

---

# **An integrated project portfolio model for selecting information technology projects**

---

**Jan Frederick de Beer**  
BSc (PU vir CHO)

Dissertation submitted in partial fulfilment of the requirements for the degree  
Masters in Business Administration at the Potchefstroom Business School,  
Potchefstroom University for Christian Higher Education

**Study leader: Dr. S.P. van der Merwe**

**POTCHEFSTROOM**

**November 1999**

---

# ACKNOWLEDGEMENTS

**I would like to express my sincere thanks and appreciation to the following people:**

- To our Heavenly Father, who provided me with the health and ability to complete this study.
- My parents Jan and Lina de Beer, for their continued interest and encouragement.
- My brother, Pietman, and sisters, Surette & Adri, for their interest, support and contributions.
- The rest of my family for their support and sacrifices.
- To my supervisor, Stephan van der Merwe, for his professional guidance and support throughout this study.
- To my colleagues at Sasol Information Technology for their interest and encouragement shown.
- To my employer, Sasol, who have made this study possible.

---

# ABSTRACT

Sasol is one of the biggest South African petrochemical companies that have recently gone through a major transformation with regards to its management of information technology. This study is intended to assist Sasol's Information managers to optimise the company investment in information technology through the management of its information technology portfolio.

This study focuses on the development of a project portfolio selection model through the evaluation of individual projects and project portfolios, by:

- aligning the project portfolio with the organisation's strategic intent and objectives to ensure that the information technologies and systems support it;
- determining the potential benefit to be derived from the projects in terms of the operational, tactical, and strategic dimensions;
- assessing the risk profile of a particular information technology project and developing risk mitigation steps;
- determining how a particular information technology project or system fits in with the organisation's existing information systems & infrastructure, thus ensuring re-use wherever possible;
- establishing how a particular information system fits in with and supports the organisation's architecture models, thereby helping the organisation establish co-existence between all the different information systems; and
- evaluating and ranking individual projects according to potential value, risks, and any resource constraints that may exist.

Successful projects are then incorporated into the organisation's information technology portfolio. The study concludes with an integrated project portfolio selection model that can be incorporated into the Sasol information management structures.

---

# SAMEVATTING

Sasol is een van Suid-Afrika se grootste petrochemiese maatskappye, wat onlangs 'n groot transformasie ondergaan het wat die bestuur van sy inligtingstegnologie betref. Hierdie studiestuk stel hom ten doel om Sasol se Inligtingsbestuurders te help met die optimisering van die maatskappy se belegging in inligtingstegnologie by wyse van die bestuur van sy inligtingstegnologie-portfolio.

Die studiestuk is daarop gemik om 'n portefeuljeseleksie-model vir die evaluering van individuele projekte en projekteportefeuljes te ontwikkel, en wel deur:

- Die projekteportefeulje met die maatskappy se strategiese mikpunt en doelwitte te versoen en sodoende te sorg dat die inligtingstegnologie en -stelsels hierdie mikpunte en doelwitte onderskraag;
- Die potensiële voordeel van projekte ten opsigte van hulle operasionele, taktiese en strategiese dimensies vas te stel;
- Die risikoprofiel van 'n bepaalde inligtingstegnologieprojek te bepaal en die nodige stappe daar te stel wat die risiko sal verlaag;
- Vas te stel hoe 'n bepaalde inligtingstegnologieprojek of -stelsel by die organisasie se bestaande inligtingstelsels en infrastruktuur inpas om sodoende te sorg dat dit waar moontlik weer gebruik kan word;
- Vas te stel hoe 'n bepaalde inligtingstelsel by die organisasie se argitekmodelle inpas en hulle ondersteun, en daardeur die organisasie in staat te stel om al die onderskeie inligtingstelsels by mekaar te laat inpas; en
- Individuele projekte te evalueer en in rangorde na gelang van hulle potensiële waarde, risiko en moontlike beperkings ten opsigte van hulpbronne, te rangskik.

Projekte wat aanvaar word, word dan in die organisasie se inligtingstegnologie-portefeulje opgeneem. Die studie sluit af met 'n geïntegreerde projekportefeulje-seleksiemodel wat by Sasol se inligtingsbestuur-struktuur ingesluit kan word.

---

# TABLE OF CONTENTS

<b>CHAPTER 1 NATURE AND SCOPE OF THE STUDY</b> .....	<b>1</b>
1.1 INTRODUCTION.....	1
1.2 PROBLEM IDENTIFICATION AND DEFINITION .....	2
1.3 OBJECTIVES OF THE STUDY .....	3
1.4 SCOPE OF THE STUDY .....	3
1.4.1 <i>Organisation under investigation</i> .....	3
1.4.2 <i>Field of the study</i> .....	4
1.4.2.1 Project management .....	4
1.4.2.2 Information technology .....	5
1.4.2.3 Project portfolios.....	6
1.4.2.4 Business architecture .....	6
1.5 RESEARCH METHODOLOGY .....	6
1.6 RESTRICTIONS OF THE STUDY .....	7
1.7 LAYOUT OF THE STUDY.....	8
<b>CHAPTER 2 CAUSAL FACTORS TO THE STUDY</b> .....	<b>10</b>
2.1 INTRODUCTION.....	10
2.2 ORGANISATION UNDER INVESTIGATION.....	10
2.2.1 <i>History of Sasol</i> .....	10
2.2.2 <i>Vision</i> .....	11
2.2.3 <i>Sasol group structure</i> .....	11
2.2.4 <i>Organisation structure (top) – Sasol Limited</i> .....	13
2.2.5 <i>Sasol Limited business units</i> .....	13
2.2.6 <i>Macro business environment</i> .....	15
2.2.6.1 Petroleum industry outlook .....	15
2.2.6.2 Deregulation of petrochemical industry within South Africa.....	15
2.2.6.3 Oil prices .....	16
2.2.6.4 Mergers in the oil industry.....	17
2.2.6.5 Emerging gas to liquid market .....	17
2.2.7 <i>Development of information technology in Sasol</i> .....	18
2.3 MANAGEMENT OF INFORMATION WITHIN THE SASOL GROUP .....	20
2.3.1 <i>Philosophy</i> .....	20
2.3.2 <i>Specific information management processes</i> .....	22
2.3.3 <i>Functions and responsibilities of governance forums</i> .....	25
2.4 SASOL INFORMATION TECHNOLOGY GROUP.....	25
2.5 CAUSAL FACTORS TO THE STUDY.....	26
2.5.1 <i>External factors</i> .....	26
2.5.2 <i>Internal factors</i> .....	26
2.6 SUMMARY .....	27
<b>CHAPTER 3 PROJECT MANAGEMENT IN THE ENTERPRISE</b> .....	<b>28</b>
3.1 INTRODUCTION.....	28
3.2 PROJECT MANAGEMENT.....	28
3.2.1 <i>Project management defined</i> .....	29
3.2.2 <i>Project portfolios</i> .....	31
3.2.2.1 Evaluation and selection techniques .....	33
3.2.3 <i>Project risk assessment</i> .....	47
3.2.3.1 Importance of risk management.....	48
3.2.3.2 Definition of risk .....	49

3.2.3.3	Risk identification .....	51
3.2.3.4	Risk quantification .....	57
3.3	SUMMARY AND CONCLUSIONS .....	61
<b>CHAPTER 4 INFORMATION ENVIRONMENT IN THE BUSINESS .....</b>		<b>63</b>
4.1	INTRODUCTION.....	63
4.2	INFORMATION TECHNOLOGY BENEFITS AND RISKS.....	64
4.2.1	<i>Information technology benefits</i> .....	65
4.2.1.1	Return on investment (cost reduction and performance enhancement) .....	65
4.2.1.2	Strategic match.....	66
4.2.1.3	Competitive advantage .....	67
4.2.1.4	Management information support.....	68
4.2.1.5	Competitive risk.....	69
4.2.1.6	Strategic information systems architecture.....	70
4.2.2	<i>Review of information technology investment evaluation methods</i> .....	70
4.2.2.1	Information technology evaluation methods for tangible benefits .....	70
4.2.2.2	Information technology evaluation methods for intangible benefits.....	73
4.2.2.3	Information technology evaluation methods for risks.....	75
4.2.3	<i>A roadmap for the evaluation of information technology investment</i> .....	77
4.3	INFORMATION TECHNOLOGY: COST VS. VALUE .....	78
4.3.1	<i>Total cost of ownership</i> .....	79
4.3.2	<i>Total value of ownership</i> .....	79
4.3.3	<i>Cost/benefit methodology</i> .....	80
4.4	STRATEGIC INFORMATION TECHNOLOGY ALIGNMENT .....	82
4.4.1	<i>Introduction</i> .....	82
4.4.2	<i>Levels of strategic alignment in organisations</i> .....	83
4.4.3	<i>The strategic alignment process</i> .....	83
4.4.3.1	The Strategic Alignment Model.....	84
4.4.3.2	Using the model.....	86
4.4.3.3	Four dominant alignment perspectives .....	86
4.5	INFORMATION TECHNOLOGY ARCHITECTURE .....	93
4.5.1	<i>Architectural frameworks</i> .....	95
4.5.2	<i>Evernden's information framework</i> .....	97
4.5.2.1	Information framework's dimensions.....	98
4.5.2.2	Structural components in the information framework .....	101
4.5.2.3	Levels of constraint.....	103
4.5.3	<i>Implementing architecture models</i> .....	104
4.6	SUMMARY AND CONCLUSIONS .....	106
<b>CHAPTER 5 MODEL FORMULATION .....</b>		<b>107</b>
5.1	INTRODUCTION.....	107
5.2	EXISTING PROJECT PORTFOLIO SELECTION MODELS .....	107
5.2.1	<i>The strategic planning model</i> .....	107
5.2.1.1	Assessment phase .....	107
5.2.1.2	Strategy phase .....	108
5.2.1.3	Execution phase .....	109
5.2.2	<i>A systems model by Kerzner</i> .....	110
5.2.3	<i>Archer and Ghasemzadeh's project portfolio selection model</i> .....	111
5.2.3.1	Pre-screening.....	112
5.2.3.2	Individual project evaluation.....	112
5.2.3.3	Screening.....	113
5.2.3.4	Portfolio selection .....	113
5.2.3.5	Portfolio balancing and adjustment.....	113
5.2.3.6	Model selection and development.....	114
5.3	DERIVED INTEGRATED PROJECT PORTFOLIO SELECTION MODEL .....	115
5.3.1	<i>Model overview</i> .....	117

5.3.2	<i>Detailed model description</i> .....	120
5.3.2.1	Business assessment .....	120
5.3.2.2	Technology assessment .....	123
5.3.2.3	Scenario building .....	125
5.3.2.4	Scenario integration .....	129
5.3.2.5	Project and programme execution .....	131
5.3.2.6	Process management .....	133
5.3.3	<i>Advantages</i> .....	140
5.3.4	<i>How does this model differ from other project selection techniques?</i> .....	140
5.3.5	<i>Implementation of the project portfolio selection model</i> .....	141
5.4	SUMMARY .....	141
<b>CHAPTER 6 CONSOLIDATION AND RECOMMENDATIONS .....</b>		<b>143</b>
6.1	INTRODUCTION.....	143
6.2	STUDY CONSOLIDATION.....	144
6.2.1	<i>Project portfolios</i> .....	144
6.2.2	<i>Project risk assessment</i> .....	144
6.2.3	<i>Information technology benefits and risks</i> .....	145
6.2.4	<i>Strategic alignment</i> .....	145
6.2.5	<i>Information technology architecture</i> .....	146
6.2.6	<i>Project selection model</i> .....	146
6.3	RECOMMENDATIONS .....	147
6.4	ATTAINING OF OBJECTIVES .....	147
6.5	FURTHER STUDY OR RESEARCH .....	149
6.6	SUMMARY .....	149

---

# TABLE OF TABLES

<u>Table 2-1: Market capitalisation of the biggest petrochemical companies</u> .....	17
<u>Table 2-2: Sasol's Information management forum responsibilities</u> .....	24
<u>Table 3-1: A comparison of project selection methods</u> .....	44
<u>Table 3-2: A mathematical model for risk assessment on information technology projects</u> ..	60
<u>Table 4-1: Information technology groupings</u> .....	66
<u>Table 4-2: Strategic Alternatives and focus</u> .....	67
<u>Table 4-3: Competitive forces and hurdles</u> .....	67
<u>Table 4-4: Major methods used for evaluating information technology</u> .....	78
<u>Table 4-5: Structural components of Evermden's information framework</u> .....	101

---

# TABLE OF FIGURES

<u>Figure 1-1: Schematic view of the layout of the study</u> .....	9
<u>Figure 2-1: The Sasol group of companies</u> .....	12
<u>Figure 2-2: Management of information philosophy</u> .....	21
<u>Figure 2-3: Sasol's information management processes</u> .....	23
<u>Figure 3-1: Risk identification process</u> .....	51
<u>Figure 3-2: Life-cycle risk analysis</u> .....	53
<u>Figure 3-3: Risk quantification process</u> .....	58
<u>Figure 4-1: Opportunities in the enterprise</u> .....	68
<u>Figure 4-2: The strategic alignment model</u> .....	84
<u>Figure 4-3: Perspective one of the strategic alignment model</u> .....	87
<u>Figure 4-4: Perspective two of the strategic alignment model</u> .....	88
<u>Figure 4-5: Perspective three of the strategic alignment model</u> .....	89
<u>Figure 4-6: Perspective four of the strategic alignment model</u> .....	90
<u>Figure 4-7: Strategic alignment control processes</u> .....	91
<u>Figure 5-1: The strategic planning model</u> .....	108
<u>Figure 5-2: The systems approach for project selection</u> .....	111
<u>Figure 5-3: Archer and Ghasemzadeh's project portfolio selection model</u> .....	112
<u>Figure 5-5: Relation between the different components of the model</u> .....	117
<u>Figure 5-6: Overview of integrated project portfolio selection model</u> .....	120
<u>Figure 5-7: Business and technology assessment phases</u> .....	135
<u>Figure 5-8: Scenario building phase</u> .....	136
<u>Figure 5-9: Scenario integration phase</u> .....	137
<u>Figure 5-10: Project &amp; programme execution phase</u> .....	138
<u>Figure 5-11: Process management phase</u> .....	139

# CHAPTER 1

## NATURE AND SCOPE OF THE STUDY

### 1.1 Introduction

Information systems play a vital role in the business success of a modern organisation. Information technology can provide the information a business requires for efficient operation, effective management, and to achieve a competitive advantage. However, information systems which do not properly support the strategic objectives, business operations, or management needs of an organisation, can seriously damage its prospects for survival and success. Managing an organisation's information technology investment for optimal value and contribution becomes increasingly more difficult because of the complexity of information technology and short lifecycle of the information technology.

An additional complicating factor is that it is often difficult to prove the value of information technology to a business. Strassmann (1997:34) for example could not find any correlation between information technology spending and measures of profitability, such as return on assets, return on net investments, or economic value-added divided by equity. He also concluded that nobody has thus far produced any evidence to support the popular myth that increased spending on information technology will boost economic performance (Strassmann, 1997:35). Davenport (1997:3) proposed a holistic perspective for information technology investment decisions that consider an organisation's entire information environment. It addresses all the organisation's values and beliefs about information (culture); how people actually use information and what they do with it (behaviour and work processes); the pitfalls that can interfere with information sharing (politics); the current investment in information technology and information technology itself.

These uncertainties (on the potential value of information technology) and the massive information technology spending, an estimated one trillion dollars world-wide (Strassmann, 1997:26), have led to new methodologies and philosophies on the optimisation of a company's information technology spending. One of the most prominent approaches to guarantee sufficient returns on information technology spending is through the alignment of information systems to corporate goals (Strassmann, 1997:3).

This study will attempt to assist the Sasol group to optimise its information technology spending through the careful selection and evaluation of projects that will contribute to its deployed information technology infrastructure and systems. An integrated approach is suggested that combines the disciplines of project management, information technology and business modelling, to formulate an integrated project portfolio selection model.

## 1.2 Problem identification and definition

In practice, there are several problems relating to the delivery of information systems in support of business needs and objectives. This study limits itself to the optimal investment decision making process for information technology through an optimised project portfolio.

Factors that complicate the investment decisions include the following:

- the interdependence between different business processes;
- there are seldom enough resources available to satisfy all the business needs;
- there is a considerable investment in information systems that are non-responsive to the dynamic and flexible business environment;
- a low level of reuse exists between information systems; and
- a large number of existing and potential new projects exist within organisations.

These problems are more prominent in organisations that:

- rely on information technology for sustained competitive advantage;
- operate in a dynamic industry which requires constant change from the organisation; and
- do not possess sufficient resources to satisfy all the demands on its information technology systems.

This study is intended to assist Sasol's information technology planners with the dilemma of how to apply limited information technology resources to realise the maximum value to the enterprise.

### 1.3 Objectives of the study

The objective of this study is to develop a project portfolio selection model that will help assist Sasol's Group information and logistics division in the selection of select an optimal project portfolio that will maximise the return on its investment in information technology. The study objective will be reached through the following sub-objectives:

- Optimising the use of information technology resources through the:
  - ◆ reduction of the risks associated with information technology deployment; and
  - ◆ maximisation of the component reuse between projects.
- Maximising the contribution of information technology to the organisation's objectives through the alignment of business and information technology strategies.
- Assisting the organisation to adapt quickly to changes in its volatile market and business environment.

### 1.4 Scope of the study

The scope of the study will be discussed in terms of the organisation which is being investigated and the definition of the field of study.

#### 1.4.1 Organisation under investigation

The organisation selected for the purpose of the study is the Sasol group of companies, and more specifically the Group information and logistics division. This division is primarily responsible for planning, coordinating, and governing all information technology initiatives within the Sasol group.

Today, Sasol is one of South Africa's top 10 private companies with an annual turnover of more than R16.6 billion (Sasol, 1998:3). The company has 14 577 shareholders (Sasol, 1998:84) and more than 24 900 employees (Sasol, 1998:86).

Sasol's business is concentrated primarily in Johannesburg, Sasolburg and Secunda although activities exist in Kwazulu Natal, the Western Cape, and other international locations. A more detailed description of the Sasol group can nevertheless be found in Chapter 2.

## 1.4.2 Field of the study

### 1.4.2.1 Project management

The Project Management Institute (PMI, 1996:4) has defined a project in terms of its distinctive characteristics: a project is a temporary endeavour undertaken to create a unique product or service. Temporary means that every project has a definite beginning and a definite end. The end is reached when the project's objectives have been achieved, or when it becomes clear that the project's objectives cannot be met and the project is terminated. In addition, temporary does not generally apply to the product or service created by the project. Most projects are undertaken to create a lasting effect.

The temporary nature of projects may apply to other aspects of the endeavour as well:

- the opportunity or market window is usually temporary – most projects have a limited time frame in which to produce their product or service; and
- the project team, as a team, seldom outlives the project - most projects are performed by a team created for the sole purpose of carrying out the project, and the team is disbanded and the members reassigned when the project is completed.

A project involves doing something which has not been done before and is, therefore, unique. Because the product of each project is unique, the characteristics that distinguish the product or service must be progressively elaborated. These distinguishing characteristics will be broadly defined early in the project and will be made more explicit and detailed as the project team develops a better and more complete understanding of the project.

Project management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. Meeting or exceeding stakeholder needs and expectations invariably involves balancing competing demands, among them:

- Scope, time, cost, and quality.
- Stakeholders with differing needs and expectations.
- Identified requirements (needs) and unidentified requirements (expectations).

#### 1.4.2.2 Information technology

Information technology is defined as the technology used for the production, storage, and communication of information using computers and microelectronics. Information technology is therefore used to transform data resources into a variety of information products (O'Brien, 1996:6). Information is an increment in knowledge - it contributes to the general framework of concepts and facts that are known. Information can be defined as data that has been converted into a meaningful and useful context for specific end users. Thus data is usually subjected to "value-adding" processes (called data processing or information processing) where (a) its form is aggregated, manipulated, and organised; (b) its context is analysed and evaluated and (c) it is placed in a proper context for a human user (O'Brien, 1996:38). Information systems on the other hand is an organised portfolio of systems for obtaining, processing, and delivering information in support of the business operations and management of an organisation. Information systems include the following (Zwass, 1992:8):

- Transaction processing systems for operational data processing that are needed, for example, to register customer orders and to produce invoices and payroll checks.
- Management reporting systems capable of producing reports for specific periods, designed for managers responsible for specific functions in an organisation.
- Decision support systems, expressly designed for the support of individual and collective decision making.
- Executive information systems, which support the work of senior executives and of company boards by giving them ready access to a variety of summarised company data against a background of general information on the industry and the economy at large.
- Office information systems, which support and coordinate knowledge work in an office environment by handling documents and messages in a variety of formats – text, data, image and voice.

A system is a set of components (subsystems or elementary parts) that operate together to achieve a common objective (O'Brien, 1996:32). These objectives are realised in the outputs of the system. An efficient system uses its inputs economically in producing its outputs. An effective system produces the outputs that best meet the objectives of the system (Zwass, 1992:18). The

hallmark of a system, as opposed to an unrelated collection of components, is synergy, an effect best defined by Aristotle: "The whole is greater than the sum of its parts".

#### 1.4.2.3 Project portfolios

A project portfolio is a group of projects and/or one or more project programmes, which are carried out under the sponsorship and/or management of an organisation. Hence, these projects must compete for scarce resources available from the project sponsor. This results in a need to select among available projects in order to meet the organisation's objectives in some optimal manner.

#### 1.4.2.4 Business architecture

As an organisation grows and becomes more complex, management makes greater demands on its information systems. It requires data that is quickly accessible whenever and wherever it is required, in a useful format for easy interpretation, consistently accurate throughout every department, responsive to rapidly changing business conditions and can be shared across the enterprise. However, data quality does not just happen, nor will it result from focusing on application development productivity. Quality must be planned. Enterprise Architecture Planning (EAP) is a modern approach for planning data quality and business alignment.

EAP results in a high-level blueprint of data, applications and technology that is a cost-effective, long-term solution, not a quick fix. Management participation provides a business perspective and credibility, and demystifies the systems planning process. EAP can be labelled as business-driven or data-driven because (Spewak & Hill, 1992:xx):

- a stable business model (independent of organisational boundaries, systems, and procedures) is the foundation for architectures;
- data is defined before applications; and
- data dependency determines the sequence for implementing application systems.

### 1.5 Research methodology

This is primarily a literature study on the major aspects affecting the selection of projects and the composition of an organisation's information technology project portfolio. Taking into account that the study incorporates and integrates three individual topics namely project management, information technology (especially the valuing of information technology), and business

modelling, the literature study will be confined to interpretation of the fundamental concepts of the above mentioned subjects. It will focus on the following subjects:

- project management (with the focus on project risk identification, and quantification);
- configuration management;
- critical success factors for information technology related projects;
- the evaluation of proposed projects (with the emphasis on the financial, and value propositions of the proposed project);
- information technology project failures;
- information technology strategy and architecture plans; and
- the evaluation of portfolios.

The results of the literature study will then be combined into a decision making model that will assist information technology planners to optimise their information technology investment.

## 1.6 Restrictions of the study

This study is restricted to the selection of an optimal project portfolio to support the objectives of a business and does not concern itself with the management of the acquisition/development processes relating to the individual projects.

Another definite limiting factor of this study is the multitude of related aspects that can influence the success of projects and project portfolios. It is therefore not an objective of this study to supply a comprehensive method by which the success of project portfolios can be guaranteed. For this reason, it will focus only on the formulation and maintenance of project portfolios and not project management in general.

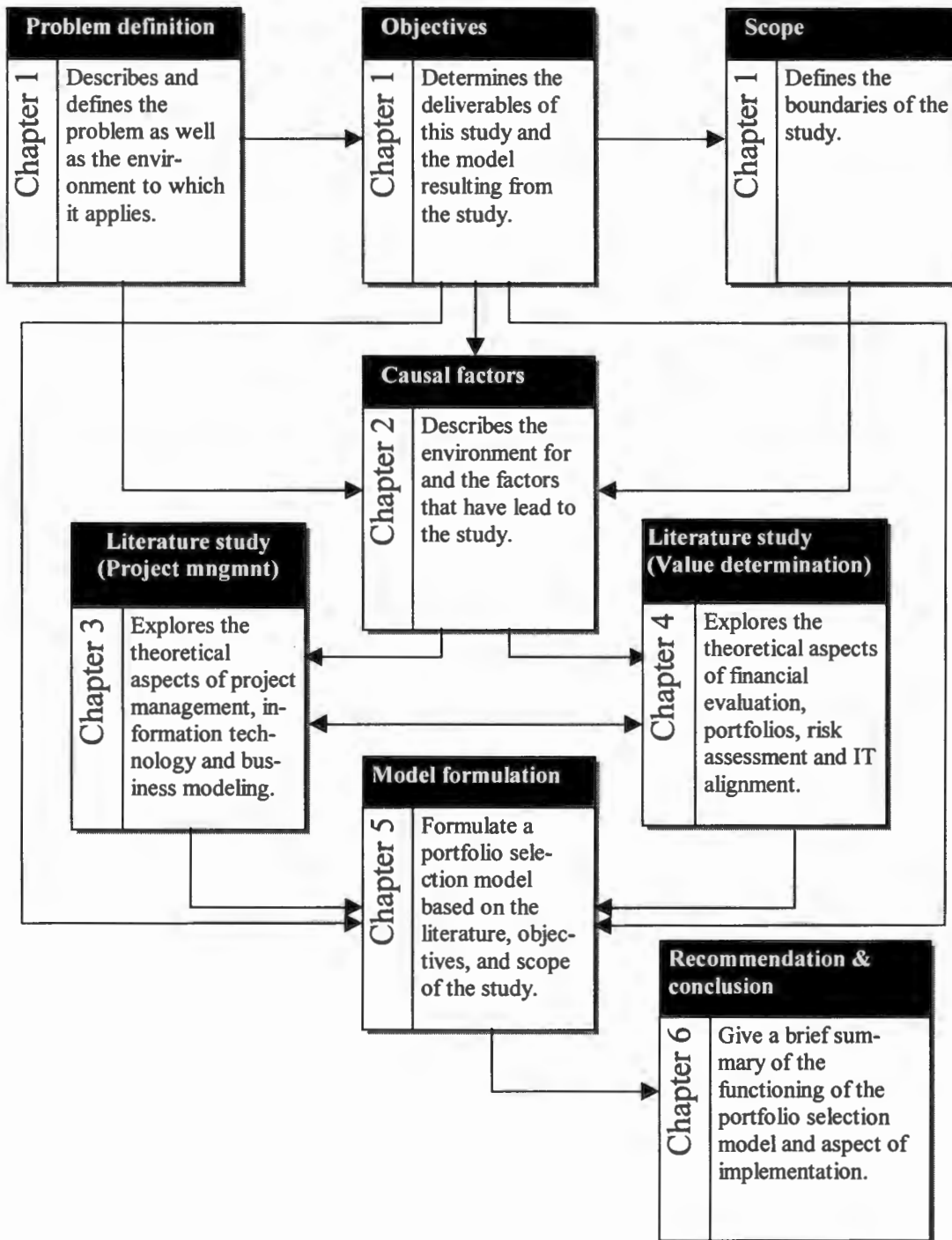
As pointed out in section 1.4.1, this study is also limited to the Sasol group of companies, and more specifically the Group information and logistics division that is responsible for information technology strategy formulation, architectures, and information technology related governance.

## 1.7 Layout of the study

The layout and flow of the study are set out in Figure 1-1:

- Chapter 1 provides an overview of the study including the problem definition, the objectives, and its scope. This chapter also provides a short overview of the different fields of the study.
- Chapter 2 focuses on the causal factors of the study. It also defines and describes the organisation and work function chosen for the purpose of the study.
- Chapter 3 encompasses a literature study of project management and factors that influence the possible success of these endeavours. Other related issues include an overview of information technology, architecture development and business modelling.
- Chapter 4 is used for another literature study on how the value of information technology and its contribution to business is determined. Aspects such as portfolio evaluation, risk assessment and business alignment are also covered in this chapter.
- In chapter 5 all the theoretical aspects of information technology project formulation and management are combined into an integrated management model.
- Chapter 6 concludes the study with a final summary, conclusions and recommendations on the implementation of the model within the Sasol environment.

Figure 1-1: Schematic view of the layout of the study.



# CHAPTER 2

## CAUSAL FACTORS TO THE STUDY

### 2.1 Introduction

This chapter is divided into three major sections. The first section provides background information on the Sasol group of companies. Sasol's structures and methodologies with regard to the management of information are discussed in the second section. The third section deals with the factors that have led to this study.

### 2.2 Organisation under investigation

#### 2.2.1 History of Sasol

In 1947, 20 years after the publication of a white paper by Parliament, legislation detailing the establishment of an oil-from-coal industry in South Africa was passed. Sasol Limited was founded in 1950 by the South African government to manufacture fuels and chemicals from indigenous raw materials (Meintjies, 1975:17).

Construction on Sasol's first synfuels plant started in 1951 and by 1955 this operation was marketing petrol as well as its first range of chemicals (Meintjies, 1975:35). During the 1960s, Sasol became a major supplier of raw materials to the chemical industry (Meintjies, 1975:80). This included products such as solvents for paints, butadiene and styrene for synthetic rubber and ammonia for nitrogenous fertiliser. When Sasol's first naphtha-cracker became operational in the mid-1960s, ethylene for the plastics industry was added to the product portfolio.

In 1964, Gascor was established. Construction began on its first gas pipeline and by 1966 this pipeline, which connected 250 industrial companies in the greater Johannesburg area to pipeline gas, was completed (Meintjies, 1975:97). In 1981, another 95km pipeline was completed connecting Secunda to the existing pipeline network. Today, the distribution network consists of about 1 350 km of underground pipelines.

The decision to refine imported crude oil was made in 1966 (Meintjies, 1975:126) and led to the establishment of National Petroleum Refiners of South Africa (Natref) at Sasolburg in 1969 (Meintjies, 1975:128). Sasol (52.5%), the major shareholder, was joined by Total (30%) of France and the National Iranian Oil Company (17.5%) (Meintjies, 1975:128). In 1989 the National Iranian Oil Companies relinquished its shareholding in Natref. The remaining partners, Sasol and

Total, took up their pre-emptive right increasing their shareholding to 64% and 36% respectively (Sasol, 1999).

The OPEC oil-crisis of the early seventies presented Sasol with the opportunity to increase its synfuels production capacity as well as assist in reducing South Africa's dependence on expensive imported crude oil. This led to the construction of a second synfuels plant, Sasol Two - tenfold the size of Sasol One - in Mpumalanga between 1976 and 1980 (Sasol, 1999).

The construction of Sasol Three, almost an exact replica of Sasol Two, commenced adjacent to the Sasol Two plant in 1979. By the time the third plant was fully operational in 1982, Sasol had invested R5 800 million in the two Secunda plants. Today these two plants have an estimated replacement value of R49 082 million and are jointly known as Sasol Synthetic Fuels (Pty) Ltd (SSF) (Sasol, 1999).

Sasol became a private sector company when Sasol Limited, the group's holding company, was listed on the Johannesburg Stock Exchange in 1979. Sasol bought the State's 50% share in Sasol Two in 1983 and Sasol Three's 50% share in July 1991. The loans on these plants were fully paid up, together with 16% interest per annum, by January 1996 (Sasol, 1999).

### 2.2.2 Vision

Sasol has stated its vision as follows (Sasol, 1998:1)

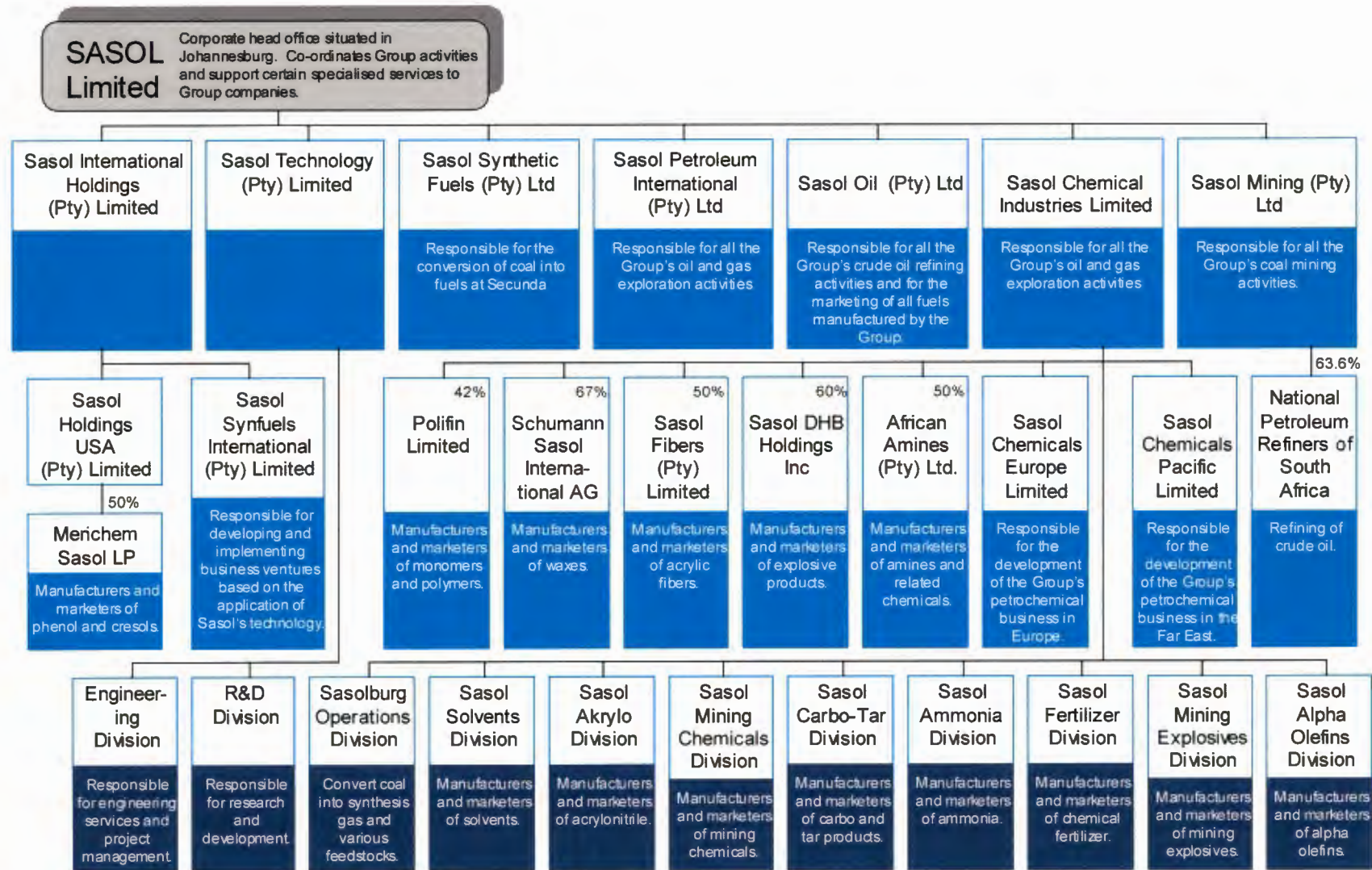
To be a respected global enterprise, harnessing our talents in applying unique, innovative and competitive technologies to excel in selected markets in the energy, fuels, chemicals and related sectors in Southern Africa and world-wide.

### 2.2.3 Sasol group structure

Sasol's organisational structure is shown in Figure 2-1 (Sasol, 1998:18).

The managing director reports to the Sasol board, while the organisation has seven major business units, namely Sasol Mining, Sasol Synthetic Fuels, Sasol Chemical Industries, Sasol Oil, Sasol Technology, Sasol Petroleum International and Sasol Synfuels International.

Figure 2-1: The Sasol group of companies



## 2.2.4 Organisation structure (top) – Sasol Limited

Sasol's business is primarily concentrated in Johannesburg, Sasolburg and Secunda although activities exist in Kwazulu Natal and the Western Cape. Some of the Sasol business units operate on an international scale, the most notable of these being Sasol Petroleum International and Sasol Synfuels International that operate in the Middle East (Qatar), Western Africa (The People's Republic of Congo and Gabon) and Eastern Africa (Mozambique and Nigeria). Several of the Sasol business units have sales and support offices in the United States of America, Europe (Germany and England), and the Far East (Hong Kong).

## 2.2.5 Sasol Limited business units

Sasol has structured itself into seven core business units, namely Sasol Mining, Sasol Synthetic Fuels, Sasol Chemical Industries, Sasol Oil, Sasol Technology, Sasol Petroleum International, and Sasol Synfuels International:

- Sasol Mining is responsible for all activities to mine and deliver coal for the Sasol Group. During the 1998 financial year (Sasol, 1998:21) 44.4 million tones of saleable coal was mined for the operations of Sasol Synthetic Fuels at Secunda and Sasol Chemical Industries at Sasolburg. The company has also exported 2.4 million tons of saleable coal to Europe and the Far East.
- Based at Secunda, Sasol Synthetic Fuels uses unique Sasol processes to manufacture synthesis gas from low-grade coal and to convert it into a large range of valuable hydrocarbons, including synthetic liquid fuels and pipeline gas. These products provide the bulk of the building blocks for most of the South African chemical industry (Sasol, 1998:31).
- Sasol Chemical Industries Limited produces and markets more than 120 chemical products (Sasol, 1998:37) from the benefaction of coal at Sasolburg and from various feedstocks purchased from Sasol Synthetic Fuels at Secunda. The main products manufactured at Sasolburg include ammonia, ammonium nitrate, ammonium sulphate, cresols, phenol, hydrogen, industrial pipeline gas, methanol, ketones, mining chemicals, nitric acid, paraffins, various solvents and waxes. The SSF feedstocks are processed into a range of value adding chemicals at Secunda including acetic acid and propionic acid, acetone and other ketones, acrylonitrile, alcohols, ammonia, argon, carbon products,

fertilizers, mining explosives, granular sulphur, 1-hexene, 1-pentene, and a mixture of Krypton and Xenon.

