This section represents the main terms in Techno-Logic; the section describes the business vocabulary and facts definitions used by Techno-Logic. Firstly, definitions of general business concepts (Table 162) and second section define specific HR department concepts in Table 163.

a) Business Terms

TABLE 162: TECHNO-LOGIC BUSINESS CONCEPTS

Term	Description	Status	Fact Statements
Risk	Exposure to the chance of loss; a hazard or dangerous chance of loss or experiencing a negative impact on business objectives.	**Under revision**	- Techno-Logic *has* Risk assessment - Each risk *has* mitigation plan. -Each risk *has* impact level/value
Customer	A person or company that purchases products or services from Techno-Logic	**Active**	-Techno-Logic *has* customer -Each Customer *has* ID, name and contact info. - Customers *buy* products or services
Strategy	Techno-Logic's set of plans as components of the Techno-Logic mission intended to achieve the goals, over a period of time.	**Under revision**	-strategy *is a component* of the plan for mission - strategy *determines* organisation unit - Strategy *valid* for 2 years
Employee, Staff	A person who is paid to work for an organisation or for another person	**Active**	Employee *has* identification number
Service	A value that Techno-Logic offers to its customer for an agreed fee	**Pending**	- Each service *has* service type - Each customer *is assigned to* at least one service - Each service must *have*

			catalogue *documents*
Market	The targeted economical and commercial area of Techno-Logic's services	**Under revision**	-Market *has* segmentations - Market must *have* analysis
Competitors	Companies that offer e-learning solutions and services to the same market served by Techno-Logic	**Active**	- Competitors *have* profile - Competitors must *have* analysis
Partners	A contributor of capital, services, products, training or any aspect of the Techno-Logic business model, usually sharing its risks and profits and gaining mutual benefit.	**Active**	- Partners *have* contact information - Partners must *have* value

b) HR-Specific Concepts

TABLE 163: TECHNO-LOGIC HR SPECIFIC BUSINESS CONCEPTS

Term	Description	Status	Fact Statements
Recruitment	The process of hiring employees/staff to work for Techno-Logic	**Active**	-Recruitment *has* process -Recruitment *is for* vacancy
Interviewer	A Techno-Logic staff member who asks questions during an interview	**Active**	Interviewer *responsible for* evaluation Interviewers *has* assessment criteria Interviewers *are related to* opening position
Interview	A meeting in which the Interviewer asks questions to see if the applicant is suitable for a job	**Active**	-Interview *made for* applicants -Interview *made by* interviewer -Interview *has a* result
Applicant	A person who formally applies for a job vacancy at Techno-	**Active**	-Applicant *apply for* vacant

	Logic		**position** -**Applicant** ***interviewed by*** **interviewer** -**Applicant** **should** ***attend the*** **interview**

7.2.5 Process Model (Design Process)

To describe the business processes of Techno-Logic, in this section we provide examples of business processes that could be implemented as a recruitment process. Techno-Logic can decide which alternative process to implement based on the assessment criteria specified in Table 164 and with confirmation to the main objectives of the organisation.

TABLE 164: KPIS AND QUALITY FACTORS

Assessment Criteria	Implementation cost, implementation time, execution time, efficiency, maturity
Quality Factors	Accuracy, response time, integration time, automation level, reduction in human error

1) Process Design One

The following process (Figure 62) represents Alternative 1 of the design processes to fulfil the recruitment goal.

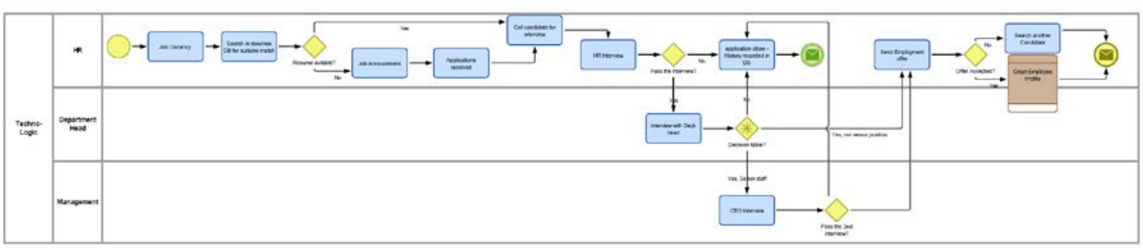


FIGURE 62: RECRUITMENT PROCESS (ALTERNATIVE 1)

TABLE 165: T-LOGIC RECRUITMENT PROCESS 1 PATTERN

Process Name	Recruitment Process 1
Goals	Deliver mature systematic recruitment process initiated and completed by HR department
Capabilities	- Store application in DB for future use - Several stages of assessment and interviews
Limitations	- Information systems cost - Long life cycle
Consequences	Implementation and fulfilment time-consuming
Suitable Implementation	Enterprise sized companies with huge number of applications and positions requiring very high skilled people.
Implementation Requirements	Work flow, database, interaction platform
Alternative Implementation	Staff take responsibility for advertising, screening applications, paying fees to service providers to manage and save applications for example on job websites

2) Process Design Two

The following process (Figure 63) represents Alternative 2 of the design processes to fulfil the recruitment goal.

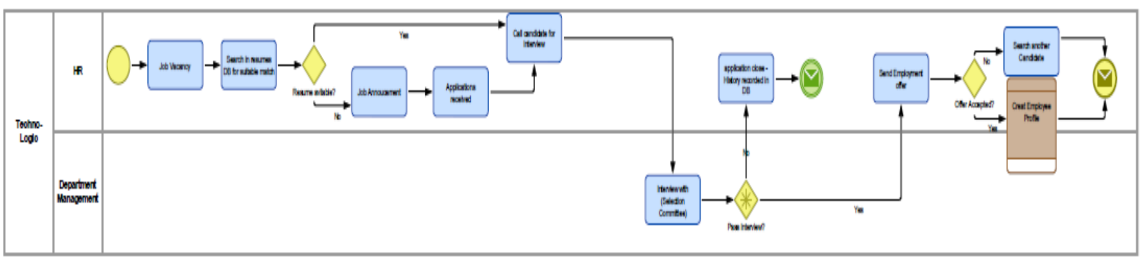


FIGURE 63: RECRUITMENT PROCESS (ALTERNATIVE 2)

TABLE 166: T-LOGIC RECRUITMENT PROCESS 2 PATTERN

Process Name	Recruitment Process 2
Goals	Deliver mature systematic recruitment process initiated and completed by HR department
Capabilities	- Reduce the interview and selection time, by only using one interview with a multiple member selection committee - decision made collaboratively

Limitations	- Not necessary to involve top management - In some cases, it is not enough to have one interview with the candidate
Consequences	Less top level governance
Suitable Implementation	Holding and shareholder companies, universities and federal independent entities.
Implementation Requirements	HR staff, database, work flow, communication platform
Alternative Implementation	Staff take responsibility for advertising, screening applications, fees to service providers to manage and save applications, for example on job websites

3) Process Design Three

The following process (Figure 64) represents Alternative 3 of the design processes to fulfil the recruitment goal.

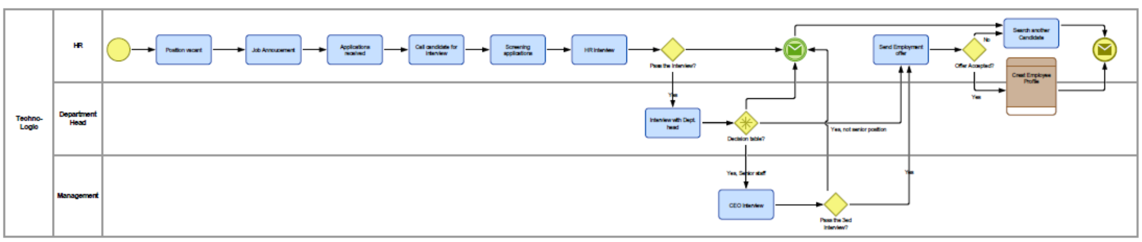


FIGURE 64: RECRUITMENT PROCESS (ALTERNATIVE 3)

TABLE 167: T-LOGIC RECRUITMENT PROCESS 3 PATTERN

Process Name	Recruitment Process 3
Goals	Deliver mature systematic recruitment process initiated and completed by HR department
Capabilities	No need for technology, lower implementation cost
Limitations	No storage of history and applications
Consequences	Losing applications and selection history of recruitment process
Suitable Implementation	Companies not willing to invest in IT
Implementation Requirements	Manual, newspaper advertisement, basic IS may be required, e.g. email
Alternative Implementation	If there is no HR team, any management level staff can take responsibility for the advertising, screening and selection

4) Process Design Four

The following process (Figure 65) represents Alternative 4 of the design processes to fulfil the recruitment goal.

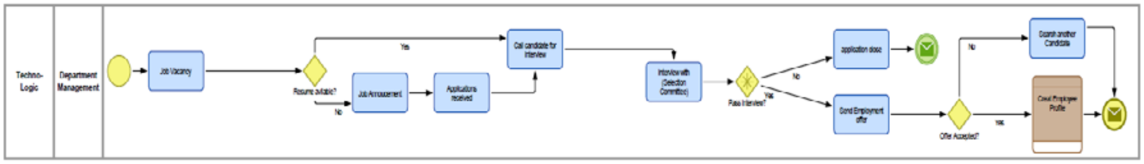


FIGURE 65: RECRUITMENT PROCESS (ALTERNATIVE 4)

TABLE 168: T-LOGIC RECRUITMENT PROCESS 4 PATTERN

Process Name	Recruitment Process 4
Goals	Ad-hoc systematic recruitment process initiated and completed by management
Capabilities	No need for technology, no HR staff, lower implementation cost
Limitations	No storage of history and applications, process is straightforward
Consequences	Losing applications and selection history of recruitment process; evaluation by non-specialists
Suitable Implementation	Companies not willing to invest in IT or in HR department
Implementation Requirements	Manual, newspaper advertisement, basic IS may be required, e.g. email
Alternative Implementation	Management level staff will take responsibility for advertising, screening and selection

7.2.6 Processes Assessment

Process X Criteria matrix

A scale from 1 "very low" to 5 "very high" is used in this assessment to evaluate and select among the alternative processes described in Table 169.

TABLE 169: PROCESS EVALUATION AND SELECTION CRITERIA

	Process One	Process Two	Process Three	Process Four
Cost	4	3	2	1
Implementation time	4	4	3	2
Execution time	3	2	3	2
Efficiency	4	4	2	2
Maturity	5	4	2	1
Sustainability	5	4	2	1

Techno-Logic decided to implement Process Design three to be assessed after a year for potential upgrading to Process Design two.

7.2.7 Rules, Constraints and Decision Model

The following Table 170 describes T-Logic business rules and decisions:

TABLE 170: BUSINESS ACTIVITIES RELATED RULES AND DECISIONS

<table>
<tr><th>Activity</th><th>Rules Related</th><th>Related Decisions</th></tr>
<tr><td>Activity 2</td><td>HR staff must search in the available database before using paid advertisement media</td><td>Screening available applications first, if not sufficient go to advertisement methods
<table>
<tr><th>Application available in DB?</th><th>Screening successful?</th><th>Application successful?</th><th>Advertisement needed?</th></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>No</td></tr>
<tr><td>Yes</td><td>No</td><td>-</td><td>Yes</td></tr>
<tr><td>Yes</td><td>Yes</td><td>No</td><td>Yes</td></tr>
<tr><td>No</td><td>-</td><td>-</td><td>Yes</td></tr>
</table></td></tr>
<tr><td>Activity 4</td><td>Each application can be submitted for only one position</td><td>N/A</td></tr>
<tr><td>Activity 4</td><td>Applicant can create more than one application for different positions</td><td>N/A</td></tr>
<tr><td>Activity 6, 7 and 8</td><td>The interviewer must use the assessment form to assess the applicant’s suitability for the position</td><td>N/A</td></tr>
<tr><td>Activity 6, 7 and 8</td><td>The applicant is considered unsuccessful if they fail in at least one of the scheduled interviews</td><td>
<table>
<tr><th>Pass HR interview?</th><th>Pass Dept. head interview?</th><th>Pass CEO interview?</th><th>Successful?</th></tr>
<tr><td>No</td><td>-</td><td>-</td><td>No</td></tr>
<tr><td>Yes</td><td>No</td><td>-</td><td>No</td></tr>
<tr><td>Yes</td><td>Yes</td><td>No</td><td>No</td></tr>
<tr><td>Yes</td><td>Yes</td><td>Yes</td><td>Yes</td></tr>
</table></td></tr>
<tr><td>Activity 10</td><td>Employment offer must state all employment conditions</td><td>N/A</td></tr>
<tr><td>Condition 5/Activity 11</td><td>HR staff must receive written offer acceptance letter from applicant before creating employee profile</td><td>N/A</td></tr>
</table>

7.2.8 Resource Allocation

To fully satisfy the processes, a number of resources are required, some human resources, and others information systems and financial resources.

Human Resources: An HR staff member is required to handle recruitment, employment, payment, holidays and other HR related responsibilities; this is highly necessary and suggested with the following specifications (Table 171):

TABLE 171: HUMAN RESOURCE STAFF ROLE SPECIFICATION

HR Staff	
Status	Operational
Education	BA in Business, management or social science related field
Role	Supportive and administration responsibilities related to staff recruitment, employment, development and maintaining records of employee related activities (training, payroll, misconduct), besides enforcing organisational policies and ensuring they are not violated.
Belonging assets	- One PC connected to the internet - Scanner and printer - Desk with stationery - Employee profile and payroll (folders and softcopy)
Authority	- Develops, advises on and implements policies relating to the effective use of Human Resources within the company - Accountable for daily HR services - Reports directly to CEO - Interprets and advises on employment legislation - Policies compliance and misconduct penalties
Responsibility	- Develops job descriptions, prepares advertisements, checks application forms and shortlists candidates for interview - Conducts initial interviews, assessments, makes recommendations - Provides new employees with all needed information - Continuously evaluates and improves recruitment process - Arranges required training

IT Resources: The table below (Table 172) shows the IT resources required to support the recruitment process:

TABLE 172: IT RESOURCE SPECIFICATIONS

IT resource	**Details**
Web Server	Server to publish online the website and employment site where applicants can search and apply for vacancies
SOA Platform (development and engine)	To develop services using SoaML specifications and then run the software services in BPEL execution flow.
Database	Database to store the data of the software applications and recruitment/applicant data

Financial Resources: The financial resources could vary depending on Techno-Logic's decision on both HR and IT resources: Hiring HR staff (level of experience, education, certificates); IT resources might need to hire a developer to develop the system, or might decide to outsource the development. The same applies to the platform, whether Techno-Logic is willing to buy IT resources (hardware and software), or outsource it and pay a monthly fee using cloud services. This option is currently suggested because of the limited size and resources of Techno-Logic.

7.2.8.1 Resource Assessment

Resource assessment has two stages: 1) Suitability assessment: before agreeing on resource specification, to assess the match with the requirements; 2) Sustainability/ long-term continuous assessment to see if the resource has achieved the goal and expectations. Examples of assessment criteria include:

a) Human Resources: willingness to learn, collaborative with team members, working under pressure and within limited deadlines
b) IT resources: scalability, sustainability, robustness, efficiency and security
c) Finance resources: Return On Investment (ROI), available liquidity and budgeting

7.2.9 Development and Implementation Model

Techno-Logic aims to reduce its expenses and spending during 2013. Most likely Process No. 1 is not suitable, as the automation and development required might increase the cost and time to execute. In case Techno-Logic decides to develop an automated process, the SOA platform is highly recommended. The following steps describe how to move from the business process model to the implementation model using SoaML (OMG, 2012) to build automated services to serve the business process activities. Note that Techno-Logic has no legacy applications, therefore the service development starts from scratch.

a) Define Use Cases

The use cases describe where the human agent needs to take action through the process (Table 173). Other activities not specified as use cases will be assumed to be automated.

TABLE 173: USE CASES

Use Case	Description
Search Resumes	The HR staff should be able to search resumes available in the system DB, including retrieving and viewing resumes
Advertise Vacancy	The HR staff should be able to change the status of the position to vacant, whereby the vacancy will appear publicly to all users to search and view
Apply for vacancy	The applicant should be able to apply for any open vacancy, including viewing the vacancies
Schedule Interview	HR staff should be able to schedule interviews and notify the parties
Update Status	HR staff need to update the status of the application (successful, unsuccessful, on hold, under review, etc.)
Send Offer	HR staff should be able to send employment offers to successful applicants and wait for / record the response (accepted, not accepted)

b) Develop Service

Developing the service using SoaML requires understanding of the functional and non-functional requirements that will be fulfilled by service participants. To do this, we first need to define the participants of the service delivery as shown in Figure 66.

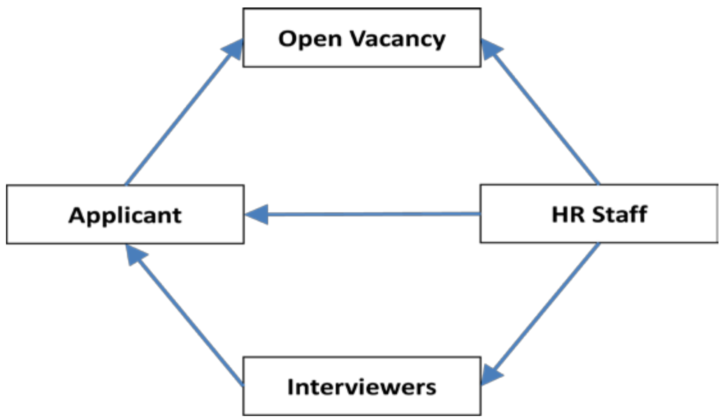


FIGURE 66: SERVICE PARTICIPANTS

Then we start developing the services using contracts among those participants as proposed (Figure 67) in the SoaML specifications (OMG, 2012).

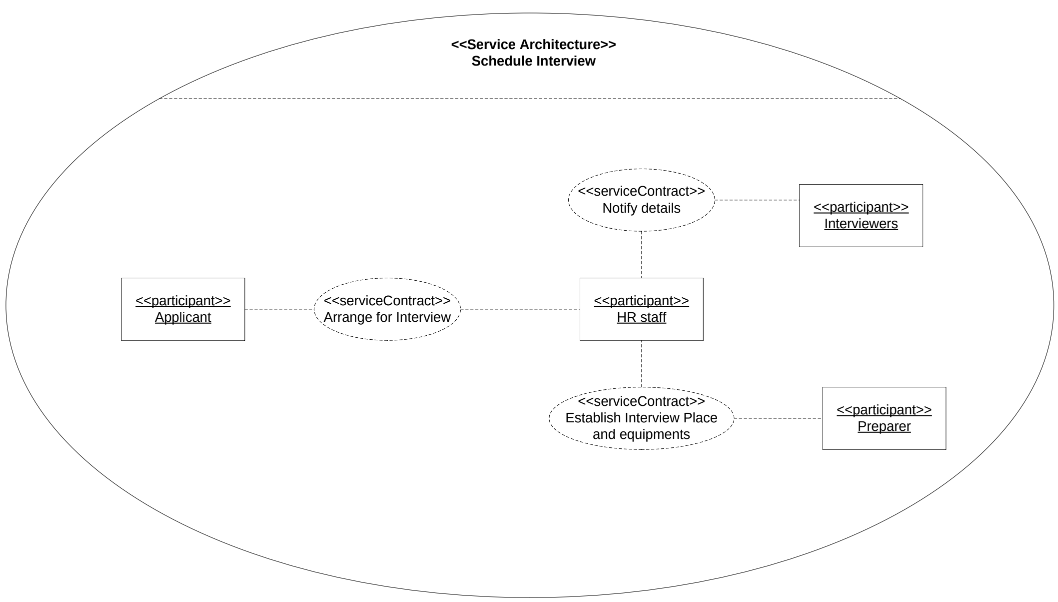


FIGURE 67: SCHEDULE FOR INTERVIEW SERVICE ARCHITECTURE

We build the service architecture, including contracts and participants. The service architecture contains the participants and a contract between them. This is a high-level service structure: it specifies the service without regard for realisation, capabilities or implementation. It describes how participants work together for a purpose by providing and using services expressed as service contracts. It is modelled as a UML collaboration, where the service contract is the specification of the agreement between providers and consumers of a service as to what information, products, assets, value and obligations will flow between them. Finally, a participant represents some party that provides and/or consumes services. Participants may represent people, organisations or systems. Figure 68 shows the participants of the scheduling interview service.

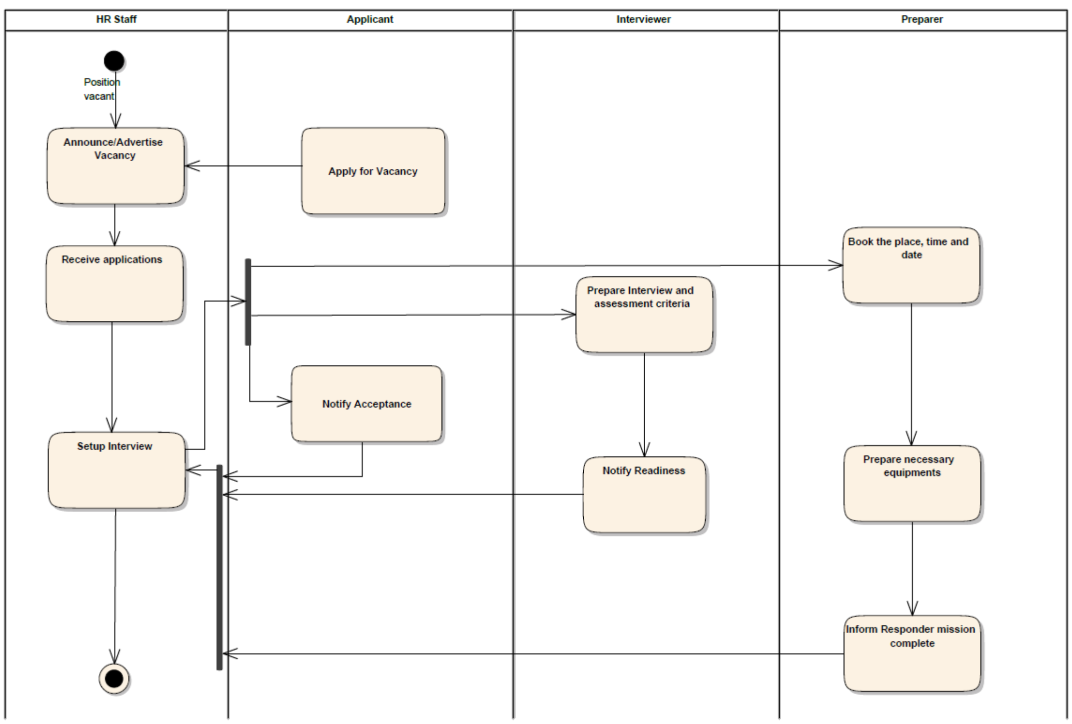


FIGURE 68: SERVICE ACTIVITIES MODEL

I have created an activity diagram to capture the interactions among the participants sequentially. It is assumed that the applicant initiates the process by locating a job application. The activities shown in the figure are software process activities, which are not equal to the business processes presented in the early stage of the modelling. Each participant in the activity diagram has a swimlane, which contains the actions carried out by that participant within the process. The overall behaviour emerges as an orchestration of the actions carried out by each of the participants. Interactions with participants must be consistent with the service contracts through which they interact.

