CHAPTER 1 - INTRODUCTION

"It is not the strongest of the species that survives, nor the most intelligent, but the one that is most responsive to change."
- Charles Darwin

1.1 - MOTIVATION

1.1.1 - Technology and society

The local and global impact of technology on society, business and industry, cannot be questioned any longer[1]. Technology is accepted as being "...the most pervasive force influencing human lives today..."[2]. It "...plays a pivotal role in the interactions among individuals, society, and nature..."[2] and has been identified as a key driver in the evolutionary development of man[2]. It has always played a major role in the creation of wealth and is even today accepted as a key source of competitive advantage[3]. It is identified by Porter as being one of five forces that drive industry competition and "the power of it as a competitive variable lies in its ability to alter competition through changing industry structure"[3].

[1] Piquito, N., and Pretorius, L., 2000, Technology as a driver for economic development in South Africa, South African Journal of Industrial Engineering, Vol.11, Nr.1

[2] Khalil, T.M., 2000, Management of Technology - The key to competitiveness and wealth creation, McGraw-Hill

[3] Porter, M.E., 1988, The Technological Dimension of Competitive Strategy, Strategic Management of Technology and Innovation, First Edition, Irwin, pp. 211 - 212

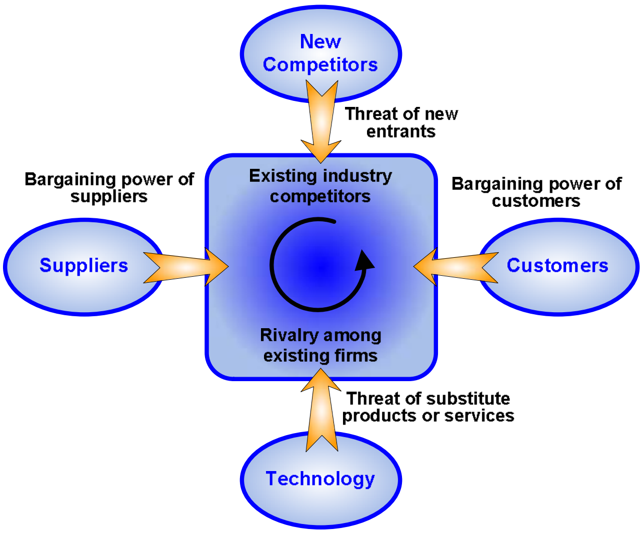

Figure 1: Forces driving industry competition

Khalil (2000)[2] defines a company's competitiveness as its "…ability to exploit ideas and resources in a timely, cost-effective manner in order to accomplish desired goals and objectives…." He continues and states that companies that are unable to harness and optimally utilise technology will lag and may even not survive.

The world is changing. New technologies emerge, the rules of the economical bout are constantly changing, and pure muscle power does not determine the victor anymore.[2] The magnitude and speed of technological change is increasing and the scale, dynamics and complexity of the global market place along with it. The market is demanding integrated, higher quality products with a broader scope. Shorter turn-around times and less-than-perfect service are generally not acceptable anymore. The combined pressures of scale, scope, and integration (world class competitiveness factors) place a tremendous burden on the local business in terms of its mode of execution and the resources it employs to deliver its offerings to the market[4].

[4] Christensen, J.F., 2002, _Corporate strategy and the management of innovation and technology_, Industrial and Corporate Change, Vol.11, Nr.2, pp.263-288

FACTOR	TRADITIONAL	NEW
Life cycle	Long life cycles	Short life cycles
Innovation	Few innovations	Continuous innovations
Competition	Expected Competition Competitors and the enemy Cooperation not allowed	Stronger Competition Alliance with competitors accepted
Market	Expected Market Local Market	Uncertain Market Global Market
Quality	Quality is desirable	Quality is imperative
Production	Mass production Produce in large lots No commitment to suppliers Large inventories Fixed manufacturing	Customised production Produce in small lots Suppliers are partners Reduced inventories (JIT) Flexible manufacturing
Organisation	Large corporations vertically Integrated companies Bureaucratic organisations Financial methods control the organisation	Smaller plants; companies rely on outsourcing Nimble organisations Financial methods to serve the organisation's objective

Table 1: Changing trends in industry

As *Table 1: Changing trends in industry*[2] corroborates, the factors of life cycle, innovation, competition, market, quality, production and organisation all add up to elevate MOT to that of a critical management function. Thus, the acquisition and management of technology must be executed in such a manner as to optimise the ever-present dichotomy of cost vs. benefits, without compromising the competitiveness of the company[5].