- Sasol Oil (Pty) Limited markets liquid fuels, gaseous fuels and lubricants. Liquid fuels include liquid petroleum gas, petrol, fuel alcohol, illuminating paraffin, jet fuel, diesel and a variety of fuel oils. About one-third of the liquid fuels marketed is produced from crude oil through Sasol's share of the Natref oil refinery at Sasolburg. The rest is produced by Sasol Synthetic Fuels and is marketed on its behalf. Sasol also imports some liquid fuels to supply its export markets (Sasol, 1998:53).
- Sasol Technology (Pty) provides the necessary coordination, technical and project execution support during the business evaluation and execution phases of the Group's many development and technology-related initiatives. These initiatives include a natural gas-to-diesel plant in Qatar and another in Nigeria. Feasibility studies are undertaken for other international ventures (Sasol, 1998:61).
- Sasol Petroleum International (Pty) Limited is responsible for Sasol's international petroleum exploration and production activities. The company focuses on selected high-potential areas and invests in partnerships with experienced international oil and gas companies. Sasol Petroleum International's initiatives are aligned with Sasol's globalisation strategy and its energy business in Southern Africa (Sasol, 1998:69).
- Sasol Synfuels International (Pty) Limited is responsible for developing and implementing international business ventures based on the application of Sasol's Fischer-Tropsch synthesis technology. The company initiates and develops potential ventures from project conception to the project execution stage (Sasol, 1998:71).

As can be seen from the description of the different Sasol business units above, Sasol consists of a very diverse portfolio of companies. These business units differ in primary function e.g. mining (Sasol Mining), exploration (Sasol Petroleum International), production (Sasol Synthetic Fuels and Sasol Chemical Industries), marketing (Sasol Oil) and technology development and commercialisation (Sasol Technology and Sasol Synfuels International). The business units are also in different life cycles.

## 2.2.6 Macro business environment

Sasol's macro business environment is going through some profound structural changes. These changes augment the challenges that the company faces in the new global market, with numerous new competitors and less protection from the South African government. In order for Sasol to survive well into the next millennium it must learn to do business and be competitive in the new market place. This is especially true with regard to its use of information

### 2.2.6.1 Petroleum industry outlook

The petroleum industry is currently facing substantial overproduction of crude oil on the world market. In the fall of 1998, retail gasoline prices were at the lowest point in twelve years. Oil prices are likely to remain low throughout 1999 because of over production among OPEC members and the problems experienced by the Asian economies. Oil demand probably will remain weak throughout the next two years resulting in a gradual build-up of crude oil inventory. The lower gasoline prices have led to higher consumption which will support gasoline prices. However, in spite of demand and production profit, margins will remain low for oil companies (Williams, 1998).

In recent years, higher prices and growth in demand for oil have allowed oil companies to spend more on exploration and production. In 1996 expenditure amounted to \$58 billion. The primary reason for the emphasis on exploration and production is the narrow margins of the refining and marketing segment. Many oil companies have sold their refining and marketing operations to focus primarily on exploration and production. In addition, many refineries have shut down their operations because of excess capacity and low margins. As a result, the refining and marketing sectors are becoming increasingly concentrated. However, this is likely to result in significant economies of scale in production, distribution, and marketing.

### 2.2.6.2 Deregulation of petrochemical industry within South Africa

Sasol has always received some form of protection for its synthetic fuels business from the government. In 1995 consultants Arthur Anderson set guidelines for tariff protection and recommended the withdrawal of the subsidy by the millennium. The government currently guarantees the group a minimum price of \$17 a barrel of crude, against world prices of less than \$12. The tariff fell to \$16 from 1 July 1999, where it will remain until June 2000, when it will be reviewed. The government is under pressure from various groups to abolish the tariff protection.

Sasol is currently preparing itself for the abolishment of the tariff protection through a R2bn investment to upgrade synfuel and feedstock capabilities at Sasol Synthetic Fuels in Secunda. The company is also currently investing into high-value chemicals and aims to boost chemicals output and contribution to group profit to 50% by 2000, from the current level of 34.7% (Collett, 1998:34)

### 2.2.6.3 Oil prices

The global oil industry is moving towards consensus that it is in for a sustained period of low oil prices. Some analysts see this as the start of a structural change in the oil industry, and that only companies which keep their costs down are likely to survive. This crisis has also led to the recent mergers between major oil companies, such as Mobil and Exxon. The following factors have led to the upheaval in the oil industry (Williams, 1998):

- The collapse in Asian oil demand growth which, prior to its collapse, was a buoyant industry;
- the seeming inability of the Organisation of Petroleum Exporting Countries (OPEC) to manage markets, production, prices, oil and perhaps even its own survival;
- the shift among more OPEC nations toward embracing foreign investment in their upstream sectors, a prospect that has been largely off-limits prior to the dazzling success Venezuela has had with this strategy;
- the evolution and spread of technology that has rendered many hitherto marginal fields economically viable and slashed finding and development costs for many others. This has essentially levelled the playing field for many independents;
- the emergence of Wall Street as a 500-lb gorilla dominating corporate strategies in the oil industry, with the scramble by firms to please investors driving such startling developments as the largest industrial mergers in history (Exxon Mobil and BP Amoco) and the biggest writedowns in memory (Royal Dutch/Shell);
- the campaign by governments to make the Caspian Sea region the world's "backup" Persian Gulf, in an effort to reduce reliance on the vital oil supplies of one volatile region;

- the drive of Iraq and Iran to rebuild their oil sectors after many years of warfare and hardship; and
- the prospect that higher oil taxes emanating from the Kyoto climate change treaty will curb oil demand growth still further in the next millennium, giving more breathing room to renewable energy sources that otherwise would be on life support in a world of \$10/bbl oil.

The oil price has a substantial impact on the operating margins of Sasol, since the South-Africa petrol price is linked to international petrol prices. Sasol's GTL technology is also relatively expensive, with high production costs. The government has in the past protected Sasol against low oil prices with rebates and subsidies, but these protective measures are being phased out. This all leads to a much more competitive environment for Sasol that will demand better efficiency, lower costs and technological advances if it is to survive in the global playing field.

#### 2.2.6.4 Mergers in the oil industry

Several spectacular mergers have dominated the oil, gas and petrochemical industries, the biggest of these being the mergers of Exxon and Mobil, and British Petroleum and Amoco. These mergers have created tremendous economies of scale for exploration, marketing and research and development. The following table shows the market capitalisation of the major public petrochemical companies (Sasol was added for comparison purposes).

Table 2-1: Market capitalisation of the biggest petrochemical companies.

<b>Company</b>	<b>\$billion</b>
Exxon/Mobil	253
BP Amoco + Arco	188
RD/Shell	178
Chevron	57
ENI	48
Total Fina	42
Elf	37
Texaco	28
Sasol	2.9

The largest of these companies, Exxon/Mobil, is approximately 87 times bigger than Sasol.

#### 2.2.6.5 Emerging gas to liquid market

Processes to convert gas to synthetic petroleum have been under development for more than 70 years. Sasol was until recently operating the only commercially viable Gas to Liquid (GTL) plants in the world. GTL produces high-quality, essentially sulphur-free petroleum products such

as diesel, naphtha (used to make gasoline) and jet fuel. These liquid fuels are also easier to transport than the natural gas from which they are made. A renewed world-wide interest in GTL technology is fuelled by the increasing need to utilise gas from oil fields for environmental reasons, the large start-up costs of liquefied natural gas technology, the advances in GTL technology, and economics (Knot, 1997:16).

The four major contenders to build the first commercially viable, full-scale GTL plant, are the Royal Dutch/Shell Group, Sasol Ltd, Exxon Corp and Syntroleum. A fifth Company, Catalytica, has received U.S. government funds to develop its own GTL technology. The major barriers to entry into the GTL market are the high cost of catalyst development and long time to production (Knot, 1997:16).

These operations will be profitable at an oil price of \$10-\$13/bbl. GTL products may even justify premium prices because of their quality and unique features. Even with a price premium of \$3-\$5/bbl over standard diesel, the high quality, high-purity blending stock derived from the GTL process is much less expensive than alternatives (Knott, 1998:17). Industry analysts say that major oil companies see GTL as a way to capture equity positions in large gas reserves (Crow, 1998:34).

Sasol has enjoyed a near monopoly in the GTL field for almost 50 years. Very powerful competitors are now entering the GTL industry. This may have a profound impact on Sasol's future competitive position.

### 2.2.7 Development of information technology in Sasol

The highlights of the development of information technology at Sasol were (Fourie, 1996):

- Early 1960's – ICL tabulators were used. Programming was done by changing physical wiring on an electronic board. Data was stored on nylon punch cards. Commercial functions and stores inventories were executed.
- 1966 – Sasol I installed an ICL mainframe computer with 10K memory and 4 tape readers. Input was done by paper punch cards. Salaries, commercial, maintenance planning, main stores inventories and production planning and simulation were the main applications running in batch mode. This mainframe was later upgraded to 20K memory and 6 tape readers.

- 1972 – The ICL mainframe computer was replaced with a 131K memory Sperry mainframe computer. No off-the-shelf packages available. About thirty systems were developed in-house.
- 1977 – The Mapper development system was implemented.
- 1983 – IBM mainframe was bought and the Walker online systems implemented.
- 1985 – The first IBM XT personal computer (PC) was installed in Sasol. Walk-in computer centres were established with printers and PC's. People had to book time to use these PC's. The number of personal computers in Sasol grew gradually since 1985 to an estimated installed base of 10,000 personal computers in 1998.
- 1986 – The first Local Area Network (LAN) established. It linked four PC's. The number of LAN's grew to more than 170 in 1998.
- 1986 – A country-wide SNA network was deployed to link the main Sasol sites with the IBM mainframe computers in Sasolburg and Secunda.
- 1989 – The two IBM mainframes were consolidated into one mainframe computer situated in Johannesburg.
- 1990 – Implementation of an open TCP/IP router based Wide Area Network (WAN). This network was upgraded constantly and today connects more than 30 Sasol sites across South-Africa as well as a few overseas offices.
- 1992-1994 – Various applications were downsized from the mainframe computer to smaller UNIX based mini computers. This is still the trend today with various SAP R/3 and MIMS application servers throughout the Sasol Group. The mainframe computer was also relocated to Secunda in 1996 because that is where the remaining Sasol user base of the mainframe computer is.
- 1995-1998 – The use of electronic mail became standard practice in Sasol and grew to an estimated 7000 mail users in 1998.
- 1996 – Various network services were launched which ranged from Internet access on the Sasol WAN, video conferencing between major Sasol sites, Electronic Data

Interchange (EDI) with trading partners and remote access to the Sasol WAN from more than 78 countries in the world.

- 1996 - 1998 – A Sasol Intranet was established and is growing daily with more than 40 web-servers spread throughout the Sasol Group. This is the most prominent sign of the network era in Sasol.

It is estimated that the Sasol Group of companies today invest over R 450 million per year in information technology. Apart from this investment by the Sasol Group, Polifin Ltd. also spends an estimated R90 million per year on information technology. These estimates include expenditure on process control related information technology.

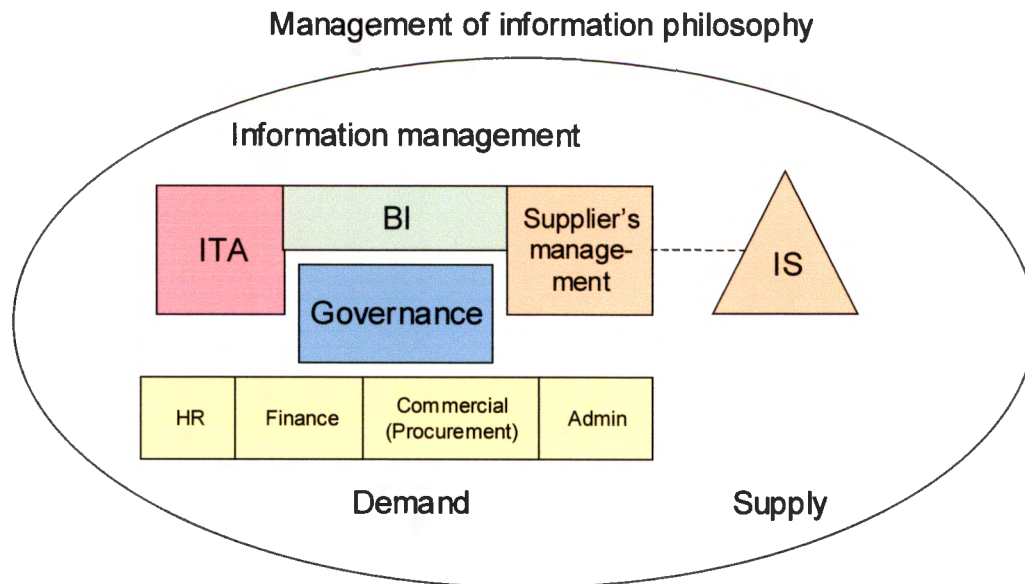
## 2.3 Management of information within the Sasol group

Sasol underwent a major restructuring exercise in December 1997 when the responsibilities for the supply of information was separated from the management of information within the business units. Before this transformation all the information technology related functions and roles were performed by typical in-house information technology functions called Group Information Division (GID). The new information management philosophy is based on a federal model where each business unit assumes full responsibility for all information technology aspects, and a new group Sasol information technology (Sasol IT) has the responsibility to deliver information technology solutions in accordance with governance rules and good commercial practices to the different business units.

### 2.3.1 Philosophy

The philosophy behind Sasol's management of information technology as a strategic resource and to create a sustained competitive advantage is described in this section. The next diagram illustrates the Sasol information management processes on a conceptual level. A more detailed explanation of these processes is given in section 2.3.2.

Figure 2-2: Management of information philosophy



The main components of Sasol's information management philosophy are the following:

- **Information management (IM)** is the function that aims to utilise information as a competitive lever by bringing stakeholders together. It is defined as the sum of information management governance, business information requirements, supplier management, and information technology architecture.
- **Business information (BI)** determines the demand for the supply of information. BI, through understanding the business, the business needs and information technology trends and technologies, aligns information (systems and technology) with business. It manages information, advises as a delegated responsibility of line management and is responsible for information within the framework of information technology governance.
- **Information services (IS)** supplies according to the demand as defined by information management or business information by establishing, maintaining and operating the technical infrastructure and developing systems and applications. Supplier management is the responsibility of information management and aims to ensure that the business has a constant supply of goods and services. In doing so, it aims to ensure alternative sources of supply and the reliability and cost competitiveness of suppliers.

- **Information technology architecture (ITA)** is needed to develop the technical architectures to support the business information plan. To be effective, the architectural framework must be embedded in corporate standards and policies. The ITA describes the rules needed to preserve the group's flexibility systems to meet current and future needs. These could include standards for data networks, electronic commerce, communication networks, applications delivery and methodologies.

### 2.3.2 Specific information management processes

The information management processes are crucial to Sasol's management of information technology in that they plan, govern, oversee and approve all information technology related initiatives within the Sasol group of companies. The workings of these processes are based on a number of committees or forums that assume certain responsibilities and roles. The most important of these committees/forums are:

- **Information management governance sub-working groups:** The sub-working groups perform most of the low level analysis and design work and consist of information technology specialists, certain end users, and business information consultants (BIC) from business units. Sub-working groups are also grouped in domains of interest e.g. communication, connectivity, information security, application development, modelling and simulation.
- **Information management governance forums:** These information management governance forums represent the business in Sasol's information management processes. The three most important of these information management governance forums are (a) information management intelligence function which is responsible for industry scanning and seeks new technologies that may provide a competitive advantage to Sasol, (b) the information management control function which oversees all current activities and ensures that they comply with the governance rules, and (c) the Sasol information management committee which oversees the whole governance process.

The interaction between all the governance committees and forums as well as the processes surrounding them is illustrated in the following diagram (Figure 2-3). Section 2.3.3 provides a detailed overview of the composition of these governance forums and the functions that they fulfil.

Figure 2-3: Sasol's information management processes.

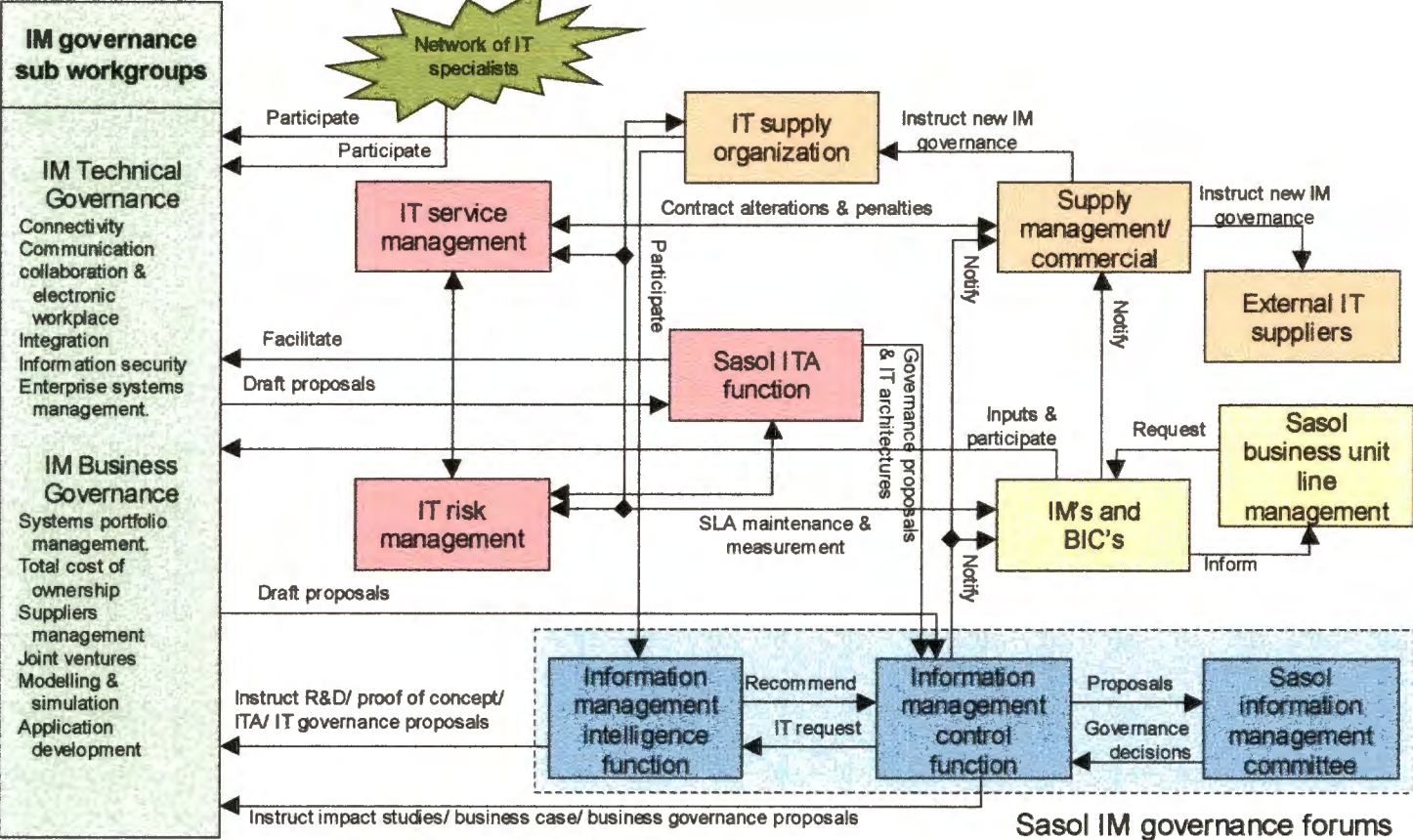


Table 2-2: Sasol's information management forum responsibilities.

	IM governance sub workgroup	Sasol IM intelligence meeting	Sasol IM control meeting	Sasol IM committee (policy meeting)
Chair	One of the IM managers	Manager Group ITA	General manager Sasol information and logistics division	General manager Sasol information and logistics division
Members	Group ITA's, Sasol business unit ITA's, information technology supply specialists, external IT specialists, Sasol Business unit BIC's and key users, and project managers	Group ITA's, Sasol business units ITA's governance domain custodians, and information technology specialists	IM managers, internal audit, group ITA, information technology service manager, information technology risk manager, and senior information technology supplier managers	Selected members of the Sasol group executive committee, selected IM managers, manager group ITA and general manager information technology supplier.
Functions	<p>The functions performed by sub workgroups include the following:</p> <ul style="list-style-type: none"> <li>▪ provide input to information technology architecture development processes;</li> <li>▪ oversee the development of information technology architecture;</li> <li>▪ identify and position new technologies;</li> <li>▪ identify and position new industry information technology standards;</li> <li>▪ discuss and position potential information technology products;</li> <li>▪ determine the impact of new technology on current information technology architecture;</li> <li>▪ develop information technology governance proposals aligned with information technology architectures;</li> <li>▪ provide technology guidance to R&amp;D projects that fall within the technical governance domains; and</li> <li>▪ do business impact analyses and business cases.</li> </ul>	<p>The IM Intelligence meeting responsibilities include:</p> <ul style="list-style-type: none"> <li>▪ ITA proposals approval;</li> <li>▪ evaluate integration, inter-working;</li> <li>▪ consider cross-functional implications;</li> <li>▪ sub workgroup conflict resolution;</li> <li>▪ present R&amp;D and proof of concept proposals to IM workgroup;</li> <li>▪ strategic technology decision making;</li> <li>▪ communicate business impact to IM workgroup;</li> <li>▪ propose business governance e.g. standards</li> <li>▪ initiate R&amp;D, proof of concept and impact studies;</li> <li>▪ determine the technology's impact on business;</li> <li>▪ manage Sasol's information technology architecture; and</li> <li>▪ maintaining of Sasol's information technology competency database.</li> </ul>	<p>The IM Control meeting performs the following functions:</p> <ul style="list-style-type: none"> <li>▪ review, consent and propose IM governance;</li> <li>▪ business impact analysis of information technology strategies, information technology architectures, policies and standards;</li> <li>▪ communicate &amp; monitor IM governance to Sasol business units;</li> <li>▪ propose group information technology projects to IM committee;</li> <li>▪ propose budgets &amp; funding of group IM projects;</li> <li>▪ governance per business governance domain;</li> <li>▪ maintain and oversee deployment of IM master plan; and</li> <li>▪ ensure sufficient level of IM training and information technology education.</li> </ul>	<p>The Sasol IM Committee is the most senior of the governance structures and must:</p> <ul style="list-style-type: none"> <li>▪ review and approve IM governance;</li> <li>▪ ensure that structures transform business strategies into information solutions;</li> <li>▪ approve group IM priorities and budgets;</li> <li>▪ approve exceptions on IM governance;</li> <li>▪ define IM responsibilities and relationships</li> <li>▪ ensure effective strategic application;</li> <li>▪ ensure effective communication and monitoring of strategic policies/standards affecting Sasol business units;</li> <li>▪ recommend for the approval of Corporate funding;</li> <li>▪ ensure benchmarking &amp; sharing of best practices;</li> <li>▪ ensure alignment of Sasol business unit's strategies with the rest of group;</li> <li>▪ ensure the use of information as a valuable resource; and</li> <li>▪ manage the interface with JVs and other subsidiaries.</li> </ul>

### 2.3.3 Functions and responsibilities of governance forums

Table 2-2 provides a more detailed overview of the functions, responsibilities, leadership and members of each of the governance forums and committees.

## 2.4 Sasol information technology group

The team supporting and establishing information technology in Sasol has grown consistently from a very small beginning in the early 1960's. The early history of what is today known as Sasol Information Technology was obtained from Fourie (1996). The following main phases could be distinguished:

- Early 1960's – A small data processing team was established to support the tabulators. It consisted of ten punch operators and three technical operators. This team reported to the financial department of Sasol I.
- 1966-1972 – With the acquisition of the mainframe the data processing team had to acquire programming skills. The team consisted of ten punch operators, eight programmers and three computer operators. It still reported to the financial department of Sasol I.
- 1972-1984 – The data processing team was moved from the financial department and reported to the administration department of Sasol I.
- 1984-1995 – Responsibility for information systems was transferred to the newly founded group information services (GIS). It consisted of about seventy people situated in Sasolburg and Secunda. GIS reported to the corporate financial manager of the Sasol Group and its head office was in Sasolburg. GIS gradually grew and received full “division” status in Sasol. Its name changed to group information division (GID) and the head office moved to Johannesburg in the early 1990's. During this period there was a failed attempt at relationship marketing with the creation of “account manager” positions. These positions were subsequently scrapped and the people involved were re-deployed in GID.
- 1996-1997 – The manager of GID now formed part of the management team of the Sasol Group and had general manager status. GID grew to an organisation with more than 250 employees.

- 1997-1998 - During a major transformation project the supply and demand of information technology services were split. The “business” side of the various Sasol companies took ownership of the demand side of IT and each company established an Information Management (IM) function. The supply side of information technology was renamed Sasol Information Technology (Sasol IT) and has just over 250 employees and an expected annual turnover of R140 million.

The supply side of information technology services was outsourced to PQ Africa in early 1999. A new company in the PQ Africa group called PQ Chem was created as a result of this. PQ Chem must compete with all the other information technology suppliers in the South African market for the Sasol business.

## 2.5 Causal factors to the study

The factors that have led to this study being undertaken can be split into internal and external, as highlighted below:

### 2.5.1 External factors

The petrochemical industry is currently going through profound and far-reaching changes in terms of new technology, consolidations, cost structures and environmental accountability that will have a major impact on the entire industry and organisations within it (see section 2.2.6 for more detail). This leads to new pressure on information technology to add its fair share of value to companies in the Sasol group.

Information and knowledge have become one of the latest means for organisations to achieve a competitive advantage. One example of how information technology has added value to companies is the unprecedented explosion of Internet technologies and how this helped organisations to capture value. (Bradley & Nolan, 1998:3).

### 2.5.2 Internal factors

Sasol is a very diversified company in terms of its operations, products, markets, and cultures (see sections 2.2.3, 2.2.4 and 2.2.5). This diversity has led to little synergy in terms of information technology infrastructure and systems, approaches and strategies resulting in losses in economies of scale and higher information technology related costs.

Sasol must respond to the changes in the petrochemical industry by lowering its production costs and improving its time to market of new products and technologies, especially Gas to Liquid (GTL) technologies, if it is to stay competitive in the market. The global market necessitates the support of operations and customers on a global scale. This has specific significance for Sasol's implementation and use of information technology.

Sasol also recently adopted a new approach to its management of information technology (section 2.2.7). This initiative created an environment where the management is sensitive to the problems and costs associated with the diversity in the Sasol group. Corporate structures (see sections 2.3.2 and 2.3.3) to effect and monitor the implementation of the recommendations and results of this study were also created during the transformation process.

A project portfolio is one of the most effective methods of managing an organisation's information technology investment because it determines the deployment of the technology and control inputs that are in a very early phase of actual deployment, thus reducing costs. This portfolio also provides management with overviews of all the interdependencies between different systems and infrastructure.

## 2.6 Summary

Chapter 2 provided an overview of the structure, operation and challenges of the Sasol group of companies. Sasol has created new structures, forums and committees to manage the implementation of information technology in the group. The causal factors that lead to this study have been identified and will henceforth be used as background information to this writing.

It was also highlighted that, in order for Sasol to survive in an increasingly competitive business environment, it should optimise its information technology spending through a balanced and optimised information technology project portfolio. The next two chapters will discuss the theoretical aspects that influence such project portfolios.

# CHAPTER 3

## PROJECT MANAGEMENT IN THE ENTERPRISE

### 3.1 Introduction

This section is the first of two theoretical chapters in this study and concentrates on the role project management plays in the information technology organisation. The topics discussed in this chapter include a general overview of project management, the unique challenges of information technology to the project manager, how project portfolios are composed and managed, and how the potential risk associated with projects is assessed and managed.

The discussions on project management only focus on the initial phases of the project aimed at learning enough about the project to assess the benefits that may result from it, the costs associated with it, and the risks that the organisation will incur when it starts the project. The other project execution phases, although very important for its successful implementation, fall outside the scope of this study.

Project management supports the objectives of the study in that controls the basic resources that an organisation deploys to acquire information technology, and is therefore in an ideal situation to optimise those resources. This chapter also forms an integral part with the next chapter that concerns itself with what an organisation should do to support its strategic goals and objectives.

### 3.2 Project management

Effective project pre-assessment and execution also helps to quantify and manage the risks associated with information technology projects. Failed projects have a very negative impact on an organisation because they consume valuable resources, harm confidence in information technology, and the organisation incurs opportunity costs.

The available project management literature is too comprehensive for this study, which will accordingly only focus on the creation of an environment conducive to effective project management, risk assessment and management, project planning, and trade-off analysis between different projects.

### 3.2.1 Project management defined

In order to understand project management, one must begin with the definition of a project.

Kerzner (1998:2) defines a project as any series of activities that:

- Has a specific objective to be completed within certain specifications;
- has defined start and end dates;
- has funding limits (if applicable); and
- consumes resources (i.e., money, people, equipment).

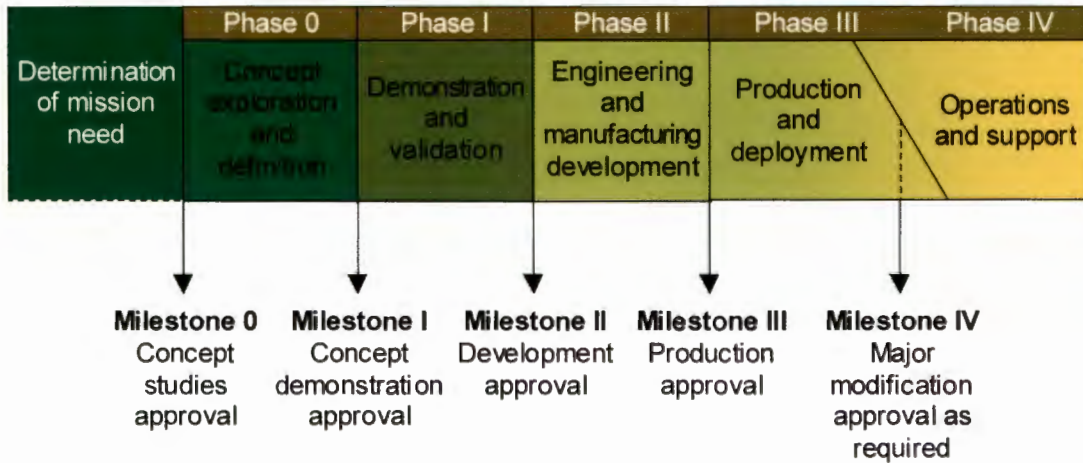
He describes project management as a process that involves project planning and project monitoring.

- Project planning involves the definition of:
  - ◆ work requirements;
  - ◆ quantity and quality of work; and
  - ◆ resources needed.
- Project monitoring involves the following activities:
  - ◆ progress tracking;
  - ◆ comparing actual outcome to predicted outcome;
  - ◆ analysing the impact of the project; and
  - ◆ making adjustments to the project activities.

The Project Management Institute (PMI, 1996:4) has defined a project in terms of its distinctive characteristics: a project is a temporary endeavour undertaken to create a unique product or service. *Temporary* means that every project has a definite beginning and a definite end. *Unique* means that the product or service is different in some distinguishing way from all similar products or services. The PMI uses the term project management to describe an organisational approach to the management of ongoing operations. This approach, more properly called management by

projects, treats many aspects of ongoing operations as projects in order to apply project management to them (PMI, 1996:6).

A project may progress through a series of more or less well-defined phases through a build-up in size and resource consumption, and then begins to decline after a peak activity and finally terminates. The generic definition of project phases and their related milestones is illustrated in the following diagram (PMI, 1996:13):



The actual activities carried out within each phase will differ, depending upon the general class or type of project. The following classes of projects can be distinguished (Archibald, 1992:33):

- commercial and government projects under contract for products and services (e.g. telecommunication equipment contracts);
- research, product development, engineering, marketing (e.g. R&D for new products or services);
- capital facilities design and construction (e.g. major building construction);
- information systems (e.g. development and installation of an executive information system in a large firm);
- management projects (e.g. business process re-engineering projects; and
- major maintenance projects (e.g. renovation and expansion of a stadium).

Projects often interact with others, being carried out simultaneously by the organisation. And there is often an interaction between the project organisation (e.g. the research and development or information services) and other functional areas (e.g. marketing, production and finance) which have a vested interest in one way or another in the project; that is, a project may be carried out on behalf of the functional, and/or may consume resources that it controls.

Every project selected must compete for scarce resources and for the attention of management at every phase of its life cycle. The amount and type of resources required, and the type and intensity of management activity, including progress reviews, depend upon the phase of the project.

Projects and project management can be said to involve the delivery of a unique product or service using a structured management philosophy that incorporates the planning and monitoring of all the activities required to deliver the product or service.

### 3.2.2 Project portfolios

A project portfolio is a group of projects, and/or projects in one or more programmes, that are carried out under the sponsorship and/or management of an organisation. Hence these projects must compete for scarce resources (people, time, finance, server capacity and network bandwidth) available from the sponsor, since it is rare that there are enough resources to carry out every project that may be proposed and which meets the organisation's minimum requirements for certain criteria such as potential profitability. This results in a need to select from among available projects in order to meet the organisation's objectives in some optimal manner, however that may be defined (Archibald, 1992:38).

Among the many complexities in compiling an optimal project portfolio, are the following (Archer & Ghasemzadeh, 1996:6):

- There are multiple and often conflicting objectives (or criteria) associated with portfolio selection.
- Even when all the objectives have been identified, there are still problems associated with determining the trade-offs among the various criteria. In this respect, the importance of guidance from pre-defined organisational policies and budget controls in establishing selection guidelines cannot be overemphasised. There are nevertheless still other non-tangible trade-offs.

- The evaluation of proposed individual projects is complicated by two additional factors. Firstly, some of the criteria are qualitative, as opposed to quantitative, in nature. The comparison of quantitative factors is usually based on the judgement of one or more stakeholders and is normally quite different from comparing qualitative factors, for which data or analytical models are available to assist in the judgement process. Secondly, each project has risk (the probability of failure) associated with its undertaking, and there may be considerable uncertainty associated with both the level of risk and the scoring of individual projects on each specific criterion. Section 3.2.3 provides a more detailed discussion on project risk management.
- There may be a high interdependence between projects. This could be due to value contribution or resource utilisation. So, for example, in information systems developing and implementing an executive information system might require several precursor projects (e.g. a number of transaction processing systems) each of which could have benefits in its own right.
- In addition to the difficulties associated with project objectives, several constraints may often have to be considered for project selection. Major constraints, which are normally very important, include overall project budgets, scheduling, and programme considerations. Other important constraints include the market, and limitations on the workforce and its technological capacities.
- The number of feasible projects, especially in large organisations, is often very large, and there may be an enormous number of possible combinations of projects to be considered for the portfolio. Hence, it is important to eliminate individual projects from consideration on other grounds where it is feasible to do so before the portfolio process begins, in order to reduce the number of projects to be considered.
- Selection of, or adjustments to, a project portfolio is a process that recurs at more or less regular intervals. Projects which have previously been included in the portfolio should also be re-evaluated at appropriate “milestones” or “gates” to determine whether they continue to merit further development, in competition with projects which have not been included. Cancellation decisions are probably the most difficult to implement, since they often involve serious behavioural and organisational consequences.

- Finally, portfolio selection is usually not the sole responsibility of one individual. It is frequently a committee process, where objective criteria such as predicted rate of return and expected project cost go hand in hand with subjective criteria relating to the needs of the different organisations represented on the project selection committee.

### 3.2.2.1 Evaluation and selection techniques

Many articles and books have been published on the subject of project evaluation and selection, discussing well over one hundred different techniques (Cooper, 1988:95). But it seems possible to classify these techniques into two primary categories: *benefit measurement techniques* and *project selection/resource allocation techniques* (Baker & Freeland, 1975:1167). The first category tends to deal more with the evaluation of individual projects on some basis (economic or otherwise), while the second category deals with the development of project portfolios based on known evaluations of candidate projects. These techniques will be discussed in more detail in the following sections.

#### 3.2.2.1.1 Benefit measurement techniques

Benefit measurement methods can be described as systematic procedures for obtaining and integrating subjective and objective benefit data. Baker and Freeland (1975:1168) suggest the following classification of benefit measurement techniques on the basis of the thought processes that are imposed on the respondents, although it is possible for a particular measurement method to fall under more than one of these classifications.

##### 3.2.2.1.1.1 *Comparative approaches*

This category includes approaches such as Q-Sort, rating, pair wise comparison, and the Analytic Hierarchy Procedure (AHP), dollar metric, standard gamble, and successive comparison. Of these techniques, Q-Sort is most adaptable to achieving consensus in a group situation. In these methods, first the alternatives are compared and then a set of project benefit measures is computed that is based on the stated preferences. In principle, once the projects have been arranged on a comparative scale, the decision maker(s) can proceed from the top of the list, selecting projects until available resources are exhausted. The AHP approach is discussed in more detail below.