After that, it is necessary to develop the contracts: Figure 69 is an example of developing the service contract between two participants (HR staff and Applicant).

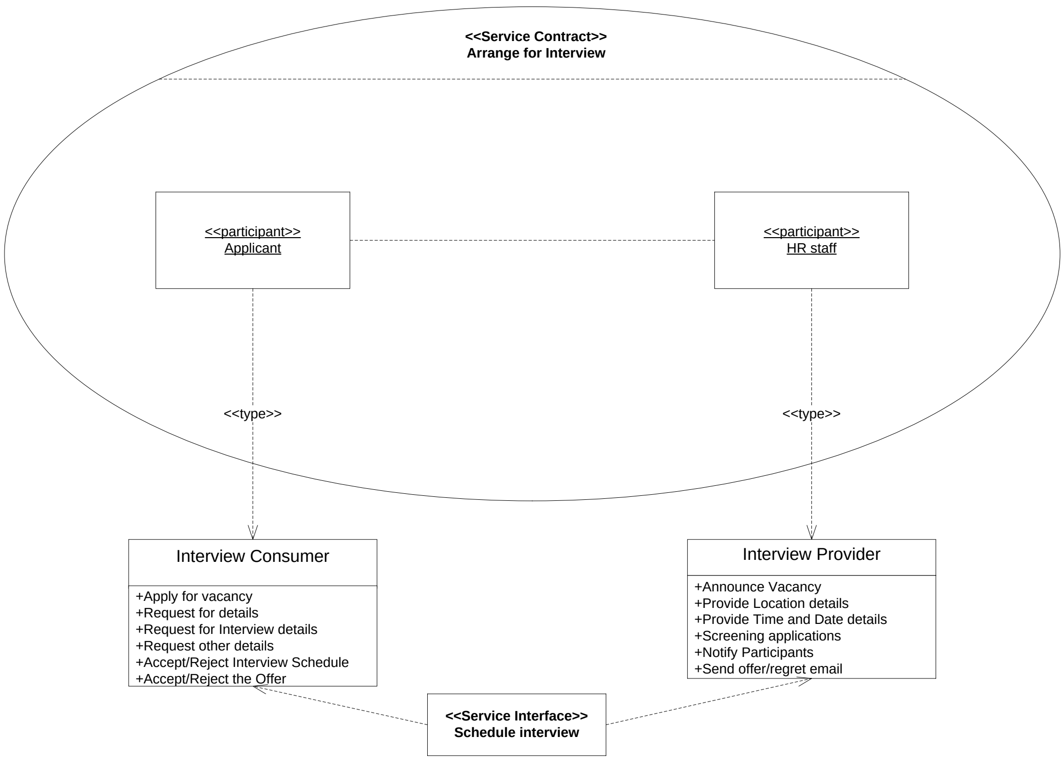


FIGURE 69: ARRANGEMENTS FOR INTERVIEW SERVICE INTERFACE

A service contract is the specification of the agreement between providers and consumers of a service to communicate information, resources, services and obligations between them. The service contract defines the roles to be played by consumers and providers of the service. Many service contracts have only two roles: a consumer and a provider. However, any number is permitted. The service contract also defines the connections across which roles may interact.

The operations used to pass messages to a role are collected into an interface for that role; a service interface defines the interface and responsibilities required for a participant to play a role in a service contract. This is the means for specifying how a participant behaves in order to provide or consume a service according to the contract, and can be modelled as a UML class. The service interface intends to use the interface of the consumer role and realises the interface of the provider role. Modelling the interaction between two participants in the contract is shown in Figure 70 below:

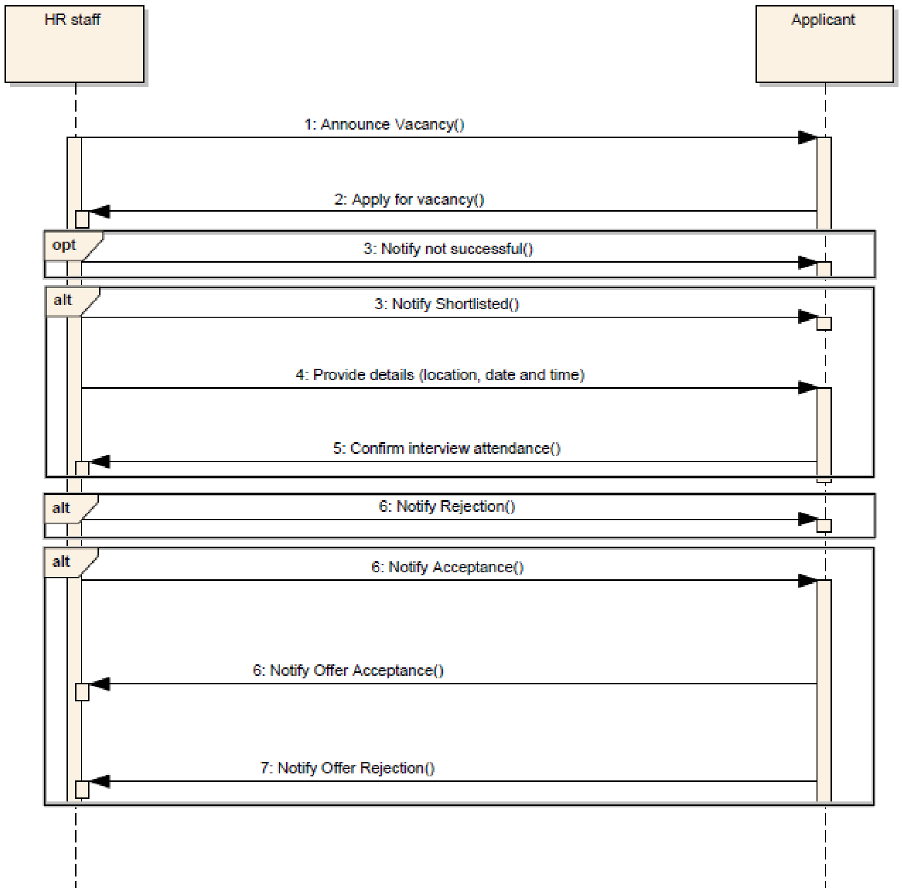


FIGURE 70: ARRANGEMENT FOR INTERVIEW INTERACTION

The behaviour of a service contract may also be modelled using other kinds of UML interaction model. It is modelled here as an interaction using a sequence diagram. Each role in the contract is given a lifeline which acts as the source and target for the sending of messages. Messages are modelled as being passed via calls to operations on the interfaces to the roles. Condition flows can be modelled using interaction fragment constructs within the sequence diagram.

Later on, we need to encapsulate the idea that the messages that are passed between roles in a service contract are specified using message types. Message types are modelled as UML classes and shown in Figure 71.

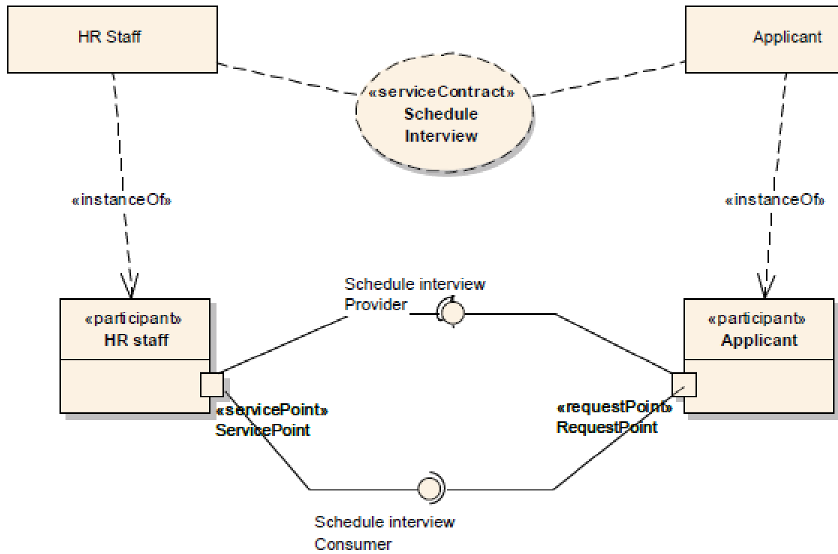


FIGURE 71: ARRANGEMENT FOR INTERVIEW SERVICE USAGE

Participation in a service contract requires the participant type have a port with the corresponding service interface. A port is a connection point for providing or consuming services. The relative interface dependencies of the request point and service point ‘fit together’ to allow a legal connection between the service consumer and provider.

Later, a request point is a port for requesting (consuming) a service. The required interfaces are reversed at a request point. The port requires the provider interface and provides the consumer interface; the relative interface dependencies of the request point and service point ‘fit together’ to allow a legal connection between the service consumer and provider as described in Figure 71. The following are the two types of access point:

- A request point is a port for requesting (consuming) a service. Note that the logic of provided and required interfaces is reversed at a request point: the port requires the provider interface and provides the consumer interface.
- A service point is a port for providing a service. The port provides the provider interfaces and requires the consumer interface. The use of a service contract is modelled as a UML collaboration use.

The full specification of a participant includes ports for every service contract in which the participant participates within the service architecture, which is presented in this model.

7.2.10 Operation and Management

The case study could not offer the possibility to implement, manage and monitor the developed specifications for several reasons, the main reason being that the development falls outside the agreed scope of this thesis, and secondly the timeframe required to undertake this is quite long combined with the design time. However, theoretically on the IS side, the framework suggests the essential information systems required for efficient business operation management and monitoring with suitable agility required to handle changes in the environment. From the research point of view, the development will be based on modern approaches to managing information systems through Model Driven Architecture (MDA) and Service Oriented Architecture (SOA), methods presented in much of the research (Meijler et al., 2006; Vidales et al., 2008; Kim, 2008; Radhakrishnan and Wookey, 2004; Jardim-Goncalves et al., 2006). Research efforts have been made in the area of Model Driven Architecture (MDA) (OMG, 2003). MDA lies in the area of Model Driven Engineering (MDE), and the main objective of MDA is to move information system development and design principles towards model abstraction and transformation, where models can be transferred horizontally and vertically. MDA has the ability to model environment, business and IS artefacts, which improves the interoperability, alignment, and traceability of the entire system, while SOA can offer standard system integration, loosely coupled components and simplified process orchestration. After implementation, system monitoring and adaptation is required to ensure a high level of stability. Some products have tools related to system health checking and activity monitoring, for example some COTS systems (IBM, 2008; Oracle, 2006). The goal is to keep the system under control and provide the management with the required insight to improve the operational work and risk assessment/mitigation. The adaptation will be conducted in two ways: automatic adaptation, as in a multi-agent system changing the low-level rules to conform with the high-level rules to match organisational goals, and even the management system triggers some actions in the face of changes in environment, knowledge or stakeholders activities. In other cases, it could be manually adapted, to reconfigure the system or conform to new requirements that arise from performing the previous steps. At this stage, we should be able to answer the following:

a) Do any new requirements need to be considered?
b) Are there any threats, weaknesses or gaps to cover?
c) Is there any change in current requirements, objectives or organisational goals?

The suggested model separates the essential business systems to increase the agility, and the rule engine is separated from the processes, as well as the event management. Such as structure allows usability and flexibility to change with no need to change the whole architecture. Activity monitoring systems and decision support systems will offer continuous system health and checking mechanisms to monitor the activities and support decision-making, as shown in Figure 72.

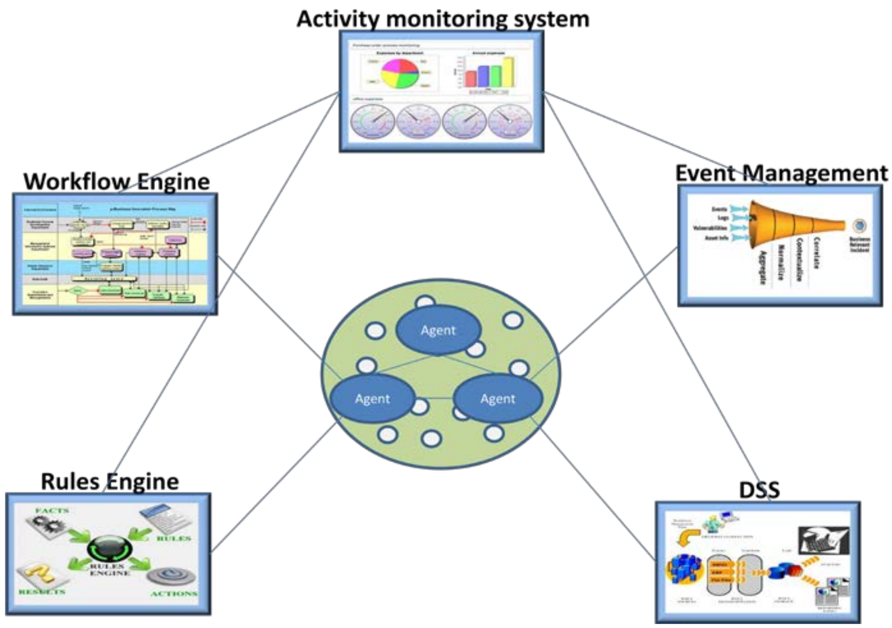


FIGURE 72: OPERATION AND ADAPTATION

7.3 Reflection and Conclusion

In this case study, a candidate future 'to be' business model has been developed and evaluated based on the Techno-Logic shareholders' business objectives. Lightweight RDBMM implementation have been presented for SME company in short period in comparison to usual EA projects time. The dynamic simulation model in this case study offer basis for future development and understanding of the factors that influence Techno-Logic performance. The alignment of business and IT were possible using RDBMM framework. The main contribution of this chapter is presented as the following:

1) Adapting the RDBMM to develop the enterprise models of a newly established SME, Techno-Logic
2) The goal model represents the goal hierarchy and goal decomposition that conforms to the BMM classification
3) The BMM allowed strategic evaluation and assessment to take place. Assessment was completed of the business model components and impact of internal/external influencer factors using:
   a. Design rationale method for reasoning and sense-making

b. System dynamic modelling to improve insight into market impact factors

4) Developing business rules and business constraints to which the business operations should conform.
5) Aligning business processes and business activities to the business motivation model
6) Evaluating different business scenarios and making decisions regarding suitable alternatives
7) Developing SoaML components for software design to fulfil the use cases in the business processes

Figure 73 shows the Techno-Logic enterprise maturity assessment performed by the author after applying the RDBMM framework. Comparison of the results of the Info2cell case with those from the Techno-Logic case identifies commonalities and differences. These observations are discussed in Chapter 8, as part of an overall research review of this thesis; lessons learned regarding the implication of the RDBMM framework in the Techno-Logic implementation are discussed.

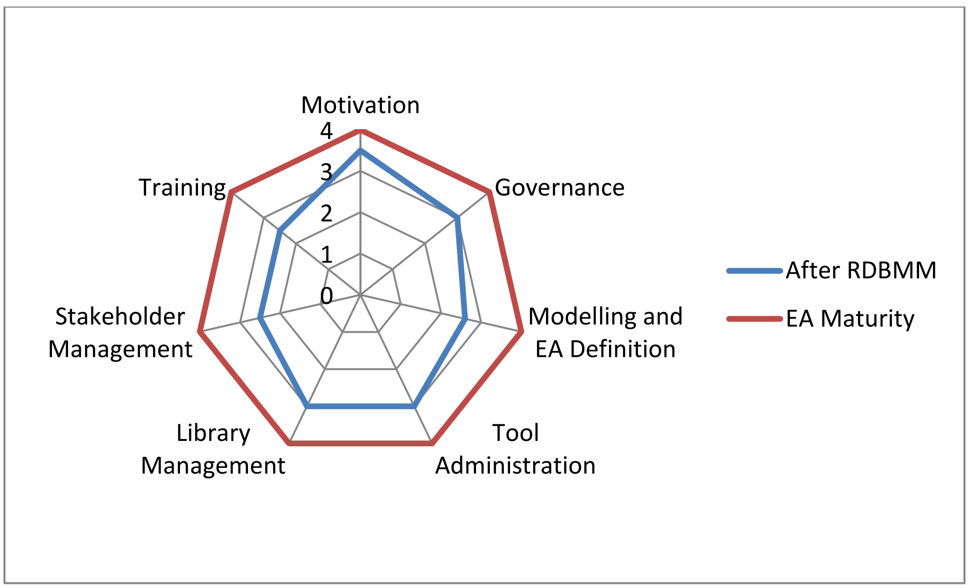


FIGURE 73: TECHNO-LOGIC EA MATURITY AFTER RDBMM

Chapter Eight: Evaluation of RDBMM and its Applications

This chapter analyses and evaluates the research framework and the industrial case studies presented in this thesis. Chapter 5, the framework, and Chapters 6 and 7, the case studies, have already contributed in building, analysing and testing the RDBMM. This chapter reviews the two applications, the Info2cell and T-logic case studies, undertaking an analysis of the results, and comparing and contrasting the two case studies. This chapter also discusses the trustworthiness of the academic practices applied in both case studies. In addition, it considers the industrial perspective of the evaluation with the aims of determining the usefulness, comprehensiveness, ease of use and limitations of the framework, and examining managerial perceptions of whether these changes produce improved performance, insight and improved staff perceptions about enterprise visibility, in order to stress the academic viability of this research. Finally, the future scope of the framework is presented and discussed.

8.1 RDBMM Evaluation Roadmap

Several design science evaluation methods were discussed in Hevner et al. (2004) and Wieringa (2010). A combination of selected methods used in this research conforms with the suggested methods for design science research (discussed in Table 174). The authors choose methods by which the framework can represent real life cases with their special circumstances in order to evaluate the framework. This is because we found it appropriate to evaluate the RDBMM framework in settings in which the researcher is actively and passively involved (for instance, interviews and discussions with stakeholders in the workplace to explain the objectives of the research and to understand from them the nature, issues, tasks and responsibilities of their work). Thus, Table 174 shows the selected methods include the evaluating structure and behaviour of the framework (i.e. an experiment method), observational methods through case studies and asking stakeholder opinions, descriptive and analytical evaluation on how the artefacts were used and will be used in the future RDBMM framework. Key aspects of these methods are shown in the shaded rows of Table 174.

TABLE 174: DESIGN RESEARCH EVALUATION METHODS

Type of design evaluation method (Hevner et al., 2004; Wieringa, 2010)	Key aspects of the design evaluation method (Wieringa, 2010; Hevner et al., 2004)
Experiment methods (controlled experiments, simulations with artificial data)	
Field experiment	Others use the framework in the field, under controlled conditions, to achieve goals set by the researcher, in order to produce justification that the framework will produce the desired effect
Lab demo	Prototype exercised by researcher on a realistic example in an artificial environment or technique used by researcher on a realistic example in an artificial environment to show that the framework can produce the desired effects
Lab experiment	Others use the framework in artificial, controlled conditions to achieve goals set by the researcher in order to produce justification that the framework will produce the desired effect
Observational methods (case study, field study)	
Case study	Others use the framework in the field to achieve the project goals to show that the framework has produced the desired effects
Action research	Researcher uses the framework in the field to achieve project goals and to acquire knowledge to show that the framework can be used in practice to help others
Pilot project	Others use the framework in the field to provide data to the researcher
Field demo	Researchers use the designed framework in the field and demonstrate that the framework is usable in practice
Opinion	Researcher asks stakeholders if the framework could be useful and also asks them to provide information about possible support for the framework
Descriptive methods (informed argument, scenarios)	
Benchmarking	Researcher uses the designed framework on a standard example in an artificial setting, and compares the framework with other existing frameworks
Illustration	A small example to explain the framework in order to allow the reader to understand the framework and how it works
Testing methods (functional testing, structural testing)	
Analytical methods (static analysis, architecture analysis, optimisation, dynamic analysis)	

Figure 74 shows the roadmap that was taken in this research to evaluate the RDBMM framework using the selected methods. The boxes in Figure 74 represent specific step in the RDBMM evaluation roadmap: the solid arrows represent connections between steps to imply the order of steps in the roadmap, and the dashed arrows represent information exchange between the development of the framework in the roadmap and the repository symbol (which represents the existing related literature and the experience gained from the exploratory case study). The roadmap shown in Figure 74 was found to be an economical and timely way of evaluating the RDBMM framework. Step 1 shows the early assessment of the framework which was undertaken between the researcher and the research advisors: this iterative process was used throughout the construction of the framework, sketching small examples for each particular developed construct. Besides the evaluation methods adopted from design science evaluation (Table 174), to ensure conformity with business school research themes (social science research) the author adopted more steps to evaluate the framework from a philosophical and methodological stance, also to ensure the rigour of the case studies practices, internal validation was used through analysing findings in cross-case comparisons; and finally to discuss the limitations and propose improvements for a future RDBMM framework. As shown in Figure 74, the first three steps have been addressed in Chapters 5, 6 and 7. The later steps will be discussed in this chapter.