1.1.2 - Technology and business

The valuation and measurement therefore today of technology as an investment, and information technology (IT) specifically, has been elevated to a core management activity on the chief information officer's (CIO) agenda.

With the aftermath of the $1.7 trillion dot.com lesson[6] still haunting the information technology and financial sectors worldwide, the lesson learnt of adopting the *correct* business model and the acquisition of the *correct* technological resources in support of

[5] Walker, M., 2000, *The importance of IT strategy*, Pulp and paper, Vol.74, Issue 9

[6] Kleinbard, D, 2000, *The $1.7 trillion dot.com lesson*, http://money.cnn.com/2000/11/09/technology/overview

the *correct* strategy, cannot be emphasised more[7]. Khalil (2000)[2] supports this view when he refers to an American NRC workshop as identifying the prime industry need as that of knowing *how* to integrate technology into the overall strategic objectives of the firm. He continues and states that the identical report identified the third most important industry need as that of knowing *how* to assess / evaluate technology more effectively.

Technology has thus infiltrated the business at all layers and has become the proverbial *"thorn in the flesh"*. Survival without is impossible, yet embracing it, is equally risky. It is the double-edged sword which but holds no respect for incompetence, but when wielded correctly transforms the mediocre local enterprise into a global force. It demands top management attention when procured, yet seemingly disappears in the business processes, after implementation.

The management of technology must therefore not only occupy itself with the strategical issues of "why", but also with the tactical and operational issues of "how" and "in what manner".

1.1.3 - Management of technology

Inline with the growth of technology, the discipline of MOT has gained in stature over the last decade. It has grown from the humble R&D function to the highly esteemed position next to that of the CEO. The rising level of technology management studies indicates that the body of knowledge surrounding the discipline of MOT has expanded equally.[11] Chanaron and Jolly (1999) corroborates this phenomenon with the expansion of the conventional perspective on MOT towards a "transdisciplinary approach to technological management"[10] as *Figure 2: The relationship between R&D management, MOT and technological management*, indicates.

[7] Dué, R.T., 1997, *A strategic approach to IT investments*, Information Systems Management

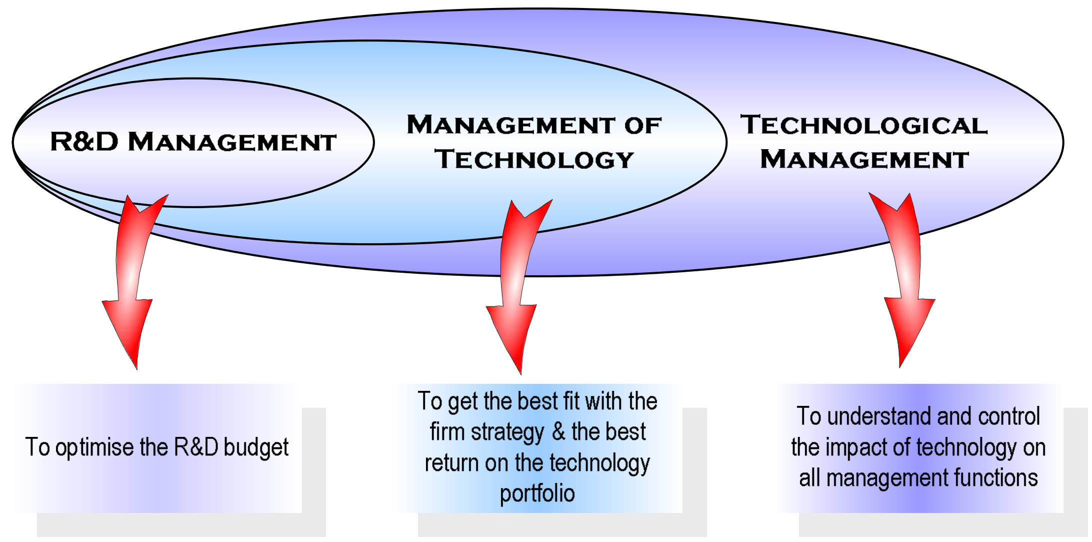

Figure 2: The relationship between R&D management, MOT and technological management

If ever there was a time that the sheer volume of information availability is inundating us, then it is now. This statement holds true also for Technology Management. Google©, the world's largest internet search engine[8] and searching 3,083,324,652 web pages produces spectacular search results when queried with the phrase "Technology+Management". A staggering 5,410,000 hits are returned in just 0.15 seconds. Delimiting this search further to "Technology+Management+Strategy" delivers a still incomprehensible result of about 3,000,000 hits in just 0.54 seconds.