##### 3.2.2.1.1.2 *Analytic hierarchy process*

The Analytic Hierarchy Process (AHP) is a comparative approach which was developed by Thomas Saaty in the 1970's (Saaty *et al.*, 1980:16). It has received much attention, has been applied in a diverse areas, and has been the subject of a voluminous body of literature. Its main

use is in selecting one project from a list. The use of AHP in solving a decision problem involves the following steps (Zahedi, 1986:96):

- 1) Setting up the decision hierarchy by breaking down the decision problem into a hierarchy of interrelated decision elements.
- 2) Collecting input data by pairwise comparisons of decision elements.
- 3) Using the “eigenvalue” method to estimate the relative weights of decision elements.
- 4) Aggregating the relevant weights of decision elements to arrive at a set of ratings for the decision alternatives.

Despite the logical and scientific foundations of AHP and its wide application, a number of criticisms of this approach has also appeared. However, the major advantages of AHP are (Bard & Sousk, 1990:226):

- The AHP structures the decision problem in levels that correspond to an understanding of the situation: goals, criteria, sub criteria, and alternatives. By breaking the problem into levels, the decision maker can focus on smaller sets of decisions.
- In pairwise comparison only two factors are compared each time. This helps analysts and decision makers to focus, understand, and discuss issues.
- People may often disagree on certain judgments, but these judgments usually have little or no impact on the final decisions. AHP allows for performing sensitivity analysis, reducing the rhetoric in debates that can often arise in group settings.
- AHP is quite accessible and conducive to consensus building.
- AHP handles qualitative factors as easily as quantitative factors.

The following disadvantages are associated with the use of the AHP method:

- Relative ranking of alternatives may be altered by the addition of other alternatives. This issue, perhaps the most controversial aspect of AHP, has been discussed in a number of articles by both critics and proponents of AHP (Dyer, 1990:252).

- The bounded 9 point scale used in the AHP method inherently may give results that are outside accepted consistency standards. The problem is most severe with large numbers of alternatives, but it can exist when there are only three. Experimentation may be necessary to reach a consensus on the numerical values to be associated with the AHP semantic scale (Harker & Vargas, 1987:1389).
- As the number of criteria and alternatives increases, the number of pair wise comparisons required of the decision maker quickly becomes burdensome (Lim & Swenseth, 1993:64). So for example, in a hierarchy with 4 levels and 6 alternatives on each level, the decision maker must make  $(4*6*5)12 = 60$  comparisons. In order to reduce this problem in large scale AHP problems, Saaty (1996:85) has developed a modification of the method in which fewer comparisons are performed. If this method is used, the analyst has to strike a comparison between robustness of the estimates and speed of the procedure in order to determine how many comparisons to perform (Kamenetzky, 1982:703).
- The AHP method implicitly assumes that evaluators are inconsistent in expressing their preferences. Once some level of consistency is achieved through consistency checks, no errors should exist in the input data (Zahedi, 1986:102). This is not actually the case in practice, since not all random errors are likely to be eliminated by consistency checks.
- When decision makers select a project portfolio, they must often deal with some interdependency among projects.
- The AHP method does not address resource limitations in portfolio selection.
- The AHP method does not address the important issues of project interdependence.

#### 3.2.2.1.1.3 *Scoring models*

These approaches (Baker & Freeland, 1975:1168) assume that a very small number of decision criteria such as cost, work force availability, and probability of technical success, can be defined which will be used to specify the desirability of each alternative project. The merit of each project is determined with respect to each criterion. The scores are combined (when different weights are used for each criterion, the technique is called “Weighted Factor Scoring”, probably the most commonly used scoring model) to yield an overall benefit measure for each project. Advantages of the scoring models are (Coopers, 1988:112):

- although the way of measuring benefits is relative, projects can be added or deleted without affecting the benefit scores of other alternatives;
- they allow integration of qualitative and quantitative attributes; and
- these techniques are relative easy to understand and use.

The disadvantages of the scoring models are (Coopers, 1998:113):

- project risks are not explicitly considered;
- weighting is required, which is cumbersome and difficult to evaluate;
- these techniques are not well suited for situations where one project influences the desirability of another; and
- they do not answer the question “Are any of these projects really good projects?”

#### 3.2.2.1.1.4 *Benefit contribution models*

The benefit contribution models require the respondent(s) to tie projects directly to organisational objectives, goals and system requirements. This is in contrast to the scoring models that evaluated specific project characteristics. Project benefit with these projects is measured in terms of contributions to a number of project objectives. The resulting measure may or may not be relative depending on the specific approach. Alternatives may be added or deleted without influencing the benefit score of others. This category includes methods such as:

- **Economic return techniques** (Brigham & Gapenski, 1994:388): Five primary methods are used to rank projects and decide whether or not they should be included in the capital budget namely: payback period, accounting rate of return, net present value, internal rate of return and profitability index. The capital asset pricing model can also be used. It has the advantage that it includes a provision for risk but does not appear to be suitable for discrete project comparisons (see section 4.2.2 for more detail on the economic return techniques).
- **Benefit/Cost techniques** (Wena *et al.*, 1998:148): These techniques involve the calculation of a ratio of benefits to costs, where the inputs may in fact be derived from present value calculations of both benefits and costs, in order to transform them to the same time basis (see sections 4.2.1 & 4.3 for more information).

The advantages of economic return and benefit/cost techniques are:

- ◆ comparisons are in easy understood language; and
- ◆ with certain techniques the best projects are clearly identified by the calculated measure, depending upon the class of projects being considered.

The following disadvantages exist for the above mentioned techniques:

- ◆ it is difficult to include non-tangible benefits; and
  - ◆ detailed data is needed for estimated cash flows.
- **Risk analysis:** These approaches involve a succession of choices, where the probabilities of particular outcomes must be estimated (see section 3.2.3.3 for more detail). The advantages of risk analysis techniques are the following:
- ◆ more than one stage in a project can be considered; and
  - ◆ the expected values of outcomes at each stage can be determined.

The disadvantage of risk analysis is that these approaches require estimations of probabilities of possible outcomes, which may be difficult to determine.

#### 3.2.2.1.1.5 *Market research approaches*

There is a wide variety of market research approaches that can be used to generate data for forecasting the demand for new products or services, based on concepts and prototypes that can be presented to potential customers to gauge the potential market for the product or service. Techniques used include consumer panels, focus groups, perceptual maps, and preference mapping among others. Among the advantages of these market research approaches are (Cooper, 1988:101):

- The market is the driving force for any new product or service. Resources should not be wasted on developing products or services with little or no demand.
- Projections of market demand and pricing are essential for the determination of resources that can be devoted to development projects.

Disadvantages of market research approaches are (Cooper, 1988;104):

- market research does not consider other factors such as development, production and distribution costs and timing;
- these techniques are useful only for market-driven products and services and cannot be used for internally consumed products and services, such as information systems; and
- unless the product or service being considered is very similar to one already on the market, the uncertainty in the forecasting of the customer acceptance rate will be extremely high.

#### 3.2.2.1.2 Project selection/resource allocation techniques

Although this group of techniques may be used in its own right in certain cases, project selection/resource allocation techniques are normally used to represent a second stage in portfolio selection, with inputs that can be the outputs of the first stage benefit measurement methods (Baker & Freeland, 1975:1170). A number of these approaches have been suggested in the literature, and several will be discussed briefly in the next few sections.

##### 3.2.2.1.2.1 *Ad hoc approaches*

- **Profiles.** This is a crude form of scoring model, where limits are set for the various attribute levels of a project, and any projects which fail to meet these limits, are eliminated. Advantages of profiles:
  - ◆ they are very efficient; and
  - ◆ all projects are judged on the same basis, given the values of particular attributes.

The disadvantages of using profiles are that it is very arbitrary, and requires specific limits to be set on various criteria. These may be difficult to determine.

- **Interactive selection** (Hall & Nauda, 1990:126). This involves an interactive process between the managers championing projects and decision maker(s) responsible for choosing the portfolio. The key feature is that selection criteria are better articulated as the process continues. The advantages of the interactive selection model are:
  - ◆ project managers have an incentive to make their projects look more attractive to the decision maker (this may also be a disadvantage);

- ◆ it helps managers to become very familiar with all aspects of the project; and
- ◆ the project is more likely to fit strategic objectives of the decision maker(s).

The disadvantage of the interactive selection technique is that it will make all projects look more alike than they really are (Hall & Nauda, 1990:127).

#### 3.2.2.1.2.2 *Strategic planning tools*

The strategic implications of portfolio selection are complex and varied. Hax and Majluf (1995:24) discussed a number of techniques for developing strategies including the use of portfolio matrices, to be discussed below. The first two relate to other tools that have been discussed in the literature.

- **Cognitive modelling or policy capturing.** This is a method which examines global decisions to determine the components (actual decision processes) that went into them. There are two approaches: replication of decisions, and evaluation of decisions. The intent is to calibrate the decision process so that future decisions can be consistent within the context of previous decisions. The advantage of this technique is that it allows for the analysis of global decisions in order to understand how they were made. The disadvantages on the other hand are:
  - ◆ only past decisions can be examined, and it requires a relatively large number in order to get the maximum benefit; and
  - ◆ these approaches are of little use in relatively new situations.
- **Cluster analysis** (Matthieu & Gibson, 1993:286). This is a method which helps in selecting projects that support the strategic positioning of the firm. The main advantage of cluster analysis is that it helps an organisation to maintain its strategic positioning. The disadvantage however is that it only helps in finding clusters of similar projects, but does not select specific projects from within the clusters.
- **Strategic matrices** (Ward & Griffiths, 1996:273). A number of matrices have been developed to aid management decision making with respect to information systems planning, utilisation and resourcing. Portfolio matrices are basically two-dimensional pictorial representations of all the projects under consideration. In all the matrix approaches, the position of a project within a matrix suggests the pursuit of a particular

strategy. The main strategic planning tools that focus on information systems planning are the following:

- ◆ The Sullivan matrix, considers the types of information systems and technology management issues, depending on the combination of infusion and diffusion of information technology in the organisation. Infusion can be defined as “the degree to which information technology has penetrated an organisation in terms of importance, impact or significance” (Ward & Griffiths, 1996:274), and diffusion is “the degree to which information technology has been disseminated or scattered throughout the organisation”. Sullivan identifies the need for new demand driven and decentralised planning approaches to improve the management of the strategic and high potential quadrants, in addition to the better understood planning approaches required for “backbone” (key operational) and “traditional” (support) systems. These new approaches are based on the identification and use of critical success factors (CSFs) plus an “eclectic” planning method to deal with the strategic aspects when information systems/information technology is considered in establishing the objectives or is being used to transform business processes – i.e. when there is a complex relationship between information systems/information technology and the business.
- ◆ The Information Technology Assessment and Adoption (ITAA) matrix developed by Huff and Munro (1985:335), considers how organisations have adopted information systems/technology as a competitive weapon. Huff and Munro consider the relative roles and importance of business issues and technology in the process of developing so-called strategic systems. Most companies, it seems, are either “technology driven” – looking for ways of deploying new technology to advantage – or “issues driven” – looking for new business opportunities within the known possibilities of existing technology. These relate mainly to high potential and key operational type environments, and few companies achieve “normative” planning where business issues and opportunities and technology are effectively matched – an “ideal” planning relationship as they describe it – i.e. that which is required for strategic applications to be developed.
- ◆ A matrix developed by Ives and Learmonth (1984:1195), consider how the “value adding potential” of information systems/technology in the business and the

“quality of information systems resources” (i.e. the ability of the organisation) affect what is done with information systems/technology and how it is managed. They consider how a vision of what is possible plus strength of resources are essential if information systems/technology is to be used as an offensive – i.e. strategic – weapon, and how the two are often interrelated. In most organisations the lack of vision reduces the ability of even good resources to do more than “explore” opportunities as issues arise. Low quality of resource implies a “safe” support systems only approach, and the company will become very vulnerable due to its inability to respond to new high potential or strategic applications developed by competitors. In such a case, “vision” is not enough – the resource must be improved at the same time and it must “beware” of information systems/information technology investments by competitors.

Matrix analysis approaches are attractive because they reduce an apparently infinite continuum of alternatives to a manageable, pertinent number of discrete options from which high-level directions can be determined. They demonstrate relationships that evolve over time, but that will normally have to be managed to success simultaneously in the organisation.

Like many such models developed to assist management, they are often overly simple, and more complex models would be needed to reflect the diversity of reality. As complexity is added, however, clarity of perception often dims. Without intending to introduce confusion by complexity, it is worth considering a few further aspects of the models.

Independent of the specific type of matrix display used, the advantages of project portfolio matrices are (Archer & Ghasemzadeh, 1996:17):

- ◆ Portfolio matrices are well-organised, disciplined methodologies which facilitate the selection of a portfolio of projects.
- ◆ Managers often neglect to use a rational economic approach. Portfolio matrices lead them to make decisions that are more rational than if they use unaided judgement.

- ◆ Portfolio matrix methods are judged to be successful for strategic planning by those who use them. A survey of Fortune 1000 companies showed that almost all respondents believe their use of portfolio planning to have a positive impact (Haspelagh, 1982:63).
- ◆ Portfolio matrices present information to decision makers in a “user-friendly” manner. It can also be used by groups of decision makers in meeting.
- ◆ Portfolio matrices give an overall perspective of all projects under way on a single map.
- ◆ Portfolio matrices tend to enforce a strategic discipline in decision making. They also provide a commonly understood vocabulary to facilitate idea exchange among decision makers.

The major disadvantages associated with project portfolio matrices are (Archer & Ghasemzadeh, 1996:18):

- ◆ the scope of portfolio matrices ignores other relevant strategic issues;
- ◆ portfolio matrices have little theoretical or empirical support (Armstrong & Brodie, 1994:74);
- ◆ project labels (e.g. pearl, star, and so on), common to this approach, are appealingly easy to use, but they may lead decision makers to overlook profit maximisation (Armstrong & Brodie, 1994:75);
- ◆ no single empirical study has demonstrated that portfolio matrices are valuable as a decision aid (Armstrong & Brodie, 1994:74); and
- ◆ excessive rigidity, which is inherent in these methods, could lead to a mechanistic type of thinking which could stifle rather than enhance creativity.

#### 3.2.2.1.2.3 *Optimisation Models*

The objective of an optimisation model is to select from the list of candidate projects a set that provides the maximum benefit (e.g. maximum net present value) to the organisation. Optimisation models are generally based on some form of mathematical programming, which not

only supports the optimisation process, but takes into account project interactions such as resource dependencies, budget constraints, technical interactions, market interactions, or programme considerations. These models also generally support sensitivity analysis, an important aspect of making choices when the portfolio is being fine-tuned. Optimisation models based on a variety of mathematical programming techniques or combinations of these have appeared in the literature. However, most of these models do not seem to be used extensively in practice (Souder, 1973:907). Probable reasons for this include the need to collect massive amounts of input data, the inability of most models to include considerations of risk, and in some cases the model complexity.

There are potential uses of mathematical programming in conjunction with other approaches. For example, 0-1 integer programming could be used to apply constraints such as resource utilisation and project interactions, and the goal programming allows multiple objectives to be considered simultaneously (Santhanam *et al.*, 1989:588), while a project matrix approach is not applicable to large problems (Rasmussen, 1986:85).

#### 3.2.2.1.3 Summary of project portfolio selection techniques

This section contains a summary of the characteristics of some of the portfolio selection techniques that were discussed in the preceding sections. This discussion is relatively general, in that it will not consider special adaptations of the techniques mentioned, which may have been made to broaden and enhance the application of the technique mentioned. Column 1 of Table 3-1 shows some of the project selection techniques previously discussed, and column 2 indicates whether the technique has a rigorous theoretical grounding. For each technique an indication is given of which of the set of project or portfolio characteristics shown in columns 3 to 11 are taken into consideration. Columns 12 to 17 are decision support characteristics, which the technique may provide to decision makers. In the best of all possible worlds, a good portfolio selection technique would consider all of the project/portfolio characteristics, and provide decision support of all the types indicated. In practice this has not been the case, as is shown in the table.

Table 3-1: A comparison of project selection methods.

Method	Theoretical basis	Project/portfolio characteristic								Support characteristic					
		Multiple objectives	Project interdependence	Mutually exclusive	Resource limitations	Qualitative attributes	Number of projects	Project phases	Project risk	Parameter estimate uncertainty	Sensitivity analysis	Portfolio balancing	User-friendly interface	Overall perspective	Group support
<b>Comparative</b>															
Q-Sort					Y	Y	S/M							Y	Y
Pairwise comparison					Y	Y	S								
Scoring		Y			Y	Y	S-L								
Analytic hierarchy process	Y	Y			Y	Y	S-M				Y		Y	Y	Y
<b>Benefit contribution</b>															
Economic return	Y						S-L	Y			Y				
Risk analysis	Y	Y					S-L	Y	Y	Y	Y				
<b>Market research</b>															
Market research		Y				Y	S								Y
<b>Strategic planning</b>															
Portfolio matrix		Y			Y	Y	S-M		Y			Y	Y	Y	Y
Cognitive modelling		Y				Y	M-L					Y		Y	Y
Cluster analysis	Y	Y				Y	M-L						Y		Y
<b>Ad hoc</b>															
Profiles		Y					S-L						Y		
<b>Optimisation</b>															
0-1 integer LP	Y		Y	Y	Y		S-M	Y			Y				
Goal programming	Y	Y	Y	Y	Y		S-L	Y			Y		Y		

Source: Archer and Ghasemzadeh (1996:23).

The following is a brief discussion of the characteristics considered and decision support supplied, in the order of the columns in the table (Archer & Ghasemzadeh, 1996:24):

- **Theoretical basis of the portfolio selection method:** The existence of a sound theoretical basis for a portfolio selection method greatly increases the likelihood that its application will produce a result that can be trusted by decision makers.
- **Multiple objectives:** In selecting projects, more than one objective may be considered simultaneously in making portfolio selection decisions.
- **Project interdependence:** In some cases, projects may not be independent of one another.

- **Mutually exclusive projects:** A good example of mutually exclusive projects arises when several alternative approaches are proposed to solve a particular problem. Then the choice must be made among the alternatives, with only one being chosen.
- **Resource limitations:** Resource limitations are ever-present, but are not explicitly considered by methods that consider only one project at a time, such as benefit contribution and market research methods. On the other hand, constraints such as these can be handled by comparison techniques, which rank projects according to some objective(s).
- **Qualitative attributes:** Some project attributes such as resource requirements may be expressed quantitatively. But qualitative attributes may be needed to express project characteristics such as those about which there may be considerable uncertainty or which are normally expressed as “fuzzy” values or political characteristics.
- **Number of projects:** The number of projects that can be considered during portfolio development depends upon the technique used. Smaller numbers help to reduce information overload for decision makers, making it easier to use a broader range of selection methods. For medium to large numbers of projects, decision makers need the type of support that allows them to consider the most relevant information without being buried by it.

In Table 3-1, the number of projects typically handled by each method is shown as S (small .less than 10), M (medium .10 to less than 30), and L (large .30 or more). There are few methods which successfully handle large numbers of projects without using relatively arbitrary selection criteria. Hence, it is important to use screening to eliminate as many projects as possible on other logical grounds not related to overall considerations.

- **Project phases:** Most projects, unless they are very small, are broken down into phases, for ease of management control. Some of these phases represent points at which the project has reached some recognised state of completion and can be evaluated against measurement of objectives achieved, such as resource consumption, perceived quality of the product or service under consideration, and degree of satisfaction with the project up to that point.

- **Project risk:** Risk should play a significant role in making project selection decisions. This is very clear from the portfolio matrix approaches that frequently use risk as one of the dimensions displayed.
- **Uncertainty:** Uncertainty, as the inaccuracy in the estimates of project variables, in most parameters should also decline as the project moves through its phases, because decision makers have more accurate data upon which to base their predictions as the project moves closer to completion.
- **Sensitivity analysis:** The value of a portfolio's objective function is an estimate of the sum of contributions from all the projects in the portfolio. This is dependent upon the values used for each of the independent variables or attributes of each project, such as payoffs, costs and risks. Sensitivity analysis provides a means of measuring how robust the objective function is to changes in these parameters.
- **Portfolio balancing:** Portfolio balance is important on certain portfolio dimensions, such as risk, size of project, and short term vs. long term projects. For example, the proportion of high risk projects should not be too high due to the fact that failures of a large number of these projects could be extremely dangerous to the future of the company. On the other hand, low risk projects may not carry the high return that is often typical of risky projects, so the expected return from the portfolio may be too low if project selection is too conservative in the risk dimension. Balance in project size is also important, because the commitment of a high proportion of resources to a few large projects can be catastrophic to the firm if more than one fails. And too many long term projects, no matter how promising they are, may cause cash flow problems.
- **User-friendly interface:** Decision makers with the responsibility for making portfolio selection are typically managers who are not highly experienced computer users, but in recent years they have come to be expected to use computers as decision support tools.
- **Overall perspective:** Selecting a project portfolio is a strategic decision, and the relevant information must be presented in such a way that it allows decision makers to develop an overall view of the portfolio without overloading them with related information unless they specifically require it.

- **Group support:** A large proportion of portfolio selection decisions are made by groups of managers. This requires that all the managers involved in the decision should have ready access to relevant information, and that they be able to contribute their knowledge in the decision making process.
- **Strategic considerations:** Certain methods such as Q-Sort lend themselves to overall considerations of the set of projects proposed for the portfolio. These methods provide a means for high-level classification of projects into strategic categories. Strategic planning approaches such as cognitive modelling and cluster analysis also take a broad strategic perspective.

### 3.2.3 Project risk assessment

This section will provide an overview of project risk assessment and management as well as information technology specific project risks. For the purposes of this study this section on risk management will focus on risk identification and assessment as well as information technology specific project risks. A general overview of other aspects of risk management is also provided. The potential value of project risk management lies in the fact that it helps the organisation to avoid unnecessary high risk projects, and manage the risks of the current projects, resulting in more successful information technology projects and a higher return on an organisation's information technology investments.

The ultimate purpose of risk management is risk mitigation, which is the act of reversing a project's schedule, budget and scope or quality in such a way that the uncertainties in a project are reduced without any significant impact on the objectives. Risk mitigation requires risk quantification in order to determine the impact on the project (Kerzner, 1998:885).

It is important that a risk management strategy be established in the early stages of a project and that the risk be continually addressed throughout the project lifecycle. Risk management includes several related actions: risk identification, risk quantification, risk response, and risk control or lessons learned (Kerzner, 1998:878):

- **Risk identification.** This is a process of examining a situation and identifying and classifying the areas of potential risk.
- **Risk quantification.** This requires conducting an analysis to determine the probability of events and the consequences associated with their occurrence. Many tools exist to aid

in the analysis, such as schedule network models and life-cost models. The purpose of risk analysis is to discover the cause and effects, and magnitude of the risk perceived and to develop and examine alternative options.

- **Risk response.** This includes techniques and methods developed to reduce or control the risk. There is no risk management if there is no provision for handling the identified and quantified risk.
- **Risk control and lessons learned.** This includes methods for documenting lessons learned about risk management to benefit future decision makers.

Risk control and risk response is not within the scope of this study and will therefore not be elaborated on. It is, however, necessary to develop risk response and control plans for the projects that are being implemented. This is an essential requirement for the management of projects.

Once the process of risk assessment is complete, results could be used as guidelines in deciding where to focus the development and verification resources to employ a more planned control over the product life cycle. Risk assessment results can be useful in:

- Identifying overly complex modules needing detailed inspection;
- identifying noncomplex modules likely to have a low defect rate and may therefore be candidates for development without detailed inspection;
- estimating programming and service effort, identifying troublesome code, and estimating testing effort; and
- identifying components with high risk factor that would require the development of effective fault tolerance mechanisms.

### 3.2.3.1 Importance of risk management

Studies suggest that about 25% of projects initiated to develop large scale systems are abandoned, 75% of those that are operational either are not used or do not perform as intended, and the average software-development project exceeds its schedule by 50% (Nidumolu, 1996:77).

The result of the project failures is that valuable resources spent on the development of the project are lost and that the organisation has received very little if any return on its investment. Another aspect to consider is the opportunity costs associated with these failed initiatives.

If an organisation is able to identify and manage the risks associated with the development and implementation of information technology projects, it will have more resources available to spend on new information technology projects and realise the returns on existing projects.

### 3.2.3.2 Definition of risk

Kerzner (1998:869) defined risk as a measure of the probability and consequence of not achieving a defined project goal. Risk assessment provides a formalisation and structure for selecting strategy alternatives and should be a major element in the decision making process.

Risk also has three primary components (Kerzner, 1998:869):

- An event (an unwanted change);
- a probability of occurrence of that event; and
- the impact of that event (amount at stake).

Conceptually, risk for each element can be defined as a function of uncertainty and damage; that is,

$$\text{Risk} = f(\text{event}, \text{uncertainty}, \text{damage})$$

In general, as either the uncertainty or damage increases, so does the risk.

It is important to realise that project performance is a multidimensional construct, and not a mere measurement of the project budget and time schedules. This study considers two important dimensions of software-development project performance that may imply different relationships with independent variables, namely (Nidumolu, 1996:78):

- the extent to which the development process is under control (called process control); and
- the extent to which the software developed at the end of the project is able to generate distinctly new products or functions in response to changing business needs (called product flexibility).

These two performance dimensions were selected because there is typically a trade-off perceived between them: In order to meet tight deadlines and budgets, software developers often develop

systems that meet the immediate needs of the users without adequately considering their long-term flexibility, therefore increasing the cost of maintaining them.

Another element of risk is the cause of risk (Kerzner, 1998:870). Something, or the lack of something, induces a risky situation. The source of danger or risk is also called hazard. Certain hazards can be overcome to a great extent by knowing them and taking action to prevent them. This leads to a second conceptual equation (Kerzner, 1998:870):

$$\text{Risk} = f(\text{hazard}, \text{safeguard})$$

Risk increases with hazard but decreases with safeguard. The implication of this equation is that good project management should be structured to identify hazards and to allow safeguards to be developed to overcome them. If enough safeguards are available, then the risk can be reduced to an acceptable level.

Risk management is an organised means of identifying and measuring risk and developing, selecting and managing options for handling these risks (Kerzner, 1998:871). According to the Project Management Institute (PMI, 1996:111), there are three definitions of risk management:

- Risk management is the formal process by which risk factors are systematically identified, assessed and provided for.
- Risk management is the formal, systematic method of managing that concentrates on identifying and controlling areas or events that have a potential of causing unwanted change.
- Risk management in the project context, is the art and science of identifying, analysing, and responding to risk factors throughout the life of a project and in the best interest of the objectives.

Proper risk management therefore implies the control of possible future events, and is proactive rather than reactive.

Risk assessment and management is important for this study for the following reasons:

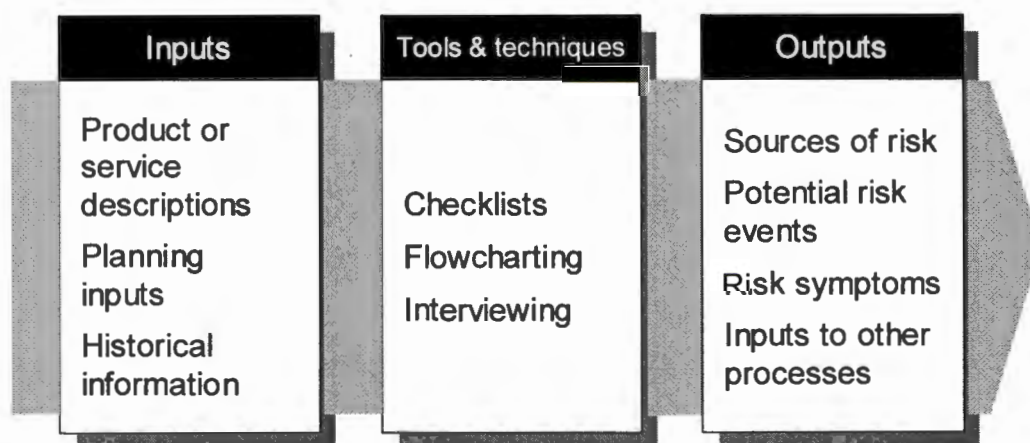
- it reduces the overall risk of the project portfolio;

- it conserves scarce resources that may be consumed to correct any project misfortunes; and
- it increases the chances that all the project objectives may be achieved, hence it increases the return on investment of the information technology resources of an organisation.

### 3.2.3.3 Risk identification

Although risk identification is one of the first steps in the project management process, it remains a continuous process throughout the project lifecycle. The main benefit of the risk identification process for this study is that it provides an overview of the risk profiles of all the projects in question. This risk profile should also be taken into consideration when projects with similar returns are compared.

Figure 3-1: Risk identification process



Source: Project management institute (PMI, 1996:113)

The results of this process are also very useful in the project execution phases of the project, as it helps to identify the potential risks associated with the project, and assists the project managers to manage the project to successful completion.

#### 3.2.3.3.1 The risk identification process

The first step in risk management is to identify and assess all potential risk areas. The thoroughness with which this identification is accomplished will determine the effectiveness of risk management.

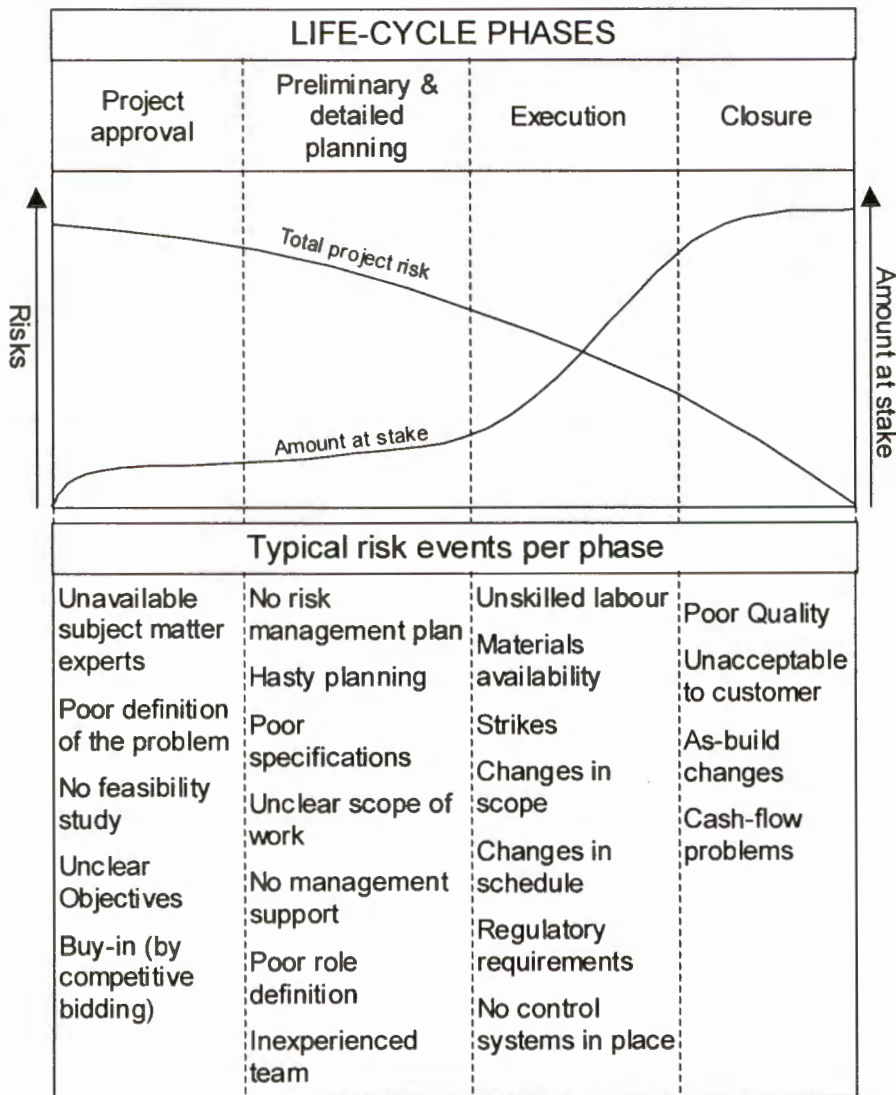
Risk identification, according to the Project Management Institute (PMI, 1996:111), is not a one-time event and should be performed on a regular basis throughout the project. Risk identification should address both internal and external risks. Internal risks are things that the project team can control or influence, such as staff assignments and cost estimates. External risks are things beyond the control or influence of the project team, such as market shifts or government action.

Some risks always exist in project, technical, test, logistics, engineering, and market acceptance areas (Kerzner, 1997:879). Technical risk may involve the risk of meeting a performance requirement, but may also involve anything from risks in the feasibility of a design concept, to the risks involved in using state-of-art equipment or software. Engineering risks include reliability, maintainability, operability, and trainability concerns. The understanding of risks in these and other areas evolves over time. Consequently, the risk analysis must be continued through all project phases.

Risk identification may be accomplished by identifying causes-and-effects (what could happen and what will ensue) or effects-and-causes (what outcomes are to be avoided or encouraged and how each might occur) as illustrated in Figure 3-1.

Risks can also be identified according to life-cycle phases, as shown in Figure 3-2. In the early life-cycle phases, the project risk is high because of the lack of information. In the later phases, the financial risk is the greatest (Kerzner, 1997:879).

Figure 3-2: Life-cycle risk analysis



Source: Kerzner (1997:880)

Any source of information that allows the recognition of a potential problem can be used for risk identification. The most common sources include the following (PMI, 1996:113):

- The nature of the product to be produced by the project will have a major effect on the risks identified. Products that involve proven technology will, all other things being equal, involve less risk than products that require innovation or invention. Risks associated with the product of the project are often described in terms of their cost and schedule impact.
- The outputs of the processes in other knowledge areas should be reviewed to identify possible risks. For example:

- ◆ **Work breakdown structure** – non-traditional approaches to detail deliverables may offer opportunities that were not apparent from the higher-level deliverables identified in the scope statement.
  - ◆ **Cost estimates and duration estimates** – aggressive estimates and estimates developed with a limited amount of information entail more risk.
  - ◆ **Staffing plan** – identified team members may have unique skills that would be hard to replace or may have other commitments that make their availability tenuous.
  - ◆ **Procurement management plan** – market conditions such as a sluggish local economy may offer opportunities to reduce contract costs.
- Historical information about what actually happened on previous projects can be especially helpful in identifying potential risks. Information on historical results is often available from the following sources:
    - ◆ **Project files** – one or more of the organisations involved in the project may maintain records of previous project results that are detailed enough to aid risk identification. In some application areas, individual team members may maintain such records.
    - ◆ **Commercial databases** – historical information is available commercially in many application areas.
    - ◆ **Project team knowledge** – the individual members of the project team may remember previous occurrences or assumptions. While such recollections may be useful, they are generally less reliable than documented results.
  - Expert judgement consultation is not only important for risk identification, but also for forecasting and decision making. Expert judgement techniques however have the potential to be biased in the identification of risk (Kerzner, 1997:881).

#### 3.2.3.32 Information technology project risks

Information technology projects in particular are subject to project risks (*see section 3.2.3.1*) and have a relatively high failure rate. Kerzner (1998:562) considers the problems associated with

project failure, making the point that plans can fail no matter how careful we are. Some basic reasons for failure are considered to be:

- The corporate plans are not understood at lower organisational levels.
- Project plans try to accomplish too much in too little time.
- Poor financial estimates.
- The project plans were based on insufficient data.
- A planning group performed planning with little or no input from the actual workers.
- No one knows the ultimate objective.
- No one knows the major milestone dates, including written reports.
- Project estimates are best guesses, and are not based on standards or history.
- Not enough time was given to proper estimating.
- People are consistently shuffled in and out of the project with little regard for schedule.

These causes of failure are all within the control of the project manager, and demonstrate a failure of management. Thus the root cause of failure is seen to be management ineptitude and flaws in the project organisation, allowing mistakes of various kinds to go uncorrected (Kharbanda & Stallworthy, 1992:5).

Kharbanda and Stallworthy (1992:5) also pointed out that problems leading to project failure are normally interlinked. This is especially true for information technology projects which must satisfy often intangible goals and objectives that are difficult to define.

Nidumolu (1996:78) has identified uncertainties regarding user requirements as one of the key factors affecting the outcome of software development projects. The requirements-analysis phase of the software development project is one of most critical phases and also has the greatest impact on subsequent phases. He went further and identified the following three dimensions of requirements uncertainty, namely:

- The extent of changes in the user requirements over the course of the project; this is derived from the concept of environmental instability in organisation theory, which describes the extent of change in the task environment;
- the extent to which users differ among themselves in their requirements; this is derived from the concept of environmental heterogeneity in organisational theory, which describes the degree of variety or heterogeneity in the task environment; and
- the extent to which the process of converting user needs to a set of requirements specifications can be reduced to mechanical steps or objective procedures; this is derived from the concept of task analysability in organisational theory, which describes the extent to which a conversion process can be reduced to mechanical steps or objective procedures.

The fact that the environment for a project is only known and stable for less than one year (Kerzner, 1998:867) only aggravates the problem of changing user requirements. The project planners and managers should therefore strive to complete all projects within this timeframe.

Radosevich and Dahle (1996:40) have identified vendor management as one of the major risks for information technology projects. This is due to the fact that the information technologies are characterised by short technology life cycles, mergers and takeovers, and product cancellations. They propose that information technology executives consider a proposed vendor's financial health, marketplace performance, reinvestment tendencies, technology directions, customer relationships and global capacities before committing themselves to a particular technology or vendor. The contracts should also stipulate what happens in the event of product cancellations and buy-outs.

It is important to take note of the different factors that may affect the outcome of information technology projects in the risk quantification phase (section 3.2.3.4) when the viability of a specific project is assessed.

#### 3.2.3.3.3 Deliverables of risk identification

The Project Management Institute has identified several important deliverables of the risk identification process, the most important of which include (PMI, 1996:114):

- The potential sources of risk for the project. Sources of risk are categories of possible risk events (e.g., stake-holder actions, unreliable estimates, team turnover) that may

affect the project for better or worse. The list of sources should be comprehensive, i.e., it should generally include all identified items regardless of frequency, probability of occurrence, or magnitude of gain or loss.