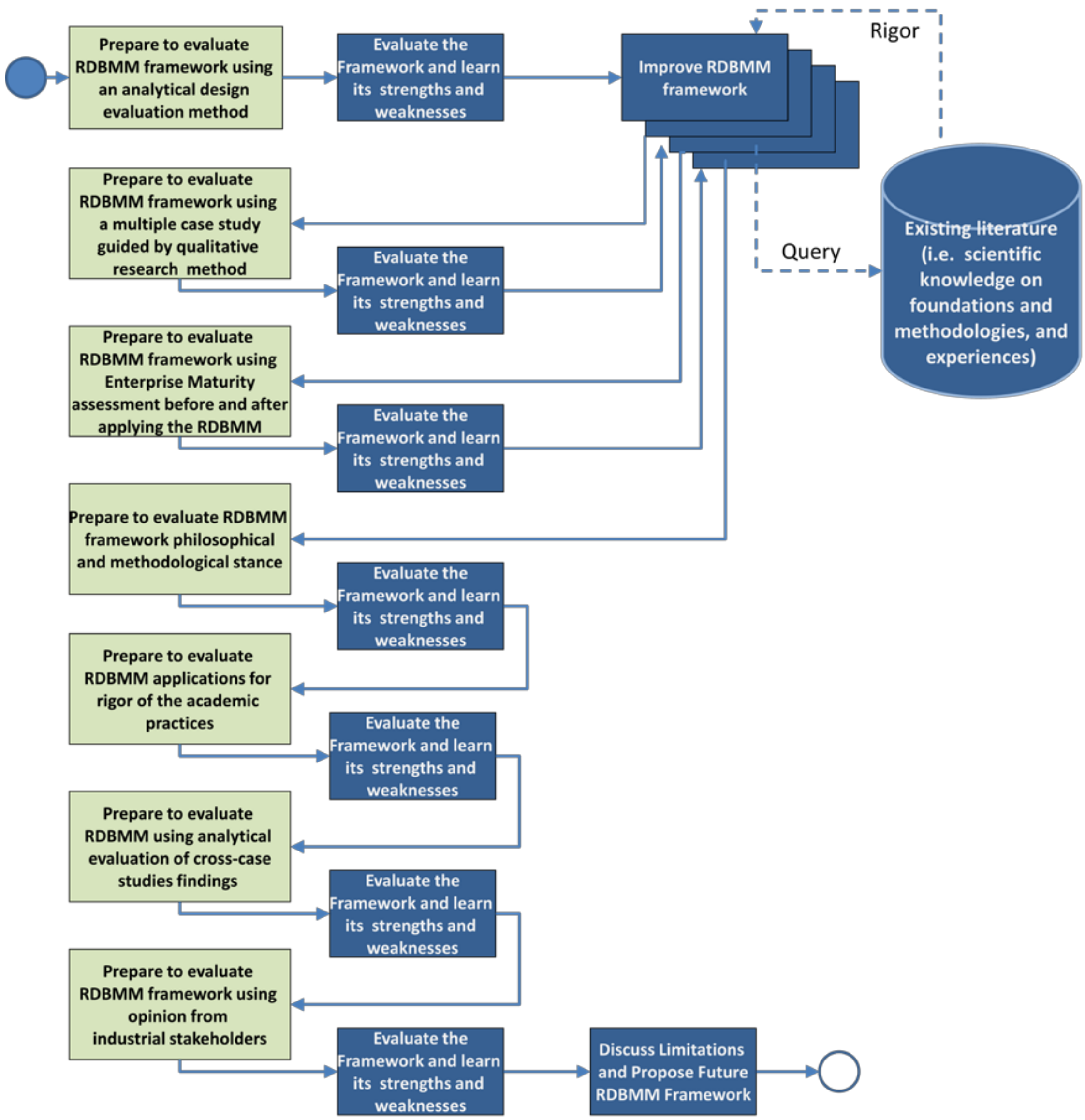


FIGURE 74: ROADMAP FOR EVALUATING RDBMM FRAMEWORK

8.2 Evaluation of RDBMM's Methodological and Philosophical Stance

Niehaves (2007) argued that behavioural science research and design science research are two complementary parts of the IS research cycle. Obtaining knowledge about information systems that are necessarily employed in an organisational context requires the adoption of both research paradigms. The RDBMM was built on a mixture of theories, and enterprise modelling can take on objectivist and subjectivist views, which are represented in enterprise motivation and stakeholder viewpoints about enterprise knowledge. It can be objectivist in terms of the structure and models that need to be fulfilled and addressed using quantitative data, and subjectivist in terms of understanding and filling this structure by understanding people's concerns and perceptions in depth. The representation of collected knowledge takes several forms, from the formal textual form in SBVR to the symbolic forms in the KAOS, BPMN, SOMAL and UML models. The system dynamic modelling method is based on the objective and subjective views and the design rationale helps to socially construct the arguments about the design. This subjective view is linked to an extent to social relativism, and ultimately, the interpretivism view of interpreting reality through formal models that encourage thinking and sense-making: this also truly informs the other analysis and design models. Reality has different phases and ultimately it is embedded in the socio-technical system setting, however socio-technical, enterprise and information system design also have strong roots in design science and can take on the positivist or the interpretivism paradigms. Nevertheless, as stated before, the research has emphasised interpretivism to construct knowledge socially and subjectively, while adopting the positivist viewpoint may result in failure to understand the context and issues of each particular case. The design science methodology for information systems research helps to combine multiple paradigms in one study, such as theorising in DSRIS and the case study approach. Adopting several analysis tools and mechanisms offer more capabilities for combining such research paradigms towards achieving a comprehensive and effective socio-technical system analysis and design framework. For instance, the tools combine quantitative analysis based on stock and flow diagrams in system dynamics modelling and qualitative analysis in design rationale modelling. Therefore, in socio-technical systems, in order to analyse the social aspects effectively and bring social understanding to technical development, an interpretivist approach which is subjectively directed is extremely important for fusing aspects of socio-technical systems. This all made design science in IS research is sound ontology (Iivari, 2007).

8.3 RDBMM Industrial Applications: Overview

8.3.1 Info2cell Case Study

In the Info2cell case study, semi-structured interviews were used to identify the social issues, and were processed through a narrative-based analysis. This case has successfully analysed social aspects as part of the holistic socio-technical modelling effort. This added academic value in combining the social aspects with enterprise modelling for socio-technical system analysis and design. Dynamic modelling was presented in this case study, where the dynamics of revenue and customers changes during time were presented to offer more insight about future status and aid strategy design. Using the design rationale, the RDBMM delivered several argument visualisation structures in this case study, which are considered as a pre-step to the design decision to make sure that the decision-makers adopt the most suitable choice. These models can also be shareable in the case of the decision-making team, to support collaborative teamwork. However, since most of the enterprise architecture and socio-technical systems approaches focus on a narrow scope of influencers, this case study presented a variety range of external influencer considerations such as political, economical, regional, operational and other value-stream stakeholders. SBVR controlled natural language was used in this case study to share common understanding between stakeholders and to reduce the possibility of misinterpretation of business concepts and requirements. Finally, the complexity of the business and technical issues were reduced by separating concerns into a set of views/models that focus on specific enterprise knowledge using different modelling mechanisms. This case tried to align social aspects to the strategy and tactics.

8.3.2 Techno-Logic Case Study

T-Logic is a small start-up firm, and applying the RDBMM framework in this case helped to explore a short implementation life cycle. In the T-Logic case study, an example set of designed processes was produced, which can offer an optimised version of the current process based on a set of pre-defined criteria: decision-makers will decide which process is more suitable and meets the enterprise requirements and capabilities using the evaluation criteria. This feature is considered as one advantage of the RDBMM framework for optimising and re-engineering enterprises. This case study aligned the information system development using SoaML with the operational level. Reasoning using design rationale models was presented as reasoning about market, products and resources of T-Logic to support strategic decision-making. System dynamics models were presented to model the market performance of T-Logic, comparing it to the average competitor based on a set of pre-defined criteria, some actual and others expected. Risk analyses were presented, especially those related to market, operational, competitors and strategic goal conflicts. In this case study, SBVR controlled natural language was used to share common understanding between stakeholders and to reduce the possibility of misinterpretation of business concepts and requirements. Overall, the complexity of the design was reduced by separating out the analysis concerns using the suggested modelling mechanisms in the RDBMM framework.

8.4 Assessing the Rigor of the Practical Application of RDBMM: A Critical Evaluation of the Quality of the Case Studies

Based on Lincoln and Dezin (2008) and Wisker (2007) we will proceed to use the criteria of truthfulness and authenticity to evaluate the practical application of the RDBMM, examining its rigor and quality in terms of trustworthiness and authenticity criteria, as follows:

- All 'row data' are available for referential adequacy: this thesis includes appendices of the interviews undertaken, questionnaires and case studies and stakeholder issue analysis. Other sources of documentation and archival records are available. Besides this, the author undertook some direct observations and ad hoc meetings. Names and identifiable references to persons have been hidden for data protection. All may be available upon request as long as the request meets the university regulations.
- Useful feedback was obtained for checking and evaluating the data. The subjective nature of the research made it difficult for the manager to confirm the validity: they mentioned that at least 70% of the data were true from their point of view, and they agreed on the importance of the RDBMM framework in enterprise analysis, design and development.
- In the case studies, the transferability requirements are met by explaining the nature of the work and the deliverables to the stakeholders before starting the case study activities: later the data (the complete analysis based on the RDBMM framework) was handed to the managers in both case studies for evaluation purposes.
- Process and methodological notes are included throughout the thesis; however, the case studies in Chapters 6 and 7 include both data reductions and analysis. Moreover, they include data reconstruction and synthesis artefacts.
- Two polar or opposite case studies were used (Eisenhardt 1989, Miles and Huberman, 1994), which is a form of extreme case sampling technique (Creswell 2004, Patton 2002). Efforts to achieve fairness were pursued during the data collection and analysis stages, where care was taken to make sure that the interviewees included members of

the different groups or segments within the organisation for each case study. The interviews were undertaken with stakeholders from different departments and different levels to maximise the fairness as much as possible.

8.5 Findings and Comparison of the Case Study Applications

The BMM was initially evaluated based upon the capabilities and limitations of the socio-technical system approaches identified in an exploratory literature review. This analysis, in addition to the exploratory case study, helped to identify the requirements of socio-technical systems in the 21st century and therefore to develop the RDBMM framework. The enterprise model acts as a 'knowledge repository' in the form of graphical and textual formats. It was designed to facilitate knowledge capture in the form of a systematic approach involving case-specific processing requirements and information needs, including the explicit definition of the interactions among the artefacts of the specific environment in which the socio-technical system exists. The simulation models of the revenue influencers involved in the Info2cell case study quantified the dynamic aspects in terms of the behaviour of the money flow. This facilitated decision-making regarding the new policy of content owners, the policy of mobile operators and changes in customer demand. The Info2cell case has shown benefits in terms of insight, business forecasting and enterprise alignment maturity when Info2cell applied the RDBMM. Hence, this case application proved to be a useful learning resource for the implementation of the RDBMM.

The application of RDBMM in the T-Logic case furthered an understanding of the market forces and justified the decisions made regarding the services, products, partners, employment and IT system development according to the company's capabilities and objectives. During this case study, the RDBMM was focused on the setup motivation model and refining the goals. Later, the model offered reasoning on the goal choices and decisions. The Design Rationale modelling improved the understanding of the impacts of change in a complex market and therefore helped in designing a dynamic model simulation and building suitable business activities.

The application of RDBMM by T-Logic demonstrated its significant role in enabling decision-making in the socio-technical system modelling. The combination of enterprise models, design rationale models and system dynamic simulation models was key, as they played complementary roles in order to enable strategic planning and decision-making on business practices by using the proposed RDBMM framework in the T-Logic case study.

The knowledge gained through the Info2cell case was applied during the application of RDBMM in the T-Logic case. It made it possible to identify the analysis and design skills needed to increase the maturity of the enterprise business activities. Using the hybrid framework of the enterprise model, reasoning model and system dynamic simulation model helped to better design systems for current and future enterprises, resulting in the application of the RDBMM in both case studies. This proved useful in:

- Understanding the complex as-is situations of the Info2cell business
- Analytically designing strategic planning and an enterprise model for Info2cell
- Providing useful insights into Info2cell's organisational issues and T-Logic's marketing analysis: this helped in decision-making during the analytical design of the socio-technical aspects
- Classifying goals according to their level of operational abstraction and alignment to associated processes and dimensional features
- Assessing the future process design of the T-Logic recruitment system through the use of a set of KPIs
- Compiling a capacity plan and conflict plan (capability matrix, goal matrix, resource matrix and process matrix)
- Developing to-be activities of T-Logic, which are assessed, justified and aligned to drive IT architecture using SoaML for service-oriented architecture development, followed by suggested components to manage and operate and monitor business activities and their applications

Table 175 shows comparison between the both case studies where RDBMM were implemented with different settings.

TABLE 175: CROSS-CASE COMPARISON OF RDBMM'S INDUSTRIAL APPLICATIONS BASED ON OBSERVATIONS AND RESULTS OF THE INFO2CELL AND T-LOGIC CASE STUDIES

Context	Info2cell	T-Logic
Time Frame	16 weeks (including two weeks of intensive meetings)	10 weeks (including one week of intensive meetings)
Problem Domain	Value-added services firm looking to improve operational, collaborative and innovative work	E-learning services providers, looking to setup new strategy and business structure to enter the market
Approach	'as-is' structured modelling	'to-be' agile life cycle approach
Focus	Organisational issues	Market issues
Data Collection	Semi-structured interviews Document analysis Some observation	Semi-structured interviews Document analysis Follow-up calls
Outcomes	Longer-term modelling to cover 'as-is' models RDBMM is applicable, however, to fully help the organisation, RDBMM needs to be integrated into organisational practices to improve leadership, communication, initiative and an innovative culture	Shorter modelling lifecycle RDBMM helped to develop strategic models focusing on the market and organisational establishment Detailed data about market, technology and partners required to make decisions and implement business execution

The reason for selecting the two case studies was to use two companies that were polar opposites in terms of their characteristics. The availability and willingness of the companies to contribute to this study was the main guide for the selection. One of the important outcomes of this study was realising that 'as-is' architecture is not always performed as it is documented to perform: this causes the organisation to have two different 'as-is' architectures, the actual 'as-is' and the documented 'as-is', and the difference between these can be recognised as a gap between the plan and practice. Moreover, the design of 'to-be' architecture should also consider what 'it might be' under specific circumstances: simulation, and reasoning help to justify choices and understand exceptional scenarios, RDBMM helped identifying the gap between the current state of the enterprise as documented, and the current state as performed, and also helped to identify the enterprise's future state as a target, and the possible states expected to emerge (Figure 75).

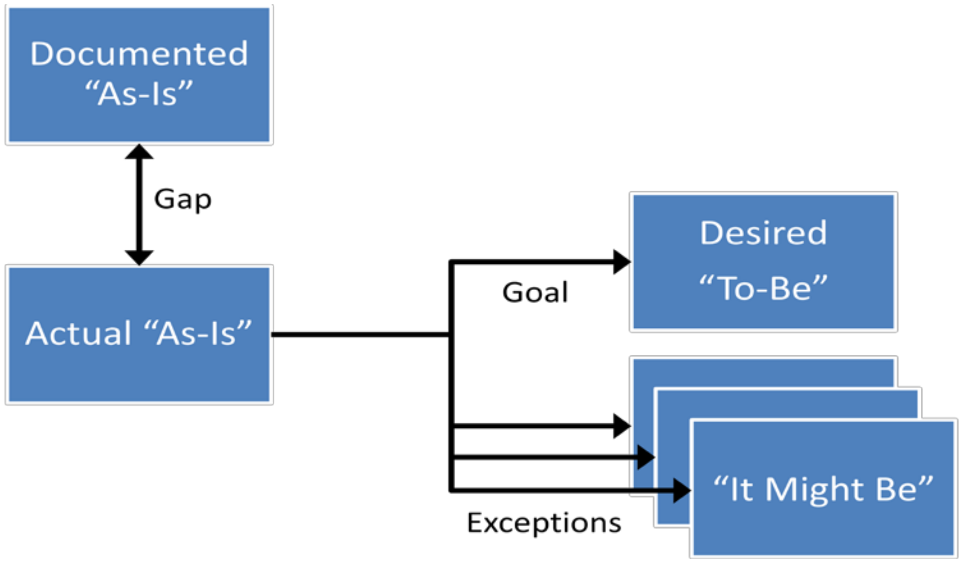


FIGURE 75: ENTERPRISE MODEL STATUS

Analysing social aspects relies more on the analyst's experience in mining the issues that most frequently influence enterprise performance. The recognised social aspects in both case studies are: trust, communication (collaboration and coordination), relations, culture, innovation, satisfaction, personal motivation, language, norms and values, competition, bias. One of the important issues that should be considered is that both case studies are companies from the Middle East (ME), where the culture, management and communication style are different from other places in the world. It was noticed that the communication between employees and middle managers is less formal. This might vary across countries in the area. Country and organisational culture is a factor that obviously influences the organisational work, and therefore the implementation of technology. People from ME are more likely to express their emotions more freely during communications with each other's. In addition, there is a noticeable lack of research and development (R&D) in the ME, which obviously influences the pioneering and innovative aspects of the work culture. Lessons have to be learnt from emerged and developed countries in order to create success. The suggested RDBMM can offer insight into these issues by helping to build a proper enterprise model, highlighting enterprise options and alternatives and visualising decision-making in addition to forecasting using dynamic simulation models. Some enterprises consider technology as a strategy, where part of or the complete business model relies on technology and technology innovation, as in the Info2cell case study, and some other companies use technology heavily in their business activities to support the primary processes of communication, analysis and reporting. Finally, there are enterprises where technology has minimum involvement, mainly in office applications, emails and supporting data sheets, as in the T-logic case study, where this is due to the limited number of employees, which was also reflected in the manager's decision in choosing among the designed processes. Enterprises need to build their own IT/IS identity, they are usually aware of their competitors' technical capabilities, and usually try to adopt something similar, otherwise the enterprise will completely lose its ability to compete in the marketplace. RDBMM offer the necessary agility required for business activities and IS development. The following Table 176 summarises the findings of the case studies and the proposed RDBMM strategy.

TABLE 176: COMPARISON OF CASE STUDIES

Case Study	Existing enterprise model	Findings	Proposed Strategy
Info2cell	Established plan, improvement on-going and process models exist	No visibility of organisational behaviour Innovation process works slowly	Build enterprise model 'as-is' Reasoning required Needs forecasting Analysis of organisation and potential strategic directions
T-Logic	Visionary plan	Unstructured planning Little insight No market analysis	Build enterprise model 'to-be' Reasoning required Needs forecasting Market and strategic direction analysis required

Looking into the original issues which the research aimed to investigate, the issues appearing in the case studies from the perspectives of Dynamics, Complexity, Uncertainty and Reasoning can be summarised as in following Table 177:

TABLE 177: FINDING CLASSIFIED ACCORDING TO THE PROBLEM ORIGIN

Case	Dynamics	Complexity	Uncertainty	Reasoning
Info2cell	Daily activities are very dynamic, resulting from customer requirements	Enterprise complexity is considered to be medium; innovation and development tasks are considered to be the most complex matters in Info2cell	Uncertainty results from changing technology and market trends, some related to political and economic factors in the ME region	Reasoning for designing business activities has been used in the case study; no formal techniques were used before
T-Logic	Market size (volume of customers and competitors)	Complexity comes from handling large customer requirements, besides managing the supply chain process	Uncertainty mostly emerges from technology change and brand recognition, customer acceptance	Reasoning used for strategic decisions related to market, technology and partners

Moreover, the consideration of a wider risk scope led to enterprise maturity increasing: one weaknesses of the wider consideration of external influencers is represented in the cost of time of the analysis: enterprises need to decide the value of investing in increasing enterprise maturity and risk assessment. A set of influencing factors has been recognised in both case studies. The factors described in the Table 178 below can be tested or re-considered in other scenarios in order to understand the impact of these factors in different contexts.

TABLE 178: INFLUENCING FACTORS DISCOVERED IN THE CASE STUDIES

The Factor	Type	Case Study	Opportunity/ Threat
Legal compliance factors	External/Country regulations	Info2cell T-Logic	Threat: breaking the country's law may cost the company penalties, damage its reputation or completely prevent it from operating in the country.
Competition factors	External/Industrial	Info2cell T-Logic	Threat: in the open market, competition is increasing, company needs to maintain and continuously acquire competitive advantages.
Operator data access	External/Partner specific regulations	Info2cell	Threat: operators limiting customers' data access, however, these data are very important for studying the patterns of consumer behaviour and market trends, and limited access prevents appropriate service development
Compliance with operator policies	External/Industrial regulations	Info2cell	Threat: Particular operators might have additional policies, however, these policies might limit the freedom of service delivery and development.
Technology and innovation factors	External/Industrial	Info2cell T-Logic	Threat: technology change requires rapid adaptation and learning to create business opportunities; failure to cope with new market trends might make the company's service become outdated.
Economic factors	External/Country	Info2cell T-Logic	Threat: Jordan's economy is suffering from recession; how might this impact the purchasing power of the consumer? Opportunity: The economic boom in Saudi Arabia: this will increase purchasing power and business opportunities for public, private and individual consumers.
Supply chain factors	External/Industrial	T-Logic	Threat: Issues related to technical support and delivery rely on the commitments of the partner; brand success in terms of price, quality and uniqueness play an important role in customer acceptance

TABLE 178: INFLUENCING FACTORS DISCOVERED IN THE CASE STUDIES (CONTINUE)

The Factor	Type	Case Study	Opportunity/ Threat
Political factors	External/Regional	Info2cell	Threat: ME is an unstable region: any political problems might change the business forecasting direction suddenly. Opportunity: New business models might take advantage of the new situation. e.g. political news subscription and broadcasting, special interest web/mobile blogs, forums and applications.
Environmental factors	External/ Regional	Info2cell T-Logic	Threat: snow, flood or extreme heat and dust storms might have a limited temporary impact.
Human Resource	Internal/Organisational	Info2cell T-Logic	Threat: Finding skilled staff is a challenge, losing skilled staff may cost the organisation more than tangible calculations can demonstrate.
Leadership	Internal/Management	Info2cell	Threat: the absence of leadership might lower motivation and goal orientation.
Collaboration	Internal/Organisational	Info2cell T-Logic	Threat: If collaboration is low it might break the knowledge sharing cycle. Opportunity: High team collaboration speeds up task accomplishment, improves knowledge sharing and the quality of creative thinking
Staff compliance with rules	Internal/Organisational	Info2cell	Threat: impact on productivity.
Motivation and trust	Internal/Individual and team	Info2cell	Threat: Lack of trust may lower motivation and collaboration among staff members.

8.6 Validation of RDBMM from the Industrial Applications

Industrial evaluation has a significant input into academic and research results. Wallis (2008) argued that validating a theory in a practical sense (i.e. outside academia) by gaining the recognition of external professionals provides another higher level of validation for a theory. Yin (2009) stressed the importance of strengthening the construct validity of research by asking experts their opinion of the usefulness of the framework. The aim of this industrial validation is to understand the managers' perception of the developed framework, including the value creation compared to the time, effort and cost of such enterprise modelling effort. The actual validation was carried out by asking the managers in both case studies about their opinions and recommendations through phone interviews, which were scheduled and planned later during the analysis and modelling effort.

Because of the distance constraint, the only way to conduct interviews with the managers at Info2cell and T-Logic was over the phone. The interviews were guided by the interview protocol shown in Appendix (H). The funnel interview concept advocated by Sekaran (2003) was adopted, meaning that the questions were asked in a broad way then gradually narrowed to more case-specific details. One of the challenges of addressing the strengths and weaknesses of the RDBMM framework is evaluating it while maintaining attention on its robustness, comprehensiveness and applicability. The mangers were aware of the inverse relationship between maturity and flexibility and between quality and time/speed. Suggestions and recommendations for improvement from each case study are discussed in the following sections.

8.6.1 Info2cell Case Study Validation

The manager answered the questions related to the usefulness of the RDBMM, saying that "it is obvious that a tremendous amount of work has been done, the knowledge presented in the case study document was holistic", and when asked about particular models such as goal models, design rationale and system dynamics, he said that "the models look interesting, and mapping hierarchical goals is important for operations managers to keep an eye on the long-term goals". About the design rationale, he said "he always encourages employees to use mind-mapping tools to organise their thinking and tasks, and that design rationale should be beneficial in a way, especially in brainstorming meetings when mid and high level managers discuss strategic decisions and choices". He wondered whether there is a collaborative version of this tool available to share and exchange the rationale models with managers. The manager was not sure about the system dynamic model and said that "if we were able to expect something might affect the business, it will not be difficult to understand its impact on the business". I explained that when the data set becomes much larger, the dynamic model will be an easy and fast way to visualise behaviour and pick up behaviour patterns from the model, while the managers can change variables to test different ‘what if’ scenarios. He was excited to see the impact of such a modelling capability on a larger data set. The manager was happy to see the mapping between strategy and operations, he said that "they had already started a process modelling initiative a year before, and were modelling all of the processes in the company, yet it is important to map this to the strategy and objectives. It is also important to reason about it, the most interesting thing was to analyse the issues related to the employees to work out the gap between design and practice: such issues cannot be realised only by modelling and documenting the processes".

Regarding the advantages and disadvantages of the RDBMM framework, the manager answered, “with no doubt, the approach seems very interesting and I am very keen to have something similar in the organisation … this is the reason why I accepted to collaborate and offer a case study for your research".