Descriptions of the sources of risk should generally include estimates of (a) the probability that a risk event from that source will occur, (b) the range of possible outcomes, (c) expected timing, (d) anticipated frequency of risk events from that source, and (e) possible steps to mitigate the risk.

Both probabilities and outcomes may be specified as continuous functions (an estimated duration of between one and three months) or as discrete ones (a patent either will or will not be granted). In addition, estimates of probabilities and outcomes made during early project phases are likely to have a broader range than those made later in the project.

- The potential risk events that may originate from the different sources of project risk. Potential risk events are discrete occurrences such as a natural disaster or the departure of a specific team member that may affect the project. Potential risk events should be identified in addition to sources of risk when the probability of occurrence or magnitude of loss is relatively large (“relatively large” will vary by project). While potential risk events are seldom application-area-specific, a list of common risk events usually is.
- The risk symptoms sometimes called triggers, which are indirect manifestations of actual risk events. For example, poor morale may be an early warning signal of an impending schedule delay or cost overruns on early activities may be indicative of poor estimating.

#### 3.2.3.4 Risk quantification

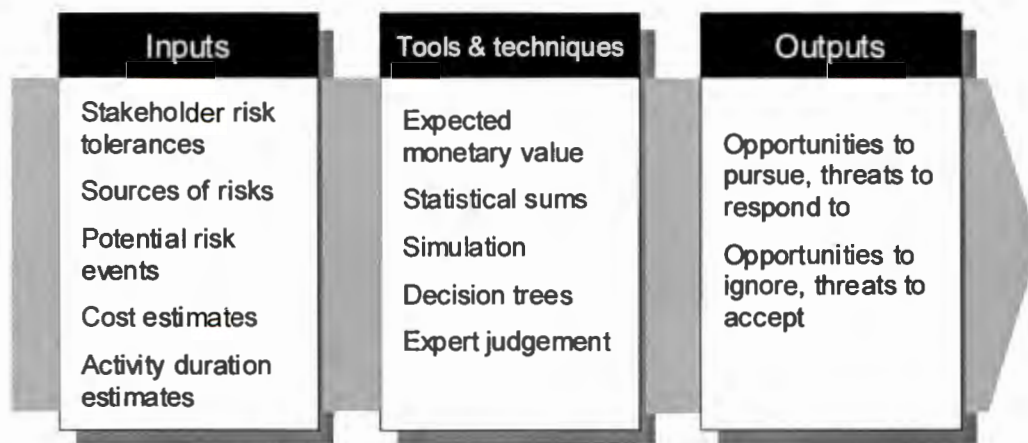
Risk quantification involves evaluating risks and risk interactions to assess the range of possible project outcomes. It is primarily concerned with determining which risk events warrant response. It is complicated by a number of factors including, but not limited to (PMI, 1996:115):

- Opportunities and threats can interact in unanticipated ways (e.g., schedule delays may force consideration of a new strategy that reduces overall project duration).
- A single risk event can cause multiple effects, as when late delivery of a key component produces cost overruns, schedule delays, penalty payments, and a lower-quality product.

- Opportunities for one stakeholder (reduced cost) may be threats to another (reduced profits).
- The mathematical techniques used can create a false impression of precision and reliability.

The Project Management Institute (PMI, 1996:115) proposed the following model for risk quantification.

Figure 3-3: Risk quantification process.



Source: Project management institute (PMI, 1996:115).

According to the model the following inputs are required to perform a quantification of the project risks:

- **Stakeholder risk tolerances.** Different organisations and different individuals have different tolerances for risk.
- **Sources of risk.** Sources of risk are described in section 3.2.3.3.
- **Potential risk events.** Potential risk events are described in section 3.2.3.3.
- **Cost estimates.** Cost estimates are done in the detail project planning phases and therefore fall outside the scope of this study.
- **Activity duration estimates.** Activity duration estimates are done in the detail project planning phases and therefore fall outside the scope of this study.

Several modelling tools and techniques exist to describe and quantify a specific risk and determine the magnitude of a specific risk element. Kerzner (1998:885) has identified the following typical tools:

- The results of a schedule simulation may be used to quantify the risk of various schedule alternatives, different project strategies, different paths through the network, or individual activities. Schedule simulation should be used on any large or complex project since traditional mathematical analysis techniques such as the Critical Path Method (CPM) and the Programme Evaluation and Review Technique (PERT) do not account for path convergence and thus tend to underestimate project durations. Monte Carlo analysis and other forms of simulation can also be used to assess the range of possible cost outcomes.
- Quick reaction rate/quantity impact analysis is used for answering the challenges to project funding. These challenges are most prevalent just prior to full-scale production and can severely affect the project's executability. The quick reaction model also permits examination of cost impact for budget allocation in project planning in various options.
- Statistical sums can be used to calculate a range of total project costs from the cost estimates for individual work items. The range of total project costs can be used to quantify the relative risk of alternative project budgets or proposal prices.
- A decision tree is a diagram that depicts key interactions among decisions and associated chance events, as the decision maker understands them. The branches of the tree represent either decisions or chance events.
- Simulation uses a representation or model of a system to analyse the behaviour or performance of the system. The most common form of simulation on a project is schedule simulation using the project network as the model of the project. Most schedule simulations are based on some form of Monte Carlo analysis. This technique, adapted from general management, "performs" the project many times to provide a statistical distribution of the calculated results.

Mathematical models can be developed for failure and risk for specific types of projects. Kerzner (1998:887) proposed such a model for information technology related projects. Kerzner have

modelled risk as the interaction between two variables: probability of failure ( $P_f$ ) and the effect or consequence of failure ( $C_f$ ). Consequences may be measured in terms of technical performance, cost, or schedule. A simple model can be used to highlight areas where the probability of failure ( $P_f$ ) is higher (even if there is a low probability of occurrence). Mathematically, this can be expressed as the union of two sets  $P_f$  and  $C_f$ . Table 3-2 shows a mathematical model for risk assessment on hardware-software projects. In other words, the risk factor (defined as  $P_f \times C_f$ ) will be largest where both  $P_f$  and  $C_f$  are large, and may be high if either factor is large.

Table 3-2: A mathematical model for risk assessment on information technology projects.

$$\text{Risk Factor} = P_f + C_f - P_f \cdot C_f$$

$$P_f = a \cdot P_{M_{hw}} + b \cdot P_{M_{sw}} + c \cdot P_{C_{hw}} + d \cdot P_{C_{sw}} + e \cdot P_D$$

$$C_f = f \cdot C_t + g \cdot C_c + h \cdot C_s$$

Where:

$P_{M_{hw}}$  = Probability of failure due to degree of hardware maturity

$P_{M_{sw}}$  = Probability of failure due to degree of software maturity

$P_{C_{hw}}$  = Probability of failure due to degree of hardware complexity

$P_{C_{sw}}$  = Probability of failure due to degree of software complexity

$P_D$  = Probability of failure due to dependency on other items

and where: a, b, c, d, and e are weighting factors whose sum equals one.

Where:

$C_t$  = Consequence of failure due to technical factors

$C_c$  = Consequence of failure due to change in costs

$C_s$  = Consequence of failure due to changes in schedule

and where: f, g, and h are weighting factors whose sum equals one.

Source: Kerzner (1998:887).

Magnitude	Maturity Factor ( $P_M$ )		Complexity Factor ( $P_C$ )		Dependency Factor ( $P_D$ )
	Hardware $P_{M_{hw}}$	Software $P_{M_{sw}}$	Hardware $P_{C_{hw}}$	Software $P_{C_{sw}}$	
0.1 (low)	Existing	Existing	Simple design	Simple design	Independent of existing system, facility, or associate contractor
0.3 (minor)	Minor redesign	Minor redesign	Minor increases in complexity	Minor increases in complexity	Schedule dependant on existing system, facility, or associate contractor
0.5 (moderate)	Major change feasible	Major change feasible	Moderate increase	Moderate increase	Performance dependant on existing systems performance, facility or associate contractor
0.7 (significant)	Technology available, complex design	New software similar to existing	Significant increase	Significant increase/major increase in number of modules	Schedule dependant on new system schedule, facility, or associated contractor
0.9 (high)	State of art, some research complete	State of art, never done before	Extremely complex	Extremely complex	Performance dependant on new system schedule, facility, or associate contractor

Magnitude	Technical factor ( $C_t$ )	Cost Factor ( $C_C$ )	Schedule Factor ( $C_S$ )
0.1 (low)	Minimal or no consequences, unimportant	Budget estimates not exceeded, some transfer of money	Negligible impact on programme, slight development schedule change compensated by available slack
0.3 (minor)	Small reduction in technical performance	Cost estimates exceed budget by 1 to 5 percent	Minor slip in schedule (less than 1 month), some adjustment in milestones required
0.5 (moderate)	Some reduction in technical performance	Cost estimates increase by 5 to 20 percent	Small slip in schedule
0.7 (significant)	Significant degradation in technical performance	Cost estimates increase by 20 to 50 percent	Development schedule slip in excess of 3 months
0.9 (high)	Technical goals cannot be achieved	Cost estimates increased in excess of 50 percent	Large schedule slip that affects segment milestones or has possible effect on system milestones.

All risk factors should be identified before selecting handling techniques. For example, software development risks associated with subcontractors may be an overall risk to a project that might not be evident from looking at risk factors on isolated items. The handling technique for an isolated subcontractor software development risk might be quite different from an overall risk in that area.

### 3.3 Summary and conclusions

Projects are one of the most important methods used to deliver information technology to an organisation. The fact that projects are naturally done in a phased manner provide the organisation an ideal opportunity to build checkpoints or gates into the process to continuously evaluate projects in terms of the potential value that they may add to the organisation. The organisation can also use the selection of projects as a method to influence and manage the ultimate information technology portfolio that it uses to support and enhance its business.

A proper risk assessment and risk management plan affords the organisation an opportunity to mitigate the risks associated with a particular project, and therefore enhances the chances of the project being completed successfully, and deliver the value that it is intended to deliver. This is fairly important, as information technology projects are notorious for their very high project failure rates.

Project portfolios exist in any organisation and should be managed like any stock portfolio to reduce the organisation's exposure to unnecessary high levels of risk and at the same time maximise the possible return or value from the projects it undertakes. And at the same time the organisation should maximise the returns it receives from its investment in information technology. It is not

uncommon for organisations to have projects in their portfolio that have conflicting objectives, or are almost exact duplicates of each other. The number of variables and projects that must be considered in the portfolios is very high. In order to implement any portfolio management technique meaningfully every attempt must be made to reduce the number of alternatives beforehand.

Several techniques exist that might be used to compile, evaluate, and optimise the projects portfolios that an organisation manages. A lot of literature is also devoted to the establishment of the potential value that an information technology project might add to the business (the next chapter focuses on this topic). It is clear from the literature that the potential value of information technology is complex and in most cases difficult to determine.

# CHAPTER 4

## INFORMATION ENVIRONMENT IN THE BUSINESS

### 4.1 Introduction

This chapter will describe information technology in the context of the business environment and how it might support the business in reaching its objectives. The description of information technology in the business context is important for this study for the following reasons:

- Information technology does not operate in a vacuum, and must support the business. In most non-information related industries the only way information technology can add value to the organisation is through the support, enhancing, and enablement of the business that funds its existence. It is therefore important to position the information technology projects in such a manner that it can optimally support the business and is aligned with the business strategies, goals, and objectives.
- In order to assist the business with the assessment of the potential value of information technology, this study also includes some literature on how to attach a true value or cost to information technology. These methodologies are very helpful in the selection of the most appropriate information technology projects for the business.
- Information technology provides the “infrastructure” that modern organisations use to conduct business. In order to function in the infrastructure provider role, information technology must also be architected as such. This study therefore also includes a section on information technology architecture, which provides a conceptual framework an organisation might use to standardise the infrastructure and govern the interfaces between different information technology components. If this is done successfully the organisation can leverage from existing information technology investments – prolonging the technology lifecycle – and achieve greater economies of scale and scope.

This chapter will firstly describe information technologies in terms of the value and benefit they might have to the business. Emphasis is placed on the techniques used to quantify the value and benefit of information technology. These techniques are very useful in the evaluation of information technology projects. Thereafter the total lifecycle costs of information are discussed using the concept of “Total Cost of Ownership”. A relative new concept “Total Value of

Ownership” that emphasis the value of information technology – rather than the cost thereof – is also discussed.

Some attention is also given to what is called business and information technology alignment. This section is fairly important as it ensures that the business and information technology managers share the same vision, goals and objectives. Without alignment between business and information technology, each party pursues its own agendas normally at the cost of the organisation. Although the strategic alignment processes are not explicitly reflected in the final project selection model, it plays a very valuable role in creating an environment conducive to the successful implementation of the model.

The last section of this chapter describes an architectural framework which an organisation can use to document and manage the diversity of current and future information technology investments.

## 4.2 Information technology benefits and risks

Information technology has grown from being a means of automating data processing to being the critical infrastructure for doing business today. According to Wena *et al.* (1998:145), firms spend between 1.5% and 3% of their revenue on information technology. Clearly, information technology more than any other is judged to be one of the most critical success factors of a business organisation in today's global, competitive market.

However, measuring information technology investment is difficult. This is because most information technology benefits are qualitative, indirect, and diffuse. For instance, a decision support system may improve managers' decision making capability, but it is difficult to predict the extent to which the system will actually lead to better decisions, and even if it does have the desired effect, putting any kind of value on the better decision may present a new range of problems. In addition, many of the impacts that information technology creates are "ripple effects" in areas inside and outside an organisation that makes the information technology investment evaluation process even more complex.

According to Wena *et al.* (1998:145), the best information technology investments are those which help to maximize the value of the firm. They also contend that in order to do so, information technology investment decisions need to be able to maximize information technology benefits while minimizing information technology risks. There are three reasons why knowing

information technology benefits and risks is important. First, some information technology benefits are lost through inappropriate management, while some are lost because they are not recognised by the management in the early information technology planning stage. Second, it is important to identify the benefits to be measured prior to selecting applicable evaluation methods. This is because some methods are suitable for evaluating tangible benefits while others are more suitable for intangible benefits. Finally, the recognition of risk as an important component in information technology investment decision making has long been recognized (McFarlan, 1981:145). Information technology investment must recognise that the future is uncertain, and so must any evaluation technique in order to lead to correct decisions and recommendations.

#### 4.2.1 Information technology benefits

In general, the benefits of information technology investments can be classified into six broad classes, namely to (a) provide an adequate return on investment; (b) support the strategic initiatives of the organisation; (c) facilitate the creation of a competitive advantage; (d) support managerial decision making; (e) act as a competitive response; and (f) provide a good framework for business strategic information system architecture. The following sections briefly define these six broad classes (Parker & Benson, 1988:65). Each category has particular characteristics that bear on the measurement of value.

##### 4.2.1.1 Return on investment (cost reduction and performance enhancement)

If information technology is used to substitute human effort and automate tasks and business processes, the major benefits are likely to be an increase in system effectiveness and efficiency. Possible examples of benefits involved include, cycle time reductions, headcount reductions, reduction in communication time and related printing costs, increased income from product/service quality improvements, timeliness and accessibility of data, activity-based cost improvements, operating process improvements relative to industrial benchmarks, and growth without corresponding increase in overheads (Wena *et al.*, 1998:148).

Stephanie Barrett (Barrett, 1986:7) offers one framework. She suggests that value of information technology can be considered in groups, called competitive impact and performance improvements as represented in Table 4-1.

Table 4-1: Information technology groupings.

Group	Effect/impact
<b>Competitive impact</b>	Competitive edge
	Maintenance of leadership or share
	Entry into new product/market area
<b>Performance improvements</b>	Reductions in staff
	Reductions in operating locations/entities
	Increased resource use efficiency
	Improvements in customer services
	Increased staff efficiency

Source: Parker and Benson (1988:66).

The second category, performance improvements, is a good list of values which are measurable. The first category reflects other classes of values not so easily measured by methods such as cost/benefit analysis and return on investment.

A second way to think about value is the value chain itself (Parker & Benson, 1988:66). The value chain allows description and analysis of the exact means a company uses to produce its products and interact with customers and markets. Here the question is, what efficiencies can one introduce into the value chain to improve business performance?

The development of value in traditional terms, cost-benefit analysis and its focus on cost reduction justification, can be the same elements that provide competitive advantage and provide improved services in non-profit circumstances.

#### 4.2.1.2 Strategic match

Corporations have strategic goals, as do operating units and lines of business. A value of information technology is to support the achievement of these goals directly or to support the operationalisation of activities necessary to reach goals (Parker & Benson, 1988:66). The point here is not to change the strategic goals but rather to improve the organisational capacity to accomplish the goals that exist.

Barrett (1986:7) discusses the various kinds of strategic goals an enterprise might have (see Table 4-2).

Table 4-2: Strategic alternatives and focus.

Strategic Alternative	Strategic Focus
Status Quo	Stability
Concentration	Single product line
Horizontal integration	Control of competitors
Vertical integration	Change cost to profit centre
Diversification	Broadening product line
Joint ventures	Complementary benefits
Retrenchment	Reduction of activity
Divestiture	Removal non-fitting entity
Liquidation	Removal non-fitting entity
Innovation	Seizing leadership position

Source: Barnett (1986:7).

The value contributed by information technology is the enabling of the focus, enhancing the capacity of the business organisation to achieve its roles in, ultimately, the strategic alternative. Strategic match may be quite simple, the essential strategy of the firm or its lines of business is straightforward. In Porter terms, it is the generic strategies of cost focus or differentiation, applied to a broad-focus or narrow-focus market (Porter, 1980:34).

#### 4.2.1.3 Competitive advantage

A major theme of corporate strategy is the creation of barriers and hurdles against competitive inroads against the firm (Porter, 1985:7). Part of the strategy is product and market oriented (such as creating distinctive products), but a great deal is also creating distribution and market relationships and channels that bind the firm and its customers or suppliers together in ways that make displacement of the firm more difficult for competitors.

The potential uses of information technology to create barriers to competition can represent considerable value to the enterprise. Some possible examples are shown in Table 4-3.

Table 4-3: Competitive forces and hurdles.

Competitive force	Possible barrier or hurdle	Means for raising hurdle through information technology/systems
New competitors	Capacity or resources needed	Extensive networks in place Extensive automation in place
Buyers moving down into our business	Efficiency of scale	Our order and delivery systems provide enhanced services
Suppliers moving up into our business	Effectiveness of experience and scale	Our order systems offer enhanced service to our customers
Substitute products	Efficiency/pricing quality	Our operational systems provide leading capabilities
Our existing competitors	Bonds to our customers; quality and performance	Information systems offer enhanced value to our customers.

Source: Cash and Konsynski (1985:141).

Inter-organisational systems are a primary vehicle for accomplishing competitive advantage. This is especially true for systems that optimise the value chains of different organisational units.

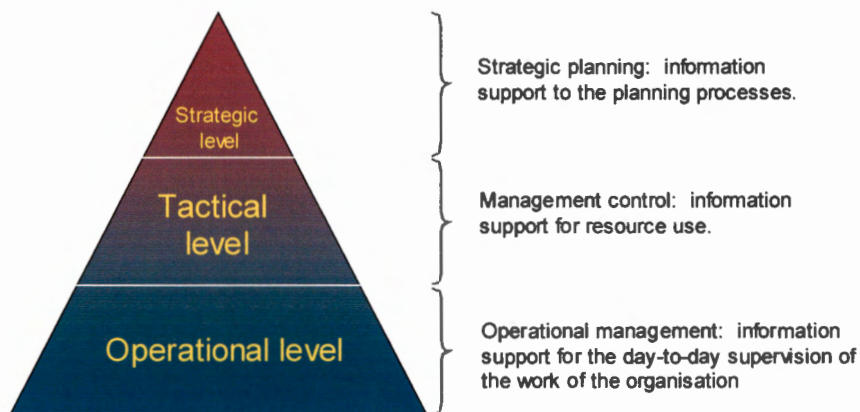
The focus in this value class is on the contribution of information technology in altering the strategic business plan, in the ways suggested above, to add value to an organisation's products and relationships with its customers. The value lies in the competitive impact, that is, the strength of the bonds built between an organisation and its customers and suppliers, the value that gets added to its products, the modes of distribution, and the ways the organisation interacts with its customers (Parker & Benson, 1988:69).

#### 4.2.1.4 Management information support

As an intangible benefit, management information is the leading example of hard-to-quantify information systems benefits. Parker and Benson (1988:70) expanded management information systems into three sub-categories namely:

- **Traditional management support.** Anthony's management paradigm (see Figure 4-1) is useful in specifying the value of information in providing management support.

Figure 4-1: Opportunities in the enterprise



Adapted from Parker and Benson (1988:70).

The value of information in the three areas can be measured in traditional cost-benefit terms: cost reduction and improved performance. Beyond this, management information provides value in quality control, multiple time period planning, and consideration of alternative deployment and use of resources.

- **Strategic management monitoring.** Enterprises have a fundamental strategic approach to the business in which they are engaged. Such strategic approaches describe the posture management has toward the business. The way a company approaches competition and establishes its posture in its businesses creates opportunities for information technology. For example, if a company intends to be aggressive and seek to dominate its markets, then management information directed at measuring how the firm is actually doing, and how the competition is doing, may be most useful.
  
- **Strategy and the management of performance.** Several companies have used information technology with great success to gain a competitive advantage (Parker & Benson, 1988:71). This notion of confidence in the abilities of information technology to gain a strategic advantage is not shared by many other organisations. They fail to see that it can be used successfully in their organisations or industries. Information technology however can make a difference in the execution of strategy, by making management better and smarter in pursuing the strategy. This is the point of value for information technology.

The three categories of management information value link the use and availability of information to the key factors in business performance. For management control, it is information about the key resources in the business and the key operational tasks. For the basic company approach to the industry, it is the monitoring of industry conditions and competitor performance. In the case of strategy, it is the monitoring and measurement of basic business performance.

Brown and Gatian (1995:225) have, for example, found that organisations who have been successful in the implementation of strategic information systems tended to perform better than their respective industries and individual organisations in almost all financial respects. The only notable exception is sales per employee.

#### 4.2.1.5 Competitive risk

For an organisation to achieve outstanding performance it has to “beat the competition”. The problem however is that the competition has heard the same message. Value from this class is based on overcoming others’ capabilities to mimic or leapfrog what the organisation is doing currently (Ghemawat, 1986:55).

Cost-benefit analysis does not work at all for capturing this class of value. The problem of catching up and overtaking exists for everyone, so value is a function of keeping up with the competition and a major source of pressure for investment justification in information technology (Parker & Benson, 1988:72).

#### 4.2.1.6 Strategic information systems architecture

The information systems business can be compared with a manufacturing business. There is a production environment that must exist to make it possible to create products and to manufacture and deliver those products to customers. The information systems organisation has its “factory” in the computer, communications network, and software environments needed to provide services to the enterprise. It must have a plan so that incremental investments can be aligned with the long-range strategic plan. Investment in this environment is an important value to the enterprise (Parker & Benson, 1988:72).

#### 4.2.2 Review of information technology investment evaluation methods

Most information technology evaluation methods for tangible benefits are designed to compare costs of investment alternatives or attempt to provide procedures for the quantification of benefits and risks. Such methods tend to rely on the help of technical personnel and accounting data for evaluation. While methods for intangible benefits put emphasis on the process of obtaining agreement on objectives through a process of exploration and mutual learning, such methods tend to rely on a thorough understanding of the opportunities and the threats of failure of the information technology investment.

##### 4.2.2.1 Information technology evaluation methods for tangible benefits

The major categories for tangible benefits include: return on investment, cost-benefit analysis, return on management, and information economics (Wena *et al.*, 1998:148).

###### 4.2.2.1.1 Return on investment

The rate of return on investment (ROI) is a productivity measure defined as the profit or return divided by the investment required to help obtain the profit or return of a firm. ROI methods are supported by a number of formal capital investment appraisal techniques. The best known are those based on evaluating the current value of estimated future cash flows on the assumption that future benefits are subject to a chosen discount factor. The basic assumption of ROI methods is that an investment today should yield a positive return in the future. Thus, time value functions are used extensively to provide an analytical framework (Wena *et al.*, 1998:149).

There are three commonly used ROI methods, net present value (NPV), discounted cash flow (DCF), and payback period. NPV and DCF calculations base their discount rate on an interest rate regarded as appropriate by the financial managers of the organisation, while payback period method does not require an assumption of fixed interest rates. Methods based on payback simply require an information technology project to repay its investment over a prescribed period. Using the above methods, various investment alternatives can be evaluated using several possible interest rates. In general, all ROI methods require the estimation of cash flow rates. Clearly, ROI methods do not include intangible benefits in the evaluation process. These methods favour using benefits which are directly attributable, often, but not necessarily, in the form of direct cost savings. ROI methods, however, are unable to capture many of the intangible benefits that information technology brings to the organisation.

#### 4.2.2.1.2 Cost-benefit analysis

Cost-benefit analysis (CBA) tries to overcome the problem of ROI by finding some surrogate measure for intangible costs or benefits which can be expressed in monetary terms. For example, if one of the objectives of introducing an information technology is to increase the customer satisfaction, the benefit may be expressed in terms of the saving in the cost of returned products and reducing the number of customer complains. The approach attempts to deal with two problems, namely:

- the difficulty of quantifying the value of benefits that do not directly accrue to the investor in the project; and
- the difficulty of identifying the benefits or costs which do not have an obvious market value or price (intangible factors).

Therefore, the CBA method is useful where the costs and benefits are intangible, but the method requires the existence of a broad agreement on the measures used to attach a value to the intangibles. On the other hand, if there is broad disagreement on the appropriate form of surrogate input values, other methods should be considered.

#### 4.2.2.1.3 Return on management

Parker and Benson (1988:72) argue that information technology serves primarily to help the management do its job. Wena *et al.* (1998:151) describe a concept, developed by Strassmann, of a value-added productivity measurement system as an approach to identify the impact of information technology on business unit performance. In the return on management (ROM)

approach, all measures of productivity use the simple ratio of "output/input". Thus, the main problem is how to define the output of management. In the ROM concept the output of management is defined as management's "value-added", which is simply everything left after subtracting all the direct operating costs from the value-added due to direct labour. Strassmann proposes an index of the total performance of management due to the introduction of information technology. This index is obtained by dividing the management value-added by the costs of management. Strassmann argues that this index has none of the undesirable attributes of ROI methods, since it does not get weighed by the imprecision of asset accounting. Instead, it focuses on the most important impact of information technology, namely the value added by management generated by the information technology in excess of management's total costs.

The advantage of the ROM methods is that they concentrate on the contributions of information technology to the management process. The disadvantage is that the residual assigned as the value added by management cannot be directly attributed to the management process. The methods may well be best used to complement some of the most classical methods, in particular for ex post evaluations.

#### 4.2.2.1.4 Information economics

Information economics (IE) is a variant of cost-benefit analysis, tailored to cope with the particular intangibles and uncertainties found in information systems projects. It retains ROI calculations for those benefits and costs which can be directly ascertained through a conventional cost-benefit process. However, the decision making process used in IE methodologies is based on a ranking and scoring technique of intangibles and risks factor associated with the information technology investment. It identifies information technology performance measures and uses them to rank the economic impact of all the changes on the organisation's performance caused by the introduction of the information technology. Here also, surrogate measures are often used for most intangible and risks factors which are hard to estimate (Parker & Benson, 1988:16).

The strength of the IE method is that it links the quantification and comparison approaches with qualification approaches. The limitation of IE, however, is that it does not deal with the mechanism but only with its outcomes. Another limitation is the focus on simple, idealized settings that can be modelled with applicable mathematical models, often requiring many simplifying assumptions. Clearly, real-world information systems involve complex relationships, variables and parameters; even when rigorous models can be formulated they cannot be solved analytically (Wena *et al.*, 1998:151).

#### 4.2.2.2 Information technology evaluation methods for intangible benefits

##### 4.2.2.2.1 Multi-objective, multi-criteria

This method attempts to develop a general measure of utility where utility is defined as the satisfaction of an individual's preferences. The method is based on the belief that people's behaviour is determined to some extent by their feeling that their preferences are recognized. People appraise the relative usefulness of different desired outcomes in terms of their preferences and they rank goals by applying a preference weight to each goal. Where there are many stakeholders the best information technology investment is that which will deliver the highest aggregate utility or which provides the highest overall measure of satisfied preferences (Wena *et al.*, 1998:152).

The multi-objective, multi-criteria (MOMC) method is probably best applied to complex projects which attempt to meet the needs of many different users and where the benefits are intangible. The method is able to explore the value of a set of system proposals in terms of relative preferences for different system features. Also, consensus on the most desired system attributes is achieved by means of a thorough exploration of alternatives and preferences. However, the MOMC method does not provide any data for an ROI calculation which can be used to compare an investment justified by the use of a standard cost-benefit analysis. Development of MOMC based methods is still in its infancy, but these methods have already generated a great deal of interest and discussion among researchers (Wena *et al.*, 1998:152).

##### 4.2.2.2.2 Value analysis

This method emphasizes value rather than cost. The method is based on the following three assumptions (Keen, 1981:10):

- innovation is value driven and not cost driven;
- intangibles can be identified and subjectively assessed but rarely measured accurately, as surrogate measures are often used to satisfy the requirement for most inputs; and
- an inevitable clash exists between persons driven by cost and those driven by effectiveness.

The analysis begins with the observation that most successful innovations are based on enhancing value added rather than cost savings. A multi-stage iterative process begins with a prototype system. Rather than developing extensive specifications, the analysis provides simple models that can be expanded and modified until all complex aspects of the problem are included. Users are

asked to provide the analyst with feedback on the values and limitations of the solution obtained from the prototype. The main difference between other information technology evaluation methods and value analysis (VA) is that the former directly aim at a final solution, while the latter uses an evolutionary process to get to a "satisfying solution" which may be further improved.

Advantages of VA include (Wena *et al.*, 1998:153):

- quick identification of user requirements to establish agreed values for outputs, which would normally be classed as intangible;
- improved communication between analysts and users, which gives decision makers some assurance that the benefits can be realized by means of prototype demonstrations;
- incremental evaluation of benefits and costs, which enables management to continue the evaluation process or stop at any time;
- an evolutionary approach, which results in user-tailored systems; and
- providing greater user satisfaction than traditionally developed systems.

However, the method has several disadvantages (Wena *et al.*, 1998:154):

- establishing the required surrogate values and developing a prototype can be a long and costly process;
- the method's lack of an initial estimate of final costs and benefits, which may commit management to unexpected future expenditures;
- without target estimates for "final solution values", existing programme revisions can be significant.

#### 4.2.2.2.3 Critical success factors

This method is used to explore the potential value of information systems. It invites the analyst to explore with executives the factors that are in their opinion critical to the success of the business, in particular, the factors that are important for the functions or activities for which the executives are responsible. Issues can be ranked by the executives into levels of importance (Wena *et al.*, 1998:152).

The implementation of methods based on critical success factors (CSF) involves comprehensive interviewing of key managers to obtain their views about business mission, objectives, and current problems. After the interviews, the managers' opinions are cross-tabulated, compared, and ranked. From a group discussion about the divergence of opinions an agreement about systems investment priorities is expected to emerge.

The advantage of the method is that it provides a focus on the issues that are regarded as important by the respondents. It also heavily relies on prototyping and pilot installations before proceeding. In this regard, the technique takes advantage of lessons from the disciplines of organisational learning, adaptive planning, and personal development. The CSF method may be considered to provide the right antidote against some of the worst excesses for conceiving accurate, but meaningless, payback numbers obtained from accounting-oriented cost-benefit analyses.

#### 4.2.2.3 Information technology evaluation methods for risks

##### 4.2.2.3.1 Real option

Although the DCF and NPV methods appear to cope with information technology risks by the choice of discount rate, in practice they can lead to erroneous conclusions in the face of uncertainty even when the apparent range of interest or the existence of certain types of risks are possible. Also, the method can lead to the possibility of unexpected outcomes (Brookfield, 1995:57). This is because NPV analysis ignores the time series interactions among contingent investments, and the possible consequences of delayed effects from the expected benefits and costs. In this sense, real option analysis recognizes the incremental value arising from flexibility. The fact that flexibility gives rise to additional value is a recognition of the altered probability distribution of potential outcomes and its impact on risk exposure. In other words, where there is a significant degree of uncertainty in outcomes for information technology investments, the waiting game might produce substantial benefits (Brookfield, 1995:58).

The value of waiting is a reflection of the costs associated with an irreversible investment. That is, if there is an element of a sunk cost in an investment, then once the investment has been made the sunk cost is incurred. If an investor is making investment decisions on the basis of NPV, then it is almost certain that miscalculations will be made if embedded options are not recognized. In this context, the identification of real options helps to explain the value of flexibility by demonstrating that managers are not miscalculating investment outcomes and are acting rationally.

The method uses three basic types of data (Wena *et al.*, 1998:153):

- current and possible future business strategies;
- the desired system capabilities sought by the company; and
- the relative risks and costs of other information technology choices that could be used.

The method can help assess the risks associated with information technology investment decisions, taking into account that business strategies and system requirements may change.

#### 4.2.2.3.2 Portfolio approach

Portfolio approach focuses on three important dimensions that influence the risk inherent in an information technology investment. They are:

- Sizes of the projects and workload to be handled by the system. Note that the larger the monetary expense in the projects, the larger the workload, levels of staffing, the amount of time, and the larger the number of departments affected by the information technology, the greater the risk.
- Experience of management with the technology. Because of the greater likelihood of unexpected technical problems, information technology risk increases as familiarity of the system team with the hardware, operating systems, database handler, and project application language decrease.
- Capability in handling complex highly structured project. Such projects usually carry less risk than projects which are less structured as their outputs are to a greater extent subject to the manager's judgment and hence less vulnerable to change.

The portfolio approach (PA) suggests that a company not only assesses relative risk for a single information technology project, but also develops an aggregate risk profile of the information technology investment. For instance, in an industry where computers are an important part of product structure, managers should be concerned when there are no high-risk projects. In such a case, the company may be leaving a product or service gap which may present an opportunity for the competition to step in. On the other hand, a portfolio loaded with high-risk projects suggests that the company may be vulnerable to operational disruptions when projects are not completed as planned.

#### 4.2.2.3.3 Delphi approach

The Delphi approach (DA) is a technique in which several experts provide individual estimates of the likelihood of future events associated with the decision situation. The estimates are collected and distributed to all experts, who are then asked if they wish to modify their initial ratings based on inputs from other experts. After all inputs have been collected, final individual values are evaluated and summarised. If the results are reasonably consistent, final overall values are assessed for all. If any inconsistency is detected, the experts will be asked to discuss the instances of inconsistencies and attempt to reach a compromise on the final value. This and other final values will be adopted and used to compute the risks associated with the investment. This approach is particularly useful for the risk analysis of a new information technology investment where the risks involved in the investment may be primarily unknown or unfamiliar to managers (Wena *et al.*, 1998:152).

#### 4.2.3 A roadmap for the evaluation of information technology investment

Previous discussions have provided the information that makes it possible to decide which evaluation method is suitable for a particular information technology investment (summarised in Table 4-4). The information technology architecture development process might be very useful in the development of information technology investment roadmaps (see section 4.5.2.1.6 for more information).

According to Wena *et al.* (1998:153) a road map for the evaluation of information technology investment should be based on the following three major considerations.

- The process suggests that the evaluation of both tangible and intangible benefits should be carried out for all types of information technology investments. Although each type may require a different evaluation emphasis (e.g., quantitative versus qualitative, and tangible versus intangible) most information technology investments involve both quantitative and qualitative benefits to a certain degree.
- The process also urges that assessing the risk of information technology investments is important and required in the information technology evaluation process to ensure that the benefits are sufficient to offset the risks. Most evaluation methods incorrectly assume that appropriate human skills and controls will ensure success, but this is not so.
- The process recommends that the intangible benefits and risks should be evaluated prior to tangible benefits. This is because research in cognitive psychology suggests that an

individual confronted with a simultaneous consideration of both qualitative and quantitative factors tends to assign greater salience to concrete factors at the detriment of more abstract criteria. The proposed process, therefore, suggests that decision makers perform an assessment of intangible benefits prior to tangible benefits.

Table 4-4: Major methods used for evaluating information technology.

	Evaluation category				
	Model/procedure examples	Measures of information technology benefits factors	Measures of information technology risks	Major advantages	Major limitations
Return on investment	NPV, DCF, pay-back period formulas	Tangible	discount rates, surrogate measures	Mainly quantitative focus on efficiency	no intangible, reliance on accounting data
Cost-benefit analysis	cost/benefits formulas	tangible factors	same as ROI	Mainly quantitative focus on effectiveness	surrogate measures for intangible factors
Return on management	productivity based formulas	tangible, labour value-added as intangible	not addressed	mostly qualitative measures of efficiency	limited quantitative measures, assumptions hard to meet
Information economics	same as ROI supplemented with ranking and scoring	tangible and some intangible	surrogate measures, risks with ranking and scoring	qualitative and quantitative measures	major simplifying assumptions and models
Multi-objective, multi-criteria	math models and multistage iterative processes	tangible and intangible	several measures of utility and risks	mainly quantitative, multiple and conflicting objectives	relatively new in MIS, still in development
Value analysis	multistage, evolutionary process	tangible factors	not addressed	tangible factors	prototyping, need several revisions to final results
Critical success factors	multistage, evolutionary process	user's surrogate measures	user's surrogate measures	intangible factors, centred on effectiveness	highly qualitative process
Real option	multistage process	tangible and intangible factors	surrogate measures for risks and costs	many intangible, centered on effectiveness	highly subjective and qualitative
Portfolio approach	financial models	measures for cost savings	direct measures of risks	higher efficiency	mainly quantitative
Delphi approach	multistage, evolutionary process	user's surrogate measures	user's surrogate measures	tangible and intangible factors	highly qualitative

Source: Wena *et al.* (1998:154).

### 4.3 Information technology: cost vs. value

The management practice of justifying information systems projects is pretty well established. The logic is clear: The anticipated benefits from investments in information technology should be greater than the costs.

Several interesting problems interfere with cost-benefit analysis. One is time. Benefits are usually derived long after the costs of the project are incurred, so time-value and discounted cash flow

techniques are applied. Another problem is intangible benefits, those things that seem important but are not amenable to strict cash analysis. The analyst is reduced to making estimates of additional revenues that might be derived with the system, in effect, attempting to value something that is pretty difficult to pin down (Parker & Benson, 1988:62).

Parker and Benson (1988:63) have identified other more fundamental problems with traditional cost-benefit approaches, including the use of return on investment (ROI) as the primary means for driving corporate decision making with regard to information technology. The use of traditional cost-benefit techniques, according to Parker and Benson, has the effect of converting decision making into a numbers game and shields management from having to understand the projects themselves. Just the term "hurdle rate" – the concept that projects have to have a minimum ROI to qualify for consideration – conveys the nature of the game played. If the project can achieve the rate, it's a good project; if not, it's a bad project. Worse, the character of the benefits chosen for projects that successfully compete in an ROI context, strongly tend to favour cost reduction because of its discrete and measurable character. In many cases this is appropriate, but it is not appropriate to exclude from consideration the other important sources of value for projects (Parker & Benson, 1988:63).

#### 4.3.1 Total cost of ownership

Many companies have responded by falling back on a "total cost of ownership" (TCO) approach. This methodology was designed to identify and measure components of information technology expense beyond the initial cost of implementation. While TCO can be a useful tool to reduce ongoing costs by improving information technology management practices, it is not a sound basis for decision making (Dempsey *et al.*, 1998:130). Not only do TCO analyses often leave out important cost categories such as complexity costs, they ignore benefits altogether. They also neglect soft and strategic factors, lack a well-defined base for comparison and have difficulty evaluating lifecycle costs.

#### 4.3.2 Total value of ownership

Even when an investment is for a new application that supports a core business process, cost is part of the equation. But the real question is always, "Is it worth it?" Information technology decisions may be harder to make because measurement is difficult, complexity is rife, and technology is constantly changing, yet the essence is the same (Dempsey *et al.*, 1998:131).

To determine whether an information technology investment is worthwhile, companies must look at its total value of ownership (TVO), which has three ingredients: a sound cost/benefit methodology to evaluate the incremental value created by information technology investments; robust management processes that integrate information technology into normal business planning and the maturity of business judgment to make difficult trade-offs effectively.

#### 4.3.3 Cost/benefit methodology

A robust cost/benefit analysis takes into account the particular issues that distinguish information technology investment decisions. The analysis comprises three key elements (Dempsey *et al.*, 1998:132):

- Cost/benefit categories are a comprehensive set of mutually exclusive categories covering the one-off information technology and business costs involved in the decision, the ongoing information technology and business costs that will be incurred, and the incremental business revenue generated as a result of the investment.
- Impact categories classify each cost or benefit according to its quantifiability and predictability. Hard impacts, such as the cost of new hardware or the savings in personnel costs after a process has been automated, are controllable and easily quantified. Soft impacts, such as market share or productivity gains, are less certain and depend on uncontrollable factors such as consumer response, but can and should be quantified through simple analysis. Unquantifiable impacts, such as improved competitive position or increased customer satisfaction, are uncertain and difficult to quantify, but must be described and debated if companies are to reach the right decision.
- The evaluation approach defines how the outcome of an investment will be measured. It takes into account the time frame over which the investment will be judged, the business and systems areas within which its effect will be measured, the financial method that will be used to evaluate the results, and the base case against which the results will be compared.

Taking account of these factors calls for real care. The first step is to scrutinize the cost/benefit categories to make sure that all relevant items are included. The categories that are often missed in information technology decisions are (Dempsey *et al.*, 1998:136):

- **Transition costs**, or the one-time costs occasioned by the move to the new system (other than the initial hardware, software, and integration investments). They may be incurred if business is interrupted or stopgap information technology solutions are required.
- **Complexity costs**, which are among the most important and most frequently neglected costs associated with information technology investments. They include the ongoing increases in operating costs that arise when a company supports multiple technologies or standards.
- **Technical risk**, or what might happen if the project is delayed or key functionality is not delivered. How likely is it that things will go wrong? How big would the impact be? What contingency plan is in place?
- **Future flexibility value**. Another crucial factor in information technology decisions is the impact of an investment on the responsiveness of a company's systems. Adding a technology to the portfolio may solve today's problem, but hamper future development. Conversely, an investment in a robust, simple infrastructure may have modest immediate benefits, but a dramatic effect on the speed of systems development and deployment in the longer term.
- **Commercial factors**. When choosing a technology or a vendor, it is vital to consider whether that technology or vendor will be around for the entire life of the system.

Once a company has identified all relevant costs and benefits, the next step in the analysis is to evaluate their impacts. Hard impacts are easily quantified. To give the process teeth, they should be put into the budget. Soft impacts should also be quantified, at least roughly, to see whether they are big or small and to understand what drives them. If they are essential to the justification of an investment, they should also be put into the budget.

Many supposedly unquantifiable impacts such as market share gains or improved customer retention are not really unquantifiable at all, and should be estimated. In cases of genuinely unquantifiable impacts, a company should try to predict what broad effect they might have on key drivers of strategic value such as customer satisfaction or sales force productivity.

The third step in the analysis is to ensure that the evaluation approach employs an appropriate base case and time frame. Any assessment of value prompts the question "Relative to what?" For

information technology decisions, the answer is "Relative to the status quo." In practice, this means evaluating the cost of standing still by establishing a base case against which to compare alternatives. The base case is particularly critical in infrastructure decisions, since these are often made to avoid steady increases in maintenance costs or the disruption caused by overloaded networks or outdated systems.

When evaluating an investment, companies should ensure that they extend their net present value analysis over the real life of the asset. An application that will be a core element of the business for decades should not be evaluated by means of a five-year NPV. Neither should a desktop vendor selection that can be changed next year.

## 4.4 Strategic information technology alignment

### 4.4.1 Introduction

Firms today seek sustainable competitive advantage through their ability to provide a dynamic and unique mix of product, pricing, promotion, distribution channel, and technology. Hyper-competitive markets bring pressure for firms to shorten product life cycles, rapidly identify and penetrate new market segments, dramatically increase operational efficiencies, and condensed supply chains and distribution channels.

Strategic alignment of information technology and business has remained a major issue for more than a decade. While there appears to be no single strategy or combination of activities that will let a company achieve alignment, executives should work toward minimizing those activities that inhibit alignment and maximizing those that bolster it (Bruce, 1998:16).

Business strategy in these markets is highly dependent on leveraging technology to the fullest extent and gives us insight about how firms will compete in the future. In these markets, alignment between the business strategy and information technology is not a luxury – it is a cost of entry (Bruce, 1998:20).

Alignment is defined by Webster as "*bringing parts or components into proper coordination; to bring into agreement and close cooperation.*" Successful alignment can be accomplished via coordination of strategic objectives with a number of key components: resources, management processes, decision making mechanisms, performance measures, rewards and incentives. Measures of alignment will be different for firms of different sizes, in different growth phases, and in different industries.

#### 4.4.2 Levels of strategic alignment in organisations

Organisations typically achieve strategic alignment by passing through three levels (Chan & Huff, 1993:51):

- **Awareness:** Information systems professionals have frequently been accused of not understanding, or not even caring about, the businesses that employ them. This accusation was especially true before the 1980s with centralised mainframes. In the modern competitive environment information systems, professionals appear to have recognised that they are as much part of the business as any other function and should act accordingly.
- **Integration:** The integration level is marked by the acceptance of the need for a meshing of the organisation's operational plans and those of information systems. This meshing can occur in two distinct ways. The first way, in which information systems plans are formulated following the creation of the business plans, is undoubtedly the most common. In contrast, some organisations, especially in information-intensive industries, recognising the centrality of their information resources to their businesses, develop business plans and information systems plans simultaneously.
- **Alignment:** Chan and Huff called the final level of business and information systems alignment “strategic alignment”. It carries the idea of second-level integration one major step higher. Whereas the second level is concerned with integrating operational business and information systems plans and activities, the strategic alignment level concerns integrating information systems with the organisation's fundamental strategies and core competences.

#### 4.4.3 The strategic alignment process

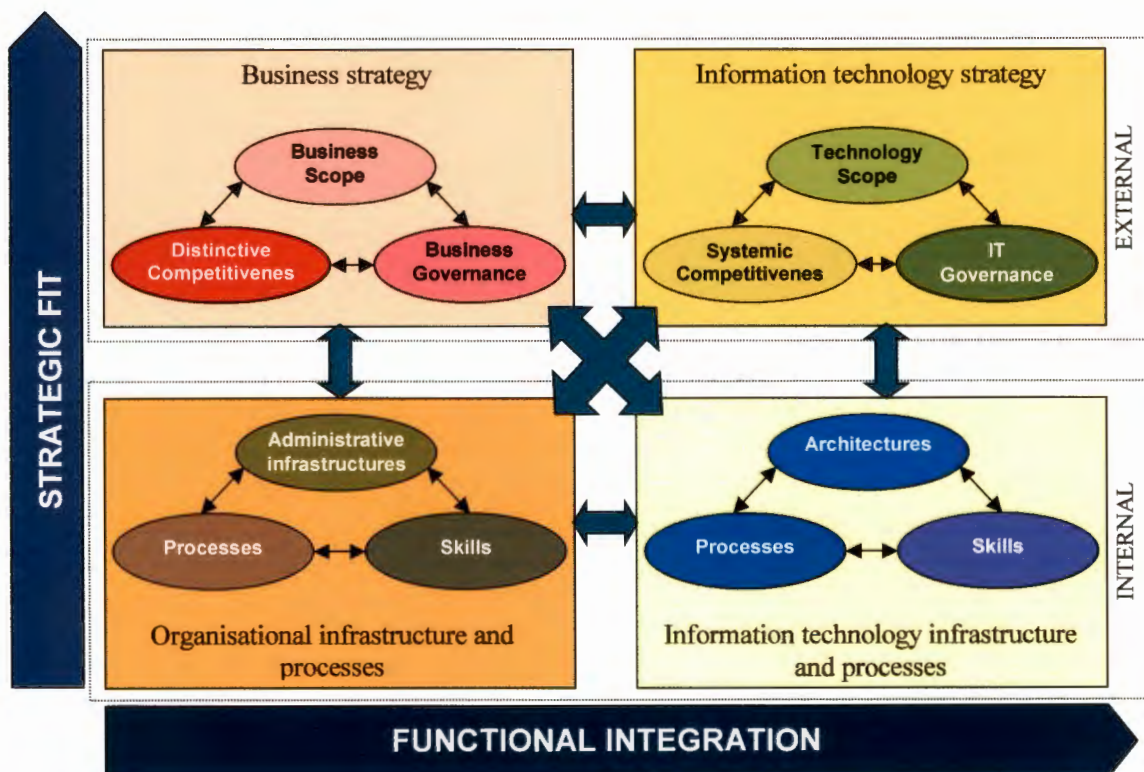
The strategic alignment model (see Figure 4-2) identifies the need to specify two types of integration between business and information technology domains. The first, termed strategic integration, is the link between business strategy and information technology strategy reflecting the external components. More specifically, it deals with the capability of information technology functionality to both shape and support business strategy. This capability is particularly important, as information technology has emerged as an important source of strategic advantage to firms. The second type, termed operational integration, deals with the corresponding internal domains, namely, the link between organisational infrastructure and processes and information

systems infrastructure and processes. This type highlights the criticality of ensuring internal coherence between the organisational requirements and expectations and the delivery capability within the information systems function.

#### 4.4.3.1 The Strategic Alignment Model

The concept of strategic alignment is based on two building blocks: strategic fit and functional integration (shown as the vertical and horizontal axes of Figure 4-2.)

Figure 4-2: The strategic alignment model.



Source: Luftman (1996:26).

##### 4.4.3.1.1 Strategic fit

The strategic fit axis recognises the need for any strategy to address both external and internal domains. The external domain is the arena in which the organisation competes and is concerned with business scope decisions such as product-market offerings, distinctive competency decisions. In contrast, the internal domain is concerned with choices that define the administrative structure, the design or redesign of critical business processes and the acquisition and development of human resource skills.

Within the business strategy field, the fit between external positioning and internal arrangement has long been argued as critical to economic performance. The strategic alignment model

proposes that an information technology strategy should also be defined in terms of an external domain – how the firm is positioned in the information technology marketplace – and an internal domain – how the information technology infrastructure should be configured and managed.

The two right-hand boxes in Figure 4-2 compare the external and internal choices facing information technology strategy with those relating to business strategy. In the external dimension, information technology strategy is driven by (Luftman, 1996:27):

- **Technology scope** – those critical information technologies that support business strategy initiatives or shape new business strategy initiatives for the organisation. This is analogous to business scope, which deals with choices pertaining to product – market offerings in the output market.
- **Systemic competencies** – those attributes of information technology strategy (e.g., system reliability, interconnectivity, flexibility) that contribute positively to the creation of new business strategies or better support of existing business strategy.
- **Information technology governance** – selection and use of relationships such as strategic alliances or joint ventures to obtain key information technology competencies. Such choices cover a complex array of inter-organisation relationships, such as strategic alliances, joint ventures, marketing exchange, and technology licensing.

The internal information systems domain is dominated by three major issues (Luftman, 1996:28):

- **Information technology architecture** – choices that define the portfolio of applications; the configuration of hardware, software, and communication and the data architectures that collectively define the technical infrastructure.
- **Information technology processes** – choices that define the work processes central to operations of the information systems infrastructure, such as systems development or operations.
- **Information technology skills** – choices pertaining to the acquisition, training, and development of the knowledge and capabilities of the individuals required to effectively manage and operate the information technology infrastructure within the organisation.

#### 4.4.3.1.2 Functional integration

As described above, the need to integrate information technology and business strategies has long been advocated by both researchers and practitioners (Niederman & Brancheu, 1991:480).

The strategic alignment model identifies the need to specify two types of integration between business and information technology domains. The first is at the strategic level (top two boxes in Figure 4-2), looking at the potential for information technology to both shape and support business strategy. The second is at the operational level (bottom two boxes in Figure 4-2), looking at the link between organisational infrastructure and processes and information systems infrastructure and processes.

#### 4.4.3.2 Using the model

Research has shown that effective management of information technology means achieving a balance among the choices made across all four domains. The question, then, is how to conceptualise and achieve this type of alignment (Henderson & Venkatraman, 1999:480; Luftman, 1996:28)

The simplest approach calls for considering all combinations of any two domains. If, for instance, the organisational and information technology infrastructures can be reconfigured easily, then a perspective that reflected only a strategic view of integration – i.e., the fit between business and information technology strategies – could suffice. Unfortunately, most organisations suffer from internal inconsistencies (Luftman, 1996:29). For instance, a simple two-way perspective that considered only external issues (business and information technology strategies without any regard for the internal, organisational domains) could seriously underestimate the difficulty (risks) of redesigning key business processes. Luftman (1996:29) further argues that, at a minimum, any given planning process must consider the interaction between both dimensions of strategic fit and functional integration.

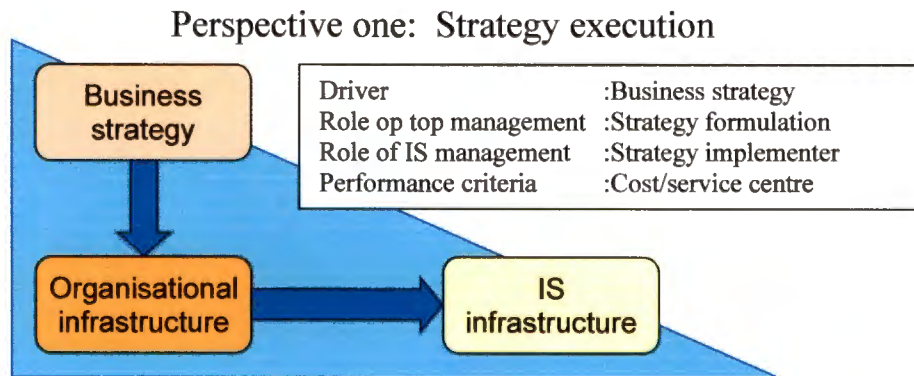
#### 4.4.3.3 Four dominant alignment perspectives

To understand the interactions between choices that create fit and those that create integration, an alignment perspective must be taken. The following section summarises four dominant alignment perspectives, each representing a “triangle” of issues for business and information technology domains as well as internal and external domains. Each perspective is unique in terms of the driver – the specific domain that establishes the distinct management orientation – and the relaxation conditions – those choices that are not incorporated into the planning process.

#### 4.4.3.3.1 Perspective one: strategy execution

As depicted in Figure 4-3, this perspective is anchored on the notion that a business strategy has been articulated and is the driver of both organisational design choices and the design of information systems infrastructure. This alignment perspective is, perhaps, the most common and widely understood as it corresponds to the classic, hierarchical view of strategic management (Henderson & Venkatraman, 1999:477). It is important to identify the specific role of management in making this perspective succeed. Henderson and Venkatraman go further in that they argue that top management should play the role of the strategy formulator to articulate the logic and choices pertaining to business strategy, whereas the role of the information systems manager should be that of the strategy implementer.

Figure 4-3: Perspective one of the strategic alignment model.



Source: Luftman (1996:30).

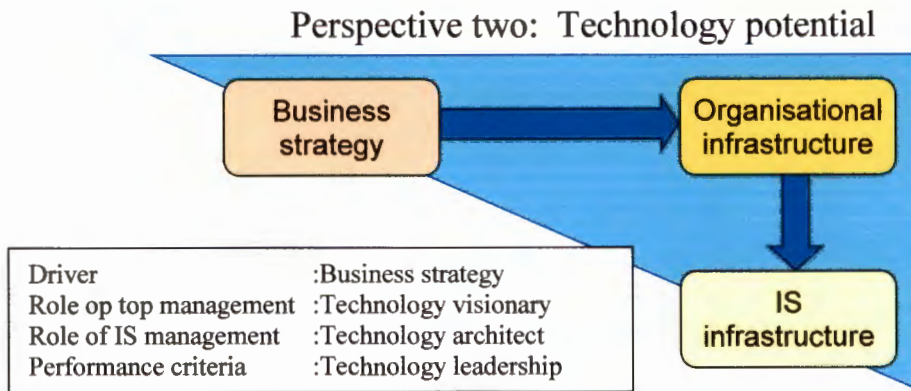
More recently, this perspective has been expanded to emphasize how possible radical changes in business processes (process redesign) could better support the business strategy (Luftman, 1996:29). The role of top management in this perspective is that of strategy formulator – to articulate the logic and choices pertaining to business strategy. The role of information systems is that of implementer – to efficiently and effectively design and implement the required information systems products and services to support the business strategy. Performance criteria in this perspective are based on financial gains and/or increased efficiency of business processes reflecting a cost centre focus.

#### 4.4.3.3.2 Perspective two: technology potential

As shown in Figure 4-4, this alignment perspective involves the assessment of implementing the chosen business strategy through appropriate information technology strategy and the articulation of the required information systems infrastructure and processes. In contrast to the strategy execution logic (see section 4.4.3.3.1), this perspective does not use the business strategy to

explore and define the organisational structure. Rather, information technology seeks to identify the best possible information technology competencies through appropriate positioning in the information technology marketplace. Further, the choices for positioning the firm with respect to key technologies and alliances must be adequately reflected in the design of the internal information systems infrastructure (Luftman, 1996:54).

Figure 4-4: Perspective two of the strategic alignment model.



Source: Luftman (1996:30).

Alignment for this perspective requires that executives understand the impact of business strategy on information technology strategy and the corresponding implications for information systems infrastructure and processes. The executive management team provides the technological vision to articulate the information technology logic and choices that would best support the chosen business strategy. The information systems manager should be a technology architect, who efficiently and effectively designs and implements the required information systems infrastructure that is consistent with the external component of information systems strategy. The performance criteria in this perspective are based on technology leadership, often utilising a benchmarking approach to assess the position of the firm in the high technology marketplace (Henderson & Venkatraman, 1999:478).

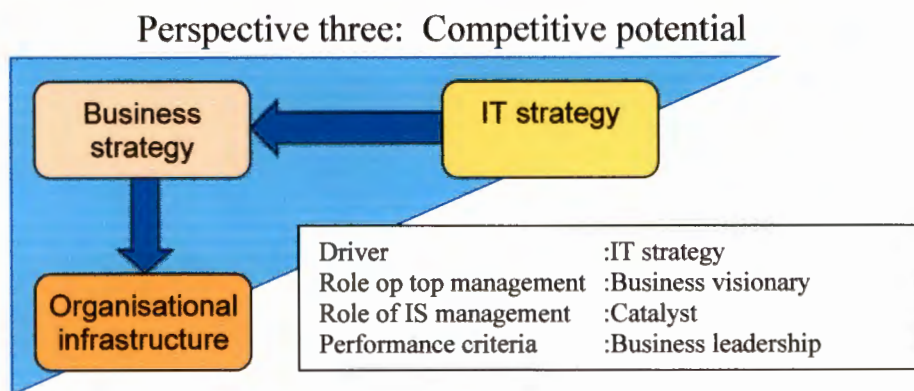
#### 4.4.3.3.3 Perspective three: competitive potential

This alignment perspective is concerned with the exploitation of emerging information technology capabilities to impact new products and services (business scope), influence the key attributes of strategy (distinctive competencies), and develop new forms of relationships (business governance) – see Figure 4-5. Unlike the two previous perspectives that consider business strategy as given, this perspective allows the adaptation of business strategy via emerging information technology capabilities. This perspective seeks to identify the best set of strategic

options for business strategy and the corresponding set of decisions pertaining to organisational infrastructure and processes.

The specific role of top management to make this perspective succeed is that of the business visionary – one who articulates how the emerging information technology competencies and functionality as well as changing governance patterns in the information technology marketplace would impact on the business strategy. The role of the information systems manager, in contrast, is that of the catalyst – one who identifies and interprets the trends in the information technology environment to assist the business managers to understand the potential opportunities and threats from an information technology perspective. The performance criteria in this perspective are based on business leadership with qualitative and quantitative measurements pertaining to product leadership such as market share, growth, or new product introduction.

Figure 4-5: Perspective three of the strategic alignment model.



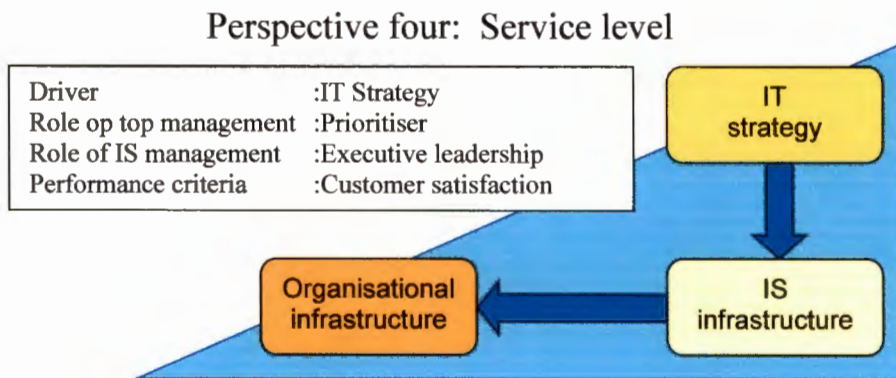
Source: Luftman (1996:30).

The specific role for top management to make this perspective succeed is that of business visionary, who articulates how the emerging information technology competencies and functionality, as well as the changing governance patterns in the information technology marketplace, would impact the business strategy (Luftman, 1996:56). The role of the information systems manager, in contrast, is that of catalyst, who helps to identify and interpret the trends in the information systems environment in order to assist the business manager’s understanding of the potential opportunities and threats from information systems. The performance criteria in this perspective are based on technology leadership, often utilising a benchmarking approach to assess the position of the firm in the marketplace (Henderson & Venkatraman, 1999:479).

#### 4.4.3.3.4 Perspective four: service level

Perspective four (see Figure 4-6) focuses on how to build a world-class information systems service organisation. This requires an understanding of the external dimensions of information technology strategy with corresponding internal design of the information systems infrastructure and processes. This strategic fit for information technology creates the capacity to meet the needs of information systems customers. As with the other perspectives, the implications of the “strategic fit” dimensions are reflected in terms of the products and services provided to the organisation – i.e., in support of the business process. This perspective is often viewed as necessary but not sufficient to ensure the effective use of information technology resources in a growing and fast-changing world (Luftman, 1996:32).

Figure 4-6: Perspective four of the strategic alignment model.



Source: Luftman (1996:30).

The specific role for top management to make this perspective succeed is that of prioritiser, who articulates how best to allocate the scarce resources both within the organisation and in the information technology marketplace (Luftman, 1996:59). The role of the information systems manager, in contrast, is that of leadership, with the specific tasks of making the internal information systems organisation succeed within the operating guidelines from top management. The performance criteria in this perspective are based on customer satisfaction obtained with qualitative and quantitative measurements using internal and external benchmarking (Luftman, 1996:60).

The strategic alignment model described here provides one framework for understanding the substantive knowledge required to align business and technology strategies. By itself, however, it does not reflect the dynamic aspect of alignment. The next section describes four key executive processes required to achieve this alignment over time.

#### 4.4.3.3.5 Achieving strategic alignment

The management challenge of translating strategic choices into operational behaviours or achieving strategic alignment is considerable. Luftman (1996:33) has identified four alignment mechanisms to aid the strategic alignment process (see Figure 4-7):

- 1) **Value management** is the mechanism for ensuring that the maximal benefits are realized from information technology investments.
- 2) **Governance** specifies the allocation of decision rights to the key executives or partners.
- 3) **Technological capability** is the mechanism for specifying and modifying the various information technology capabilities required to support and shape business strategy.
- 4) **Organisational capability** is the mechanism for specifying, modifying, and perhaps reinventing the various skills and processes required to support and shape business strategy.

Figure 4-7: Strategic alignment control processes.



Source: Luftman (1996:33).

Finally, strategic control, the central area of Figure 4-7, represents the essential need for an ongoing planning process task, which assesses and adapts the above processes in a manner that achieves internal consistency.

Several studies (Chan & Huff, 1993:54 & Luftman, 1998:32) to identify the enablers and inhibitors of information technology and business alignment have identified several factors that might assist or hinder the strategic alignment process. Some of the most significant enablers for alignment are:

- Support from senior, non-information technology executives regularly ranked as the top enabler to business-information technology alignment. This is a key finding because it highlights the need for business leaders to be aware and supportive of technology innovations. Top business executives need to recognise the value of information technology, define and communicate a "vision" of corporate success that includes information technology in a major role, and provide leadership and funding for information technology projects.
- Another highly ranked enabler is information technology management's participation in the creation of business strategies, and development of its own strategies for success. Both information technology and non-information technology executives recognise that it is easier to achieve alignment when cross-functional teams, including information technology representatives, create enterprise strategies.
- Information technology management's understanding of the business environment is another key to successful alignment. Information technology executives also need to communicate in business terms rather than technology terms. Conversely, business line managers need to have an understanding of information technology and what it means to their business.
- Prioritisation of information technology projects has consistently been cited as another important enabler of alignment. Companies that cannot incorporate technology into their business strategy in a timely manner may fall behind competitors. A key to effective prioritising is to define and support the information technology governance processes.

Some of the key inhibitors to information systems and business alignment are:

- A poor relationship between business and technology organisations and staff, and poor prioritisation of information technology initiatives, lead the list of barriers to alignment. This gets back to information technology managers understanding the business and business managers understanding information technology, the establishment of an effective information technology governance process and effective marketing of the value of information technology by information technology executives.
- Another barrier is information technology's inability to meet its commitments. Too often, information technology is overwhelmed by all it has to do. Business executives and end users become increasingly upset that projects are late and over budget. Most of these problems are not technical but still have a significant impact on information technology's credibility. They are the result of not adhering to basic project management disciplines.
- Information technology managers' inability to understand the changing business environment is also named as a major barrier to alignment. Companies that fail to invest in information technology enhancements to increase customer satisfaction will fall behind their competitors.

## 4.5 Information technology architecture

Enterprise architecture planning differs from traditional systems planning in scope and purpose. Many companies develop systems to meet the specific business needs in one area. Unfortunately, this creates a legacy of systems that do not interoperate. These "silos," or vertical solutions, and their associated architectures often duplicate efforts, deploying the same functionality and information differently.

Also, since enterprise architecture planning attempts to tie the information technology strategy tightly to business objectives, it avoids a common situation in traditional systems planning where each application must justify each part of its infrastructure: people, skills, new or modified processes and technology.

What is an architecture? The information technology industry has proposed numerous definitions for the concept of architecture, widely varying in scope and emphasis. Some examples of these definitions are:

Software architecture is principally concerned with the study of patterns of system organisation, large-grained software components, their relationships, and the models of interaction between them. It addresses the overall system properties at high levels of abstraction and from multiple perspectives, such as structure, control, and data. Architectural designs also address important system characteristics, including scalability, overall performance, processing rates, and allocation of functionality to design elements (Kirova & Kradjel, 1998:125).

The information technology architecture is the infrastructure of technology that provides the foundation for automated business procedures and practices. Just as a city's infrastructure of roads, sewers, bridges, buildings, and public utilities provides the foundation on which the city lives and operates, the corporate technology infrastructure provides the automation foundation on which the corporation operates (Curle, 1993:5).

Enterprise Architecture Planning is the process of defining architectures for the use of information in support of the business and the plan for implementing those architectures (Spewak & Hill, 1992:1).

John Zachman (Zachman, 1987:281) defines *information systems architecture*, first "by creating a descriptive framework from disciplines quite independent of *information systems*," then specifying "*information systems architecture* based upon the neutral, objective framework."

Common themes from these definitions are:

- **Architectures:** several types of architectures co-exist, namely data-architecture, an applications architecture and a technology architecture. Architectures in this context are like blueprints, drawings or models that are needed to support the business.
- **Defining:** Enterprise architecture defines businesses and the architectures that support them. Enterprise architecture however does not design systems, databases or networks but establishes a framework for these designs. The design and implementation work is initiated after the enterprise architecture definition processes have been completed.
- **Plan:** Generally the architectures define what is needed, and the supporting plan defines when the architectures will be implemented. Architectures by themselves can provide useful definitions, standards and ideas and need to be supported by implementation plans.

The information technology architecture is strategic in nature. Although it documents the current technology infrastructure, it also blueprints the future technology direction of the corporation by (Curle, 1993:6; Cottey and Chang, 1996:82):

- examining technology directions beyond a two-year window;
- providing technology migration planning;
- joining technology products and directions with strategic corporate business objectives;
- helping information systems managers track all information technology assets and set priorities;
- identifying quick wins to prove value and gain acceptance from the business community; and
- tying the information technology plan tightly to business goals.

Enterprise architecture planning aligns information technology visions with those of the enterprise and puts current and planned initiatives into a larger context. The goal is to make appropriate decisions on deploying information technology resources and map out a programme for enterprise change.

#### 4.5.1 Architectural frameworks

Architectural frameworks are overall high-level structures that define what an architecture should embrace, but often do not go into any detail of how to complete the framework item by item. Table 4-5 is an example of a leading framework that serves as blueprint for architectures. Architecture development equates to completing each matrix cell.

Though the frameworks are quite different, they do share some critical common attributes (Boar, 1995:102):

- They define the entire domain of information technology architecture.
- High-level explanations are provided for how to complete the contents of the architecture, but they often fall short on exact methodologies to complete cells.
- The frameworks are holistic: they do not view architecture as only a technical issue, but as also embracing non-technical issues.

- Because the audience for frameworks is usually higher-level executives, the emphasis is on concepts. When details are provided, they are usually provided on executive-level issues such as “values” or “principles.”

Architectural frameworks are very important in identifying the architectural problem, but are often deficient in providing detailed methodological advice on how to model the implementation of the selected framework. It is also clear that unless one does a lot of extra work, the frameworks are not easily reconciled with each other.

There are several well-known examples of architectural templates, often described by related terms such as reference model, reference architecture, domain description, or even industry standard. Widely known examples of architectural templates include (Youngs *et al.*, 1999:39):

- **The Smalltalk model-view-controller pattern:** A standard set of component roles (model, view, and controller) for user interface management, the interfaces each role must support, and the collaborations which ensure that the user interface (view) is coordinated with the model.
- **The Web architecture:** A template in which the browser and server collaborate in well-understood ways (defined by HTTP – HyperText Transfer Protocol) to present information across the Internet.
- **The workflow reference model from the Workflow Management Coalition:** A set of patterns of collaboration between standard component roles (invoking application, workflow enactment service, invoked application, monitoring application) and a detailed workflow application programming interface supported by each role for a component to be "workflow-aware."
- **The OMG object transaction services (OTS) specification:** A standard set of component roles (transaction manager, resource manager, resource) and required interfaces for transaction management in a distributed object environment.
- **The International Organisation for Standardization-Open Systems Interconnection (ISO-OSI) seven-layer model:** An architectural template for network communications with well-defined layer responsibilities and interfaces.

The same diagrams used for describing component structure and component interactions are also used in architectural templates.

#### 4.5.2 Evernden's information framework

Incorporating some elements of Zachman's Information Systems Architecture Framework, the Information Framework focuses on the information needed, used and managed by the enterprise rather than on the development and maintenance of information systems that deliver the information. As such, Evernden's information framework raises a lot of relevant issues and provides information systems architects with useful ideas and solution approaches.

While the Zachman framework is based on the development process used for traditional architecture and engineering processes, Evernden (1996:37) describes the information framework approach as akin to city planning, a process which will gradually result in a complete "city" of information. Evernden cites the following two quotes to explain this approach.

"There is a parallel between architecture design and city planning. City planners must design in the face of many unknowns, such as future transportation technologies, changing work, living, and commuting patterns, and so on. To deal with the complexities and unknowns, city planners set guidelines on, for instance, building height, setbacks, and zoning. They can ill afford to delve into such detail as prescribing building materials." (Evernden, 1996:69)

"...what our information systems need is landscape architecture, not building architecture, to provide 'bottom-up ecological and evolutionary models of system growth' " (Podolsky, 1994:90)

Central to information framework is information. Evernden defines information as *"a set of components that together comprise the knowledge or experience about a given domain. ... Data as an entity is one of the basic building blocks used to create information."* (Evernden, 1996:43)

Two relevant types of information are distinguished here:

- **Data information** includes descriptive items such as names, addresses, product numbers and cost. This is the traditional view of information with which business has filled its databases.
- **Workflow information** describes the activities, processes, and task that are carried out. This type of information includes events and triggers that connect these processes and the conditions and behaviour logic that control the flow among the processes.

By distinguishing between these two types of information, information framework draws attention to the workflow information, which is rapidly gaining in importance as organisations are reengineering their business processes.

#### 4.5.2.1 Information framework's dimensions

Information framework consists of six basic dimensions, each of which highlights a function or property of enterprise information. From Table 4-5, each information framework dimension can be selected to obtain a detailed description. These descriptions are all closely based on Evernden's (1996:42) original paper on information framework.

##### 4.5.2.1.1 Types of information

This information framework dimension describes the various ways to represent different types of information. It subdivides the information into organisational, business, and technical perspectives. Each of these perspectives has different information needs. By separating industry-wide information from business-specific information and information systems/technology-specific information, complete yet efficient models can emerge. Given that the pace of change is different for each of these perspectives, the information can also be better maintained. A detailed description of these perspectives is provided as part of the information framework grid.

This dimension is one of the two key dimensions of information framework. Together with levels of constraint, it forms the information framework structural components grid that forms the basis for organising enterprise information. The four remaining information framework dimensions are best considered within each cell on this grid.

##### 4.5.2.1.2 Levels of constraint

This information framework dimension shows the information contained in the "Types of Information" dimension as subjected to a set of increasingly specific constraints.

- Deconstruction is at the highest level of all information and is presented in its pure, proprietary form;
- at the intermediate level, composition, the information representation is altered due to constraints imposed by the combination of organisation, business and technical perspectives; and
- at the lowest level, implementation, the information is constrained by the requirements of specific applications.

This dimension is one of the two key dimensions of information framework. Together with “Types of Information”, it forms the information framework structural components grid that forms the basis for organising enterprise information. The four remaining information framework dimensions are best considered within each cell on this grid.

#### 4.5.2.1.3 Content

This information framework dimension represents the contents of each specific cell in the information framework grid. At the lowest level of granularity, a cell is the intersection of a column and a row. At a higher level of granularity, a cell can be the intersection of a view and a level.

The actual contents of the different cells in the information framework grid can vary greatly. Based on where they are located in the information framework grid, cells may contain detailed technical architectures or industry-wide business models. Each cell refers to a particular domain – a field or scope of knowledge – and a domain model – a representation of a particular field or area of knowledge that can be used to analyse and understand problems that occur in the particular domain. Finding, developing, and using domains and domain models constitutes a substantial effort by the organisation. However, completing a full set of domain models could in the long run be a worthwhile activity. According to an IEEE primer on the subject, "domain analysis has been identified as a major factor in the success of reusability in software construction."

#### 4.5.2.1.4 Transformation over time

This information framework dimension describes the transition or transformation from one version of information framework to another over a period of time. When migrating or transforming an information systems architecture, it is important to manage this transformation for all aspects of the architecture and consequently for all aspects of the information framework. A holistic, systemic, interconnected information systems perspective – rather than one that focuses on isolated parts – is needed to manage such an undertaking.