Regarding the limitations or disadvantages, he mentioned, "I can see how the approach can contribute for the long term, just I cannot see how long this will take to get sufficient Return-On-Investment (ROI). And I can see the expected high-cost and difficulty of learning all the set of tools proposed in the framework, so to get successful implementation needs a very clever analyst to realise the benefit". He added "I can't see why I need to define all this set of vocabulary and business terms, this should be really exhausting work!" I explained the importance of sharing common understanding between all employees, especially from different departments, and that it is important to build a rule management information system of specification standards fully integrated with business applications. Overall, the manager was happy about the effort made and the expressiveness of the RDBMM framework for business improvement and alignment. He suggested simplifying the process and integrating it with industry best practices.

8.6.2 Techno-Logic Case Study Validation

The manager described the framework as a guiding booklet for the firm's strategic thinking and design. This is an important indication of the usefulness of the RDBMM framework. He described the goal models as an extremely important entrance point for the firm: since the firm has just been established, he considers it important to start the activities right by knowing everything they do, why exactly they are doing it and how they are going to do it. Rationale models have been distributed among the stakeholders and they found it useful to think during every step about the advantages and disadvantages and the impact of every decision. Regarding the dynamic model, the manager thinks that the model is a crucial part and liked the simulation and the way of thinking proposed by the tool. He asked, "How can we define the variables and their values accurately to gain their potential benefit?" I explained that I defined the values based on the insight I gained from company staff: some influencing factors might need further research to accurately set up and quantify their values. Still the manager found the effort of making this model to be high: "Do we really need to do all this work and build this model by ourselves? It is just easier to let a market expert identify the right direction for us". However, the author explained his belief that it is only a way to codify the knowledge of multi-source and expert minds into a model that can help to forecast change in terms of "if this happened …", which allows the company to think about what to do, and that it is possible that market experts use similar tools to analyse market data. Nevertheless, the manger was extremely excited about the alternative processes design and the alternative methods of implementation: “This offers a good and simple way to optimise and evaluate the processes”. Regarding the alignment and service design, he added, “I have never seen anything like this before, I want to know more about the open source development environment for SOA enabling, though the skills required are not easy to find, if we are going to build our own IS I think this will be a great way where everything is just aligned perfectly and we build only what we need …”.

Regarding the suggested implementation model for operational and management requirements, the manager stated clearly, “I think this is an ideal environment, we are still so far from implementing such technology in the meantime, however I think the cost will be very expensive too”.

Overall, the manager appreciated the effort and the essential combination of the goals, processes, rules and decision support model. He said, “the analysis was design was successful in pointing out the most important areas that concern any business, although some aspects require deeper analysis and some aspects might not be required at all, the decision should be made from a strategic level to where they want the focus of the modelling to be”. He wondered how many tools need to be used to do all this work but appreciated the effort and time and sharing the results with him.

8.7 Evaluation of the Socio-technical Analysis and Design Principles from the Case Study Data

The 10 principles act as a set of situational descriptive, analysis, design and technical implementation guidelines, The RDBMM framework enables these principles. The following analysis covers how the RDBMM implementation in two case studies has enabled the 10 principles:

Principle 1: The dynamics of the organisational environment is an input to the organisation’s internal aspects

Using the RDBMM in two case studies, it was possible to test a number of enterprise contextual dynamic aspects. For instance, for external influencers in the Info2cell case study (new competitors, change in customer demand, content providers minimum grant, change in third party requests) all dynamics were simulated in dynamic models (section 6.9). Other external influencers were also simulated in the Techno-Logic case study (as understood as most influencing external aspects such as market growth rate, competitor increase rate, partners' products and support) (Section 7.2.2.7).

These dynamic aspects were input for strategic and operational decisions, such as changing tactics, designing IT/IS or producing new rules/policies. For instance, it helped to inform Info2cell to either stop spending or change the agreement with content providers within 5 years. In Techno-Logic, the understanding of market dynamic aspects helped in allocating the marketing budget and highlighted the important of selecting the right business partners which offer support; it also helped to benchmark for information systems design.

An important question is raised here: how far can the RDBMM allow an enterprise to evolve with its environment? I believe that certain factors play an important role in answering this question:

1) Analyst experience and capability
2) Strategic change and speed of decision-making
3) Ease of use and agility or technology
4) Capability of technology (capacity, performance, functionality)
5) Staff skills, motivation and ability to learn and evolve

These are called attractors of adaptation, and they will decide the level of adaptive tension considered by the enterprise and its context.

Info2cell has engaged some practices relevant to each of these factors/attractors. The company has adopted an employee of the month scheme as a reward system to increase employees' motivation and performance, offered training, and encouraged the provision of more training for employees to increase their skills and capabilities. It has deployed new technology such as ticket systems, editing and design systems for internal activities. Info2cell is continuously looking for new talents and finally offered me the opportunity to research their organisation and benefit from the outcome.

Principle 2: Knowledge as a key asset

The main objective of the RDBMM framework to capture evidence of enterprise knowledge from both case studies was documented as follows:

- Knowledge about language (terminology and concepts used)
- Knowledge about enterprise context
- Knowledge about enterprise (the six views described in Section 5.3.2)
- Tacit Knowledge of staff (experience and perspectives) using interviews, and documented in 1) reasoning models 2) dynamic models 3) narrative analysis

The knowledge life-cycle will be applied to all of these types of knowledge, for instance, knowledge should be captured, stored as formal models and narratives, then these should be applied and followed in activities, and new insight should be offered and gradually update these models. The knowledge will help in designing business activities, in monitoring and measuring the operation and in designing and implementing information systems and technology.

Knowledge of staff in operations was captured in the Info2cell case study (Section 6.10, appendix D-VI). However, only design knowledge was captured in the Techno-Logic case study due to its nature as a `to-be` focused case study.

It was recommended that it would be better for the design and the use of reasoning models to be collaborative: this was not possible in the current thesis due to limitations of time and data availability.

Moreover, Info2cell has encouraged its employees to use knowledge management tools to communicate and document knowledge. However, the RDBMM has not been tested in such a collaborative setting. It is suggested to use role-based access to RDBMM models to share and communicate, update and use knowledge among stakeholders, based on their privileges, to maximise the notion of `distributed intelligence`.

Principle 3: Analysts and designers as evolvers of internal design with context

As stated in Principle 1, analyst experience and capability is a main influencing aspect that brings understanding of the external environment. It is difficult to ask all staff to be responsible for enterprise adaptation; rather an analyst will be responsible for the recognition of behavioural patterns in the enterprise context, classifying, defining and implementing enterprise knowledge models. First, in the case studies presented in this thesis I focused on capturing the essence of knowledge that influences enterprise activities based on the well-defined theoretical foundation of the RDBMM framework. Both case studies showed how the framework can be considered unique, as it focuses on expanding the mental model of understanding patterns of behaviour using reasoning modelling and dynamic simulation. This helped to identify the influencers' impacts and the design rationale, offering more insight that can aid the production of better enterprise analysis and design. As stated before, a number of simulation assumptions were considered in the dynamic models as a result of expanding the mental models to think beyond the usual expected scenarios.

Therefore, the analyst worked as a modular designer, I collected and classified the case studies' knowledge into a set of structured views (the six views suggested in Section 5.3.2) in order to facilitate their use for internal enterprise stakeholders to distribute the responsibilities and requirements required of each agent to support the enterprise in evolving with its context.

Principle 4: Structure vs. dynamics

In both case studies, Info2cell and Techno-Logic, structural models (motivation/goals, organization structure, structural rules) and behavioural models (business processes, behavioural rules, dynamic models) were presented. Behavioural models show the transitions from one state to another or from a holistic `as-is` enterprise structure to `to-be`. In the Info2cell case study, `as-is` architecture was presented; as part of this architecture, behavioural models were modelled to show how the enterprise currently behaves and the potential impacts of a future state as presented in the dynamic models. In the Techno-Logic case study, it was not necessary to provide the current simple state of the enterprise (since it is a start-up company), therefore I focused directly on the `to-be` models with no intention of showing the transition, which will mainly be decided by a number of strategic decisions taken by Techno-Logic stakeholders. The RDBMM models have facilitated the emergent issues in the environment and simplified the chaotic situation using reasoning and dynamic modelling. The next step is creating a structure and adaptive tension towards implementing the `to-be` models. Later, one would examine how critical values (emergence and chaos) could emerge during the implementation and operation. Due to the time limitations of the PhD study, it was decided not to include a research question related to strategic decisions to be made by the stakeholders and the impact of these decisions on the business. The limited time was one important factor excluding such a question. Future research will suggest a longer period of implementation.

Principle 5: Strategy and rules as a governance hub

After applying the RDBMM in two case studies, the designed activities were always a response to higher level goals. Strategy is a Mean component towards achieving goals; objectives quantify goals and setup their boundaries. Policies are higher level directives, which are not direct enforced on business activities, while rules have stronger links and enforcement, and must be followed strictly in business design. In the Info2cell case study, structural and behavioural rules were defined to govern the design and activities of the enterprise; later decision models based on combining a number of rules in particular scenario were presented. In the Techno-Logic case study, enterprise activities designed within business process models were governed by specific business rules, and these rules were also combined for complex decisions related to each activity. Later, these constraints can be implemented in software systems. However, any change in higher level End or Mean or Directives components imply change at the lower level as a basic concept of the hierarchal alignment used in the RDBMM framework. The notion of governance was implemented in both case studies, but two aspects need further investigation for future research:

1) business agility level should be measured based on the enterprise's ability to change business rules at high speed and without interrupting usual business operations; 2) performance indicators should be assigned to strategic and tactical aspects, the hierarchal structure of the goals making measurement easier. When operational goals are achieved successfully, the higher level indicators should provide insight into the settings' success.

Principle 6: Technology architecture as enforcement level

This principle was realised in the Techno-Logic case study, since the Info2cell case study did not imply any technical development. In the Techno-Logic case study, software components based on SoaML modelling language were designed. Many of the constraints were transferred to software services, so the software will govern and check the validity of inputs and the interaction protocols. This type of implementation, and its suggested development/operational structure in the Techno-Logic case study, can automate many rules rather than involving manual checking, therefore will reduce human error and improve efficiency. Once the business process model (BPMN) is implemented, some activities will be handled in software applications (use cases); these activities will be governed by software systems and no additional manual checking will be required. Moreover, the technology will also take responsibility for monitoring business activities and operations, checking performance and sensing risk. These have been suggested as future implementations, since the focus in this thesis was on enterprise knowledge and showing examples of how it can be transferred to software components, as seen in the Techno-Logic case study.

Principle 7: Design vs. architecture

The RDBMM framework acts like an architecture of the enterprise design. As seen in the Info2cell and Techno-Logic case studies, the design models are varied: this variation is a result of different requirements and enterprise states, where I, as an analyst, made a decision to classify, separate, compare and analyse the data in different ways. For instance, in the Info2cell case study, a social aspects analysis was conducted, and the Techno-Logic case study presented the designing of a number of processes and comparing them, then developing the software components based on SoaML (Section 7.2.9). The Techno-Logic case study included the influencers' analysis and decisions about them in reasoning models, while in the Info2cell case study, influencers, impact and reasoning models were all presented in structured forms. The analysis of Techno-Logic also presented a goal correlation matrix, which was not a part of the Info2cell case study. This shows that it is possible for an analyst to use their own judgement and experience in designing different aspects. These designs should be separated (loosely-coupled components) from the main architecture which was created based on solid theoretical assumptions, to increase agility, as recommended. No particular change has been presented to measure the agility of the framework.

Principle 8: Personal goals vs. organisational goals

Organisational goals are operationalised as a set of tasks assigned to particular agents/actors. Personal goals are not necessarily confirmed to those in the assigned tasks. As seen in the Info2cell case study, some actors have more passion than that which has been assigned to them. This influences the performance and quality of their work output. Human Resource (HR) specialists should work with stakeholders to understand the expectation and align goals. Some interesting work has been done in this particular issue but still not enough, where HR specialists have tried to offer the necessary training to staff and compare salary scales with competitors. In another scenario, staff have left Info2cell after gaining the experience that they were looking for: the CEO mentioned that one of his staff is now competing with Info2cell in the market. This is natural, and organisations can do nothing about the fact that people might have hidden agendas. Following up their work and documenting tacit knowledge as much as possible could mitigate some of the problems caused by contrasting personal and organisational goals. Suggestions for implementation have been given in Section 6.10.5.

In the Techno-Logic case study, I tried to design processes and particular activities, then match staff specification to fulfil these particular tasks. Table 171 shows the specification of the person which is more likely to have common objectives with the job specifications. A qualitative assessment is recommended to understand potential personal aspects for staff (goals and motivation) before hiring. Future work toward designing a possible assessment to align personal and organisational goals is a possible direction.

Principle 9: Autonomy vs. control (process)

People are autonomous entities, therefore to make sure that the enterprise exerts enough control over these autonomous entities, it needs to organise their activities/tasks into clearly defined processes, monitored by senior members within the organisation structure and governing their behaviour using a set of policies and rules. All of these aspects were considered in both case studies. I built process models using BPMN, rule models using SBVR and organisational models using OSM. These models helped to control, monitor and govern users' activities in a structured manner towards fulfilling organisational goals and objectives. Dynamic and reasoning models have also explored some social/user issues in both case studies, such as: trust, communication (collaboration and coordination), relations, culture, innovation, satisfaction, personal motivation, language, norms and values, competition and bias. At the managerial practices level, in the Info2cell case, the CEO offered a high-level of agility (self-organising) to department managers to react to emergent events/behaviour. In Techno-Logic, as a start-up company with few shareholders, all staff have complete freedom to act as required, policies and rules have not yet matured enough, and the organisational structure is very simple and flat at this stage. Technology-based monitoring systems were suggested as future work in Sections 7.2.10 and 8.9. Finally, as complexity theory describes agents, organisations are keen to govern emergent behaviour during design-time and run-time to mitigate any risk that might influence the enterprise.

Principle 10: Lower-level activities form the higher image

In the Info2cell case study, the reputation of the company was acquired by its staff, particularly the CEO, who brought the idea of value-added services to the Middle East. Other staff members have maintained the competitive advantages and built strong relations with key customers and operators in the Middle East. Therefore, Info2cell's image was a result of the creative thinking of its staff taking all possible advantage of being the pioneer (first mover) in the market. The main challenge, as stated by the Info2cell CEO, is to bring forward creative talents that are able to invent new ideas and create new services in this very competitive market. Info2cell has faced some challenges in a number of potential services, as its current capabilities do not allow it to fulfil some potential customer requirements. Misalignment between e resources and strategic goals occurred because: 1) Info2cell did not see the necessity of working towards fulfilling these requirements; 2) no intensive analysis or feasibility study was conducted, which meant that Info2cell might have underestimated the impact of losing market opportunities. Its ultimate goal is to maintain practices that emerge from its core values. Other good practices have been adopted by Info2cell. Very recently, Info2cell decided to give opportunity to staff members to present their own ideas to a panel of middle-managers in a three hour presentation slot on the last working day of the week, giving the opportunity for ideas to flow in bottom-up innovation. In the Techno-Logic case study, I designed processes that were completely aligned to End/strategic-goals with specific measures to stabilise the alignment during run-time. Further investigation, particularly for this principle, can be undertaken in a multi-case studies analysis to explore how different companies' operational level activities form the higher-level image.

8.8 Limitations of RDBMM

This section aims to discuss the observed limitations of the RDBMM framework and its inception process (e.g. Comprehensiveness, Effectiveness, Ease of Use, Maturity Level, etc.).

The elaboration of the RDBMM framework, its applications and evaluation shows that it is a useful and powerful framework to analyse and design socio-technical systems. Some weaknesses have been recognised during the implementation and evaluation:

- The RDBMM does not show exactly what reference models or taxonomy should be used to standardise the modelling aspects with industrial best practices. A number of best practices proved successful industrial implementations either at strategic level, such as the balance scorecard (BSC) (Goldman and Suchit, 2011), Rummler framework (Rummler, 2007) or Total Quality Management (TQM) for process improvement (Black and Porter, 1996), or at operational level such as Six Sigma (Devane, 2003), the Value Reference Model (VRM) (VRM, 2012) and the Capability maturity model (CMMI) (Godfrey, 2008), or in technical management and technical services maturity such as CoBIT (Goldman and Suchit, 2011) and ITIL (Steinberg, 2011). These industrial standards are relevant, but the framework did not show how the enterprise could benefit from these to improve and speed up the analysis and design process, although some artefacts in the RDBMM are responding to some areas of these best practices.

- The three levels of RDBMM abstraction help us to understand that there are several ways to implement the same thing, and that sometimes more or different types of analysis are required to gain better insight. For example, the framework suggested using the system dynamics modelling for simulation, but system dynamics modelling could only offer either discrete or continuous time simulations. Some different aspects of complexity require analysis from different aspects: the system's adaptability could benefit from a graph transformation approach or agent based simulation (individual behaviour and rule based), and data analysis could benefit from stochastic and statistical analysis e.g. using the Monte Carlo technique for sampling numerical probability distribution. The point here is that the analyst needs to be careful about the problem and the required analysis tools that should be used.

- Although the research included a novel combination of modelling tools and aspects, still one of the limitations of EAFs is that they require continuous manual updating which is time and effort consuming, which directs the research to find a new solution. The run-time of the suggested future framework could help to automate part of the knowledge acquisition into the enterprise information system architecture.

- The RDBMM implementation process is flexible: although this is a good feature allowing configuration of the process depending on the needs, it also requires an expert to be able to configure a stable implementation process that suits the case requirements. The time required also depends on the case size, but as is known in the domain among practitioners, the EM effort should be continuous.

- I argue that the RDBMM is an enterprise modelling framework, therefore the value that could be gained from EAF implementation could be gained here with particular improvement solving the issues addressed in this research. However, the boundaries of the framework are still not very clear: the RDBMM views are mature and well framed but the level of detail that should be addressed in the technical implementation or in consideration of social aspects are left to be decided by the analyst for each particular case. Again, here more effort falls on the analyst to decide what needs to be addressed in the enterprise's concerns and to fulfil their objectives of undertaking the entire modelling effort.

- During this research, mature and strong metamodels have been proposed for enterprise architecture. For example, DoDAF/MoDAF 2.0 has a very powerful and comprehensive metamodel, though it is not necessarily for all business types; it is the same with EBMM, where the business aspects metamodel is very mature, and the Open Group recently made great progress in integrating the TOGAF and Archimate frameworks as a process and metamodel (The Open Group, 2012). The author of this thesis claims the importance of the RDBMM as essential aspects are covered in the metamodel which could be used in any type of business and are easier to use than the other metamodels: in all ways it is an extension of the OMG specification of the BMM and a set of tools and process toward its realisation, particularly in consideration of the identified research gaps (listed in Table 8). This is not to detract from other efforts in the domain that have dramatically accelerated since enterprise modelling started to receive greater attention from industry. Nevertheless, these might be considered to have a limitation in artefacts compared to artefacts covered in other frameworks.

- Although the RDBMM was presented with the aim of reducing analysis and design complexity, the stakeholders still think that it is challenging to learn and use many aspects/tools of the RDBMM framework. Providing professional training to users is essential. However, another possible solution could be found in Domain Specific Modelling Languages (DSML) in order to simplify the complexity of the enterprise design (Laforcade, 2010). Some scholars claim that DSML is similar to UML; arguably the syntax is not necessary the same, and DSML can be much easier for business people to use and understand. However, building domain graphical notations is an important aspect; the main challenges actually lie in the importance of building executable DSML that have the ability to generate the underlying software and systems artefacts.

8.9 RDBMM for Adaptive Socio-technical Systems - Future Scope

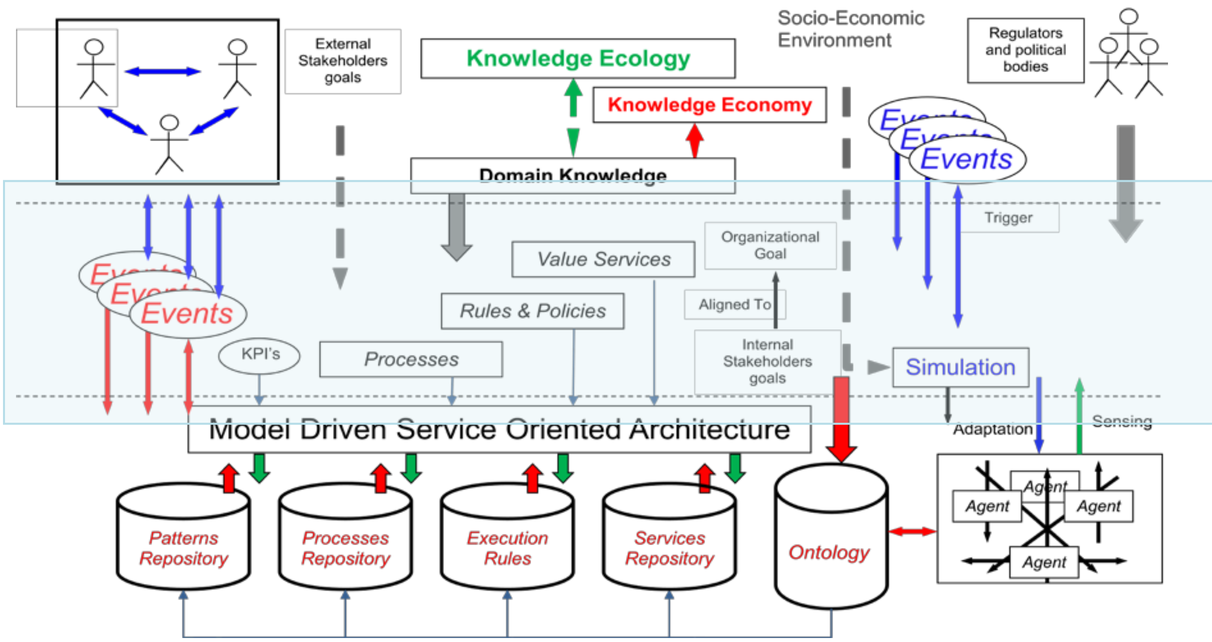
The ultimate goal of developing a socio-technical system is to create an autonomic heterogeneous system that can sustainably design and reconfigure itself to handle different types of change (Peris et al., 2008). Research in the area of adaptive socio-technical systems (Briscoe, 2010; Dini et al., 2008) suggests a need to develop a socio-technical system framework that can reconfigure itself and evolve within its context by continuously adapting to new requirements over time. Intelligent systems for the run-time environment are required to build a smart information system infrastructure (Nachira, 2007). At the socio-economic level, socio-economists try to understand the relation between society and economy and how they influence each other. The RDBMM is an enterprise knowledge framework that is concerned with knowledge transactions on all scales. Knowledge created and used by people has an impact beyond the organisation's internal activities. The RDBMM can be extended to cover the notion of future development in the adaptive socio-technical system that supports knowledge ecology[11]. Taking advantage of adaptive IS capability to enable enterprise agility. The future RDBMM framework ought to use a combination of new technology that offer intelligent automated capabilities, for instance, ontology (knowledge base) to ensure learning, adaptation, machine-to-machine communication and dynamic information system structure. This should allow systems to react quickly according to changes in business domain knowledge and will contribute to the so-called knowledge economy[12] of the industry. The future RDBMM scope is wider, the technology used and knowledge captured, documented and generated within the enterprise will contribute to both knowledge economy and further to knowledge ecology (Kuhlen, 2013).

[11] Knowledge ecology (knowledge ecosystem) is a term for modern approaches to knowledge management, which is strongly influenced by evolutionary theory and sees the enterprise as self-organising entity that generates and shares knowledge in an open network in order to support decision-making, collaboration and innovation for overall society benefit.
[12] This term refers to tangible and intangible values generated by using knowledge. Generating advance and insightful knowledge can also be achieved using intelligent technology. Decision support systems can increase economic value generation.