#### 4.5.2.1.5 Ownership

This information framework dimension considers the various owners of the contents of a cell at their appropriate levels. Information ownership is important for several reasons:

- Information that is gathered from different owners may exist in a variety of formats. Any combination or exchange of such source materials should be carefully documented.

- Information ownership is directly related to information management and maintenance. Procedures for accessing, using, and updating information – along with the costs and efforts required to do so – will need to be developed in the light of who has a claim to the information.

It would be helpful to distinguish between information management and information technology management. Information framework distinguishes the following five levels of information ownership:

- **Global:** Information commonly found in all or most industry groups. This information is common across all of the lower levels.
- **Industry:** Information that is typical of a particular industry community, such as financial services, manufacturing, or retail institutions.
- **Enterprise:** Information that is unique to a particular company, but which can be applied across all of the organisational units that makes up the company.
- **Local:** Information that is a subset of enterprise information. It may be defined within a project, organisational unit, or business application.
- **Individual:** Information that constitutes the assets owned by a person within the organisation, often offering a personalized view of information at higher levels.

An interesting characteristic of the information at the industry and enterprise levels is that research shows that as much as 80 percent of the information of an enterprise can be defined at the industry level.

#### 4.5.2.1.6 Route maps

When organisations select the appropriate business and information systems analysis and development methodologies to meet their information needs, they often end up with a variety of methodologies. While each methodology contributes its own strengths and areas of application, it is possible for the combination of these methodologies to result in conflicting information systems goals and requirements.

To help deal with this, information framework proposes methodology chains or route maps which coordinate and connect individual methodologies into a coherent, holistic, well-defined approach. This "super" methodology would support the complete cycle of organisational, business and

technical analysis, providing for information exchange among the methodologies and for the coordination of the various analysis and design activities. The concept of the route map can even be used to suggest the most effective or appropriate methodology or technique for a given situation.

Methodology chains can integrate the different methodologies both horizontally and vertically. Horizontal integration combines methodologies across analysis and development phases to provide a complete analysis and development process. These methodologies may be drawn from a single approach (such as object-orientation or information engineering) or may represent different approaches. Vertical integration combines methodologies from distinct groups or approaches that are applied to a single phase or task for the purpose of providing greater depth or a higher quality deliverable.

#### 4.5.2.2 Structural components in the information framework

The combination of the “Types of Information” and “Levels of Constraint” dimensions of the information framework provides a two-dimensional taxonomy for managing information. The columns in this grid are divided into three views, representing the perspectives of organisation strategists and managers, business analysts and designers, and technical analysts and builders. The rows are used to classify and define information elements according to design decisions, technical constraints, and organisational constraints. Each row has its own modelling technique to represent its constraints and representations.

The full taxonomy is reproduced below.

Table 4-5: Structural components of Evernden’s information framework.

LEVELS OF CONSTRAINT		TYPES OF INFORMATION									
		Organisation View			Business View				Technical View		
		Strategy Column	Structure Column	Skills Column	Data Column	Function Column	Workflow Column	Solution Column	Interface Column	Network Column	Platform Column
<b>Deconstruction Level</b>	Domain Concept Row										
	Domain Classification Row										
<b>Composition Level</b>	Generic Template Row										
	Design Context Row										
<b>Implementation Level</b>	Operational Bound Row										

Source: Evernden (1996:40).

#### 4.5.2.2.1 Types of information

A specific organisation is involved in running one or more types of business and may require the support of a technical computer-based infrastructure.

- **Organisational view:** This view represents how the organisation differs from other organisations in its goals, structure, and core competencies. It is the view of those involved in planning the organisation's strategies, designing the organisation's structure and developing organisational skills. Organisation information is increasingly important as business strives to build information systems that support business goals, reengineer business processes that cross organisational structures, and recognise that skills within an organisation often distinguish it from another.
  - ◆ **Strategy:** This column contains the goals or objectives of the organisation.
  - ◆ **Structure:** This column contains the way in which the organisation is structured or organized, such as its organisation charts and reporting structures.
  - ◆ **Skills:** This column contains the core competencies of the organisation; the things it does well or better than its competitors.
- **Business view:** This is the perspective of those involved in analysing the business, in designing customer solutions, and in managing, operating, or supporting the business. Application developers need to have a good grip on this perspective.
  - ◆ **Data:** This column contains the entities about which the organisation stores information, as well as their relationships, the definitions and descriptions of these entities and relationships, and the constraints that apply to them (such as cardinality rules and value domains).
  - ◆ **Function:** This column contains descriptions of the business functions and processes, their states and allowable transitions and the data access functions they perform to the data described in the Data column.
  - ◆ **Workflow:** This column contains descriptions of the dynamic or behavioural aspects of process or workflow, the events or triggers that initiate and connect these processes and the conditions and behaviour logic that control the flow among the processes.

- ◆ **Solution:** This column contains solutions to internal problems and external customer needs. It describes products, services and support systems.

The distinction between function and workflow is a subtle yet significant one and is often the key to business reengineering efforts. Evernden views a function as a relatively static or permanent organisational component that *"can be found throughout the largely hierarchical or vertical structure of the organisation."* A workflow is described as a dynamic process by which the organisation delivers value, often stretched horizontally across the structure of the organisation. Workflow *"has a start, a middle, and an end and is related to people and their roles within the organisation."*

- **Technical view:** This view is used to maintain information about the technical structures that support the business. This is the perspective of those responsible for providing the technical infrastructure that supports the organisation's computer-based information systems. However, these technical solutions must be solidly based on previously identified business requirements.
  - ◆ **Interface:** This column contains information about the structure of programmes, including their sub-components or modules and their interfaces to link to other programmes, languages, and platforms.
  - ◆ **Network:** This column contains descriptions of the protocols, devices, and topology that make up the organisation's networks.
  - ◆ **Platform:** This column contains descriptions of the organisation's operating and data storage systems.

#### 4.5.2.3 Levels of constraint

Each level of constraint isolates a different representation of the column-based information categories based on different types/levels of constraints, such as design decisions, technical constraints, and organisational constraints.

##### 4.5.2.3.1 Deconstruction level

At this conceptual level, all possible contextual (business organisation) constraints have been removed. Industry-wide models for the classification of key concepts are applied. For example, at this level, the domain concepts and classifications of the business view are defined

independently of the technology that could be used to develop and implement a solution application and of the particular organisation that operates the business.

- **Domain Concept:** This row describes the domain concepts used for classifying the information within a given column. Conceptual and domain analyses are used to provide a high-level perspective that helps identify industry-wide (and hence often reusable) qualities of the information.
- **Domain Classification:** This row provides the actual classification of the information within a given column, based on the established domain concepts. Using classification theory and domain modelling, this results in a communications medium that both business and technical people can understand. These models become valuable for business and information systems analysis purposes.

#### 4.5.2.3.2 Composition level

At this logical level the organisation, business, and technical views are integrated. The constraints these views impose on each other are modelled to provide a more business – or context – specific view of the information.

- **Generic Template:** This row provides high-level logical models of the information.
- **Design Context:** This row groups information items into a logical model which can subsequently be used for the development of a specific application or project.

#### 4.5.2.3.3 Implementation level

At this physical/technical level a specific application is defined. It is a product of the constraints (such as the existing structures of legacy systems) and options (such as the possibilities of new technologies) identified during the composition process.

- **Operational Bound:** This row places the information in a particular, implemented design. This design is usually fixed, constrained, and restricted within the operations of the enterprise.

### 4.5.3 Implementing architecture models

Planning enterprise architecture lets you address current and planned initiatives as a portfolio of assets rather than individual items. In the same way that a broker manages a stock portfolio for certain attributes e.g. total investment, level of risk and return, one can manage information technology as a portfolio to the defined goals of the business. By treating information technology

assets as a coordinated whole, the overall investment, level of risk and flexibility to change can be managed and made to work for the good of the organisation.

Cottey & Chang (1996:80) propose a high-level enterprise architecture planning model. The main activities of this model is as follows:

- Determine the current state of the enterprise, including how technologies are used, where they are deployed, how the enterprise is organised from information technology and business perspectives, and the health and capabilities of the current solutions.
- Identify the current initiatives or planned information technology initiatives, including current design and development efforts, joint ventures, and strategic plans.
- From the current initiatives a current future state should be formulated. This current future state is where the enterprise will end up if the current plan or method of doing things continues unaltered.
- Thereafter the desired future state must be determined, where the enterprise would end up if its vision were completely implemented. The vision gap, the difference between where the enterprise is headed and where it would like to be, is then derived.
- The "necessary initiatives" are the efforts required to move an enterprise toward its vision. They are the basis for a "transition plan" to change the enterprise's direction toward its desired future.

The sum of these initiatives forms the enterprise's technology and application release strategy and focuses its efforts on the most critical tasks.

To succeed, enterprise architecture planning must look for quick wins to prove its value. Because planning seems like more work than just building, these quick wins reassure the business people that it is worth the extra effort.

Fortunately, architecture planning is an iterative process, "fortunately" because the iterations allow you to find the quick wins through a first pass. Then, once others in the organisation are convinced of the value of planning, subsequent iterations can drill out additional detail or cross into further areas.

## 4.6 Summary and conclusions

Information technology is becoming an integral part of modern business and therefore has a profound impact on business performance; the potential year 2000 problem and Internet growth can be seen as examples of this (Lucrezio, 1999:34; Lucas and Baroudi, 1994:11; Bolded *et al.*, 1997:1112).

The value of information to the business can take many forms (*see section 4.2.1*). The measurement of the value of information technology however is much more problematic, as many of the potential benefits of information technology are subjective, on a strategic level, or are realised in other functional areas. Every attempt possible should be made to quantify the benefits of information technology, or at least give the benefits some visibility in the organisation.

Proper alignment between information technology and the business is critical to how the business perceives information technology and to what extent information technology adds value to the business (Henderson & Venkatraman, 1999:481). The “Strategic Alignment Model” (*section 4.4.3.1*) provides an overview of the complexities involved in the alignment of information technology and business. To complicate matters even further, the alignment is not a static end-state but changes continuously as the market changes. Several different perspectives or philosophies exist in the strategic alignment field depending on the organisation’s market, strategies, and operating environment. These different perspectives determine largely how information is applied and measured in the organisation (*see sections 4.4.3.3.1 through 4.4.3.3.5 for more information on the different perspectives*). The information technology project portfolio to a large extent determines the information technology applications and infrastructure that an organisation will use; it should therefore strive to maximise the information technology value and business alignment derived from the individual projects.

Architecture development is a relative new technique used to create some form of order in the chaos of real life information technology. Architecture achieves this through the establishment of “frameworks” that should guide and govern the implementation of information technology. This role of architecture should be recognised in the project selection methodology and supported whenever possible.

# CHAPTER 5

## MODEL FORMULATION

### 5.1 Introduction

Chapters 3 and 4 provided an overview of the factors that need to be considered when an organisation attempts to actively manage its information technology project portfolio. This chapter will integrate the decision making criteria into a formal process or model that will guide an organisation through the process of project portfolio management. It starts off with a short overview of existing project selection models that will form the basis of the eventual project portfolio management model. Thereafter the new project portfolio management model is described in various levels of detail and illustrated whenever possible. The chapter ends with the benefits of the model and an overview of the implementation issues involved.

### 5.2 Existing project portfolio selection models

#### 5.2.1 The strategic planning model

The strategic planning process provides an ordered set of steps designed to culminate in the development and execution of a comprehensive strategic business plan. While the following description of the process is an extremely abbreviated explanation of the process, it does catch its essence, which is to identify exactly where you are (assessment), specify what is to be done (strategy), and do/monitor it (execution).

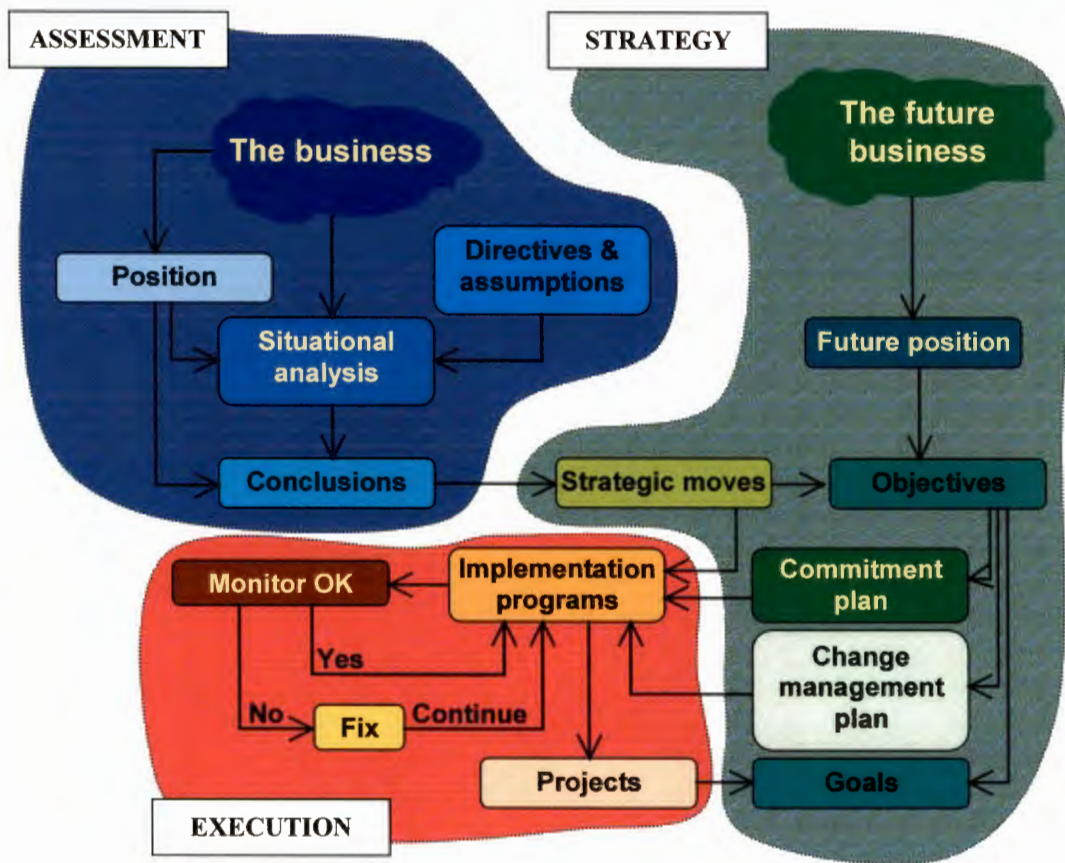
##### 5.2.1.1 Assessment phase

Assessment is the activity of developing a clear and thorough understanding of the business situation from both an internal and external perspective. Assessment culminates in the identification of “conclusions” which pinpoint critical issues requiring strategic attention. Two major sub steps, positioning and situational analysis, are used to generate conclusions, namely (Boar, 1993:93):

- **Positioning** provides a graphical way to understand the “position” of the business in all relevant strategic areas (i.e., market share, customer satisfaction, and core competencies).
- **Situational analysis** is the use of various analytical methods to interpret the data about the company and its environment.

Assessment is a data intensive and analytical intensive activity.

Figure 5-1: The strategic planning model.



Source: Boar (1993:3).

### 5.2.1.2 Strategy phase

Strategy consists of identifying the desired future state of the business (future position), the specific objectives to be achieved, and the strategic moves needed to realise the future state and objectives (Boar, 1993:188). Objectives are descriptive of what the organisation wishes to achieve. Strategic moves are prescriptive identifying the actions to be undertaken. To support the realisation of the objectives, a commitment plan to focus organisational attention on them and a change management plan to anticipate and reduce resistance to change are also developed. Once a strategy has been defined and communicated, the business can quickly determine which opportunities “fit” and which events pose “threats.”

Unfortunately, there is a great deal of ambiguity in terminology used to describe the various objects of strategic planning. The most confusing is the word “strategy”. Sometimes, strategy is used to mean specific actions to be taken. Other times, strategy is used to mean all the objects that compose the strategic plan (i.e., future business scope, future strategic positions, objectives, and a

commitment plan). Sometimes, in the same sentence or paragraph, the word strategy is used to mean both. To eliminate confusion, Boar uses the word strategy to mean the complete strategic plan and the words move, initiative or actions to denote the specific actions taken to achieve an objective.

### 5.2.1.3 Execution phase

Execution is the action of putting the plan into motion (Boar, 1993:241). It is the translation of intent into reality. Strategies are made operational through implementation programmes that are partitioned into multiple projects. Projects achieve objectives and interim objectives called goals. A process monitoring and control step is used to:

- adjust and tune the projects,
- provide learning feedback from the project experiences, and
- observe the ever changing environment for additional situations requiring strategic response.

The success of the execution step depends on the commitment and change management plans designed in the strategy step to minimize barriers and obstacles.

Throughout the entire process, quality control actions are interwoven to catch mistakes as close to the point of introduction as possible, and procedural steps are undertaken to maximise organisational input and participation. All steps focus on understanding and achieving the strategic intent of the business, which represents the long-term ambition of the enterprise.

The process is very adaptable to the culture and style of the organisation and evolves with the organisation. To minimise bureaucracy, the process can be “time-boxed” to force its execution within a specific time period. This prevents “analysis paralysis” and forces the notion that “this is a time for decisions.” The process results, specifically strategy, can be levelled consistent with the desired degree of centralisation and distribution of decision power within the organisation. For very centralised and tightly controlled organisations, the strategy can be extremely specific in detail. For more empowered organisations, emphasis can be put on the definition of the future state of the organisation and the specifics of how can be left to the entrepreneurial talents of the management team. The degree of specificity can also be mixed on an item-by-item basis to reflect varying importance. So by levelling, the process can be used to control or empower.

### 5.2.2 A systems model by Kerzner

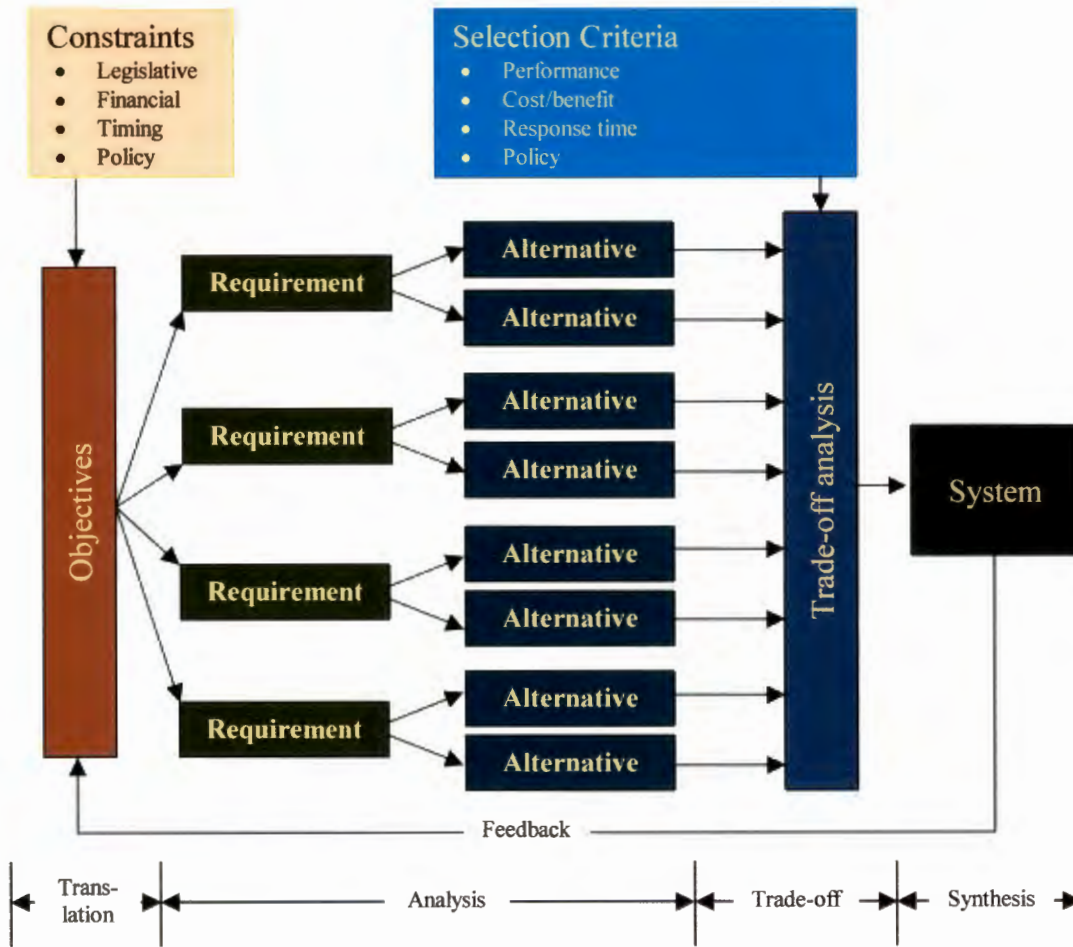
The systems analysis process, as shown in Figure 5-2, begins with systematic examination and comparison of those alternative actions related to the accomplishment of the desired objective. The alternatives are then compared on the basis of the resource cost and the associated benefits. The inputs from the constraints and limitations identify the explicit consideration of the uncertainty variables. The loop is then completed using feedback in order to determine how compatible each alternative is with the objectives of the organisation.

The above analysis can be arranged in steps:

- Input data to mental process.
- Analyse data.
- Predict outcomes.
- Evaluate outcomes and compare alternatives.
- Choose the best alternative.
- Take action.
- Measure results and compare them with predictions.

The systems approach to thinking is most effective if individuals can be trained to be ready with alternative actions that directly tie in with the prediction of outcomes. The basic tool is the outcome array, which represents the matrix of all possible circumstances. This outcome array can be developed only if the decision maker thinks in terms of the wide scope of possible outcomes. Outcome descriptions force the decision maker to spell out clearly just what he/she is trying to achieve (i.e., his/her objectives).

Figure 5-2: The systems approach for project selection.



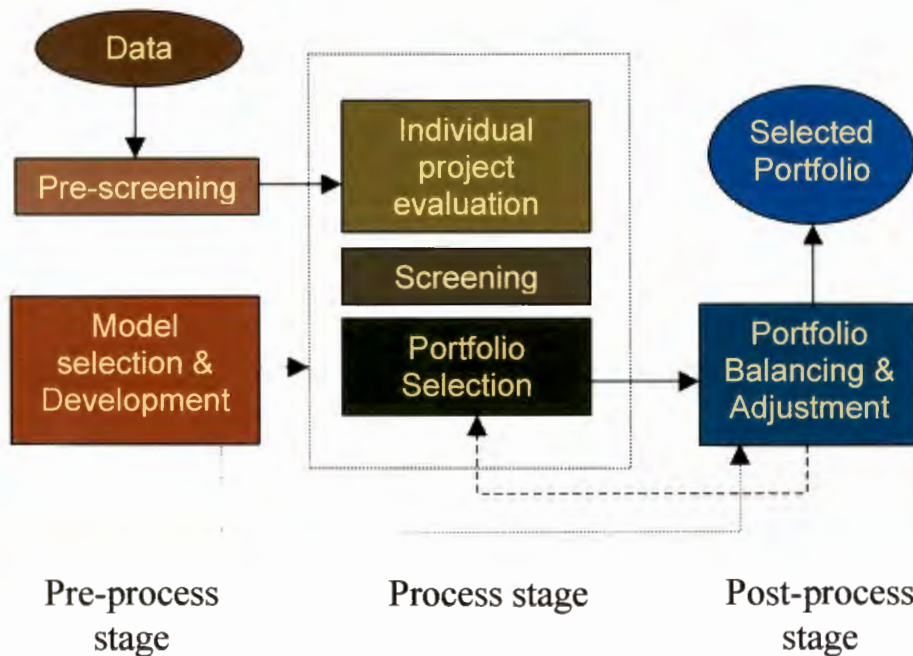
Source: Kerzner (1997:83).

Kerzner sees a systems thinking methodology is vital for the success of a project (Kerzner, 1997:84).

### 5.2.3 Archer and Ghasemzadeh's project portfolio selection model.

Archer and Ghasemzadeh (1996:31) propose an integrated approach, which takes advantage of the best characteristics of several existing methods (see sections 3.2.2.1, 4.2.1 and 4.2.2 for more detail on the different selection techniques). Their model is based on a staged approach, where the most relevant methods can be selected by the organisation and used at each stage in order to build a portfolio with which decision makers may be confident. The model basically consists of three phases, beginning with pre-processing, and going on to processing and post-processing. See the next diagram for a schematic of their integrated project portfolio selection model.

Figure 5-3: Archer and Ghasemzadeh’s project portfolio selection model.



Source: Archer and Ghasemzadeh (1996:32)

The model selection and development (the choice of techniques used in this process according to organisational needs), are discussed below. The important activities in the portfolio selection process include:

### 5.2.3.1 Pre-screening

This is used to eliminate infeasible projects before the selection process begins, based on preliminary information. It helps reduce the number of possible projects to be considered in the selection process, thereby reducing workload and information overload problems. For example, in process projects that are at a gate or milestone, could be eliminated if they are complete, to be terminated, or put on the backburner due to unsatisfactory progress. Also, large projects which do not yet have a champion or which have not yet undergone a feasibility analysis could be screened out at this stage. However, interdependence of projects, and whether or not projects are mandatory would need to be identified first (Archer & Ghasemzadeh, 1996:31).

### 5.2.3.2 Individual project evaluation

During this process, input data from individual projects is analysed and processed into a common form, which is suitable for further analysis. For example, if the method of choice were a combination of net present value combined with risk analysis, the inputs would be estimates of

costs and returns at each development phase and the commercialisation phase of a product or service, and the risks at each phase, or more simply the development and commercial risks. Uncertainty could also be input in the form of likely ranges for the uncertain parameters. Other inputs could include qualitative variables such as policy or political measures. Quantitative output from this stage would be (for example) each project's expected net value, risk, and resource requirements over the time frame of the project, along with calculated uncertainties in these output results, and any input qualitative variables on a common scale (Archer & Ghasemzadeh, 1996:33).

#### 5.2.3.3 Screening

During this activity, economic calculations from the previous stage are used to eliminate any non-mandatory projects or inter-related families of projects that do not meet pre-set economic criteria such as estimated rate of return (Archer & Ghasemzadeh, 1996:33).

#### 5.2.3.4 Portfolio selection

This process combines the outputs of the previous stage in a manner that selects a portfolio, based on the objectives of the organisation. This could involve extensive interaction with committee members (decision makers) in comparing potential projects on a number of objectives, or it could involve little direct intervention if an optimisation technique such as 0-1 integer linear programming were used. The output of this stage would be a preliminary ranking of the projects, based on the objective(s) specified for the portfolio, and an initial allocation of resources up to the maximum available. This would provide only a first cut at the problem, which would then proceed to the post-processing stage where final adjustments are made by decision maker(s), and re-calculations carried out as necessary to provide support during sensitivity analysis and portfolio balancing (Archer & Ghasemzadeh, 1996:33).

#### 5.2.3.5 Portfolio balancing and adjustment

At this stage decision makers apply judgment to make the final adjustments to the portfolio. The decision support display would be in the form of one or more portfolio matrices, which would display graphically the critical decision variables selected by the organisation for this purpose. Any interactions among the projects, such as interdependence and mutual exclusivity, would already have been taken into account in previous activities and could be displayed during this stage upon request. Portfolio balancing is a judgment problem that requires feedback to the decision maker(s) on the consequences of making deletions and/or additions at this point. Data on

this would come from sensitivity calculations, using the same model applied in the portfolio selection process. Hence there could be a substantial amount of iteration between the processing and the post-processing stage during the final adjustment process.

#### 5.2.3.6 Model selection and development

Before beginning the portfolio selection process, the organisation needs to decide which techniques it wishes to use in each stage of the processes. This would probably be a one-time process (with minor and infrequent adjustments), which would depend upon the organisation's culture, experience, and the availability of information needed as input. This is complicated by the fact that there is more uncertainty about projects which are proposed but not yet under way, as compared to projects which are already under way and for which there is more data available. This may require a combination of techniques to be used, depending upon uncertainty in the estimates. For example, simple checklists of must-meet criteria could be used during the early days of the project, while more sophisticated models might be used for more advanced projects. The important point is that the data provided for later stages in portfolio selection must be in a common format so that appropriate comparisons can be made between projects (Archer & Ghasemzadeh, 1996:34).

Considering the selection process shown in Figure 5-3, pre-screening would likely be an administrative decision based on specific guidelines. Individual project evaluation could be done by a variety of benefit contribution techniques. The screening process would again probably depend on certain guidelines that might eliminate all non-mandatory projects, for example those with an internal rate of return of less than 15% (if this benefit contribution technique was used).

During portfolio selection, all remaining projects would be compared on some basis through one of the comparative techniques such as AHP or pair wise comparison, or by optimisation. During portfolio balancing and adjustment all the projects, including those surviving the screening process but not selected during portfolio selection, would be displayed on certain dimensions such as those used for portfolio matrices, as chosen by the organisation. Information available to the users while the final balancing process is under way should include the amount of each resource consumed and the sensitivity of the objective function to changes caused by adding or deleting projects. This might require iteration back to the previous stage to refine the portfolio calculations.

Since decision makers should be directly involved with the selection process at each of its stages, support tools will be essential to implement each technique used, and the intention should be to

leave the choice of specific techniques up to the decision makers (Archer & Ghasemzadeh, 1996:34).

### 5.3 Derived integrated project portfolio selection model

The integrated project portfolio selection model will build on and include common themes from the above mentioned selection models. These common themes include:

- The usage of multiple decision making gates to filter the number of potential projects as the level of detail increases. This is primarily done to alleviate the effect of information overload and to keep the overhead costs of using the model as low as possible.
- A strong interface exists between the organisational planning functions/roles and that of project selection. This interface is mainly in an attempt to keep the information technology projects in line with the organisational goals and objectives. The interface normally manifests itself in some of the decision making criteria used to evaluate the projects.
- Multiple alternatives exist for a particular business problem. The problem of too many alternatives to consider is aggravated by the fact that specific projects must be evaluated in the bigger context for inclusion in some portfolio. Too many alternatives can lead to long and making processes.

In order to attain the objectives of the study the project selection model will also incorporate the following concepts:

- Place a strong emphasis on technology reuse between projects.
- Encouraging organisational learning between different projects is also encouraged. This might lead to the identification of similar systems which already exist in the organisation and can be used to satisfy new business needs elsewhere.
- The management of projects and the business solutions through their entire life-cycle and making sure that the business solution is used to its full potential.
- Controlling the introduction of new technologies into the organisation to achieve two objectives namely (a) the introduction of only proven technologies, and (b) encouraging technology and solution reuse.

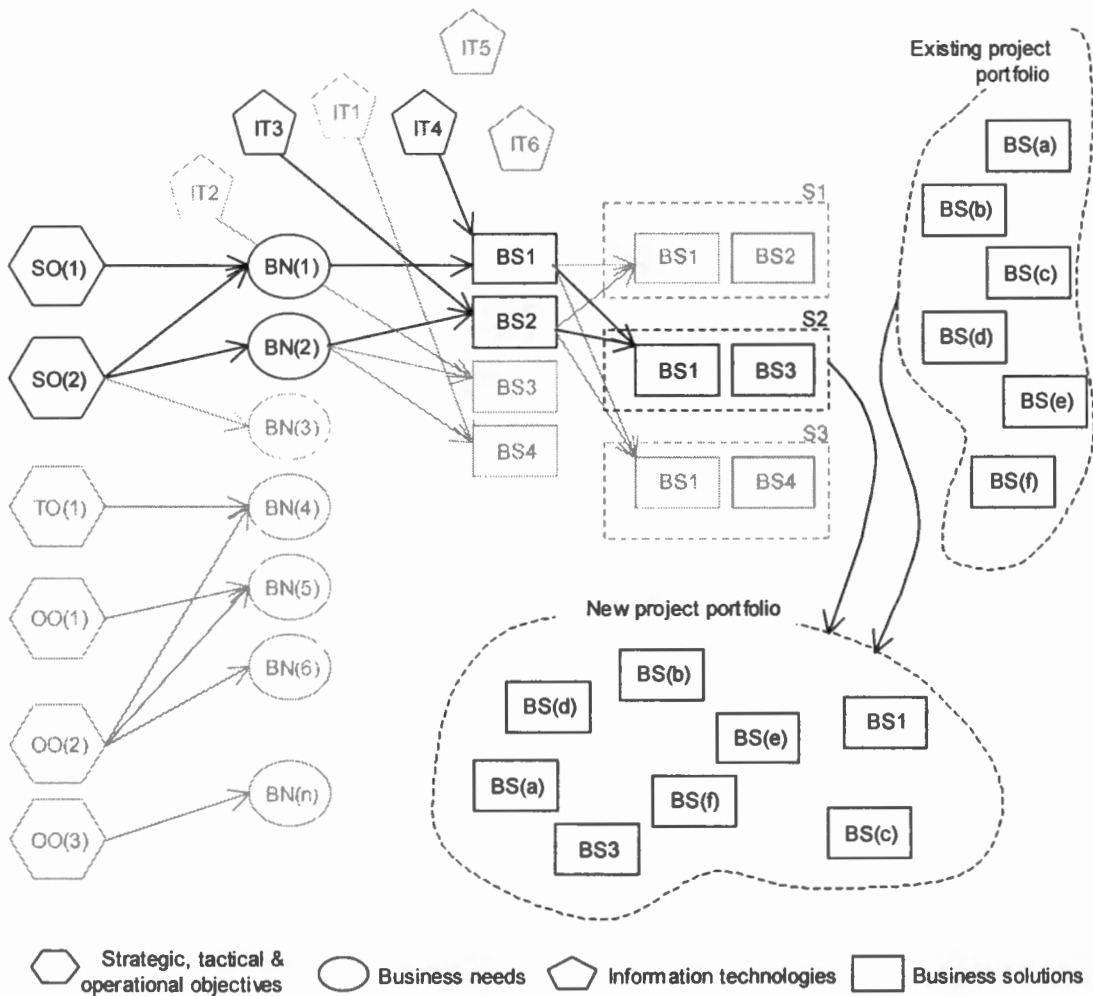
- Continuously consider the impact of a particular project on the other projects in the portfolio.

The model also uses several concepts that need some explanation.

- **Business objectives** converts the strategic vision and strategic intent into target outcomes and performance milestones. These objectives are just as applicable to the information technology organisation as the rest of the organisation and all its efforts should be directed at achieving them.
- **Business needs** is a list of user requirements needs that exists in the organisation. These business needs can be of an operational, tactical or strategic nature and should support the organisation's strategic, tactical and operational objectives.
- **Information technologies** is defined as the technology used for the production, storage, and communication of information using computers and other micro electronics. Information technology is therefore used to transform data resources into information products and has a very powerful impact on the organisation.
- **Business solutions** constitute the realisation of a particular business need using information technology as an enabler. It is important to note that information technology is merely the enabler or facilitator and that businesses must fulfil their business needs themselves.
- **Scenarios** are the grouping of different business solutions. This is done mainly to determine their interaction and mutual influences. By optimising the different scenarios, an optimal mix and match between the available business solutions is obtained.
- **The project portfolios** is the collection of the organisation information technology projects that exist.

Figure 5-4 provide an overview of how these concepts relate to each other.

Figure 5-4: Relation between the different components of the model



This integrated project portfolio selection model is described in more detail in the following sections. Section 5.3.1 describes the model on a high level. Thereafter the model is described in much more detail in section 5.3.2. The model is described in terms the processes that make up the model. Each process is illustrated graphically in Figure 5-6 to Figure 5-10, pages 135 to 139.

### 5.3.1 Model overview

The model consists of 6 phases, namely (1) business assessment, (2) information technology assessment, (3) scenario building, (4) scenario integration, (5) project execution, and (6) an overall process management function. Processes that maintain the information technology infrastructures and completed projects also support the model. Each of these processes and functions is described here under:

- 1) A business assessment is used to determine which opportunities exist for information technology and systems in the business. The main deliverables of this phase are

business needs and organisational objectives. The business needs are then evaluated against existing information technology in the organisation to find an optimum solution. If the technology to satisfy the need does not exist in the organisation or the existing technology is insufficient, new technologies are evaluated. The business assessment phase is critical for the alignment of the business goals, needs and objectives with the implemented information technology systems and projects. The model uses information from this phase in several feedback loops to insure that the information technology projects support the business.