The holistic enterprise knowledge presented in this thesis as the RDBMM framework is crucial for enterprise activity design. The information systems design usually responds to business requirements and strategic needs. In some circumstances, the IT innovates in the business model: in this case technical assessment and analysis is required to explore the potential of the technology. However, the future adaptive RDBMM considers adaptive and intelligent technical architecture, which is based on the holistic knowledge formed in the formal models set up to design business and IT, increase alignment, help in decision-making and offer a framework for continuous improvement and development. I built a UML profile to integrate knowledge from the three modelling mechanisms into one system (Figure 51), Further development required for complete implementation is as follows:

- Handling the data represented in each modelling tools as required in the other tool
- Creating a rule and event management system
- Ensuring intelligent agents are triggered for action by specific event/data from data sources
- Building a model repository for formal models

Selecting a suitable open source platform and tools is the first step in completing the development of the future adaptive RDBMM framework. To dig deeper into the details of the future framework, the domain ontology could be defined using SBVR specification. SBVR allows users to define a business vocabulary and business rules using controlled and structured natural language that can be stored, retrieved, modified and used for business and IS applications (Fayoumi and Yang, 2012). Nevertheless, this is not the only way in which the developed framework can benefit from the ontology. The knowledge repository can be linked directly to specific knowledge sources in the domain to extract the required knowledge and allow the agents to act according to the knowledge in the environment, for example, in ontology defined in the semantic web, where it could offer a standard format to extract the necessary information from the web. Another possible example could be the extraction of knowledge on the stock market from knowledge providers in real time to allow artificial agents to react immediately to knowledge-type events according to a set of pre-defined decisions triggered by the acquired knowledge. Using ontology as a knowledge source allows the developed information systems framework to continuously acquire knowledge from other sources, making it adaptable according to the changes accrued in the realisation of the dynamic information system architecture (Figure 76).



Covered in this Thesis | Other aspects are for future work

FIGURE 76: RDBMM FOR ADAPTIVE SOCIO-TECHNICAL SYSTEMS

At the sense-making stage, the enterprise information system analyst needs to define the ontology and taxonomy of the organisational development and its context. In this practice, intensive analysis is needed to understand the environment, organisation and technology status, trying to understand what needs to be developed, what kind of changes could accrue in the business environment and the ways in which people in the organisation deal with situations of doubt or instability. Uncertain situations are always present and should be taken into consideration when designing business and IT systems. There are two types of sense-making: 1) technology sense-making, which involves deciding how and where the new ontology will be used according to business rules defined for each case based on advance assessments; this analysis can be advanced using principles from ontology learning (Buitelaar and Cimiano, 2008), artificial agents (Nilsson and Darley, 2006) and DSS (Liang and Hung, 1997), which offer some inputs to internal systems; and 2) qualitative and quantitative assessments, which are needed to guide the non-automated activities that need human decisions and evaluations to build the organisational, business and technical components. Software agents might take some responsibility instead of human agents. To decide which is more suitable for a particular activity, analysis needs to be conducted to choose which activities to assign to software and which to assign to human actors. The artificial software agents will behave according to a set of defined rules, and their learning will increase based on the ontology base. They can evolve, adapt and change their behaviour according to the situation in order to achieve the assigned goal. The idea is that the agent can take the same human cognitive tasks (belief, desire, intention, and action) to be simulated by SD modelling before implementing the model as an agent and before setting up the behavioural rules. The software agents will interact with each other in a multi-agent system framework. The software agents will also interact with the human actors at some stages to audit and control the human behaviour to ensure quality and achievement of the goal.

In addition, repositories of services, rules, processes and architectural patterns are necessary for fast adaptation, choreography and orchestration of business and ISs design. The repository will offer a place to extract patterns from legacy applications 'bottom-up' or patterns of business alignment 'top-down' as well as store third parties' patterns, which can be bought and stored in the repositories. Workflow engine and business rule management systems (rule engines) are important for the execution of business designs. Table 179 shows the capability of RDBMM compared to the future RDBMM for adaptive socio-technical systems.

TABLE 179: RDBMM AND RDBMM FOR ADAPTIVE SOCIO-TECHNICAL SYSTEMS

RDBMM	RDBMM for adaptive socio-technical system
• Methodological approach • Enterprise modelling • Reasoning and sense-making • Dynamic modelling and simulation • Model-driven approach	• Methodological approach • Enterprise modelling • Reasoning and sense-making • Dynamic modelling and simulation • Model-driven approach • Run-time implementation model contains ontology use, intelligent agent systems, reusable models for orchestration

The future RDBMM provides the core information technology, knowledge/information and new media to access and share knowledge. If this notion is implemented in a large number of organisations, knowledge ecology will be achieved by the interaction among them, and evolution on all scales will be possible and fairly equal among all organisations (public and private).

8.10 Reflection and Conclusions

The BMM was selected, based on a general and specific literature review, to lie at the core of the new developed framework, the RDBMM. After the initial evaluation of BMM and other EAFs (Chapter 2), the BMM was extended to fill the gaps in the literature. A further exploratory case study (Chapter 4) helped to develop the RDBMM (Chapter 5). The RDBMM was then applied in both the Info2cell (Chapter 6) and T-Logic (Chapter 7) cases. The findings of the two case studies and their cross-comparisons are presented in this chapter. Evaluation of the enterprise maturity was undertaken in each of the case study chapters based on specific criteria described in Appendix G before and after applying the RDBMM, and this assessment showed the differences in enterprise knowledge increases and overall enterprise architecture maturity. Also, evaluations from the industrial perspective are presented and the RDBMM framework limitations listed. Based on these findings, an RDBMM framework containing design-time and run-time adaptive architecture for adaptive socio-technical systems (a future development of the RDBMM) has been conceived and proposed. This is in a transition phase and has not yet been fully tested. RDBMM for adaptive socio-technical systems will also consider intelligent adaptive technology in order to increase architecture agility and handle expected and unexpected change. The following are the concluding remarks of this chapter:

- As there is no dominant design model, there is no one dominant design process. The process can be varied from one case to another for reasons such as the state of the enterprise, the motivation of the enterprise, the environment and the resources.
- The socio-technical system is not independent, although we are building loosely coupled entities to reduce analysis and design complexity. However, there are many, sometimes complex, links between these systems and sub-systems. Research in the area of 'system of systems' has highlighted this issue, emphasising that business, IS and the environment are fused and influence each other in a continuous, deep manner.
- Continuous evaluation and adaptation is required for system survival. The evolution of needs and requirements is a fact: enterprises need to find a balanced approach to analysis, design and management to allow bottom-up evolution beyond top-down architecture guidelines. a collaborative design approach that engage operation staff in the design can be a suitable solution.
- Modelling is no longer about artefacts that should be designed and developed in long development process in order to get used. The rapid changes in the socio-technical environment require modelling of the emerged artefacts of what exists and what should get used immediately, which will create new artefacts as an organic process. Modern information systems and architecture have the ability to provide business models (business to execution) during the run-time rather than using long software and system engineering processes. Reusing, choreography and orchestration also help to accelerate the design and implementation process.

- There is no universal framework that can comprehend all types of business/enterprise requirement; allowing flexibility, extendibility and integrity is crucial for the success of any modelling framework, as long as the essential aspects are addressed so that they can play the role of a foundation for any future improvements.
- Enterprises need to realise the effort and time required to implement the RDBMM, and they need to understand the time frame for seeing a return on investment (ROI). However, stakeholders were aware of the relation between time and quality, which in turn helps in increasing the enterprise architecture maturity.
- Country culture, organisational culture, enterprise status, technical identity[13] and level of technology adoption have a clear impact on RDBMM implementation.
- The RDBMM requires professional training in order for users/analysts to be able to use the formal modelling techniques suggested as part of the RDBMM framework. Although the implementation periods in the case studies were reasonable, enterprise managers need to be aware of the time and cost of implementing such a framework in their organisations.
- Enterprises need to take advantages of intelligent and emerged technology to improve agility, responsiveness, maturity and reduce risk.

[13] Technical identity describe the way the enterprise use the technology, is the technology adopted only for supporting activities, or it is part of business model, or completely e-business model. What type of technology and how advance is it?

Chapter Nine: Conclusion and Future Work

This chapter will critically review the research that has been conducted and presented in this thesis. We will (1) draw conclusions in terms of the research objectives, assumptions and achievements; (2) summarise the contributions made to original knowledge; and (3) identify the limitations of this research. Additionally, at the end of this chapter, future extension of the framework is discussed.

9.1 Research Conclusions

This thesis has presented research on the analysis and design of socio-technical systems through complex and dynamic modelling using the proposed framework, the RDBMM. The framework for analysing and designing socio-technical systems was realised through use of enterprise, reasoning and dynamics modelling mechanisms, these were considered during the conception and evolution of the proposed framework and tested through industrial application in two different case studies. The case studies focused on the analysis and design aspect of enterprises in the design-time. In socio-technical systems, it is widely understood that the social perspective is just as important for an enterprise as the technical perspective. This has been reflected in the RDBMM framework, where thinking capability, collaboration, simulation tools and methods of visualisation during the analysis and design process are crucial to making decisions regarding how the enterprise model should be implemented. The RDBMM proposed and tested in this thesis was inspired by an extensive review of the literature on approaches to analysing and designing socio-technical systems, and on ways of modelling these systems using enterprise modelling (EM) and enterprise architecture frameworks (EAFs).The novelty of the framework lies in its ability to give equal attention to social and technical aspects, while offering a systematic detailed approach to modelling and aligning social, business and technical aspects. RDBMM is an enhanced Enterprise Modelling (EM) Framework which uses reasoning and dynamic modelling; it helps significantly in strategic design, and illustrates how it could be beneficial for sharing common understanding among stakeholders and supporting decision-making by analysing internal and external influencers using reasoning and dynamic modelling. RDBMM comprises three levels of abstraction: the third level contains detailed artefacts which are divided into six views/perspectives, and these views are supported by an implementation process and modelling tools. The research approach to analysing and designing socio-technical systems received positive feedback from the stakeholders during and after the case studies. The approach undertaken thus demonstrated its usefulness in terms of its benefits and potential to for designing adaptive enterprises, for example in knowledge comprehensiveness, visualising alternatives, decision-making and forecasting using simulation.

The planned research objectives were reviewed and analysed to identify 'achievement versus planned' for each research task. Research Objective 1 planned to review and identify research gaps (listed in Table 8) in the literature on socio-technical systems approaches with a focus on the comprehensiveness of the various approaches' consideration of social and technical issues. A literature review was carried out on socio-technical systems, including the theory involved: approaches with both a technical and social focus, and challenges facing these approaches, were discussed. This literature review also exposed the lack of a systematic detailed business-IT alignment in these approaches to carrying out socio-technical systems analysis and design activities. This led to the creation of new objectives to try to fill this gap by using the capabilities of the different approaches. In Research Objective 2, Enterprise Modelling (EM) was found to offer successful detailed implementation approaches to modelling and aligning the whole enterprise (social, business and technical aspects). EM perspectives were thus studied and analysed: the analysis of EM modelling perspectives led to new gaps being identified related to the comprehensiveness of these perspectives in offering a holistic socio-technical view: all of these perspectives still have limitations in expressing the details of the whole socio-technical system. It was then necessary to look at the work conducted in the field of Enterprise Architecture Frameworks (EAFs), where comprehensive modelling frameworks have been proposed to cover several modelling perspectives. The result of the EAF analysis led to the discovery of a gap in their ability to model socio-technical systems efficiently: the absence of dynamics modelling and reasoning was critical and needed to be addressed. By the end of Chapter 2, the research gaps had been fully identified and it had become crucial to address a solution to overcome the following limitations:

1. Approaches to socio-technical systems analysis and design mostly focus on either social aspects or technical aspects, rarely both.
2. Approaches to socio-technical systems analysis and design are limited in terms of details and systematic processes, and the semantics of the approaches which are meant to tackle aligned activities.

3. In Enterprise Modelling, a single perspective is not enough to model a comprehensive enterprise 'Socio-technical system', resulting in each perspective offering coverage of a different quality.
4. The existing EAFs fail to address reasoning and dynamics modelling.
5. Facilitating complexity, dynamics and decision-making process have not been clearly addressed: factors influencing socio-technical systems need investigation, focusing on issues such as:
   - Internal and external influencers
   - Language and issue of common understanding of terms and concepts
   - Common understanding of levels of complexity and abstraction of enterprise model concepts

To start to sketch out a solution, it was important to understand the nature of socio-technical changes and dynamics, and how enterprises make decisions about these changes in their business. Objective 3 was accomplished in Chapter 4; that is, understanding the nature of change, influencers and decisions through semi-structured interviews in two exploratory case studies (Enterprise and SME) made it possible to understand modern change drivers and how organisations react to them. New artefacts were drawn up based on the findings in these case studies. In the same chapter, Objective 4 was satisfied by reflecting on and analysing the findings using complexity theory, which helped to identify a list of guiding principles and a generic framework that describes and suggests practices for analysing and designing complex socio-technical systems. In Chapter 5, the integrated hybrid-modelling framework, RDBMM, was identified, with a focus on the business aspects of socio-technical systems that mediate changes in environment and technology planning and development, in the social aspects considered within this framework. The RDBMM is based on three levels of abstraction and proposes new artefacts belonging to six views that are required to analyse and design socio-technical systems. Modelling tools and a modelling process to support the execution of the RDBMM were proposed as well.

In Chapters 6 and 7, the RDBMM was applied successfully to two different case studies: the characteristics of this application demonstrate the ability of this framework to offer a holistic view of the enterprise, model the enterprise structure, dynamics and reasoning in an efficient way, and handle different enterprise requirements for developing information systems (IS). An evaluation of the RDBMM was presented in Chapter 8, along with a comparison of the results from the case studies which shed light on the differences between the implementations At the end of this chapter, a suggestion was presented for future improvements for this RDBMM framework to cover a run-time implementation platform with intelligent capabilities.

The research aim and objectives were set before undertaking this substantial piece of work, as outlined in Section 1.3. The planned research objectives are reviewed and analysed below to identify 'achieved versus planned' in the case of each research task.

Research Objective 1: To perform a general review of literature on socio-technical systems approaches, and identify challenges and gaps in the current approaches.
Research Objective Achieved: The focus and challenges of analysis and design approaches to socio-technical systems were highlighted, and gaps identified in these approaches, mainly issues related to the comprehensiveness of the approaches in modelling both social and technical aspects and in their capability to offer a systematic detailed alignment to analysing and designing socio-technical systems.

Research Objective 2: To identify the opportunities and gaps in the EM perspectives (the capabilities of the Goal, Agent, Role, Rule, Value and Process perspectives) and in EAFs.
Research Objective Achieved: The EM offers a systematic and detailed mechanism for modelling enterprises, especially to aid business-IT alignment. Limitations were identified related to the comprehensiveness of EM perspectives (the capabilities of the Goal, Agent, Role, Rule, Value and Process perspectives). EAs provide multi-perspective frameworks, but consideration of reasoning and dynamics was absent in twelve EAFs: the gaps in the current state-of-the-art approaches were critically discussed and listed at the end of Chapter 2.

Research Objective 3: Exploratory case study to understand dynamics, change and decision-making processes in current socio-technical systems in enterprises, to feed into the framework design by fusing knowledge and expertise with descriptive theories.
Research Objective Achieved: The exploratory case studies were analysed, and the issues involved in the small and large enterprises that influence the dynamics, change and decision-making of the enterprise were pinpointed to offer a better understanding of the requirements that the solution needs to address.

Research Objective 4: To propose new principles to guide the understanding, analysis and design of socio-technical systems.

Research Objective Achieved: New principles were developed as a result of adapting complexity theory and using it to reflect upon the socio-technical systems environment. Complexity theory was linked and applied to the findings of the exploratory case study, leading to the identification of a set of guiding principles that need to be considered in the prospective solution that can offer reasoning and dynamic modelling; new socio-technical analysis and design principles and a generic framework were proposed.

Research Objective 5: To propose a new hybrid modelling framework that overcomes the current gaps in the literature and satisfies modern socio-technical requirements, mainly in reducing complexity and modelling dynamics aspects and reasoning to support decision-making.

Research Objective Achieved: The Reasoning in Dynamic Business Motivation Model (RDBMM) was developed to model socio-technical systems, including developing the methodological implementation process and modelling tools to be used in modelling RDBMM artefacts. RDBMM contain six perspectives and new artefacts in order to offer a holistic view of the whole enterprise, and aid the dynamic and reasoning modelling presented in Chapter 5. The selected modelling tools were based on three mechanisms: 1) enterprise conceptual modelling (KAOS, SBVR, BPMN, OSM and UML); 2) dynamic modelling (system dynamic modelling); 3) reasoning (design rationale). The RDBMM framework resulted from the detailed analysis of interviews in the exploratory case study based on complexity theory, and was also based on the findings of the literature review on socio-technical system approaches, EAF, EM and modelling techniques.

Research Objective 6: To undertake case studies with industrial organisations with the aim of applying and testing the developed RDBMM framework, to model the whole enterprise as a ‘socio-technical system’.

Research Objective Achieved: Case study work was carried out with IT services firms to model the socio-technical aspects including the goals in motivation model, process model, rules models, organisation model, and reasoning and decision support insight, assessment and forecasting. Two case studies were conducted, the first with Info2cell’s ‘as-is’ modelling with a focus on social aspects and organisational issues in Chapter 6, and the second with T-Logic’s ‘to-be’ architecture with a market focus and technical development in Chapter 7. These two case studies proved the ability of RDBMM to offer comprehensive and effective socio-technical modelling using enterprise, reasoning and dynamics modelling, highlighting variances in the modelling aspects in each case.

Research Objective 7: To validate and evaluate the proposed RDBMM and its applications. Industrial implementation, case study comparison and lessons learned to be discussed, followed by proposals for a future extended framework.

Research Objective Achieved: Evaluation and assessment was undertaken with stakeholders from the case studies; the academic practice trustworthiness of the case studies was confirmed; and cross-case industrial comparison evaluated the proposed RDBMM in term of the way in which it was used in each case study. Findings, the modelling process and lessons learned were presented in Chapter 8.

Research assumptions and weaknesses: The proposed approach was tested using two case studies from the IT services industry. SMEs and specific limitations of data and time were discussed in each of the case study chapters. The approach needs further testing in other cases, for example, the manufacturing sector and maybe with a large enterprise, to prove its generalisability. The results were limited to the data provided by the case study stakeholders, although the framework was not limited. Specific case-based assumptions were applied e.g. correctness of offered data and other simulation assumptions.

9.2 Contributions to Knowledge

What this research promises to achieve through this framework and its accompanying methods/tools and methodological process is to model socio-technical systems and aid reasoning about dynamicity in the environment and facilitate complexity, through a hybrid framework that satisfies a holistic view of the enterprise. Overall, this offers a contribution in the area of socio-technical systems analysis and design and enterprise modelling, mainly related to decision support for enterprise architecture, adaptability and agility of the enterprise, business-IT alignment and consideration of social and technical aspects within the analysis and design process. It is very difficult to confirm whether the framework is generalisable in itself as an ultimate solution: different cases may require more models or artefacts to accompany the RDBMM, similar to the suggested tools; and it might be beneficial to adopt other tools with different capabilities to satisfy specific requirements or to solve different types of problem. As shown in the case studies, implementation could vary depending on the focus, status, objectives and level of enterprise modelling required.

The beauty of this framework also lies in its separation of the views, tools and process, whereby the process can start from different views based on the enterprise modelling requirements. This intertwining among enterprise modelling, simulation and reasoning is crucial to success in the enterprise modelling effort. Moreover, the abstraction levels of the framework make its generalisability possible; the high-level abstract could be operationalised in several ways.

The research has made significant contributions to knowledge in both the academic and industrial domains. The main contributions to knowledge are as follows:

1. ***Determination of strategic change forces and drivers in socio-technical systems:*** One of the important results in this thesis is related to understanding the nature of change that occurs in current socio-technical systems, as found from the exploratory case study with two polarised types of company, an enterprise and small sized IT firm. Examining the perspective of two sets of strategic and technical operational staff, the exploratory study was able to identify the external and internal change forces that push a firm to adopt new strategic, operational or technical changes, and how the decisions about this are made. The following aspects were analysed during the exploratory study:
    a. Causal loop model to visualise factors' impact relations.
    b. Example business process in practice that may include change and decisions.
    c. Findings about dynamics and requirements changes in the socio-technical environment.
2. ***Complexity principles of socio-technical system analysis and design:*** Complexity theory enriched the analysis of the exploratory case study; a reflection on theoretical concepts such as agent independency, evolution, interaction, sharing and evolving knowledge have made it possible to offer principles that fit with modern socio-technical systems. The following principles act as a set of situational descriptive, analysis, design and technical implementation suggestions:
    a) The dynamics of the organisational environment as input to the organisation's internal aspects
    b) Knowledge as a key asset
    c) Analysts and designers as evolvers of internal design with context
    d) Structure vs. dynamic aspects
    e) Strategy and rules as a governance hub
    f) Technology architecture as an enforcement level
    g) Design vs. architecture
    h) Personal goals vs. organisational goals
    i) Autonomy vs. control (process)

j) Lower level activities form the higher image

3. ***Development of RDBMM:*** development of the RDBMM three levels, the levels 1 and 2 were based on enhancement of the OMG BMM offers the following details:
   a. Increases the understanding of levels of details and abstraction of enterprise concepts by building different levels of artefact details that can be considered as required.
   b. Improves goal view by adding new artefacts describing the nature of the goal and goal evaluation; some of these artefacts are related to:
      I. Goal setting guidelines
      II. Goal classification and relations metamodel
   c. The Agent/Actor view is proposed to offer the capability of the semantic model, types of agent and relations with the goal, activities and resources.
   d. The Decision view is proposed to offer semantics among decisions and business rules and regulations from the side and issues for which the decision is made.
   e. Internal and external influencers are considered and significant risk assessment is undertaken.
   f. Shares common understanding among all stakeholders by defining business terms, concepts and facts to act as a basis of business design with the mutual benefit of socio-technical system aspects. Thus, it guarantees common understanding of terms and concepts using the SBVR specification to define all related business concepts and vocabulary.
   g. Offers an organisational structure model to define all organisational aspects and their liabilities.
   h. Offers a process view that satisfies the Mean to achieve the End in a semantically integrated manner: the process view shows the logical activities that are considered to achieve specific objectives across different organisations, organisational units, groups or individuals.
   i. All of the design rationale and system dynamic modelling helped to improve decision-making in terms of maximising insight, visualising and collaboration.
4. ***Implications of RDBMM:*** The development of RDBMM to model and provide reasoning about dynamic enterprises was initially based upon integrated use of the Enterprise model, Design Rationale model and System Dynamic model. After assessment of EAFs on the basis of the industrial testing, RDBMM was enhanced in order to introduce additional enterprise modelling stages. The integrated use of these three modelling

capabilities was documented using meta-modelling formal notation (UML object model). The RDBMM was based on the use of OMG standardised BMM concepts. The development of RDBMM is a significant contribution to knowledge in terms of its benefits, for example:

a. Modelling the enterprise (dynamic and structural aspects) as a socio-technical system (social and technical) with a support change capability and facilitation of improved decision-making.
b. Structured data gathering and formal graphical representation of the enterprise model.
c. Structured method of evaluation and simulation analysis based on the ‘as-is’ and ‘to-be’ models’ KPI results.
d. Designing a set of alternatives to implement a model that address issues of concern for the organisation being studied.
e. Identifying a set of tools to serve in a comprehensive hybrid framework offering different capabilities for analysing and designing the socio-technical system.
f. Ease of reusing and manipulating the simulation and reasoning models to test new or different scenarios.
g. Reducing time and risk of change and requirements change due to the availability of the enterprise models to act as a documented knowledge base.
h. Reducing system complexity by improving decomposition, refinement, insight and reusability.
i. Improving the assessment of internal and external risks, or any other issues that might influence the enterprise (strategic, operational and technological).
j. Facilitating the understanding of business concepts and vocabulary to share common understanding among stakeholders.
k. Improving alignment and simplifying implementation processes through a mature and clear framework supported by a systematic methodological approach.