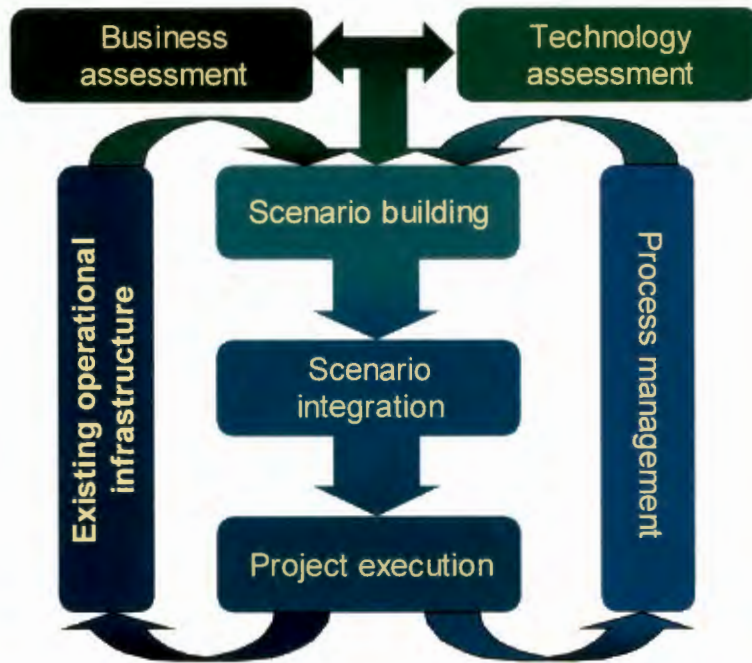
- 2) The model uses a technology assessment to identify promising information technologies in the marketplace that can be applied in the organisation. The current information technology infrastructure of the organisation is also continuously evaluated against the best that the marketplace has to offer. This may result in infrastructure upgrades if the organisation can justify the expense. Only new technologies that have passed through the technology assessment phase can be introduced in the organisation. This ensures that the technology is properly evaluated and its impact on the rest of the organisation determined. It also helps to limit the number of information technologies implemented in the organisation, thereby maximising technology reuse.
- 3) The next step in the model is the scenario building process. The main objective of this phase is to develop a range of possible solutions to the business needs. Existing and previous projects are also considered as possible solutions. These solutions are then evaluated for technical feasibility, support for the organisational objectives, its costs, and the possible contribution to the organisation. The main purpose of this high-level evaluation is to eliminate the “non-performing” solutions. The remaining solutions for all related business needs are then combined into scenarios. In building the scenarios the decision makers should aim to capture all the possible synergistic value of solutions in the portfolio. Options available include the combination of one or two business needs, reuse of solution components such as object libraries, better discounts from suppliers, and combination of resources. A second evaluation process is applied to the different scenarios to identify the most promising of these to be considered during the next step of the model.
- 4) The last decision making phase of the model considers the integration of the selected scenarios into the organisation’s existing project portfolio. Each of the scenarios from

the previous phases is thereafter incorporated in the existing project portfolio and the effect of the scenario on the project portfolio determined. The most successful scenario is then incorporated into the project portfolio. Portfolio balancing and adjustments are then done on the new project portfolio to ensure optimal resource usage. Changes to current projects and the new projects are then passed on to the project organisation for execution. Emphasis is also placed on the impact of the new technology on the organisation and change management plans initiated to insure the acceptance of the new technology by the business users.

- 5) Existing and new projects must be implemented in the most efficient manner possible. The project and programme management phase takes responsibility for the execution of the projects in the portfolio. Although the actual implementation of projects falls outside the scope of this study, it is important to take note of the interfaces between the actual project planning and selection processes and the execution thereof. The successful implementation of the projects is also critical to their eventual success and hence their business value.
- 6) A management process that accepts overall responsibility for the project portfolio is also proposed, the main function being is to ensure that the promised business benefit is obtained from the project portfolio. This also implies that they take responsibility for the deliverables of the projects even after the actual projects have terminated. The deliverables of this management function differs from that of the project managers in that they are measured in terms of the business value that the organisation receives and not the traditional time and budget measurement criteria.
- 7) Several other processes exist to maintain the existing information technology infrastructure. They fulfil a very important supporting role in that projects in the portfolio depend on their existence. These processes also maintain the architecture models the organisation uses. Inputs from this supporting function are also very valuable in the whole portfolio selection process i.e. available network and server capacity, distribution of infrastructure, and costs associated with infrastructure usage.

Figure 5-5 provide an overview of the model described above. The detail working of the model is described in the next sections. The model is described in terms of the individual processes of each phase, the inputs required by the processes and their outputs.

Figure 5-5: Overview of integrated project portfolio selection model



### 5.3.2 Detailed model description

Each of the phases and functions that constitute this model is described in detail this section. Emphasis is placed on the inputs that particular phases require and their outputs because these are the linking pins that link the whole model. Each of the detailed actions is also described in brief. Supporting documentation in the rest of the study is also linked wherever possible.

#### 5.3.2.1 Business assessment

The business assessment phase is used to establish the business goals, objectives and shortcomings to identify the possible opportunities for information technology in the organisation. Although most of this phase falls outside the domain of information technology and therefore project selection, it is added to the study to link the project selection process to the business strategy formulation and to achieve business and information technology alignment. Figure 5-6 illustrates the basic working of this phase.

These processes take place at all levels of the organisation and should include information from the operational, tactical and strategic levels.

#### 5.3.2.1.1 Inputs

<b>The business scope</b>	The business scope is the definition of the business and the environment in which it operates. The importance of the business scope for information technology project selection lies in a better understanding of what the business aims to achieve. Information technology executives should therefore be in a better position to ascertain how they can best support the business.
<b>Assumptions and directives</b>	The information technology organisation exists to provide competitiveness to the rest of the business. Its direction, as a whole, needs to be in alignment with the needs and requirements of the greater business. It should therefore be anticipated that the strategic planning effort of the business, as a whole, would provide directives and assumptions to guide, prioritise, lead, and shape the information technology and systems planning effort. These directives and assumptions bound the strategies that are permissible for the information technology organisation to undertake, and, in so doing, help assure a strategic fit between the business and the information technology function.
<b>Future business scope and position</b>	The future business scope and position defines the desired future state of the business in terms of a new business scope and a new set of strategic positions. It is this new business scope and set of positions that are to be achieved during the strategic planning cycles. The intent is to move the business from its current scope and positions to a new scope and set of positions closer to the organisation's strategic intent.
<b>Technology drivers</b>	See section 5.3.2.2.5 for information on technology drivers.

#### 5.3.2.1.2 Situational analysis

<b>Purpose</b>	To developing conclusions about the state of the business.
<b>Description</b>	Situational analysis is the collection and analysis of information about the business, from both an internal and external perspective, for the purpose of developing conclusions about the state of the business. It is performed by applying a robust set of analytical methods that aid in structuring the process of insight and discovery. Situational analysis is both a data intensive and process intensive activity.
<b>Techniques</b>	Strengths/Weaknesses/Opportunity/Thread (SWOT) analysis, critical success factors (CSF), root cause analysis, matrix analysis, technology forecasting, scenarios, value chain analysis, benchmarking, competitor analysis, industry analysis and pivot position analysis (Boar, 1996:146; Thompson & Strickland, 1996:91; Porter, 1980:126).

#### 5.3.2.1.3 Strategy formulation

<b>Purpose</b>	Formulate plans to achieve the objectives of the business and provide guidance for project selection on how to optimally support these objectives.
<b>Description</b>	Strategy making brings into play the critical managerial issue of how to achieve the targeted results in the light of the organisation's situation and prospects. Objectives are the "ends," and strategy is the "means" of achieving them. In effect, strategy is the pattern of actions managers employ to achieve strategic and financial performance targets. The task of crafting a strategy starts with solid diagnosis of the company's internal and external situation. Only when armed with hard analysis of the big picture are managers prepared to devise a sound strategy to achieve targeted strategic and financial results. A company's strategy is typically a blend of (a) deliberate and purposeful actions and (b) as-needed reactions to unanticipated developments and fresh competitive pressures (Thompson & Strickland, 1996:6).
<b>Techniques</b>	Various in the strategy development domain.

#### 5.3.2.1.4 Identify business needs

<b>Purpose</b>	To identify the opportunities in the business for the implementation of information technology
<b>Description</b>	The business needs is a list of opportunities, business problems and strategic objectives that exist in the business. The business needs are on operational, tactical or strategic levels. By satisfying the business needs information technology might be used successfully to add value the business. The potential business benefit should also be identified and quantified wherever possible.
<b>Techniques</b>	Business process analysis and business process redesign.

#### 5.3.2.1.5 Outputs

<b>Strategic objectives</b>	Strategic objectives define specific measurable states to be accomplished. These objectives must be measurable, achievable, explicit, succinct and clear, dated, and consistent with all other objectives. The strategic objectives are used as a reference against which all-important information technology decisions are evaluated. It is also one of the cornerstones for alignment between information technology and the business.
<b>Business needs</b>	A list of user requirements/business needs that exist in the organisational. These business needs can be of an operational, tactical or strategic nature and should support the organisation's strategic objectives. The results from this process should include the potential business benefit from satisfying the need. The business needs are used for the following: <ul style="list-style-type: none"> <li>• as input to identify potential information technology projects,</li> </ul>

- a reference to check the developed system/application against the user needs – form of quality assurance, and
- in the management processes, to ensure that the actual business benefit is derived from the information system.

### 5.3.2.2 Technology assessment

The technology assessment phase brings the information technology part to the table. It is concerned with identifying, assessing and documenting the technologies in the industry that might be useful for the organisation. It also fulfils a governance role in the organisation in that new technologies are tested and approved before their introduction into the organisation. See Figure 5-6 for an overview of this phase.

#### 5.3.2.2.1 Inputs

<b>IT industry</b>	<p>An overview of the information technology industry may help the organisation to:</p> <ul style="list-style-type: none"> <li>• Identify promising new technologies that may provide competitive advantages.</li> <li>• Determine the expected life cycles of existing technology, prompting the organisation to swap or upgrade technology.</li> <li>• Identify technology drivers from the industry that may influence the organisation.</li> </ul>
<b>Strategic objectives</b>	<p>Strategic objectives are used to determine to what extent the possible solutions and scenarios support the strategic objectives of the organisation (<i>see section 5.3.2.1.5 for more detail</i>).</p>
<b>Business needs</b>	<p>The business needs are used as input in identifying potential information technologies (<i>see section 5.3.2.1.5 for more detail</i>).</p>
<b>Information technology architecture</b>	<p>Problems experienced in the existing solutions framework (or architecture) may be used to speed up the technology scanning process. Improvements to the current architecture can also be tested in proof of concept projects before actual implementation. If information technology architecture is unavailable or not applicable it will be designed later in the process and integrated in the current architecture lists (<i>see section 5.3.2.4.6 for more detail</i>).</p>
<b>Information technology infrastructure</b>	<p>An overview of the information technology infrastructure currently in use in the organisation in order to determine whether new versions of it are available that need to be repositioned (<i>see section 5.3.2.4.6 for more detail</i>).</p>

#### 5.3.2.2.2 Technology scanning

<b>Purpose</b>	Continuously scan the information technology industry for new technologies that might assist the organisation in achieving its strategic objectives.
<b>Description</b>	Scan the external information technology industry for technologies that might be used in the fulfilment of business needs. Significant new developments in the information technology industry should also be assessed to determine the possible impact thereof on the organisation. The current information technology used in the organisation should also be constantly assessed to determine its lifecycle and future. When a particular technology is phased out, its impact on the organisation must be determined and alternatives suggested. This function is the organisation's watchdog on the information technology industry.
<b>Techniques</b>	Technology forecasting, scenarios and various other techniques from the technology management domain.

#### 5.3.2.2.3 Proof of concept

<b>Purpose</b>	Prove the potential value of a new information technology to the organisation.
<b>Description</b>	Proving of concept projects is done to determine the actual usefulness of new technology. This is partly necessary because of the very short technology life cycles in the information technology industry and high failure rate of "bleeding edge" technology. New technologies are implemented in a small lab environment with real-life problems. Experiences with the implementation of the technology are recorded for future use. This function acts as the organisation's gatekeeper of new technologies in the organisation.

#### 5.3.2.2.4 Technology positioning

<b>Purpose</b>	Maintain a database of available information technologies and their potential business benefit.
<b>Description</b>	<p>Technology positioning is a process whereby a database is maintained of technologies that are implemented in the organisation or approved for implementation. The technology is described in the business context of its usage in the organisation. The positioning statement should include the following information:</p> <ul style="list-style-type: none"> <li>• A vendor analysis (financial strength, strategic positioning, competitors, growth potential, market share, R&amp;D investment, etc) should also be included in the positioning statement.</li> <li>• The cost of the technology.</li> <li>• The required infrastructure to support the technology.</li> <li>• Interfaces to other similar technologies e.g. protocols,</li> </ul>

operating systems, and messaging standards.

- Existing implementations of the technology in the organisation. This can be used as “reference sites” for new projects on actual experiences with the technology in the organisation.

The technology-positioning database contains valuable information on the actual and potential uses of information technologies in the organisation. This information will encourage the reuse of technology wherever possible.

#### 5.3.2.2.5 Outputs

<b>Technology drivers</b>	Significant technologies that might have an impact on the business. Used to identify new strategic opportunities and threats for the organisation.
<b>Statement of position</b>	<p>The positioning of a specific technology in terms of:</p> <ul style="list-style-type: none"> <li>• Its use in the organisation.</li> <li>• Business needs that can be satisfied by it.</li> <li>• Support requirements associated with it.</li> <li>• An analysis of the technology’s vendor and local support in terms of: financial strength, growth potential, market share, R&amp;D investment, etc).</li> <li>• The projected costs associated with the technology.</li> <li>• If available, the architectures associated with it.</li> </ul>
<b>Technology list</b>	<p>A database of available information technologies that can be used in formulation of business solutions. The following information regarding the technology should be kept:</p> <ul style="list-style-type: none"> <li>• Its statement of position.</li> <li>• Where the technology is actually used in the organisation. Can be used as internal reference sites, and to identify personnel with experience in the technology.</li> <li>• The real cost of ownership of the technology.</li> <li>• Actual vendor performance.</li> <li>• Technology risks and potential mitigation actions.</li> </ul> <p>The purpose of the technology lists is to encourage technology reuse by leveraging on current investments. It also serves as an organisational learning tool on the technology.</p>

#### 5.3.2.3 Scenario building

Business solutions to the needs of the organisation are formulated in this phase. The different business solutions are evaluated in the first of three decision making gates. Successful projects are then combined into different scenarios for re-evaluation in the second decision making gate.

Successful scenarios progress to the next phase where they are integrated into the existing project portfolio. Figure 5-7 illustrates the processes that constitute this phase of the project selection model.

#### 5.3.2.3.1 Inputs

<b>Business needs</b>	The business needs are used as an input in identifying potential information technology projects. The potential business benefits for satisfying the need are also used in the assessment phases to determine the viability of the potential project ( <i>see section 5.3.2.1.5 for more detail</i> ).
<b>Technology list</b>	The potential information technologies that might be used to resolve the business need are obtained from the technology databases. Other implementations of similar technology in the organisation can also be used to verify its usefulness ( <i>see sections 5.3.2.2.5, 5.3.2.4.6 and 5.3.2.5.4 for more detail</i> ).
<b>Information technology architecture</b>	The solution framework (or architecture) of current projects is used as an input into the solution design process. This will speed up the process if similar projects were done in the organisation in the past. If information technology architecture is unavailable or not applicable it will be designed later in the process and integrated in the current architecture lists ( <i>see section 5.3.2.4.6 for more detail</i> ).
<b>Information technology infrastructure</b>	An overview of the information technology infrastructure to determine whether it can support the proposed solution. The costs of any infrastructure upgrading or replacement should be included in the costing of the solution ( <i>see section 5.3.2.4.6 for more detail</i> ).
<b>Strategic objectives</b>	Strategic objectives are used to determine to what extent the possible solutions and scenarios support the strategic objectives of the organisation ( <i>see section 5.3.2.4.6 for more detail</i> ).
<b>Organisational infrastructure</b>	An overview of the organisational infrastructure (administrative structure, critical business processes, organisational value systems, and the of human resource skills), used to determine the impact of a potential solution on the organisation, and whether the organisation can support the particular solution.
<b>Current projects and programmes</b>	Current projects using similar technology or addressing similar organisational needs that may be leveraged in the particular solution ( <i>see section 5.3.2.5.4 for more detail</i> ).

#### 5.3.2.3.2 Develop alternative solutions

<b>Purpose</b>	To compose different technical alternatives for a business need.
<b>Description</b>	This is the first step that actually attempts to solve a business need with information technology. The solution definition must be done on a very high level with just enough information for the evaluation at the first gate. The exact level of detail will depend on the organisation and the evaluation criteria at the first gate. Multiple solutions should be developed wherever possible. Existing

	solutions in the organisation must also be considered and wherever possible incorporated in the proposed solutions. Another source of potential solutions is the current project portfolio. The solutions should also comply with the existing architectural framework. If a framework does not exist, a new one will be developed based on the design that is approved.
<b>Techniques</b>	High-level systems design.

#### 5.3.2.3.3 High-level impact assessment

<b>Purpose</b>	The first filter to remove unviable technical alternatives.
<b>Description</b>	The high-level impact assessment is the first gate or filter to evaluate proposed business solutions. Individual proposals are evaluated against a fixed set of criteria. The criteria in section 4.2.1 may be used for the evaluation. This assessment helps reduce the number of potential projects to be considered in the selection process, thereby reducing workload and information overload problems. However, interdependence of projects, and whether or not projects are mandatory would need to be identified first.

#### 5.3.2.3.4 Develop information technology scenarios

<b>Purpose</b>	Build “solution packages” or scenarios
<b>Description</b>	<p>Scenarios of the different combinations of business needs/technology solutions are built by grouping related business needs together. The different technical solutions included in the scenario must be mutually exclusive. Risk profiles for the scenario are then built, using the sequencing of projects to mitigate or lower the risk profiles if possible (<i>see section 3.2.3 for techniques on project risk assessment</i>). This is then followed by the development of value profiles for the projects in the scenario (<i>see sections 4.2.1, 4.2.2 and 4.3 for more information on how to judge and quantify the potential value of information technology projects</i>).</p> <p>For a scenario to be valid.</p> <ul style="list-style-type: none"> <li>• It must not contain mutually exclusive business solutions.</li> <li>• All dependencies must be resolved.</li> <li>• It must contain one or more business solutions.</li> <li>• It must support an organisation’s strategic objectives.</li> </ul> <p>Scenarios differ from each other in terms of:</p> <ul style="list-style-type: none"> <li>• the composition of the different business solutions;</li> <li>• timing of each individual project;</li> <li>• sequencing or order in which the projects are executed; and</li> <li>• technologies used to solve the different business needs.</li> </ul>

5.3.2.3.5 Detailed impact assessment

<b>Purpose</b>	Second filter to remove unviable scenarios
<b>Description</b>	<p>The detailed impact assessment is the last step in the scenario building phase and acts as a filter for non-viable scenarios. Different scenarios are compared to each other in a very similar manner as in gate one. The main difference is that whole scenarios are compared and not individual projects. The information used in the comparison is basically the same as in the high-level impact assessment. The main difference is that interaction between different projects, such as shared resources and synergy between projects, is also considered and quantified. Special attention to the following is necessary as the information is needed in various other steps:</p> <ul style="list-style-type: none"> <li>• Risk assessment (<i>see section 3.2.3 for a detailed discussion on project risk assessment</i>).</li> <li>• Value calculations (<i>see section 4.2.3 for a roadmap on the evaluation of an information technology investment</i>). The value can also be described in terms of the different types/classes of value (<i>section 4.2.1 describe several classes of information value</i>).</li> <li>• Resource usage projections.</li> </ul>

5.3.2.3.6 Outputs

<b>Possible IT scenarios</b>	<p>A list of the viable information technology scenarios that promise a sufficient return, given the risk profile. These scenarios form the basis of evaluation and possible integration in the organisation's portfolio of information technology projects. A scenario typically contains the following information:</p> <ul style="list-style-type: none"> <li>• The business needs/requirements to be solved and how (which technology).</li> <li>• The sequence in which the needs are to be solved.</li> <li>• The resources required to successfully complete the projects in terms of manpower, technology, finances, organisational changes required and information technology infrastructure.</li> <li>• The risk profiles of each individual project.</li> <li>• The value that each project will add to the organisation.</li> </ul>
<b>Risk profiles</b>	<p>The risk profiles of each individual project. The risk profiles should include the following:</p> <ul style="list-style-type: none"> <li>• Stakeholder risk tolerances.</li> <li>• Sources of risk.</li> <li>• Potential risk events.</li> <li>• Impact assessment if the risk realises.</li> </ul>

<b>Value profiles</b>	<ul style="list-style-type: none"> <li>• Possible preventative actions.</li> </ul> <p>The risk profiles are used to:</p> <ul style="list-style-type: none"> <li>• evaluate the proposed projects;</li> <li>• provide inputs to the project management teams on the management of a particular project's risk; and</li> <li>• ensure the potential value from information projects actually realised.</li> </ul> <p>The potential value/benefit that is to be derived from the implementation of the individual projects. These profiles are used:</p> <ul style="list-style-type: none"> <li>• in the further evaluation of the projects; and</li> <li>• as inputs to the overall management process to ensure the actual value is realised from information technology investments.</li> </ul>
<b>Resource profiles</b>	<p>The resource requirements of the projects in terms of type, number and timeframe. Project managers and decision makers use these profiles to assist them to optimise the actual usage of the resources.</p>

#### 5.3.2.4 Scenario integration

In this phase the impact of the different scenarios on the existing project portfolio is evaluated. The optimal scenario, given the existing project portfolio, is integrated into the project portfolio and the new portfolio optimised. This phase also determines changes to the organisation that are required to enhance or ensure the benefits from the project portfolio. See Figure 5-8 for an overview of this phase.

##### 5.3.2.4.1 Inputs

<b>Possible IT scenarios</b>	<p>The different information technology scenarios that should be considered for the overall portfolio (<i>see section 5.3.2.3.6 for more information</i>).</p>
<b>Risk profiles</b>	<p>The risk profiles that needs to be considered for new projects in the project portfolio (<i>see section 5.3.2.3.6 for more information</i>).</p>
<b>Value profiles</b>	<p>The potential value of new information technology project (<i>see section 5.3.2.3.6 for more information</i>).</p>
<b>Resource profiles</b>	<p>The resources required to execute the information technology projects (<i>see section 5.3.2.3.6 for more information</i>).</p>
<b>Current projects &amp; programmes</b>	<p>A list of the current information projects and programmes. The purpose of the list is to consider all the integration issues of new projects into the current list of projects (<i>see section 5.3.2.5.4 for more information</i>).</p>
<b>Resource availability</b>	<p>A list of the available resources for the implementation of the selected information technology projects. The costs associated with the usage of the resources.</p>

<b>Organisational infrastructure</b>	An overview of the organisational infrastructure ( <i>see section 5.3.2.3.1 for more information</i> ).
<b>Information technology architecture</b>	The solution framework (or architecture) of current projects is used as an input into the update information technology architecture process. Any changes to the architecture to accommodate any new projects are incorporated into the current architecture ( <i>see section 5.3.2.4.6 for more detail</i> ).

#### 5.3.2.4.2 Introduce scenario into current portfolio

<b>Purpose</b>	To consider the effect of each scenario on the existing project portfolio.
<b>Description</b>	Combine each of the scenarios and the current project portfolio in a manner that selects a portfolio, based on the objectives of the organisation. This could involve extensive interaction with decision makers in comparing potential projects on a number of objectives, or it could involve little direct intervention if an optimisation technique such as 0-1 integer linear programming were used. The output of this stage would be a preliminary ranking of the projects, based on the objective(s) specified for the portfolio, and an initial allocation of resources up to the maximum available.

#### 5.3.2.4.3 Portfolio balancing & adjustment

<b>Purpose</b>	The final and optimum project portfolio is selected.
<b>Description</b>	<p>At this stage decision makers apply judgment to make the final adjustments to the portfolio. The decision support display would be in the form of one or more portfolio matrices, which would display graphically the critical decision variables selected by the organisation for this purpose. Any interactions among the projects, such as interdependence and mutual exclusivity, have already been taken into account in previous activities and could be displayed during this stage upon request.</p> <p>Portfolio balancing is a judgment problem that requires feedback to the decision maker(s) on the consequences of making deletions and/or additions at this point. Data on this would come from sensitivity calculations, using the same model applied in the portfolio selection process and the risk and value profiles.</p> <p>Existing non-performing projects are also terminated and removed from the portfolio</p>
<b>Techniques</b>	See section 3.2.2.1 for project portfolio evaluation, selection & optimisation techniques.

#### 5.3.2.4.4 Change management planning

<b>Purpose</b>	Identify and plan any changes to the organisation itself to accommodate the new technology.
<b>Description</b>	Information technology can only deliver its full potential if it is accepted by the organisation and actually changes user behaviour. The acceptance of the technology in the workplace is too often automatic. This however is not always the case and the resistance from the user community is one of the bigger risks for the successful implementation of information technology ( <i>see section 3.2.3.3.2</i> ). The user expectations must therefore be actively managed and hence the need for change management planning.

#### 5.3.2.4.5 Update information technology architecture

<b>Purpose</b>	The organisation's architectural frameworks should be updated to reflect the new solutions in the project portfolio.
<b>Description</b>	The architecture frameworks form the basis of new technology solutions to be developed. Work done on the development of solutions can therefore be reused in the organisation if it is captured in the organisation's architectural framework.
<b>Techniques</b>	(See section 4.5 for a detailed discussion on the formulation of information architectures).

#### 5.3.2.4.6 Outputs

<b>Information technology infrastructure</b>	Any updates of the organisation's information technology infrastructure that are required to support the implementation and operation of the information technology projects. Any potential infrastructure capacity issues should also be identified and corrective actions initiated.
<b>New projects &amp; programmes</b>	The list of new projects that should be added to the existing project portfolio.
<b>Change management plans</b>	Projects that might be needed to change the organisation's infrastructure to enhance the usage of the new information technologies introduced into the organisation.
<b>Information technology architecture</b>	A description of the information technology deployed in the organisation according to an architectural framework ( <i>see sections 4.5.1 and 4.5.2</i> ). Any changes to the existing architecture to accommodate new projects should also be applied at this stage.

#### 5.3.2.5 Project and programme execution

The project and execution phase focuses on the successful implementation of the projects in the project portfolio. Established project management methodologies exist to manage information

technology projects and will therefore not be discussed in detail in this study. See Figure 5-9 for an overview of the interfaces to and from the project and programme execution phase.

#### 5.3.2.5.1 Inputs

<b>Risk profiles</b>	The risks, risk events, risk mitigation steps, triggers and responsible personnel that can be used by the project management to manage the risks associated with the selected projects ( <i>see section 5.3.2.3.6 for more information</i> ).
<b>Resource profiles</b>	The resources required to execute the information technology projects ( <i>see section 5.3.2.3.6 for more information</i> ).
<b>Current projects &amp; programmes</b>	A list of the current information projects and programmes. The purpose of the list is to manage all the integration issues of new projects into the current list of projects ( <i>see section 5.3.2.5.4 for more information</i> ).
<b>Resource availability</b>	A list of the available resources for the implementation of the selected information technology projects.
<b>Business needs</b>	The business needs are used to ensure that the implemented information technologies actually solve the business needs which originated the particular project/s ( <i>see section 5.3.2.1.5 for more detail</i> ).
<b>New projects &amp; programmes</b>	A list of the new information projects and programmes that should be implemented.
<b>Corrective actions</b>	Any corrective action required to ensure the successful implementation of the projects under management ( <i>see section 5.3.2.6.3 for more detail</i> ).
<b>Change management plans</b>	Projects that might be needed to change the organisation's infrastructure to enhance the usage of the new information technology that is introduced into the organisation.
<b>Project status</b>	Status and progress reporting by the project management teams. It is used as feedback to the user community regarding the projects. The information is also used to oversee and coordinate all the different information technology projects.

#### 5.3.2.5.2 Information technology project management

<b>Purpose</b>	To manage the execution of the projects in the project portfolio to successful conclusion.
<b>Description</b>	The projects contained in the project portfolio must be implemented by the project organisation. The normal project management methodologies should be used. Risk profiles developed earlier should be used to reduce the overall risk of the implemented projects.

### 5.3.2.5.3 Organisational change projects

<b>Purpose</b>	To manage the organisational change projects.
<b>Description</b>	See section 5.3.2.4.4.

### 5.3.2.5.4 Outputs

<b>Project status</b>	Status and progress reporting by the project management teams. It is used as feedback to the user community regarding the projects. The information is also used to oversee and coordinate all the different information technology projects.
<b>Current projects &amp; programmes</b>	A list of the current projects in the project portfolio.

### 5.3.2.6 Process management

The process management function oversees the whole portfolio selection and implementation process. It also assumes responsibility for the delivery of the proposed benefits from the projects in the portfolio. The reasoning behind this is that the actual value from a particular project manifests after the actual completion of that project. This function also plays a coordinating role between the projects in the current project portfolio. The process management function is illustrated in Figure 5-10.

#### 5.3.2.6.1 Inputs

<b>Risk profiles</b>	The risks, risk events, risk mitigation steps, triggers and responsible personnel that can be used to identify potential problems associated with information projects being implemented ( <i>see section 5.3.2.3.6 for more information</i> ).
<b>Value profiles</b>	The potential value of new information technology project ( <i>see section 5.3.2.3.6 for more information</i> ).
<b>Resource profiles</b>	The resources required to execute the information technology projects ( <i>see section 5.3.2.3.6 for more information</i> ).
<b>Current projects &amp; programmes</b>	A list of the current information projects and programmes. The purpose of the list is to ensure that all the integration issues of new projects into the current list of projects are managed ( <i>see section 5.3.2.5.4 for more information</i> ).
<b>Business needs</b>	The business needs are used to ensure that the implemented information technologies actually solve the business need that originated the particular project/s ( <i>see section 5.3.2.1.5 for more detail</i> ).
<b>Change management plans</b>	Monitor the success for the change management programmes to ensure that the organisation uses the new technology/systems.

<b>Strategic objectives</b>	Strategic objectives to ensure that deployed information technology projects support the organisational objectives ( <i>see section 5.3.2.4.6 for more detail</i> ).
<b>Project status</b>	Status and progress reporting by the project management teams. It is used as feedback to the user community regarding the projects. The information is also used to oversee and coordinate all the different information technology projects.

#### 5.3.2.6.2 Information process management

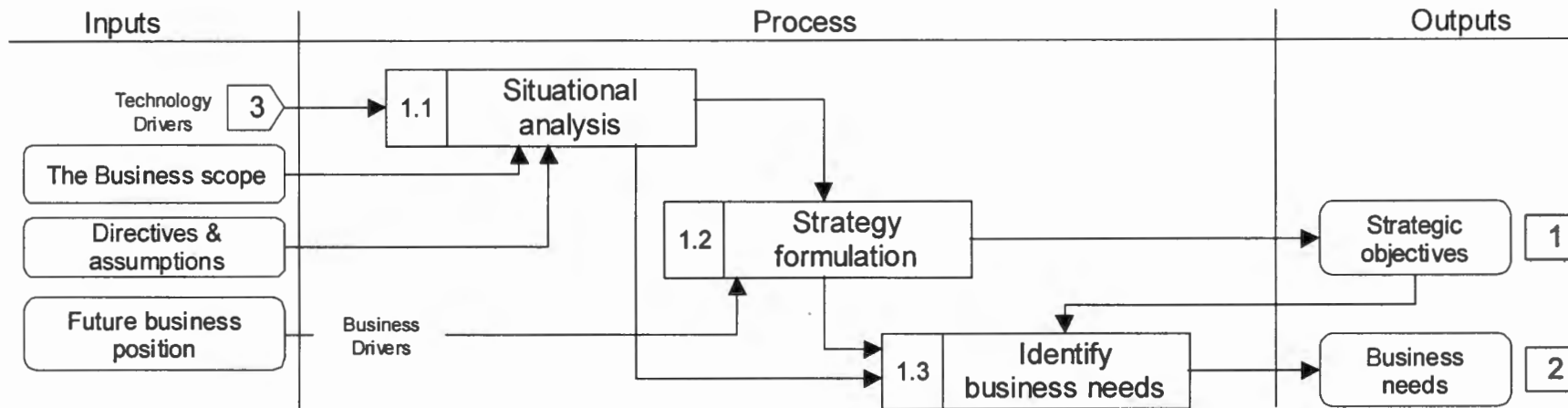
<b>Purpose</b>	To ensure that the promised business value of the information technology projects are realised.
<b>Description</b>	<p>The main use of this function is to insure that the promised business benefits are obtained from the project portfolio. This is a critical function for the successful implementation of the project portfolio. The information process management is a shared responsibility between the information technology organisation and the business owners of the projects. Main activities include, among others, the following:</p> <ul style="list-style-type: none"> <li>• Coordinates all the different projects.</li> <li>• Resolves inter-project conflict.</li> <li>• Manages the allocation of resources between different projects.</li> <li>• Initiates corrective actions when necessary.</li> <li>• Manages the products of the projects after successful implementation through their life-cycles.</li> <li>• Responsible for the alignment between business and information technology.</li> </ul> <p>Performance of the function is measured in terms of the business benefit and not project performance.</p>

#### 5.3.2.6.3 Outputs

<b>Corrective actions</b>	Any corrective action required to ensure the successful implementation of the projects under management. This could be the result of misalignment between project deliverables and organisational objectives, problems with the organisational and/or information technology infrastructures, insufficient capacity, etc.
---------------------------	---

Figure 5-6: Business and technology assessment phases.

### 1. Business Assessment



### 2. Technology Assessment

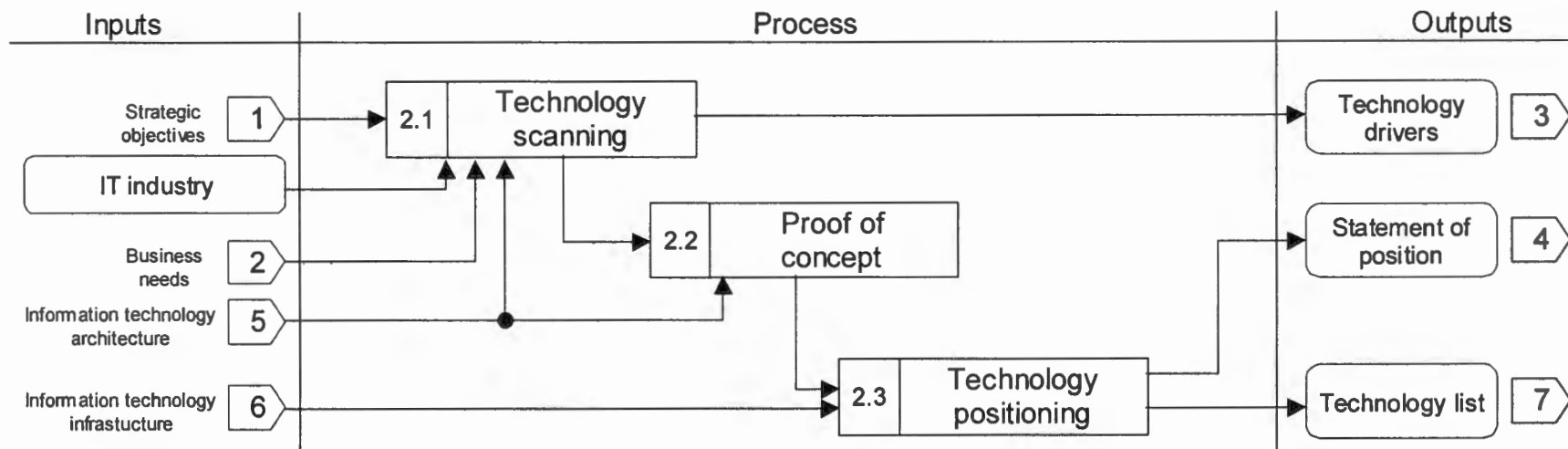


Figure 5-7: Scenario building phase.

### 3. Scenario building

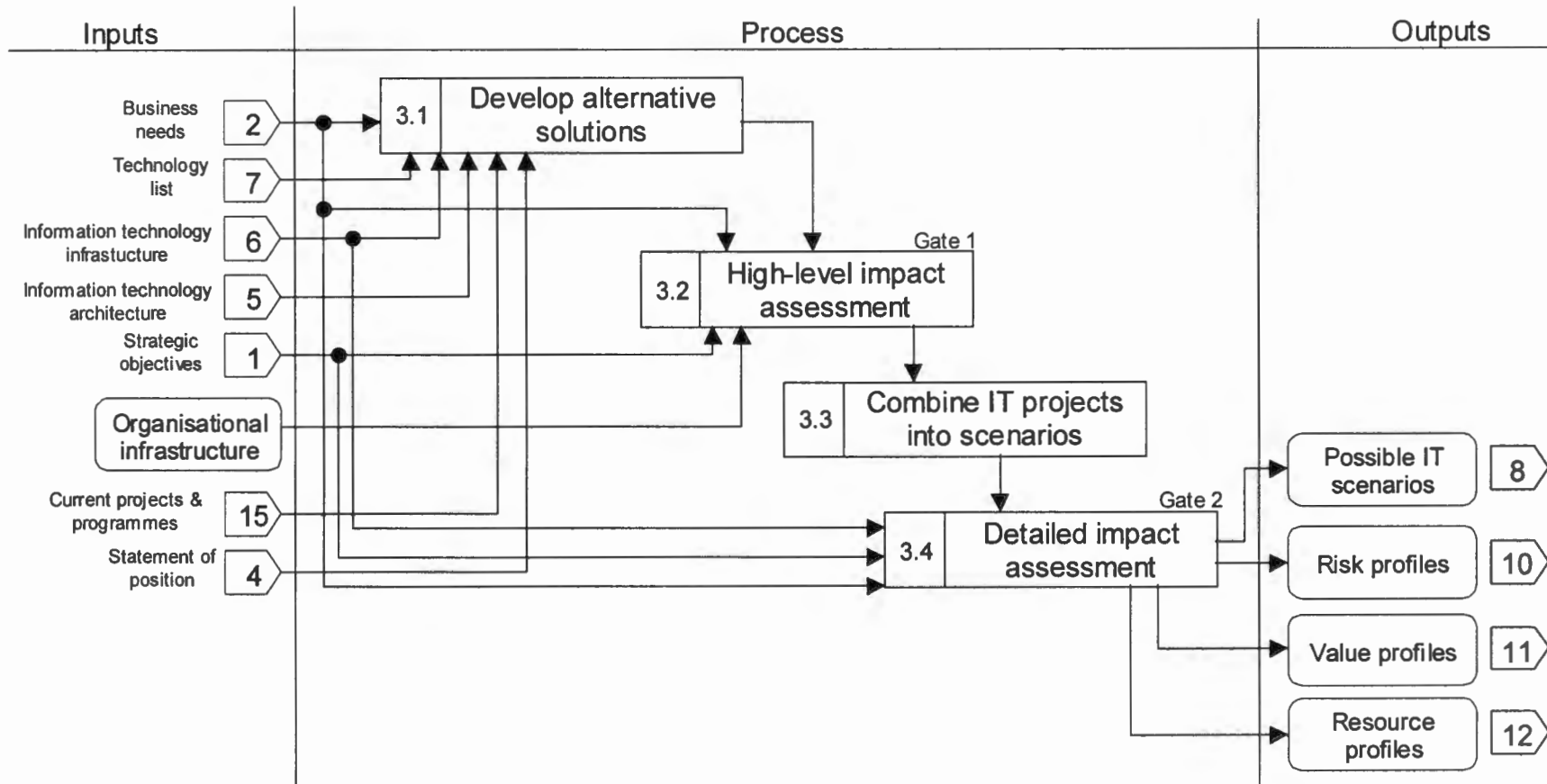


Figure 5-8: Scenario integration phase.