5. ***Development of the implementation process:*** In this thesis a proposal for an enterprise goal orientated analysis and design process has been presented, and it also gives suggestions based on the principles in Chapter 4 to analyse, design and manage socio-technical systems. The aim of the process presented in Chapter 5 is to improve the alignment among activities of the systematic detailed process, in order to tackle the modelling of the presented framework artefacts. However, the process is not typically

permanent in all development cases; it could vary between cases where a certain level of customisation is required to fit the enterprise requirements.

6. ***Industrial applications of RDBMM:*** The RDBMM was applied in two industrial case studies. This industrial application resulted in better ways of modelling the enterprise with a focus on both social and technical aspects. Moreover, it could offer suggestions for improvements in their business practices, especially related to their analysis and design of social and technical aspects. The industrial case studies resulted in specific contributions to knowledge as presented below:

   a) Info2cell case: The RDBMM was used to model the Info2cell case study, the case was rich in its diversity and in modelling the current situation 'as-is' of Info2cell. Its contribution in this case is summarised as follows:

   i. Understanding the complex as-is situations of the Info2cell business including its strategic, technical, commercial and operational departments having multi-functional activities to deliver a wide spectrum of services to customers.
   ii. Modelling goals and objectives, influencers and impacts, business concepts and facts, rules and complex decisions, process and artefacts.
   iii. Providing useful insights into the Info2cell value delivery model and helping in decision-making during analytical design rationale model.
   iv. Providing a dynamic simulation model of Info2cell revenue, including concerns of external influencers; this model can help in simulating different scenarios by changing the input values of the influencers. Several dynamic models can be built to simulate different concerns.
   v. Providing a new way to model and document organisational structure, responsibilities and capabilities, based on the OSM model suggested as part of the RDBMM.
   vi. Analysing the organisational issues and practices as presented by interviewees, very limited observations could be made which have also been reflected in the analysis: the analysis also included suggested practices to overcome a number of these issues.

   b) Techno-Logic Case: Developing the 'to-be' RDBMM architecture at the market and services/products levels based on modelling results and discussions held regarding the T-Logic value generation system. The model includes:

   i. RDBMM profile to model and document the architecture framework.

ii. Goal model showing the type and level of goals, identifying goal assessment and matrixes, and quantifying goal measurement.
iii. Reasoning about business design options and alternatives.
iv. Modelling business concepts and facts, rules and complex decisions.
v. Assessing process design and process alternatives against quality criteria, T-Logic objectives and capabilities.
vi. Dynamic modelling to understand market position and its influencers.
vii. Design and implementation model based on SoaML specification to design SOA services.
viii. Operations and Management suggested a future structure to manage change for monitoring and agile adaptation.

9.3 Research Limitations

The research focus built upon several explorations during the literature review and exploratory case study; the RDBMM was applied to two industrial case studies with different characteristics of implementation processes. Nevertheless, the following limitations of the research have been recognised based on the knowledge gained through the process of this research and the evaluation of the research practices (e.g. small sample size, modelling period, modelling tools, etc.):

- Since the exploratory case study was exploratory, a multiple case study approach was considered to provide greater understanding of the change, decision-making, and complexity phenomena involved. A cross-domain theory was applied to provide an explanatory analysis of the findings. Still, the exploratory case study and both RDBMM implementation cases were limited to IT companies, The exploratory case study was of two types of enterprise, large and small, while the RDBMM application case studies were both SMEs. More exploration within different industries could add further detail to the current findings.

- The strategy used to select the cases involved the use of two polarised types of case study that were opposite in their characteristics, in this case ‘as-is’ and ‘to-be’ modelling. A value added services provider company offered data for this study and was a candidate for the first type, ‘as-is’, as the company has been operating since the late 1990s. The second case study was a start-up company, which offered the study the opportunity to design a ‘to-be’ model from scratch. Both companies are based in the Middle East, which was not considered to be an issue of concern whilst selecting the research sites or assessing the findings. The main limitation was that the case studies are both SMEs, which prevented us from testing the modelling approach with larger-scale companies.

- There were limitations to data availability due to which the results might be limited, but not the framework, which has shown its benefits. For instance, in the Info2cell case, the dynamic model results were based on revenue data that was only available for five years. Had the provided revenue data been available for a greater length of time or on a monthly basis, the results would have proven more useful. Here it is recommended that at least one full year of monthly revenue data be gathered and analysed in future, so that all troughs and crests become visible, especially those created seasonally or by certain regional and economic factors. Also, no data was available related to variations in the novelty level of services sold, to measure customer demand for each service, which could significantly affect the revenue amount. Therefore, further data collection is required in order to understand and forecast realistic revenue and customer dynamics and their impact on strategic decisions and service development.

- Constructive fusion and sense-making activities suggest collaborative analysis and design. This was impossible to test in this thesis owing to the limited availability of case study stakeholders and the time constraints. It is recommended to use a collaborative analysis and design for future research, including evaluating the success of the approach and related emerging issues.

- The case studies did not reach the implementation and operation levels of the companies, because of the time limitation, since observing such results requires several years' observation and performance analysis. Because it was realised that implementing and developing the technical framework would take longer, the decision was made early in the process to exclude the technical part of the enterprise goal orientated approach from this research study. Other research strategy such as action research can be suitable to work closely with executives or staffs from the company to apply the framework and continually reflect and re-adapt in the work environment.

9.4 Recommendations and Future Research

The contribution to knowledge from the research has been recounted in this chapter. Based on its demonstrated benefits, the following further research is recommended which is classified either as a) future work aiming to overcome the limitations of the current research; or b) future work aiming to develop and implement the future adaptive RDBMM framework:

1. ***Further application of RDBMM:*** Further application of RDBMM in additional case studies while concentrating on various dynamics capturing and handling complex concepts and configurations may be useful in order to realise the potential benefits of the proposed framework. The RDBMM may also be implemented in different industrial sectors, for example production and urban system planning. Moreover, it is recommended to implement the RDBMM in different countries with different cultural backgrounds and different enterprise sizes (SMEs and Large Enterprises), It is important to be aware that such examples might be complex and adaptive and potentially considered as large-scale system of systems (SoS) implementation.

2. ***Case studies with increased availability of data:*** The proposed approach may be tested in environments that offer a higher availability of data. For example, data should be gathered seasonally to assess the long-term impact, mainly against 'to-be' designed models, to evaluate the optimised strategic and operational decisions in the long term.

3. ***Extension of dynamic model to MDA:*** Future work could be done on MDA in order to look for a possible one-click model transformation from the dynamic model in 'system dynamic modelling' to an implementation model using MDA's transformation capability. This is a completely innovative direction that can bring an evolution in system development by simulating different scenarios and implementing the suitable selected one: such integration may require using UML profiles and ontology platform for integration and interoperability.

4. ***Technical model design:*** The initial proposal planned in the first year of this PhD study incorporated the development of an enterprise model for business and technical systems; this was aimed at showing a link from high level requirements and human thinking about the environment and business to a modernised system architecture that considered the development of multi-agent systems for self-automation and adaptation. However, because of the large scope of this work, it was decided to reduce the work and focus only on enterprise modelling, including the dynamics, reasoning and evaluation of related

issues in the business environment. Also software design using SoaML for services oriented architecture was presented in T-logic case study. Further technical design, specification and implementation could be considered to provide full business-IT alignment in a comprehensive enterprise architecture framework.

5. ***Topology of implementation and technical architecture:*** The implementation topology was not considered widely in the research. The second case study provided highlights of this topology, and possible technical solutions available to help build the framework such as event management systems, workflow engines and rules engines triggered by changes occurring out of ecological factors, economical, political, business environment factors and human activities, to be monitored through the workflow using dashboards. This could also fall under the area of intelligent SOA frameworks.

6. ***Implementing intelligent multi-agent systems:*** an extension to the implementation model can be made to implement multi-agent systems: two models can be used and extended to achieve this 1) Belief-Desire-Intention (BDI) (Rao and Georgeff, 1995), and 2) Roles, Norms and Sanctions (Tinnemeier, 2009). Many agents' development platforms are available for adopting these models. However, MDA can provide a suitable model-based environment to create an extension, and UML and OCL (Object Constraint Language) constraints can help in defining constraints to control the upper and lower limits of the agents' dynamic behaviour.

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Appendices

Appendix A: Enterprise Modelling Artefacts Taxonomy

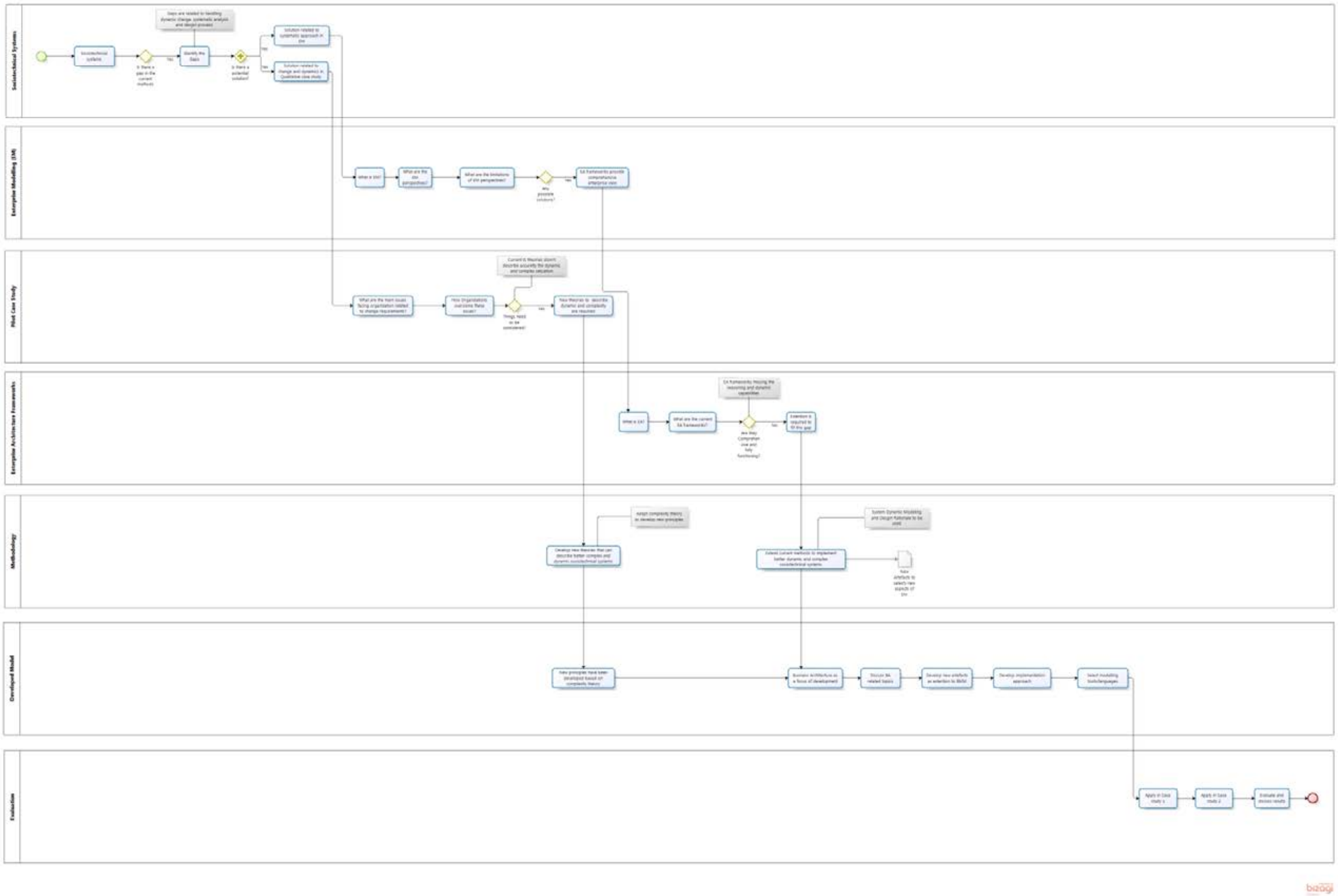
Definition of Key components and relations used in the Enterprise Modelling

Artefact	Definition
Actor	A person, organization, or system that has a role that initiates or interacts with activities; for example, a sales representative who travels to visit customers. Actors may be internal or external to an organization. In the automotive industry, an original equipment manufacturer would be considered an actor by an automotive dealership that interacts with its supply chain activities. (The Open Group, 2011a)
Position	It refers to viewpoint, opinion or location
Role	The part an individual or actor plays in an organization and the contribution they make through the application of their skills, knowledge, experience, and abilities. (The Open Group, 2011a) (General) A job function within the context of an organization with some associated semantics regarding the authority and responsibility conferred on the user assigned to the role
Agent	An agent is a person authorized to perform a certain action
Group	A collection or assembly of persons
Environment	Surroundings or conditions in which an individual or organization thrives
Activity	Any work performed on a project or as part of a program. It may be a task or a set of tasks to be completed (QGCIO)
Task	The obligation of an individual
Value	Anything of material worth which can be assessed
Goal	A prescriptive statement of intent that the system should satisfy through cooperation of its agents" (Lamsweerde, 2000). Or A Goal is a statement about a state or condition of the enterprise to be brought about or sustained through appropriate Means. A Goal amplifies a Vision. That is, it indicates what must be satisfied continually to effectively attain the Vision(OMG, 2010a).
Soft Goal	A soft goal is an objective without clear-cut criteria not associated to functional task, usually it is refer to non-functional goal.
Personal Goal	Personal goals are goals set by an individual to influence the direction of his efforts
Organizational Goal	An organizational goal is the desired state of affairs, which the organization attempts to realize. (Etzioni, 1964)
Service	It is an act of providing assistance to another person or organisation
Knowledge/Data	Data: The representation of facts, concepts or instructions in a formalised (consistent and agreed) manner suitable for communication, interpretation or processing by human or automatic means.(QGCIO)

Rule	Is a statement has a goal to govern or control behaviour.
Event	It is an occurrence. It can also mean a set of outcomes to which a probability is assigned
Policy	A service associated with maintaining law and order
Resource/Asset	A resource is any physical or virtual entity of limited availability that needs to be consumed to obtain a benefit from it (Wikipedia). Assets are economic resources.
Belief	Belief is the psychological state in which an individual holds a premise or proposition (Wikipedia)
Strategy	Strategy is the direction and scope of an organisation over the long-term: which achieves advantage for the organisation through its configuration of resources within a challenging environment, to meet the needs of markets and to fulfil stakeholder expectations". (Johnson and Scholes, 1999)
Tactics	Tactics are methods used to attain a goal
Process	A Process represents a means of realizing a course of action or fulfilling desired results.
Conflict	Conflict is actual or perceived opposition of needs, values and interests (Wikipedia)
Option	It is a choice or alternative
Assessment	It refers to estimation or appraisal or evaluation
Risk	A Risk is a kind of Impact Value that indicates the impact and probability of loss.
capabilities	An ability that an organization, person, or system possesses. Capabilities are typically expressed in general and high-level terms and typically require a combination of organization, people, processes, and technology to achieve (The Open Group, 2011a)
Object	It is a thing or a self-contained unit of data
Vision	A Vision describes the future state of the enterprise, without regard to how it is to be achieved. Vision is an overall image of what the organization wants to be or become. It usually encompasses the entire organization and is long-term in its perspective.
Mission	A Mission indicates the on-going operational activity of the enterprise. The Mission describes what the business is or will be doing on a day-to-day basis. A Mission makes a Vision operative -- that is, it indicates the on-going activity that makes the Vision a reality. A Mission is planned according to Strategies.
Responsibility	It is the duty or obligation of an individual or organization
Permeation/Access Control	Access control refers to exerting control over who can interact with a resource (Wikipedia)
Norms	It is a standard used to designate a group or a community, it becomes commonly followed by the group
Action	It refers to any activity, making action is moving from stillness mood to active mood
Location	It is a site or place, could be physical or virtual
KPI	Key performance indicators are defined as "a set of measures focusing on those aspects of organisational performance that are the most crucial for the current and future success of the organisation" (Parmenter, 2007, p. 3).
Input/output	Input is the data fed into a system or a computer/ Output is the yield or information that exit a computer or a system
Cost	It is the price of a product or service
Situation	It refers to a particular condition or situation

Audit	It refers to an evaluation of a person, organization, system, process, enterprise, project or product (Wikipedia)
Facades	It is the exterior of the enterprise architecture
Product	It is an object or artefact that has been resulted by set of activities
Relation	**Definition**
Generalization	A generalization of a concept is an extension of the concept to less-specific criteria (Wikipedia)
Association	It is a relationship or an organization
Aggregation	It is the collection of multiple data
Dependency	It refers to reliance where component need another to do something
Inheritance	It is the hierarchical transfer of all definitions and methods of a class to its sub-classes
Sequence/Timing	Sequence is the progression of elements. Timing is the spacing of time to derive an effect of a particular moment
Hierarchy	It is an organizational structure
Composition	A solution that is assembled and orchestrated from independent parts. Compositions are orchestrated assemblies of data, processes and services. Composition is not synonymous with composite application (Gartner Glossary)
Decomposition	It is the process of moulding
Union/merge	Union refers to amalgamation or uniting or merging two entities or objects
Split	It refers to dividing or separation
intersection/Share	Intersection is the convergence of two points. Share refers to splitting or dividing one component or portion
Provide	It refers to supply, where component provide something (service, product, information, etc) to another
Hurt	It refers to harm, where the component effect negatively on another component in the enterprise
Make	It refers to construct or create or produce an object
Support	It refers to the act of upholding structures
Break	It refers to damage or failure
Fuzzy effect	Fuzzy effect or logical reasoning enables the modelling of undefined concepts by making explanations in mathematic.
Play/represent	Play refers to performing a role or an act. By represent we mean the act of an agent on behalf of a person or organization
Equal/Is a	Equal refers to identical. “Is a” refers to ‘subsumption’ or the act of including something within a larger and more comprehensive group (Wikipedia)

Appendix B: Research Process



Appendix C: Exploratory Case Study Details

Targeting of Interviewees

Interviews with eleven senior, middle and junior staff from various departments across two different companies have been conducted; one is Enterprise IT Company and another SME Company. The interview schedule was designed so that the interviews lasted for average about of 60 minutes in order to generate a reasonably detailed impression of the issues encountered with the system.

TABLE 180: PARTICIPANTS AT THE IT COMPANIES - EXPLORATORY STUDY

ID	Participant's Designation	Company class	Length of Interview
EBA	Business/System Analyst	Enterprise IT	35 mins
EAM	Account Manger	Enterprise IT	60 mins
EPS	Pre-Sales	Enterprise IT	70 mins
ESS	Senior Strategic Member	Enterprise IT	40 mins
ESE	Software Engineer	Enterprise IT	120 mins
EPM	Product Manager	Enterprise IT	35 mins
SEO	CEO	SME's	100 mins
STO	CTO	SME's	40 mins
SSD	Senior System Developer	SME's	60 mins
SDB	DB architect	SME's	50 mins
SSA	System Analyst	SME's	120 mins

Interview Design

The interview schedule was designed from existing literature on approaches of analysing and designing socio-technical systems with particular attention given to factors identified as facilitators of social perception to knowledge understanding and sharing. In addition, to understand influencers impact the enterprise and the influences are affected by the enterprise during reasoning and decision-making process, that will produce design and operation impact on the entire work in term, which could offer insights into the decision-making process in dynamic environment. The interview guide was altered according to the type of company interviewed. A semi-structured interview approach was chosen rather than a structured approach, because of the exploratory nature of the research, which will be followed by explanatory cross-domain theory implication. The exploratory case study interview schedule had four sections 'themes', change in socio-technical system environment, and how this change might influence the development process, who make decision about action and who own the knowledge to make decision and perform the change. Each of which is briefly reviewed below:

Section 1: Perceptions/Beliefs about requirements and change

The schedule began with some preliminary questions about the informants, what their role was within the company, what are the change drivers in their work and what kind of challenges they face in the daily activates. Also if they have experienced knowledge visualizing tools to support their daily activities. Finally, informants were asked what the change assessment and planning level in their work is, and how they make this assessment/planning.

Section 2: Knowledge decentralizing and sharing issues

The informants at the IT companies were asked to identify the decisions and problem solving methods and to explain how the teams were interacting and share the knowledge and how decisions made at the company. The informants were asked about communication methods (formal and non-formal) in the organization, and their point of view about it is validity.

Section 3: Control and flexibility issues in management style

The informants were asked if the procedures were followed strictly in the organization and what is the level of flexibility they own in making decisions. The informants were also asked to identify the key actors participating in the solution development process, and if any issues occurred in the process to which they should refer to, if yes how they can handle it.

Section 4: Change in planning and development process

The informants were asked about the company planning and development process and how they preserve the work in term of strictly procedural planned change or flexible and emergence change type, and what management and development tools/approach they follow.

Table 181 presents a list of interview guiding questions for each particular theme:

TABLE 181: INTERVIEW GUIDING QUESTIONS

Semi-structured questions will guide data collection to provide better understanding of how change handled in the IT industry	
Question	**Theme**
1. Can you tell me about your job and responsibilities?	General
2. In your daily work activities, do you follow the processes and rules as it has have been designed?	Section 1&3:
3. How you describe the management style in your organization? Power and negotiation process?	Section 2: (Pillay et al, 2012)
4. In your daily activates how you make decision regarding what it should be done and what is not?	Section 3: (Jarke et al, 2009)
5. What is the development approach used in the organization? How do you feel about it?	Section 4:
6. Do your organization use any visualizing and modelling tools (software and business)	Section 4: (Lamsweerde, 2009)
7. What kind of difficulties you could face in the daily work?	Cross thematic
8. What are the change drivers in organization and in your work?	Section 1: (Jarke et al, 2011) (Pillay et al, 2012)
9. Is it possible to happen misunderstanding of the required work? How you overcome this issue?	Section 2: (Yu, 2009), (Lautenbacher, 2007)
10. For which level the risk assessment considered in your organization?	Section 1&4: (Tran, 2011), (Lamsweerde, 2009)
11. From your point of view, what are the things influence the organizational work, either internal or external influencers?	Section 1: (Tran and Massacci, 2011), (Yu, 2009)

Appendix D: Info2cell Case Study Details

I. RDBMM for Quality of Services Line Modelling

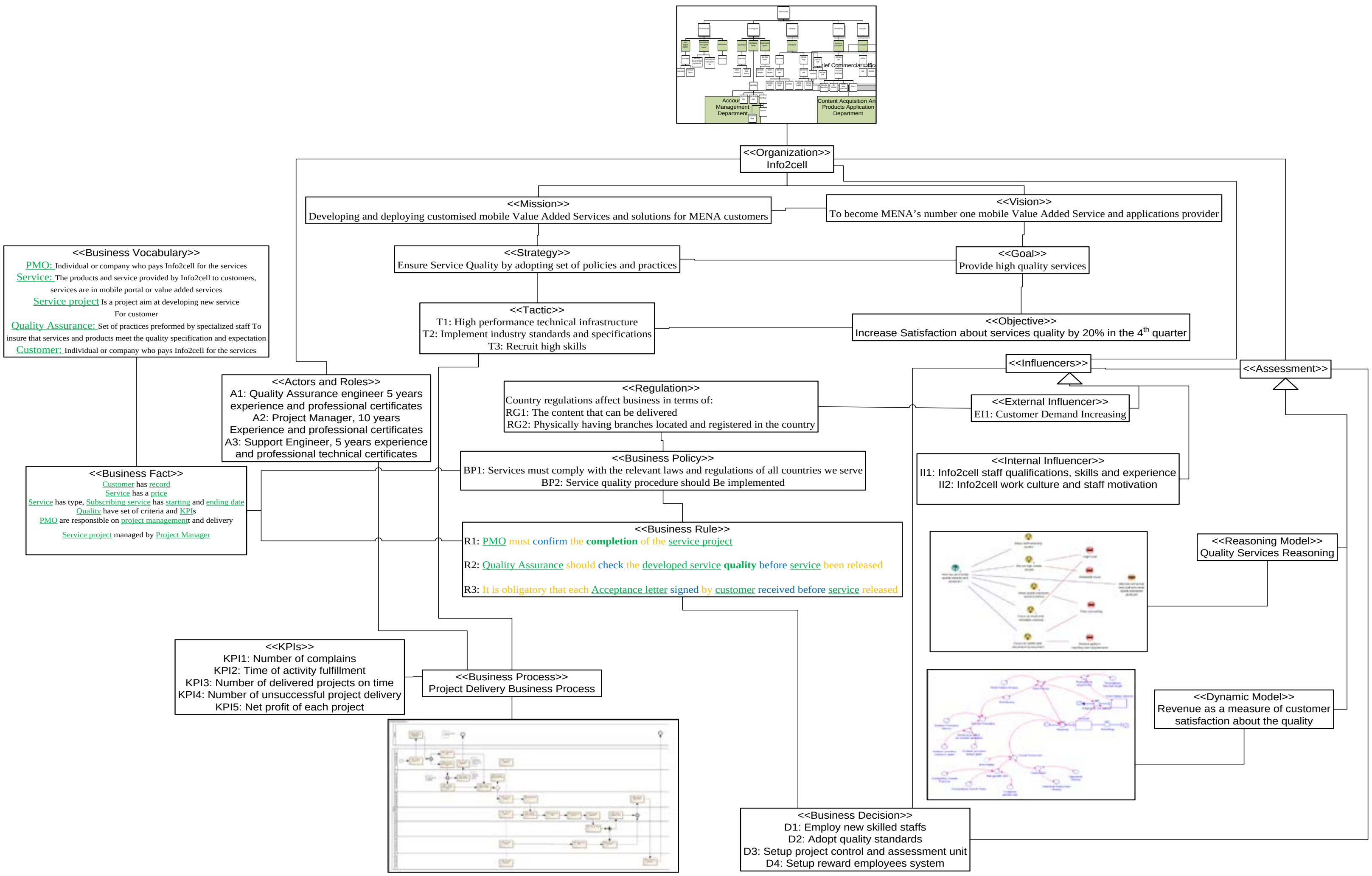


FIGURE 77: RDBMM FOR QUALITY OF SERVICES LINE

II. Quality of Service Reasoning

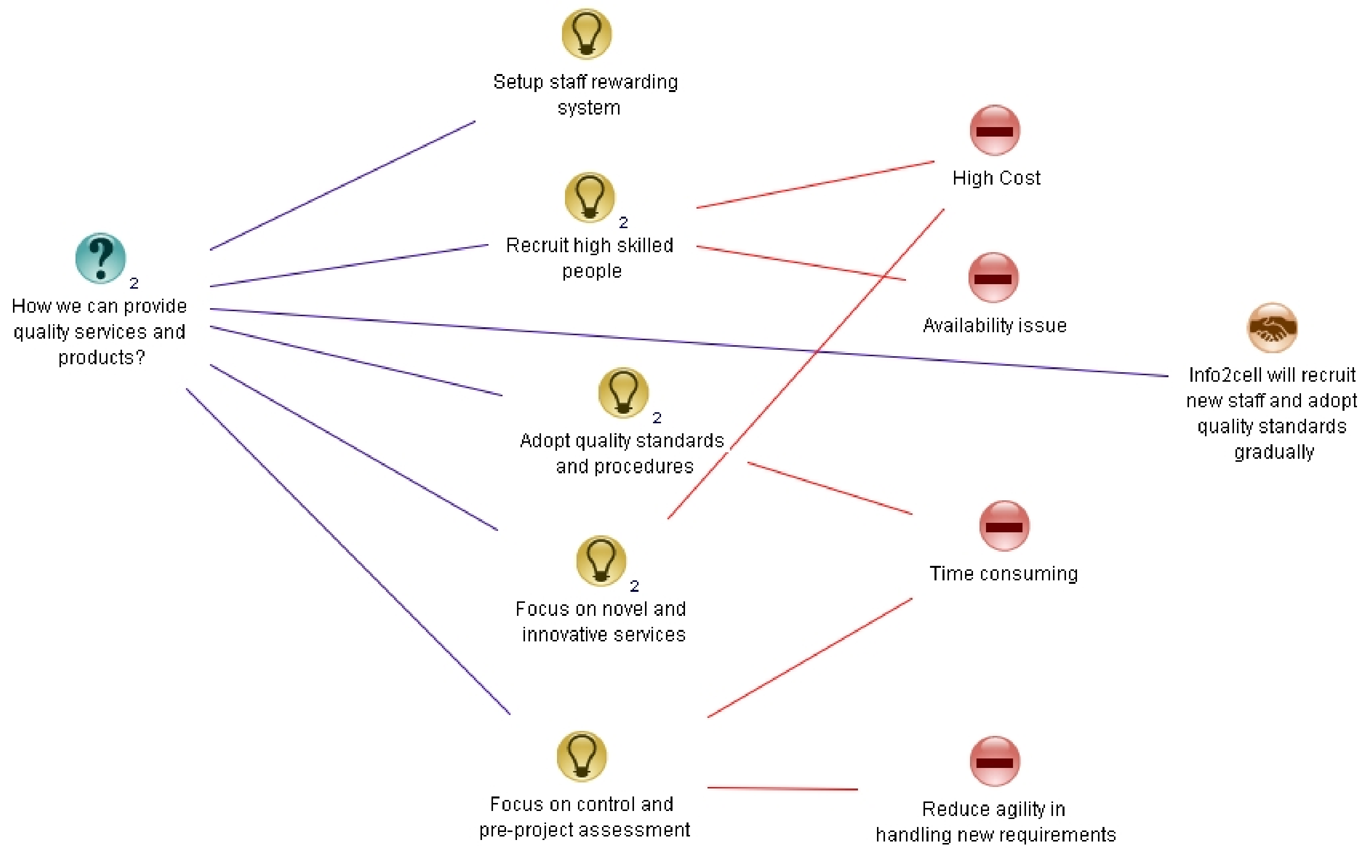


FIGURE 78: QUALITY SERVICES REASONING

III. Organization Structure

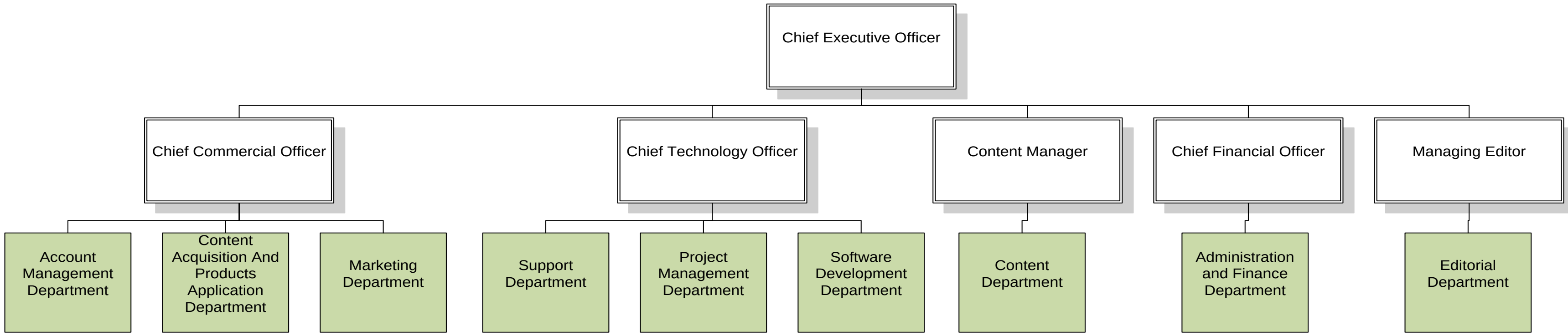


FIGURE 79: EXECUTIVES AND DEPARTMENTS

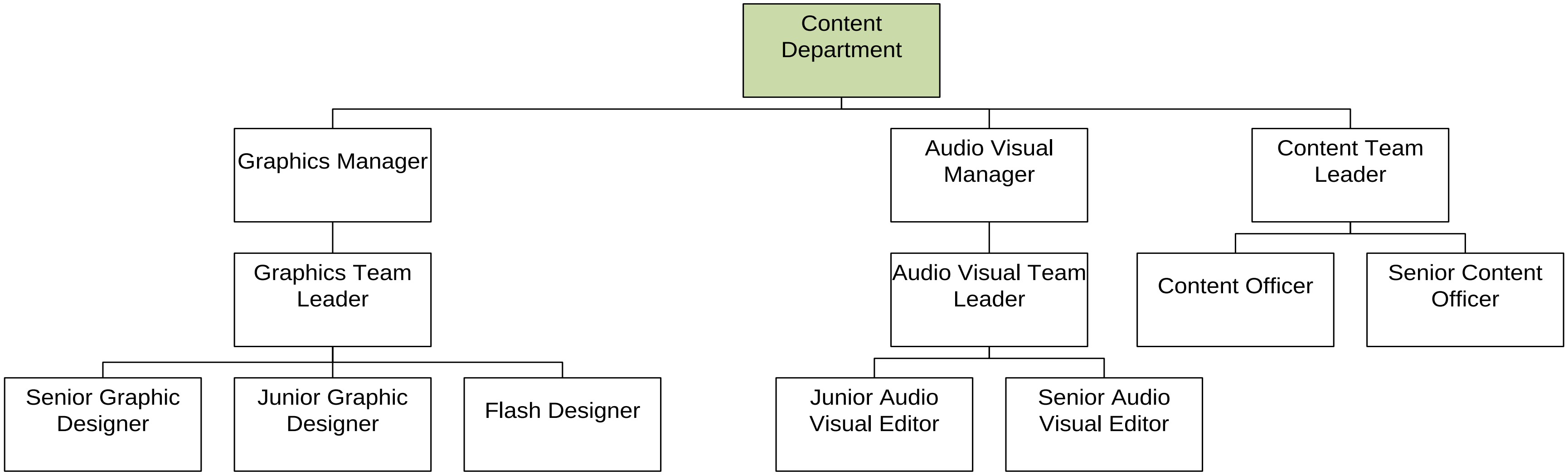


FIGURE 80: CONTENT MANAGEMENT DEPARTMENT

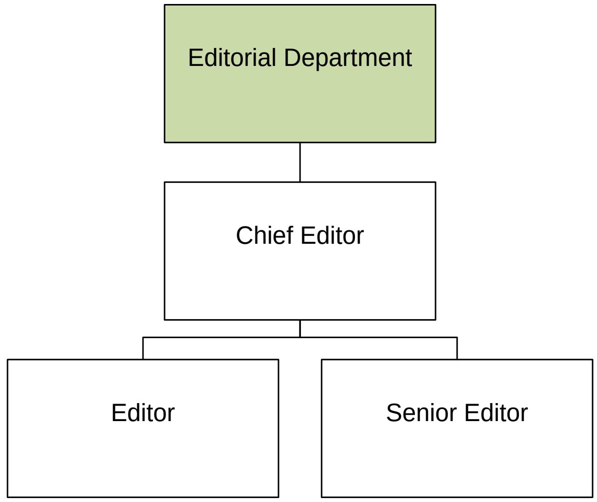


FIGURE 81: EDITORIAL DEPARTMENT

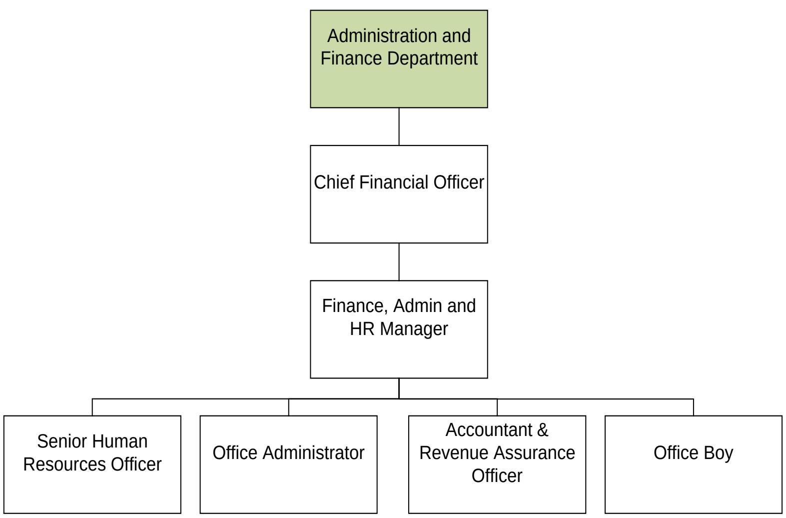


FIGURE 82: ADMINISTRATION AND FINANCE DEPARTMENT

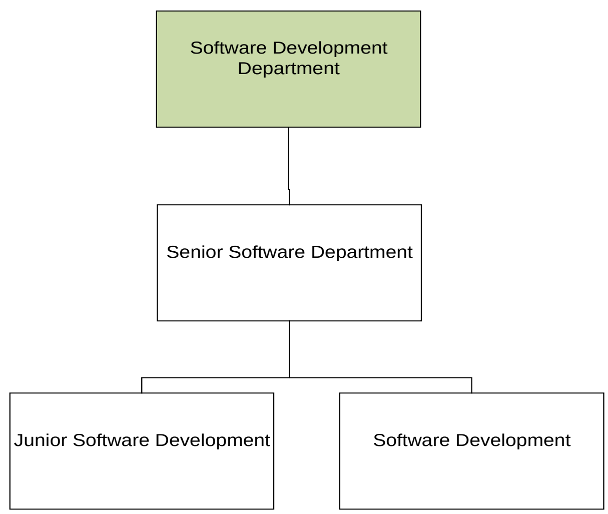


FIGURE 83: SOFTWARE DEVELOPMENT DEPARTMENT

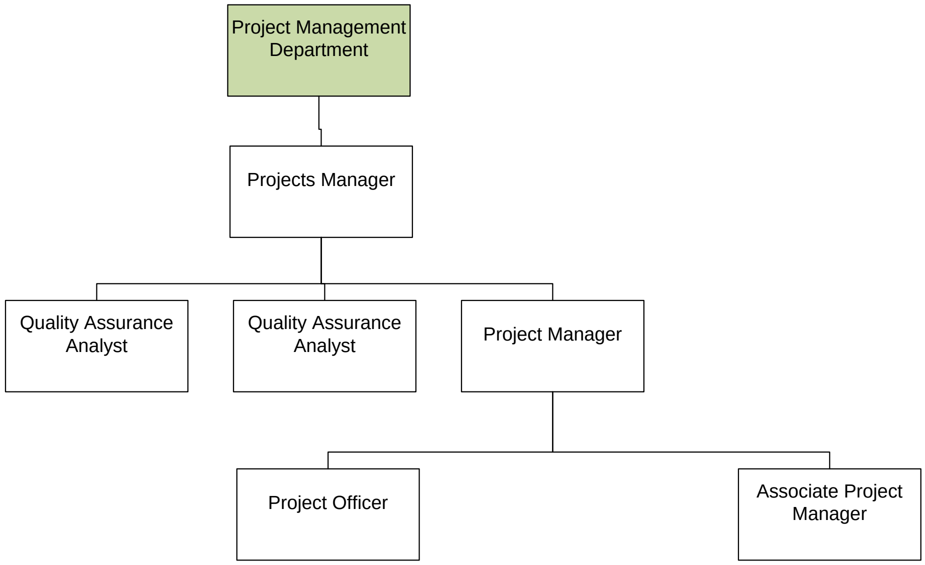
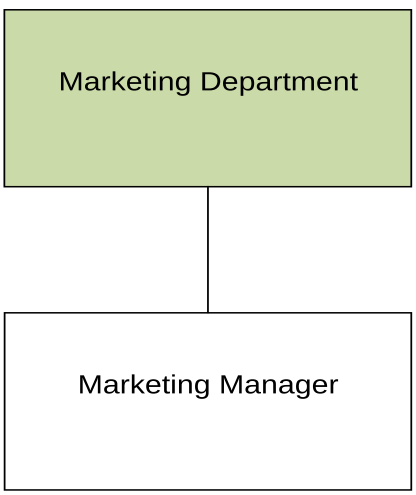


FIGURE 84: PROJECT MANAGEMENT DEPARTMENT



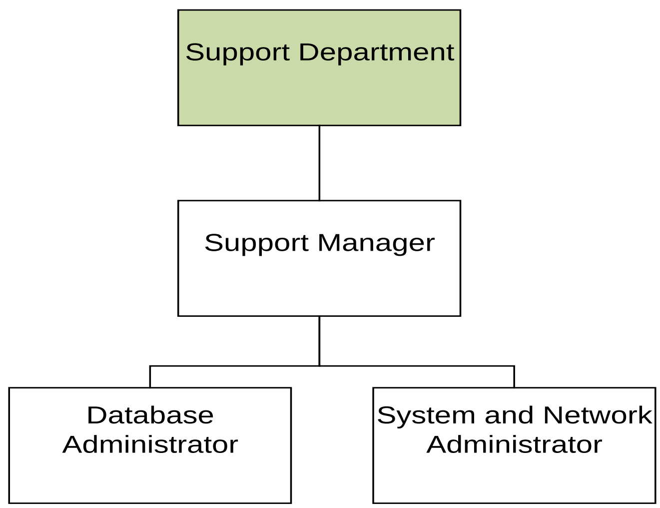


FIGURE 85: SUPPORT DEPARTMENT

FIGURE 86: MARKETING DEPARTMENT

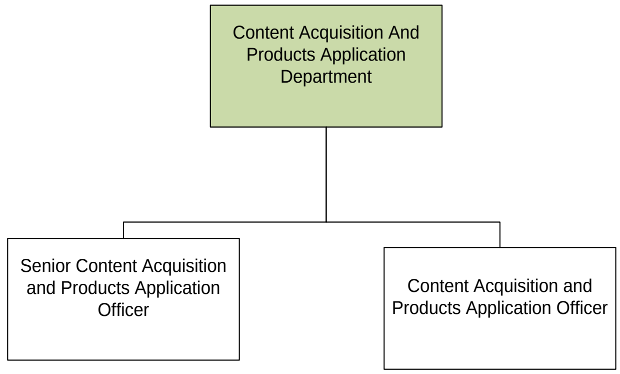


FIGURE 87: CONTENT ACQUISITION AND PRODUCT APPLICATION DEPARTMENT

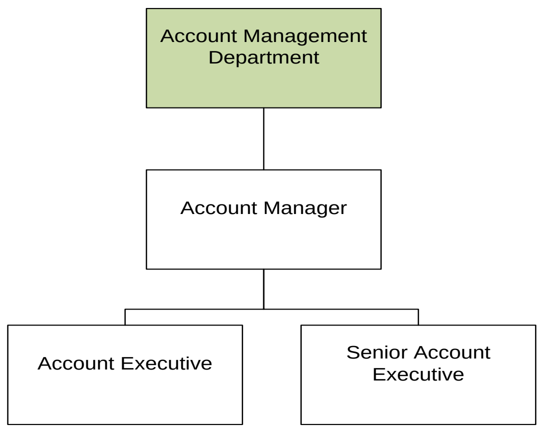


FIGURE 88: ACCOUNT MANAGEMENT DEPARTMENT

IV. Interviewees

I interviewed twelve senior, middle and junior staff from various departments across the company. The interview schedule was designed so that interviews lasted for average about of one hour in order to generate a reasonably detailed impression of the issues encountered with the system.

TABLE 182: PARTICIPANTS AT THE INFO2CELL

No.	Participant's Designation	Participant's Department	Years of Works with I2C	Length of Interview
IS1	Founder & CEO	Company Director	20	45 mins
IT1	CTO	Technical Department	8	4 x 60 mins
IT2	QA Specialist	Technical Department	4	70 mins
IT3	Software Engineer	Technical Department	2	60 mins
IT4	Support	Technical Department	1	50 mins

	Engineer			
IT5	Project Manager	Technical Department	5	35 mins
AF1	HR Manager	Admin & Finance Department	6	55 mins
AF2	CFO	Admin & Finance Department	8	40 mins
CM1	Account Manager	Commercial Department	3	60 mins
CE1	Content and Editorial Manager	Content & Editorial Departments	2	60 mins
CE2	A/V Team leader	Content Department	5	120 mins
OM1	Operation Manager	Operation Department	5	70 mins

V. Interview guiding questions

A) Election the strategic information of the company - Interviews

The interview questions have been developed through the investigation stage to fulfil the information needed to model the RDBMM. Similar questions have been used by several authors to model business-IT alignment through goal oriented modelling (Singh and Woo, 2009).

TABLE 183: STRATEGIC DATA COLLECTION INTERVIEW GUIDING QUESTIONS

Questions will guide strategic data collection to provide better alignment with operational activities and the underlying information systems
Formal data questions
12. What is the business of the company? What is the business model? **13. What are the company products and/or services?** **14. What are the Vision and Mission?** **15. Who are the stakeholders?** **16. Who are the customers?** **17. What is the company strategy?** **18. What are the organization/strategic goals used to fulfil this strategy?** **19. Can we better refine these goals to sub-goals? What are they?** **20. Are the goals fulfilling the SMART criteria?**
Strategic Sense-making questions
21. What are the dynamic forces leads the company into change? **22. What are the opportunities and threats in the industry?** **23. What are the weaknesses and strengthens of the company?** **24. What are the company competitive advantages?** **25. Are there any problems/issues face the company in its daily activities?**

26. Is there a motivation for change? What is it? Does the company possess the capability to do so?
Strategic Constructive engagement questions
27. How those strategic goals contribute in achieving the company mission/vision? 28. Are the strategic goals amenable to the external industrial environment and internal company characteristic? 29. What are the resources being devoted to attainment of the strategic goals? 30. Are the resources adequate to attain the targeted strategic goals and if not, what can be done about it?