#### 4. Scenario Integration

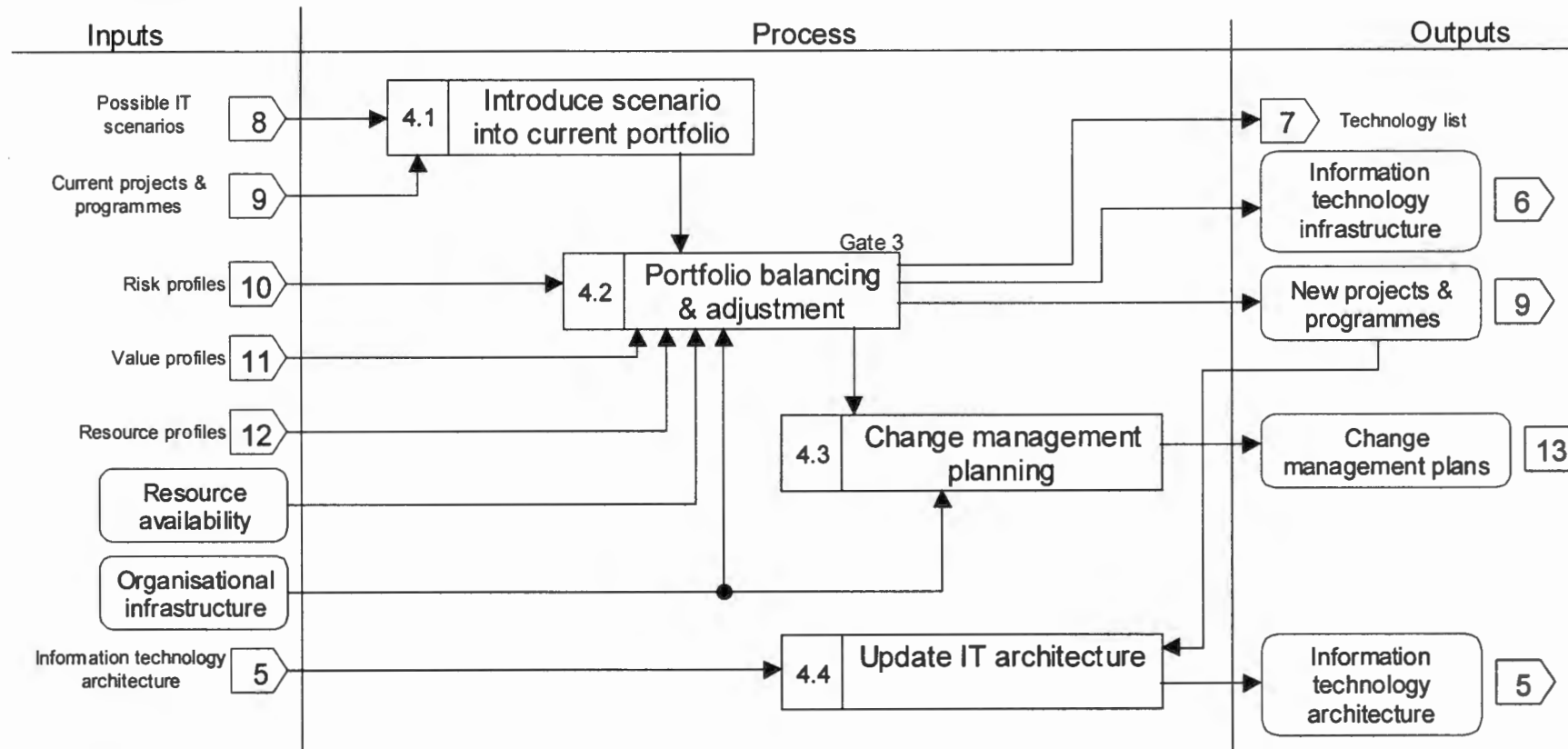


Figure 5-9: Project & programme execution phase.

5. Project & programme execution

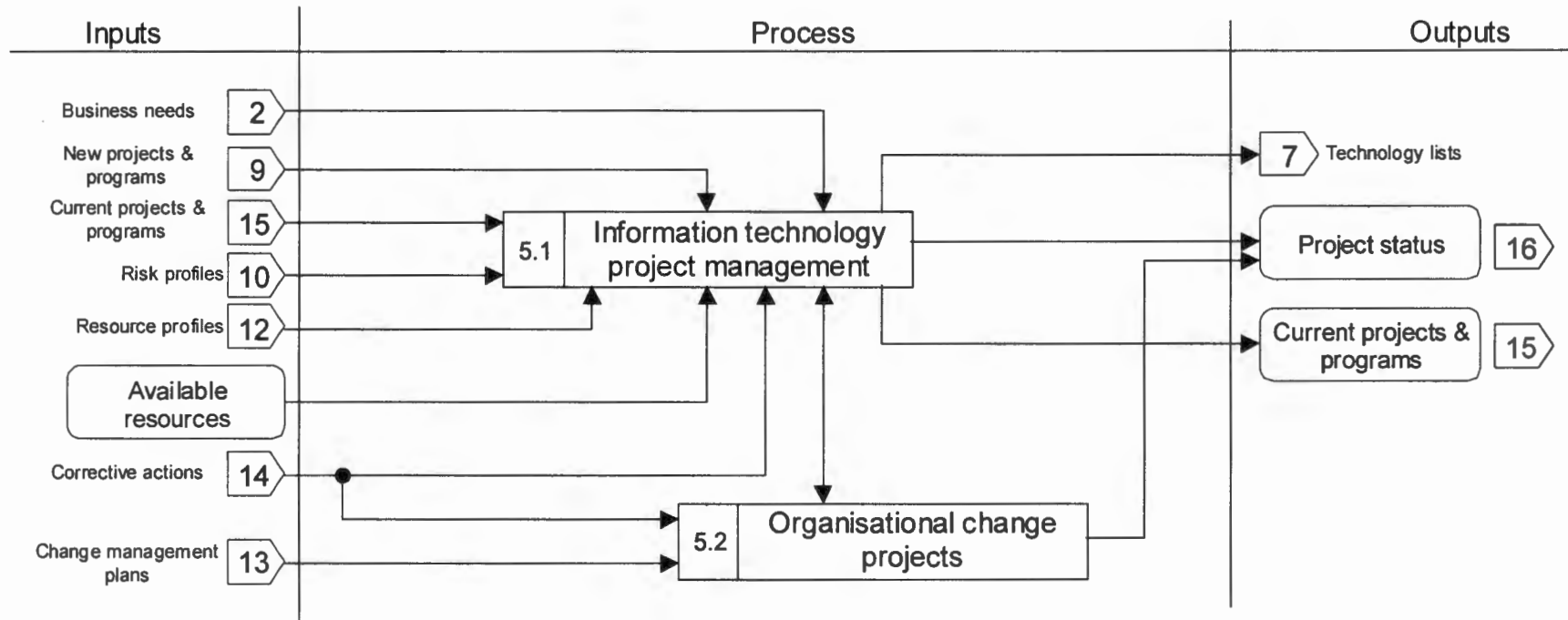
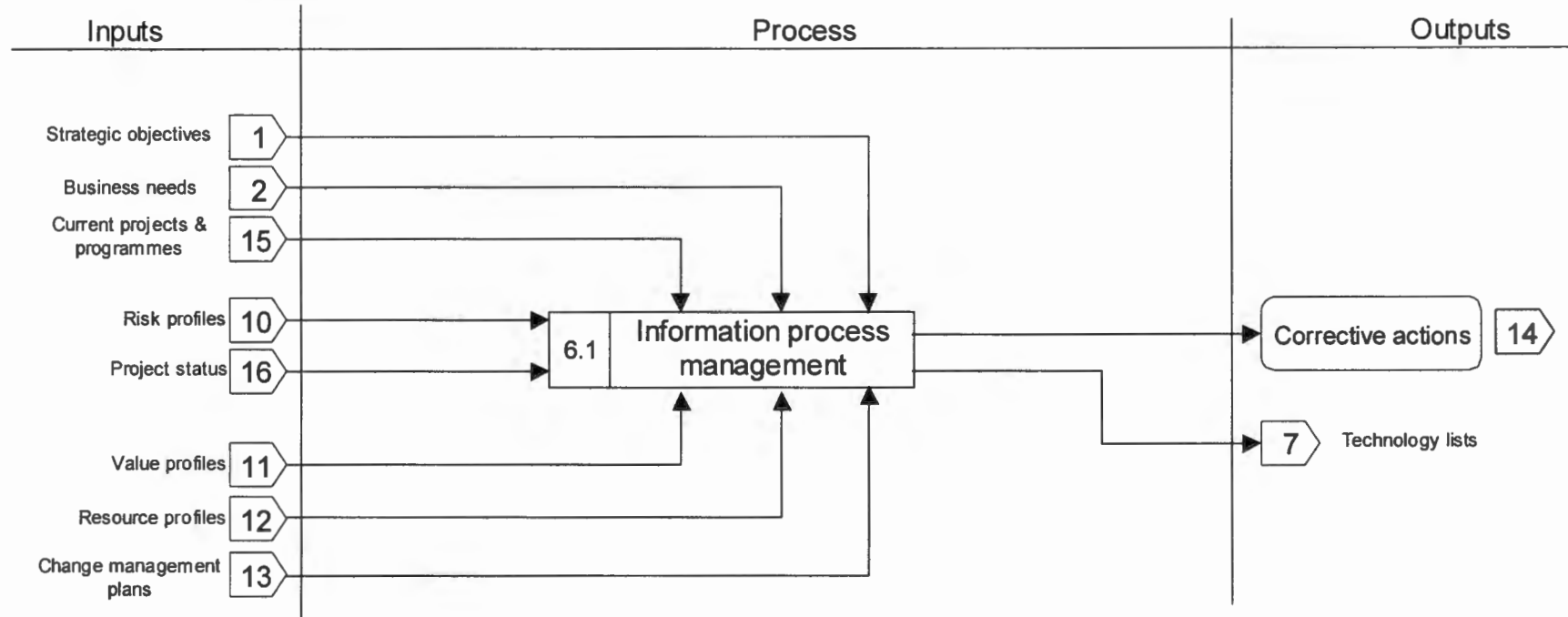


Figure 5-10: Process management phase.

## 6. Process management



### 5.3.3 Advantages

Several important advantages of this project selection model over traditional methods include the following:

- The organisation has a long-term pool of approved information technology projects that are validated, approved, integrated, and optimised. The projects can be executed as the necessary resources become available.
- The organisation has a holistic view of completed, current and potential information technology projects.
- The maximum synergies between projects are obtained.
- The organisation has a long-term view of the required resources necessary to support its information technology environment.
- The potential value from information technology is actively managed even after the project is finalised.
- Technology and solution reuse throughout the organisation is maximised, giving better economies of scale and scope.
- Sound business cases for the projects are developed as the project progresses through the model.
- The projects are selected in an open and transparent process, thereby increasing the buy in from the users and their management.

### 5.3.4 How does this model differ from other project selection techniques?

This project selection model differs from the traditional project selection techniques in the following ways:

- A particular solution is evaluated in the context that it will be used, with all the existing projects and past projects.
- A management function is created that will manage the results of the project (even after the project completion) to ensure that the promised benefits are realised.

- All related projects are combined and evaluated as a whole, optimising the combined project list.
- Previous business solutions are used as “templates” for new projects. This has the effect that the best practices of the past are automatically incorporated in new designs.
- The organisation’s strategic objectives are used at all decision points, ensuring alignment between the business strategy and the information technology project portfolio.

### 5.3.5 Implementation of the project portfolio selection model

This project selection model should be implemented as a management framework for information technology in an organisation with shared responsibility between the information technology group and the line-management of the organisation. The responsibility for information technology projects should also be shared by both parties, the information technology function and line management. One of the cornerstones for the successful implementation of the model is a strong information technology governance structure in the organisation. If the users are allowed, “to do their own thing” the model will most probably not succeed.

The exact portfolio evaluation techniques used in the model depends on the organisation and the information available. The techniques described in section 3.2.2.1 can be used as a guideline on the techniques available.

The implementation of this decision making model is not a single event but a continuous decision making cycle. The activities up to the first decision gate are not time dependant and can be executed whenever the need arises. The steps after the first gate can only be executed optimally if related projects are grouped together. This may make it necessary to execute the steps between gates one and three once per quarter. Because projects are selected in batches the timing problem is solved, because there should always be projects in waiting from previous batches. Critical new projects should be fast-tracked through the process if required.

## 5.4 Summary

Because information technology impacts on every aspect of the organisation, the selection of information technology projects will also have an impact on the whole organisation, either through the consumption of resources or the effect of the information systems on the business

performance. The selection of the most appropriate information technology projects is therefore a process that must be managed carefully and in consultation with the rest of the organisation.

The project selection process is also closely linked to the business planning-cycles where new strategic objectives are set and current objectives revisited. Any changes in the organisation's objectives and goals must also be reflected in the project selection processes as soon as possible.

The business and information technology functions must take shared responsibility in ensuring that information technology projects succeed. The information technology function must ensure that the project is completed within a predefined performance framework. The business on the other hand must ensure that the information systems are used to their fullest extent. Any slip-ups might be interpreted as a failure of the information technology project.

To ensure that the information systems deliver the maximum benefit possible to the organisation, both the information technology project and the resulting information system must be managed throughout its full life cycle.

The developed project portfolio selection model attempted to combine the different perspectives on project management into a management framework that best supports the objectives of this study.

# CHAPTER 6

## CONSOLIDATION AND RECOMMENDATIONS

### 6.1 Introduction

Chapter 4 dealt mainly with the role that project management plays in the information technology organisation. The topics discussed include a general overview of project management; the unique challenges of information technology to the project manager; how project portfolios are composed and managed and how the potential risk associated with projects is assessed and managed.

The discussions on project management in chapter 4 only focused on the initial phases of the project in an effort to learn enough of the project to assess the benefits that may result from it, the costs associated with it, and the risks that the organisation will incur in starting the project.

Chapter 5 dealt with the role of information technology in the organisation. Emphasis was placed on the techniques used to quantify the value and benefit of information technology. These techniques will be used to evaluate information technology projects in terms of their business value. Thereafter the total lifecycle costs of information were discussed using the concepts of “Total Cost of Ownership” and “Total Value of Ownership”.

The issues surrounding business and information technology alignment were also discussed in chapter 5. The process is important for this study in that effective alignment ensures that the business and the information technology organisation pursue the same strategies, goals and objectives. Without alignment between business and information technology each party pursues its own agenda, normally at the cost of the organisation. The last section of this chapter describes an architectural framework which an organisation can use to document and manage the diversity of current and future information technology investments.

Chapter 6 is devoted to the actual formulation of the project portfolio selection model. This chapter will start off with a short overview of existing project selection models that will form the basis of the eventual project portfolio management model. Thereafter the new project portfolio management model is described in various levels of detail and illustrated whenever possible. Chapter 6 ends with a discussion of the benefits of the model and an overview of the implementation issues involved.

## 6.2 Study consolidation

The study consolidation section will capture the major learning points from the different themes explored in this study.

### 6.2.1 Project portfolios

Project portfolios are a group of projects/programmes that are carried out under the sponsorship of an organisation. These projects must compete for scarce resources available from the project sponsor, since it is rare that there are enough resources to carry out every project that may be proposed and which meets the organisation's minimum requirements. Project portfolios exist in any organisation and should be managed like any stock portfolio to reduce the organisation's exposure to unnecessary high levels of risk, while at the same time maximising the possible return or value from the projects undertaken.

It is not uncommon for organisations to have projects in their portfolio that have conflicting objectives, or are almost exact duplicates of each other. The number of variables and projects that must be considered in the portfolios is very high. In order to implement any portfolio management technique meaningfully every attempt must be made to reduce the number of alternatives beforehand.

Many articles and books have been published on the subject of project evaluation and selection. It appears possible to classify these techniques into two primary categories, namely (a) benefit measurement techniques and (b) project selection/resource allocation techniques. The first category tends to deal more with the evaluation of individual projects on some basis (economic or otherwise), while the second deals with the development of project portfolios based on known evaluations of candidate projects.

### 6.2.2 Project risk assessment

Project risk is the measurement of the probability and consequences of not achieving a defined project goal. Risk assessment provides a formalisation and structure for selecting strategy alternatives and should be a major element in the decision making process.

Information technology projects have one of the worst track records in the industry. Studies suggest that about 25% of projects initiated to develop large scale systems are abandoned, 75% of those that are operational either are not used or do not perform as intended, and the average software development project exceeds its schedule by 50%.

The ultimate purpose of risk management is risk mitigation, which is the act of reversing a project's schedule, budget and scope or quality so that uncertainties are reduced without any significant impact on the objectives.

A proper risk assessment and risk management plan provides the organisation with the opportunity to mitigate the risks associated with a particular project, thereby enhancing the chances of completing it successfully so that it delivers the value it is intended to deliver. This is fairly important, as information technology projects are notorious for their very high project failure rates.

### 6.2.3 Information technology benefits and risks

Information technology does not operate in a vacuum, and must support the business. In most non-information related industries the only way information technology can add value to the organisation is through the support, enhancement and enablement of the business funding its existence. It is therefore important to position the information technology projects in such a manner that they can optimally support the business and are aligned with the business strategies, goals, and objectives.

However, measuring information technology investment is difficult. This is because most information technology benefits are qualitative, indirect and diffuse. In addition, many of the impacts that information technology creates are "ripple effects" in areas inside and outside an organisation which makes the evaluation process even more complex.

In general, the benefits of information technology investments can be classified into six broad classes, the purpose of which is to: provide an adequate return on investment, support the strategic initiatives of the organisation, facilitate the creation of a competitive advantage, support managerial decision making, act as a competitive response, and provide a good framework for business strategic information system architecture. The following sections briefly define these six broad classes. Each category has particular characteristics that have a bearing on the measurement of value.

### 6.2.4 Strategic alignment

Proper alignment between information technology and the business is critical in determining how the business will perceive information technology and to what extent the technology adds value to the business. The "Strategic Alignment Model" provides an overview of the complexities

involved in the alignment of information technology and business. Several different perspectives or philosophies exist in the strategic alignment field depending on the organisation's market, strategies and operating environment.

Successful alignment can be accomplished via coordination of strategic objectives with a number of key components: resources, management processes, decision making mechanisms, performance measurement, rewards, and incentives. Measures of alignment will differ, depending on the size and growth phase of the business and the sector in which it operates.

The information technology project portfolio to a large extent determines the information technology applications and infrastructure that an organisation will use. It should therefore strive to maximise the information technology value and business alignment derived from individual projects.

#### 6.2.5 Information technology architecture

Architecture development is a relatively new technique used to create some form of order in the chaos of real life information technology. Architecture achieves this through the establishment of "frameworks" that should guide and govern the implementation of information technology.

Enterprise architecture planning differs from traditional systems planning in scope and purpose. Many companies develop systems to meet the specific business needs in one area. Unfortunately, this creates a legacy of systems that do not interoperate. These "silos," or vertical solutions, and their associated architectures often duplicate efforts, deploying the same functionality and information differently.

Also, since enterprise architecture planning attempts to tie the information technology strategy tightly to business objectives, it avoids a common situation in traditional systems planning where each application must justify each part of its infrastructure – people and skills, new or modified processes and technology.

#### 6.2.6 Project selection model

Several project portfolio selection models are proposed by authors like Boar (1993:3), Kerzner (1997:83), and Archer and Ghasemzadeh (1996:32). Common themes from the proposed project selection models include:

- The use of multiple decision making gates to filter the number of potential projects as the level of detail increases;
- a strong linkage between the organisational planning functions/roles and those of project selection;
- the development of more than one alternative solution to a specific business need;
- the use of a predefined selection criteria to weight and score the alternatives; and
- the balancing of the portfolio to optimise the usage of resources.

The following concepts were incorporated in the project portfolio selection model in chapter 5 so as to ensure that the objectives of the study are realised:

- organisational learning between different projects;
- information system reuse between projects is maximised;
- the management of projects and the business solutions through their entire life-cycle to ensure that business solutions are utilized to their full potential;
- control over the introduction of new technologies into the organisation; and
- evaluation on a continuous basis of the impact of a particular project on the other projects in the portfolio.

It is proposed that the project selection model developed in this study be implemented by incorporating it as a management framework in an organisation's current information management system. This will ensure uniform implementation of the model and also that it is supported by the necessary governance structures.

### 6.3 Recommendations

The results of this study should be incorporated in the current Sasol information management processes. By using the model in chapter 5, Sasol will enhance the value of information technology and systems to the Sasol group.

For this model to be successful, information technology managers must have a holistic view of information technology, its potential value to the organisation, its costs, its impact on the business

and, conversely, the impact of the business on information technology. This project selection model is not a single event but forms part of a continuous decision making cycle. To implement the model the following actions could be considered:

- The incorporation of the model in the existing information management processes of Sasol as it will provide a solid base for its implementation;
- an organisation change programme must be defined and executed to manage the implementation;
- the development of detailed standardised project evaluation and selection models in the Sasol group;
- information technology and system registers must be instituted and maintained to share knowledge on previous implementations of technologies or systems;
- create an environment conducive to successful project management, strategic alignment and information management;
- standardise the business process in Sasol because it is one of the biggest sources of diversity in the Sasol group; and
- fast-track critical new projects through the process if required.

#### 6.4 Attaining of objectives

The purpose of this study was to develop a project portfolio selection model that will help Sasol's Group information and logistics division to select an optimal project portfolio that will maximise the return on its investment in information technology.

A detailed literature study (chapters 3 and 4) was carried out in order to establish the most significant factors that influence the success of information technology in the organisation and the techniques used to evaluate projects and then integrate them into a project portfolio. Based on the results from the literature study a model was developed (chapter 5) which can be used to formulate and maintain an organisation's information technology project portfolio.

Given the results of this study it is considered that the main and sub-objectives as set out in section 1.3 of this study have been achieved.

## 6.5 Further study or research

Future research on the actual implementation of the project portfolio selection model could be considered. Examples of potential future research include the following:

- The critical success factors in the implementation of the model.
- Organisational environmental factors that may influence the implementation of the model.
- The performance criteria that can be applied to evaluate the performance of the model.

## 6.6 Summary

The main purpose of this study was the development of “an integrated project portfolio model for information technology projects” to be used in the context of information management within the Sasol group of companies. During the literature study the complexities of using and deploying information technology in modern organisations became apparent. It is difficult to separate information management from other management and planning functions in the organisation, mainly because of the pervasive nature of information technology.

The model developed in chapter 5 has a holistic view of the selection of information projects and systems in the organisation. The model can also be implemented as a management framework for the implementation of information technology within modern organisations. Information projects and systems are managed throughout their complete lifecycle, thus ensuring the optimal use of resources and the maximum benefit from information technology investments.

Given the fact that the objectives of the study were achieved it is recommended that the possibility of incorporating the model in the current Sasol information management processes be investigated.

## BIBLIOGRAPHY

- ARCHER, N.P. & GRASEMZADEH, F. 1996. Project portfolio selection techniques: A review and suggested integrated approach. Innovation research working group, Michael. G. DeGroot school of business, McMaster university. 49p.
- ARCHIBALD, R.D. 1992. Managing High-Technology Programs and Projects. 2<sup>nd</sup> ed. New York : Wiley. 384p.
- ARMSTRONG, S.J. & BRODIE, R.J. 1994. Effects of portfolio planning methods on decision making: Experimental results, *International Journal of Research Marketing*, 11:73-84.
- BAKER, N.R. & FREELAND, J. 1975. Recent advances in R&D benefit measurement and project selection methods. *Management Science*, 21(10):1164-1175, Jun.
- BARD, J.F. & SOUSK, S.F. 1990. A tradeoff analysis for rough retain cargo handlers using AHP: An example of group decision making, *IEEE Transactions on Engineering Management*, 37(3):222-227.
- BARNETT, S.S 1986. Strategic Alternatives and Inter-organisational System Implementations: An Overview. *Journal of Management Information Systems*, 3(3):5-16, Winter.
- BHIDE, A. 1986. Hustle as Strategy. *Harvard Business Review*, 65(5):59-66, Sept/Oct.
- BOAR, B.H. 1993. The art of strategic planning for information technology. New York : Wiley. 366p.
- BOAR, B.H. 1994. Practical Steps for Aligning Information Technology with Business Strategies. New York : Wiley. 353p.
- BOLDED, R., WATERSON, P., WARR, P., CLEGG, C. & WALL, T. 1997. A new taxonomy of modern manufacturing practices. *International Journal of Operations & Production Management*, 17(11&12):1112-1121.
- BRADLEY, S.P. & NOLAN, R.L. 1998. Sense & Respond: Capturing Value in the Network Era. Boston, Massachusetts : Harvard Business School Press. 339p.
- BRENNER, M.S. 1994. Practical R&D project prioritisation, *Research Technology Management*, 37(5):38-42, Sep/Oct.

- BRIGHAM, E.F. & GAPENSKI, L.C. 1994. *Financial Management: Theory and Practice*. 7<sup>th</sup> ed. San Diego, California : Harcourt Brace Collage Publishers. 1135p.
- BROOKFIELD, D. 1995. Risk and capital budgeting: avoiding the pitfalls in using NPV when risk arises. *Management Decision*, 33(8):56-59.
- BROWN, R.M. & GATIAN, A.W. 1995. Strategic information systems and financial performance. *Journal of Management Information Systems*, 11(4):215-249, Spring.
- BRUCE, K. 1998. Can you align IT with business strategy? *Strategy & Leadership*, 26(5):16-22, Nov/Dec.
- CASH, J.I. & KONSZYNSKI, B.R. 1985. IS Redraws Competitive Boundaries. *Harvard Business Review*, 63(2):134-142, Mar/Apr.
- CHAN, Y.E. & HUFF, S.L. 1993. Strategic information systems alignment. *Business Quarterly*, 58(1):51-56, Autumn.
- COLLETT, N. 1998. Sasol welcomes deregulation – just not yet. *Petroleum economist*, 65(12):34, Des
- COOPER, R.G. 1986. *Winning at New Products*. Reading, Massachusetts : Addison-Wesley. 273p.
- COTTEY, P.T. & CHANG, R.A. 1996. Plan your enterprise architecture. *InformationWeek*, 585:75-82, 24 June.
- CROW, P. 1998. Gas-to-liquids processing hits its stride. *Oil & gas journal*, 96(24):34-36, Jun 15. [Available on the internet:] [http://ogj.pennwellnet.com/content/login\\_instructions.cfm?Section=Archives&ARTICLE\\_ID=21585&VERSION\\_NUM=1](http://ogj.pennwellnet.com/content/login_instructions.cfm?Section=Archives&ARTICLE_ID=21585&VERSION_NUM=1) [Date of use 22 Mar 1999].
- CURLE Jr., H.A. 1993. Supporting strategic objectives: Building a corporate information technology architecture. *Information Strategy: The Executive's Journal*, 10(1):5-13, Fall.
- DAVENPORT, T.H. 1997. *Information ecology: Mastering the information and knowledge environment*. New York : Oxford University Press. 255p.
- DEMPSEY, J., DVORAK, R.E., HOLEN, E., MARK, D., & MEEHAN III, W.F. 1998. A hard and soft look at IT investments. *McKinsey Quarterly*, 1:126-138.

- DYER, J.S. 1990. Remarks on the Analytic Hierarchy Process. *Management Science*, 36(3):249-258, Mar.
- EVANS, G.W. & FAIRBAIRN, R. 1989. Selection and scheduling of advanced missions for NASA using 0-1 integer linear programming. *Journal of the Operational Research Society*, 40(11):971-981.
- EVERNDEN, R. 1996. The Information FrameWork. *IBM Systems Journal*, 35(1):37-69.
- FOURIE, J.P. 1996. Personal interview between the IT manager for GID and the author. Sasolburg.
- GHEMAWAT, W.J. 1986. Sustained Advantage. *Harvard Business Review*, 65(5):53-58, Sept/Oct.
- GRAHAM, R.J. & ENGLUND, R.L. 1997. Creating an Environment for Successful Projects. San Francisco, California : Jossey-Bass Publishers. 253p.
- HALL, D.L. & NAUDA, A. 1990. An interactive approach for selecting IR & D projects. *IEEE Transactions on Engineering Management*, 37(2):126-133.
- HAX, A.C. & MAJLUF, N.S. 1995. The strategy concept and process: A pragmatic approach. 2<sup>nd</sup> ed. Upper Saddle River, New Jersey : Prentice-Hall. 440p
- HARKER, P.T. & VARGAS, L.G. 1987. The Theory of Ratio Estimation: Saaty's Scale Analytic Hierarchy Process. *Management Science*, 33(11):1383-1403, Nov.
- HASPELAGH, P. 1982. Portfolio planning: Uses and limits. *Harvard Business Review*, 60(1):58-73, Jan/Feb.
- HENDERSON, J. & VENKATRAMAN, N. 1999, Strategic alignment: Leveraging information technology for transforming organisations. *IBM Systems Journal*, 38(2&3):472-484.
- HUFF, S.L. & MUNRO, M.C. 1985. Information Technology Assessment and Adoption: A field study. *MIS Quarterly*, 9(4):327-340, Dec.
- IAN, M. 1989. Computing matters: Making it work to best effect, *Management Today*, 1:109-110.

- IVES, B. & LEARMONTH, G.P. 1984. The information system as a competitive weapon, *Communications of the ACM*, 27(12):1192-1201, Dec.
- KAMENETZKY, R.D. 1982. The relationship between the Analytic Hierarchy process and the Additive Value Function. *Decision Sciences*, 13:702-712.
- KEEN, P.G.W. 1981. Value analysis: justifying decision support system, *MIS Quarterly*, 5(1):1-15.
- KERZNER, H. 1998. Project Management: A Systems Approach to Planning, Scheduling, and Controlling. 6<sup>th</sup> ed. New York : Wiley. 1180p.
- KHARBANDA, O & STALLWORTHY, R. 1992. Lessons from Project Disasters. *Industrial Management & Data systems*, 92(3):3-46.
- KIROVA, V.D. & KRADJEL, H.G. 1998. The DirSA case study: An introduction to software architecture technology. *Bell Labs Technical Journal*, 3(3):125-139, Jul/Sep.
- KNOTT, D. 1997. Gas-to-liquids projects gain momentum as process list grows. *Oil & gas journal*, 95(25):16-22, Jun 23. [Available on the internet]  
[http://ogi.pennwellnet.com/content/Articles/Article\\_Layout.cfm?Section=Archives&ARTICLE\\_ID=20990&VERSION\\_NUM=1](http://ogi.pennwellnet.com/content/Articles/Article_Layout.cfm?Section=Archives&ARTICLE_ID=20990&VERSION_NUM=1) [Date of use 22 Mar 1999].
- LIM, K.H. & SWENSETH, S.R. 1993. An iterative procedure for reducing problem size in large scale AHP problems. *European Journal of Operational Research*, 67:64-74.
- LUCAS Jr., H.C. & BAROUDI, J. 1994. The role of information technology in organisation design. *Journal of Management Information Systems*, 10(4):9-24, Spring.
- LUCREZIO, F.V. 1999. Integrating technology can be real challenge for business. *Orlando Business Journal*, 15(42):34, Mar 12.
- LUFTMAN, J.N. 1996. Competing in the information Age: Strategic alignment in practice. New York : Oxford University Press. 414p.
- LUFTMAN, J.N. 1998. Enablers & inhibitors. *InformationWeek*, 700:283-286, 14 Sept.
- MATTHIEU, R.G. & GIBSON, J.E. 1993. A methodology for large-scale R&D planning based on cluster analysis, *IEEE transactions on Engineering Management*, 40(3):283-292.

- McFARLAN, F.W. 1981. Portfolio approach to information systems. *Harvard Business Review*, 59(9): 142-151.
- MEINTJIES, J. 1975. Sasol 1950-1975. Kaapstad : Tafelberg-Uitgewers Beperk. 184p.
- NIDUMOLU, S.R. 1996. A Comparison of the structural Contingency and Risk-Based Perspectives on Coordination in Software-Development Projects. *Journal of Management Information Systems*, 13(2): 77-113, Fall.
- NIEDERMAN, F.& BRANCHEU, J.C. 1991. Information systems management issues for the 1990s. *MIS Quarterly*, 15(4): 475-501, Dec.
- NORTON D.P. 1984. The Economics of Computing in the Advanced Stages. *Stage by Stage*, 4(2):1-5, Summer.
- O'BRIEN, J.A. 1996. Management Information Systems: Managing Information Technology in the Networked Enterprise. 3<sup>rd</sup> ed. Boston, Massachusetts : IRWIN. 623p.
- PARKER, M.M. & BENSON, R.J. 1988. Information Economics: Linking Business Performance to Information Technology. Englewood Cliffs, New Jersey : Prentice Hall. 287p.
- PODOLSKY, J. 1994. Parks, not Buildings. *Datamation*, 40(19):90, Okt 15.
- PMI (Project Management Institute). 1996. A Guide to the Project Management Body of Knowledge. Upper Darby, Pennsylvania. 154p.
- PORTER, M.E. 1980. Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York : The Free Press. 396p.
- PORTER, M.E. 1985. Competitive Advantage. New York : The Free Press, 557p.
- RADOSEVICH, L. & DAHLE, C. 1996. Taking your chances: New pressures and higher stakes are forcing companies to rethink how they justify and oversee IT risks. *CIO*: 36-46, April 15.
- RASMUSSEN, L.M. 1986. Zero-one programming with multiple criteria. *European Journal of Operational Research*, 26:83-95.
- SAATY, T.L. 1996. The Analytic Network Process: Decision Making with Dependence and Feedback. Pittsburgh, Pennsylvania : RWS Publications. 370p.

- SAATY, T.L., ROGERS, P.C. & PELL, R. 1980. Portfolio selection through hierarchies, *The Journal of Portfolio Management*, 6(3):16-21, Spring.
- SANTHANAM, R., MURALIDHAR, K., & SCHNIEDERJANS, M. 1989. A zero-one goal programming approach for information systems project selection, *OMEGA*, 17(6): 583-593.
- SASOL. 1998. Annual report, 1998 Johannesburg : Creda Communications. 114p.
- SASOL. 1999. About Sasol Available on the internet <http://www.sasol.com/about.htm#History> [Date of use 16 May 1999].
- SCHNIEDERJANS, M.J. & SANTHANAM, R. 1993. A multi-objective constrained resource information system project selection method. *European Journal of Operational Research*, 70:244-253.
- SOUDER, W.E. 1973. Analytical effectiveness of mathematical models for R&D project selection. *Management science*, 19(8):907-923, April.
- SPEWAK, S.H. & HILL, S.C. 1992. Enterprise Architecture Planning: Developing a Blueprint for Data, Applications and Technology. New York : John Wiley & Sons, Inc. 367p.
- STRASSMANN, P.A. 1997. The Squandered Computer: Evaluating the business Alignment of Information Technologies. New Canaan, Connecticut : The Information Economics Press. 426p.
- THOMPSON, Jr. A.A. & STRICKLAND III, A.J. 1996. Strategic management: concepts & cases. 9<sup>th</sup> ed. Chicago : IRWIN, 1035p.
- VANDERSLUIS, C. 1997. Risk analysis software: A definite safe bet. *Computing Canada*, 27, June 23.
- WARD, J. & GRIFFITHS, P. 1996. Strategic Planning for Information Systems. 2<sup>nd</sup> ed. New York : John Wiley & Sons, Inc. 586p.
- WENA, H.J., YEN, D.D. & BINSHAN, L 1998. Methods for measuring information technology investment payoff. *Human Systems Management*, 17(2):145-154.
- WILLIAMS, B. 1998. Oil producers face key question – How long will prices stay low? *Oil & Gas Journal*, 96(52):18-24, Dec 28. [Available on the internet:]

[http://ogj.pennwellnet.com/content/Articles/Article\\_Layout.cfm?Section=Archives&ARTICLE\\_ID=22426&VERSION\\_NUM=1](http://ogj.pennwellnet.com/content/Articles/Article_Layout.cfm?Section=Archives&ARTICLE_ID=22426&VERSION_NUM=1) [Date of use 21 Mar 1999].

YOUNGS, R., REDMOND-PYLE, D., SPAAS, P. & KAHAN, E 1999. A standard for architecture description. *IBM Systems Journal*, 38(1):32-51.

ZACHMAN, J.A. 1987. A framework for information systems architecture. *IBM Systems Journal*, 26(3): 276-292.

ZAHEDI, F. 1996. The Analytic Hierarchy Process – A Survey of the method and its application. *Interfaces*, 16(4):96-108.

ZWASS, V.1992. Management Information Systems. Dubuque : Iowa. Wm.C.Brown Publishers. 896p.