B) Election the operational information based on goal oriented - Interviews

TABLE 184: OPERATIONAL DATA COLLECTION INTERVIEW GUIDING QUESTIONS

Questions will guide election of operational and personal requirements related to intended information systems of the organization
Formal data questions
1. Can you describe the task you perform? How it contribute in organizational goal? 2. How you measure the goal achievement? What is the KPI's of the goal? 3. How the outcomes contribute toward the overall performance of the previous and followed task? 4. What is the level of difficulty of achieving this goal? Is it new experience or repeated? 5. Is achieving the goal contain or face any unethical activities? 6. Any Conflicting between goals/tasks assigned to you? 7. What are the company resources allocated to you to perform this task? 8. Any conflict between your tasks and the resources assigned to you? If yes, what you can do about it? 9. Any other risks associate with execution the goal? 10. Any history related to this goal? How this can effect on your performance? 11. Any other things can effect on achieving the goal? 12. Do you devote any personal resources to increase the performance of your tasks? 13. Are these personal resources adequate for you to perform your tasks? If not what you can do about it?
Operational Sense-making questions
14. With the resources allocated to you to perform the task, what is the company expectation of you to utilize these resources? 15. What purpose does the performance of your task serve in the firm? 16. Do you feel there is any conflict between your expectation and the company expectations of those performed tasks? If yes, what they are?
Operational Constructive Engagement questions
17. What do you expect from performing your tasks? 18. What inhabit you from performing your tasks?

VI. Issues X Staff tables

a) Internal issue matrix

TABLE 185: INFO2CELL INTERNAL ISSUES

Issue/Staff Code	IS1	IT1	IT2	IT3	IT4	IT5	AF1	AF2	CM1	CE1	CE2	OM1
Employees feel lack of trust in rewarding system.			**X**								**X**	
Marketing department need more planning, market and services insight and initiative actions.	**X**							**X**				
Employees do not feel the appreciation from senior and management staff.											**X**	
Supportive processes (HR/Admin processes) are very slow and less efficient.			**X**			**X**			**X**		**X**	
Employees can't see a value of "employee voice" means							**X**					
Research and Development is required to improve innovation and maintain market leadership.	**X**	**X**										**X**
Services localization, personalization and customization are very important for company success.	**X**								**X**	**X**		
Unclear key performance indicators may effect on goals clarity.									**X**			
Salaries scale lower than market average and work load	**O**		**X**		**X**		**O**				**X**	
Work load is high (quality X time)			**X**		**X**					**X**		

The assessment criteria are not clear and are not shared with the employees.				**X**								**X**
Communication between departments featured by ad-hoc actions				**X**		**X**						**X**
Department managers should work harder to improve management and leadership not only to fulfil their tasks								**X**		**X**		
It is not easy to find the required skills and qualifications in the market.	**X**							**X**				
	O = The person made the opposite claim					**X= The person made claim**						

b) External issues matrix

TABLE 186: INFO2CELL EXTERNAL ISSUES

Issue/Staff Code	IS1	IT1	IT2	IT3	IT4	IT5	AF1	AF2	CM1	CE1	CE2	OM1
The market trend is changing rapidly	X	X		X		X		X	X			X
Operators control and monopoly the customers data		X										
Mobile applications projects should be selected carefully		X		X				X			X	
Competitors are increasing in the VAS market	X		X				X	X		X		
Customer demand increasing and market expanding		X		X	X				X	X		
Some countries policies regarding service providing require local partner		X						X				
Market talents acquisition cost the company losing a lot of employees	X		X							X		X
The content providers increase the debt payment/minimum grant		X										
The services price governed by market and local	X					X		X	X		X	

Establishing a good relationship with customers/operators is a key factor of revenue sustainability.					X	X			X			
Operators may influence the revenue and service success			X							X		X
	O = The person made the opposite claim					**X= The person made claim**						

Appendix E: T-Logic Case Study Details

I. Interviewees

I interviewed five shareholders from the company. The interview schedule was flexible to the time the shareholders are free and the period they can offer, Semi-structured interviews with guiding questionnaires that used in the previous case study have been used for T-Logic case.

TABLE 187: PARTICIPANTS AT THE T-LOGIC

No.	Participant's Designation	Participant's Department	Years of Experience	Length of Interview
EM	Executive Manager	Management Department	9	3X45 mins
MM	Marketing & Sales Manager	Management Department	8	2 x 60 mins
DM	Development Manager	Management Department	10	50 mins
TM	Training Manager	Management Department	8	60 mins
PM	Project Manager	Management Department	5	55 mins

Appendix F: Socio-technical Systems Risk Types

In the table below list of the most common risks could face the enterprise

TABLE 188: RISK TYPES AND CLASSIFICATIONS

External Artefacts	Type	Description
Global Economy	Institutional /Organizational	Economy of the whole world countries.
National Economy	Institutional /Organizational	Economy of the country where the enterprise located, taking in consideration the relation is tight with the regional and global economy
Climate	Environmental	Climate status and change influence directly or indirectly the enterprises and economy.
Natural Disasters	Environmental	Earthquake, volcanoes and hurricanes effect directly on national economy and enterprises.
Caused events	Social based	Things happen with intention such as Terrorism, strikes and demonstrations also influence enterprises and economy
Political Situation	Institutional	Stability in political situation has direct impact on

	/Organizational	economy and enterprises i.e. Egyptian revolution and how it drops down the economic growth.
Natural resources	Environmental	The resource influence the GDP rate, thus influence the national economy, industry and therefore the enterprises. The resources could include human and sustainable resources.
Customer Demand	Social	Costumer demand might change with time, this change force enterprises to setup change to meet customer expectations.
Competitors	Institutional /Organizational	Competitors' services, products and prices play crucial role in enterprise business model and marketing strategy.
Partners	Institutional /Organizational	Partners as (providers or distributors or resellers) can influence work by their ability to deliver with high standard and quality.
Emergent Technology	Technical	Emergent technology could disturb market direction, thus, understanding and adapting the new technology can increase competitive advantages
Government Regulation	Institutional /Legal	Government regulations may limit the enterprise activities and could put additional cost. Therefore, it is important to comprehend the regulations before designing business.
Culture	Social	Understanding the country culture where the enterprise operate/target is important key success factor
Industrial Policies	Institutional /Legal	Industrial policies similar to country policies might enforce new level of boundaries on the enterprises work in specific industry. e.g. strong regulations applied to the healthcare and medicine industry.
Internal Artefacts	Type	Description
Employees	Social	Employees motivation, goals, expectation, capability, skills and background play crucial role in the enterprise performance
Organization Culture	Social	Country culture and organization culture intertwining between themselves with great impact on enterprise activities. common norms are different between organizations even in the same country
Leadership Style	Institutional /Organizational	Top-down, Bottom-up, heterogeneous leadership style will impact performance, knowledge sharing and control mechanism.
Organizational Structure	Institutional /Organizational	Structural, network, product base, project base, mixed or flat organizational structure should align with enterprise objectives before deciding the suitable structure which will impact on enterprise activities.
Business Model	Institutional /Organizational	Deciding the core business activities and supportive business activities will help to decide how to manage the enterprise with focus on delivering/making value
Intellectual Properties	Institutional /Organizational	What are the properties needs to be protected and how to protect intellectual properties? What kinds of risks

		associate to intellectual properties and who are the potential violators?
Technology Adopted	Technical	Technology used in the enterprise can influence the activities, facilitate, assess and help in decision-making. Ordinary technical components are not enough to smart enterprises in information era.
Performance	Social /Technical	Enterprise performance should have clear measure against objectives, how we can say the performance is suitable to the enterprise growth.
Assets and capital	Institutional /Organizational	Capital and assets compatibility are important for work efficiency, any shortage in assets can affect the enterprise.
Motivation and Strategy	Institutional /Organizational	Enterprise motivation act as a guideline for the enterprise
Policies and Rules	Institutional /Organizational	Work as a guideline for internal governance, the 3rd enforcement level after the country and industry policies and should be compatibility with them.
Knowledge flow	Social /Organizational	Knowledge should be managed (tacit or explicit) technical and social practices help to improve knowledge management likely to implement to improve internal process and efficiency.
Technology Reliability	Technical	The level and amount of work that the IS's can do efficiently
Technology security	Technical	The security is important aspects, many organization lost millions of pounds caused by lacking of technical and IS's security. The risk could damage the enterprise work.
Technology Usability	Technical	The level that stakeholders feel comfortable to use and work on IS's, how much they feel it is useful to work and make daily activities easier. Many organizations faced fail in IS's implementation due to the negative user experience.
Design Thinking	Social/Cognitive	Design should be involved in all of the enterprise levels, it is important because the enterprise need thinkers to adapt the enterprise to its dynamic environment.
Creativity	Social/Cognitive	Creativity in business model, creativity in using the assets and technology, creativity in business decisions are characteristic of the first mover enterprise.

Appendix G: Guiding Assessment Questionnaire

The following questionnaire is based on (Ganesan, 2011) to assess maturity and implementation of enterprise wide process modelling projects. This assessment guide has been used to assess Info2cell enterprise model maturity.

TABLE 189: ASSESSMENT OF ENTERPRISE MODELING MATURITY BASED ON CEPROM FRAMEWORK

1.0	Motivation	Assessment Questions	Response Parameter	Response Options	Score
1.1	Vision	Has the Vision of the enterprise process modelling initiative is well documented?	No documented Vision exists	0	
			Exist just as an idea within process modelling team	1	
			Documented Vision exists but not clear	2	
			Documented Vision exists, clear but not communicated	3	3
			Documented Vision exists, clear and socialized	4	
1.2	Mission	Has the Mission of the enterprise process modelling initiative is well documented?	No documented Mission exists	0	
			Exist just as an idea within process modelling team	1	
			Documented Mission exists but not clear	2	
			Documented Mission exists, clear but not communicated	3	3
			Documented Mission exists, clear and socialized	4	
1.3	Objectives	Has the Objectives of the enterprise process modelling initiative is well documented?	No documented Objectives exists	0	
			Exist just as an idea within process modelling team	1	
			Documented Objectives exists but not clear	2	
			Documented Objectives exists, clear but not communicated	3	3
			Documented Objectives exists, clear and socialized	4	
1.4	KPI	Has the Performance Measures (KPI) of the enterprise process modelling initiative is well documented?	No documented List of KPI exists	0	
			Exist just as an idea within process modelling team	1	
			Documented List of KPI exists but not clear	2	2
			Documented List of KPI exists, clear but not communicated	3	
			Documented List of KPI exists, clear and socialized	4	
1.5	Service	Has the Service Definition of	No documented Service Catalogue definition exists	0	

	Definition	the enterprise process modelling initiative is well documented?	Exist just as an idea within process modelling team	1	
			Documented Service Catalogue definition exists but not clear	2	2
			Documented Service Catalogue definition exists, clear but not	3	
			Documented Service Catalogue definition exists, clear and	4	
2.0	Governance	Assessment Questions	Response Parameter	Response Options	Score
2.1	Governance Framework	Does a Governance/Decision Making Framework exist for classifying decisions based on impact and define implementation criteria for process modelling?	No Governance Framework Exists	0	
			Governance Framework exists just as an idea with process	1	
			Basic Governance Framework Exists	2	2
			Advanced and Traceable Governance Framework Exists	3	
			Advanced, Traceable and Socialized Governance Framework Exists	4	
2.2	Maturity Model	Does a Maturity Model Framework for process modelling that classifies state of affairs of process modelling into various stages is available?	No Maturity Model Framework Exists	0	
			Maturity Model Framework exists just as an idea with process team	1	
			Basic Maturity Model Framework Exists	2	2
			Advanced and Traceable Maturity Model Framework Exists	3	
			Advanced, Traceable and Socialized Maturity Model Framework Exists	4	
2.3	Operating Model	Is there a defined operating model for enterprise process modelling available or utilized? Operating Model defines roles/responsibilities of stakeholders as well define mechanism of how process modelling is conducted - centralized or distributed for effective project management?	No defined Operating Model exist	0	
			Adhoc on-the-go Operating Model is used	1	
			Basic Operating Model exists with stakeholders defined	2	
			Advanced Operating Model with stakeholder as well mechanism for	3	3
			Advanced Operating Model available and well socialized with various teams	4	

2.4	Budget and Cost Estimations	Are there mechanisms in place to track budget and cost incurred for enterprise process modelling initiative?	No defined Estimation Model for budget and cost exist	0	
			Adhoc on-the-go Estimation Model is used	1	
			Basic Budget and Cost Estimation Model available with defined	2	2
			Advanced Budget and Cost Estimation Model available with defined parameters and traceable	3	
			Advanced Budget and Cost Model available with defined parameters, traceable and socialized with various	4	
2.5	Alignment with Other Initiatives	Does a structured mechanism or documented understanding of alignment of enterprise process modelling with other organization initiatives like EA, BPM, EM is	No documentation exists for initiatives alignment	0	
			Exist just as idea within process team	1	1
			Documented Alignment approach exists but not clear	2	
			Documented and clear Alignment approach exists but not communicated	3	
			Documented, clear and socialized Alignment approach exists	4	
3.0	Modelling and Architecture Definition	Assessment Questions	Response Parameter	Response Options	Score
3.1	Modelling Methodology	Is there a structured documented process modelling methodology available? Is that document kept alive as the process modelling service progresses?	No Process Modelling Methodology documentation exists	0	
			Exist just as idea within process team	1	
			Basic Process Modelling Methodology Document exists	2	2
			Detailed Process Modelling methodology document exists with various process	3	
			Advanced Process Modelling methodology document exists with various process modelling scenarios explained as well as	4	
3.2	Process Architecture Blueprint	Has the business process architecture blueprint - value stream and major enterprise processes for business functions are defined? Whether	No Process Architecture Blueprint exist	0	
			Vague grouping of major processes exist - but not as a blueprint document	1	

		the major processes are identified and baselined?	Basic blueprint of business process architecture exist but the process to define	2	2
			Structured approach is utilized to define business process architecture blueprint (Clean Slate, Basic or Advanced approach) and	3	
			Structured approach is utilized to define business process architecture blueprint (Clean Slate, Basic or Advanced approach), documented and socialized with	4	
3.3	Modelling in Practice - Conceptual Metamodel definition	Process Modelling in practice - Is there a defined conceptual metamodel along with properties of each element of conceptual metamodel for modelling business processes exists?	No Conceptual Metamodel exists	0	
			Exist just as idea within process team	1	1
			Elements and relationships of Conceptual Metamodel defined	2	
			Elements, relationships and properties of Conceptual Metamodel defined	3	
			Elements, relationships, properties of Conceptual Metamodel defined and socialized with various	4	
3.4	Modelling in Practice - Activity Aids (templates/ guidelines/ checklists)	Process Modelling in practice - are there templates/guidelines/checklists available for various process modelling aspects - activity modelling, elicitation mechanism, properties of elements gathering, issue and risk templates etc	No templates/guidelines/checklists documentation exists	0	
			Exist just as idea within process team	1	
			Documented templates/guidelines/checklists exists but not clear	2	2
			Documented and clear templates/guidelines/checklists exists but not communicated	3	
			Documented, clear and socialized templates/guidelines/checklists exists	4	
3.5	Process Modeling Quality	Does a structured mechanism exist to validate the quality of business process models? Are there checklist/guidelines available to ensure that the process models adhere to adopted process modelling	No Process Modelling Quality monitoring exists	0	
			Exist just as idea within process team	1	
			Documented Process Modelling Quality monitoring mechanism exists but not	2	2

		methodology completely?	Documented and clear Process Modelling Quality monitoring mechanism exists but not communicated	3	
			Documented, clear and socialized Process Modelling Quality monitoring mechanism exists	4	
4.0	Tool Administration	Assessment Questions	Response Parameter	Response Options	Score
4.1	Tool Evaluation and Selection	Does a structured approach is utilized for understanding the pros/cons of market available enterprise process modelling tools to evaluate and select them?	No approach used	0	
			Tool Selection was done based on some vague idea that existed in process modelling team	1	
			Adhoc approach was used for Tool Selection wherein secondary research was	2	2
			Structured Tool Selection criteria/checklist was used and primary research was conducted with the vendors	3	
			Structured Tool Selection criteria/checklist was used and primary research was conducted with the vendors and socialized with stakeholders within the firm	4	
4.2	Tool Deployment	Is there a standard operating procedure listed down for tool deployment - deployment, availability and accessibility for various stakeholders across the firm?	No standard operating procedure for Tool Deployment exists	0	
			Exist just as idea within process team	1	
			Documented Tool Deployment standard operating model exists but not	2	
			Documented and clear Tool Deployment standard operating model exists but not communicated	3	3
			Documented, clear, socialized and followed Tool Deployment standard operating model exists	4	
4.3	Platform Management	Is there a standard operating procedure listed down for platform management - user group definition, properties/access controls for users and maintenance of users?	No standard Platform Management operating procedure	0	
			Exist just as idea within process team	1	
			Documented Platform Management operating procedure exists but not	2	

			Documented and clear Platform Management operating procedure exists but	3	3
			Documented, clear, socialized and followed Platform Management operating procedure	4	
4.4	Tool Operation Procedure	Is there a standard operating procedure listed down for tool operation - model management, import/export of process models, publications of models, backup policies etc?	No standard Tool operating procedure exists	0	
			Exist just as idea within process team	1	
			Documented Tool operating procedure exists but not clear	2	
			Documented Tool operating procedure exists and clear but	3	3
			Documented, clear, socialized and followed Tool operating procedure exists	4	
5.0	Library Management	Assessment Questions	Response Parameter	Response Options	Score
5.1	Process Model Availability	Is there a common understanding on how the process models shall be made available to various stakeholders across the firm - html repository, team space, portal, wiki etc and how exactly the process models are linked/delinked?	No approach used	0	
			Process Library/Repository is maintained only within the process team without	1	
			Adhoc Process Library/Repository is maintained that doesn't follow any structure	2	
			Advanced Process Library/Repository exists with a structured approach that allows customization of linking/delinking business processes	3	3
			Advanced Process Library/Repository exists with a structured approach that allows customization of linking/delinking business processes and socialized through intranet with stakeholders	4	
5.2	Repository Features	How advanced are the features of the process library - does users have options to search, view or browse process	No features available	0	
			Only basic process models are made available	1	
			Navigation to various process models and hierarchy is possible	2	

		repository?	Search of business process models is enabled along with navigation to various	3	3
			Advanced features of search, view, browse process models along with portal that users can view and edit is	4	
5.3	Business Glossary	Does a business glossary detailing all the relevant terms that are associated with enterprise process modelling (specific to the firm and general terms) is made available to stakeholders?	No Business Glossary exists	0	
			Exist just as idea within process team	1	
			Documented Business Glossary exists but not clear	2	
			Documented and clear Business Glossary exists but not communicated	3	3
			Documented, clear, socialized Business Glossary exists and kept live	4	
5.4	Repository Feedback Mechanism	Does a feedback mechanism for various models that are part of the process library/repository is available for stakeholders to	No feedback mechanism exists	0	
			Exist but not as part of process library/repository	1	
		Communicate comments/changes?	Feedback mechanism is available for various stakeholders as part of process	2	2
6.0	Stakeholder Management	Assessment Questions	Response Parameter	Response Options	Score
6.1	Stakeholder Buy-in	Does buy-in for the enterprise Process modelling initiative is garnered from various stakeholders of importance - from CXO community, to executive managers and line managers? Also are teams of various other initiatives like enterprise architecture, compliance team, product teams etc are gathered sufficiently by the process modelling team council?	No Stakeholder buy in exists	0	
			Only process modelling team knows what is happening and internally discussed for projects happening	1	
			Only line managers of process modelling team are informed and buy in is	2	2
			Sufficient buy-in from various stakeholders level is solicited - from CxO team, executive management of various functions/business units and line managers/business process owners	3	

			Sufficient buy-in from various stakeholders level is solicited - from CxO team, executive management of various functions/business units and line managers/business process owners as well as other enterprise initiative owners	4	
6.2	Communication & Engagement Model	Is there a communication strategy and proper engagement management approach at various levels of stakeholders is defined?	No communication mechanism in place	0	
			Only process modelling team communicates among themselves for projects involved	1	
			Adhoc communication mechanism exists but only for certain stakeholder community - especially for line management of	2	
			Proper communication strategy in place and events are defined for communication but mostly the communication is push system from process	3	3
			Advanced two way communication and appropriate engagement model exists among the process modelling team and	4	
6.3	Stakeholders Time Management - Elicitation	Is there an organization mandate which enables the process modelling initiative/team to effectively utilize stakeholders (process owners and process line management & team) time for elicitation of process details?	No mandate in place	0	
			Elicitation management time is basically a push mechanism from process modelling team	1	1
			Organization mandate exists for both push and pull mechanism for utilizing stakeholder time for process model information elicitation exercises	2	
6.4	Stakeholder Time Management - Validation	Is there an organization mandate which enables the process modelling initiative/team to effectively utilize stakeholders	No mandate in place	0	
			Validation time management is	1	1

		(process owners and process line management & team) time for validation of process details?	basically a push mechanism from process modelling team		
			Organization mandate exists for both push and pull mechanism for utilizing stakeholder time for process model information validation exercises	2	
7.0	Training	Assessment Questions	Response Parameter	Response Options	Score
7.1	Training Mandate	Are training mandate exists and utilized properly for various stakeholders (especially information providers/domain experts/subject matter experts) part of enterprise process modelling initiative?	No Training Happens	0	
			Adhoc training happens based on specific request	1	
			Structured training materials are available but training happens only based on specific request	2	2
			Training calendar, on demand training as well as online self-training materials available, established and communicated with stakeholders	3	
			Training calendar, on demand training as well as online self-training materials available, established and communicated with stakeholders	4	
7.2	Training Utilization	Are training mandate exists and utilized properly for process modeller community (for modelling community with more stress on information elicitation, modelling methodology and tool) part of enterprise process modelling initiative?	No training happens	0	
			Adhoc training happens based on specific request	1	2
			Structured training materials are available but the training happens only based on specific request	2	
			Training calendar is published and internal as well as external experts train stakeholders on process modelling topics based on training materials created	3	

			Training calendar, on demand training as well as advanced online self-training materials available, established and communicated with process modelling community	4	
7.3	Training Document availability		Training materials are not made available to stakeholders	0	
			Training materials are made available to stakeholders but there is no revision happening to these documents	1	1
			Revised training materials are available and utilized to train and certification system for various stakeholders involved exists	2	

Appendix H: RDBMM Evaluation and Validation from Industrial Perspective

This section presents the evaluation and validation protocols from industrial perspective. Set of questions have been asked for the managers to validate the framework, the managers point of views have been discussed in the chapter 8. And the questions themes were classified to address the novelty, usability, comprehensiveness, effectiveness and Ease of use, Strengthens, Weaknesses

The questions described as the following:

TABLE 190: RDBMM VALIDATION AND EVALUATION QUESTIONIERS

Questions guide validation and evaluation of the RDBMM framework from industrial perspective
Formal data collection questions
1. **How you preserved the novelty of the framework, is this similar to something you have done or seen before?** 2. **How effective the overall approach? Have you preserved any value from this framework? Is it comprehensive to cover the whole required knowledge?** 3. **How easy are the framework and the overall implementation?** 4. **As a manager, can you please tell me how useful do you think this framework to managers in managing, controlling and analysis and design the enterprise?** 5. **From your point of view, what are the strengths and weakness of this framework?** 6. **Any other preserved or observed issue would you like to mention?**

Appendix I: RDBMM Metamodel