The result is similar when the knowledge depositories of South African academic institutions is probed and queried. The University of South Africa's Oasis Library Catalogue[9] delivers a corroborating result:

- TECHNOLOGY is in 8059 titles.
- MANAGEMENT is in 21857 titles.
- STRATEGY is in 3839 titles.
- Both "STRATEGY" and "TECHNOLOGY" are in 259 titles.
- Adding "MANAGEMENT" leaves 137 titles.
- There are 137 entries with STRATEGY, TECHNOLOGY & MANAGEMENT.

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[8] Costello, S, 2000, _Google, claiming largest index, tapped by Yahoo_, IDG News Service Boston Bureau, http://www.idg.net/idgns /2000/06/26 / GoogleClaimingLargestIndexTappedBy.shtml

[9] http://oasis.unisa.ac.za/

Therefore, if the management of technology is such an important strategic and operational organisational function and the information surrounding it so numerous and readily available, one would surmise that accepted techniques and adequate management capability exists to directly link invested technology resources to the strategic and operational goals of the organisation.

1.1.4 - MOT resources

Alas, the body of knowledge encompassing technology management carries such a theoretical weight, that it suffocates all information pertaining to everyday practical implementation. While "the efficient utilisation of technological resources is a critical aspect of the management of techno-economic enterprises"[2], the MOT resource knowledge base has become bunglesome to work with. Views are in excess and techniques are available in isolated abundance, yet no clear *process* and widely accepted *methods* exits. As with the project management practise, no "Guide to the Project Management Body of Knowledge" has yet been established for the practise of MOT. Chanaron and Jolly (1999)[10] state that MOT is yet still an evolving discipline. Phaal *et al* (2001)[11] concurs that "...no particular textbook or approach to technology management has achieved wide acceptance...". He continues by referring to the technology management "handbook" of Gaynor (1996)[12] as "...a collection of disparate views on technology management...". Even Vernet and Arasti (1999)[13] throw the figurative "last stone" when they state that "...the models for selecting the strategic field of technological development have been poorly presented and discussed in the literature".

"Managers must be equipped with predictive methodologies and decision tools that are reliable, flexible, practical, and fast. There is need for new ideas, imaginative methodologies, and performance criteria that have been tested in real-life situations"[2]. The contemporary technology management function is thus wasting valuable company resources if it is unable to ensure the generation of business and technological

[10] Chanaron, J.J. and Jolly, D., 1999, *Technology management: expanding the perspective of management of technology*, Management Decision, 37/8

[11] Phaal, R., Farrukh, C.J.P. and Probert, D.R., 2001, *Technology management process assessment: a case study*, International Journal of Operations and Production Management (Special Issue on Process Research in Operations Management), 21 (8), pp. 1116-1132

[12] Gaynor, G.H. (Ed.), 1996, *Handbook of technology management*, McGraw-Hill, London

[13] Vernet, A. and Arasti, M.R., 1999, *Linking business strategy to technology strategies: a prerequisite to the R&D priorities determination*, International Journal of Technology Management, Vol.18, No.3/4, pp.293-307

knowledge, through a formal set of workable methods, in order to evaluate strategy and operation accordingly for alignment and company gain.

”...To this end, it is necessary to develop both an accepted framework for understanding technology management issues, and a range of tools and techniques to support the implementation of strategy...”[11]. The development of an internal technology strategy assessment framework within the services sector, utilising total quality management (TQM) principles, resides within these parameters.

1.2 - PROBLEM STATEMENT

As stressed earlier, the discipline of MOT is still evolving. In order to cope with increased pressures of time and complexity, industry is probing for new methods and paradigms to address their strategic and operational management needs. Hybrid, tangent disciplines are thus forming on the peripheral of the conventional understanding of MOT[10] (refer to *Figure 2: The relationship between R&D management, MOT and technological management*). The discipline of technology strategy has also not been left untouched. Current literature is not singular in its *views* and *methods* of technology strategy, its *interface* with business strategy, and *how* technology strategy is *executed* and *assessed* internally. No integrated model exists to guide the chief technology officer (CTO) from overall organisational-wide strategic positioning right down to the assessment and alignment of technology artefacts / building blocks. The fundamental questions of WHAT, HOW and WITH WHAT needs to be addressed and thus the research problem necessitates investigation into the following aspects in order to develop such a model:

- The literature defining what is exactly encapsulated in the expression of “technology strategy” must be reassessed. The scope, content and context of the subject matter of technology strategy must be ring fenced for this instance of research so as to establish the base from which all further discourse will be extrapolated.
- A theoretically founded method set must be established in order to view (model) the internal organisational composition, view the impact of strategy and technology, and the combination thereof on the typical services organisation.

- The accepted frameworks that are available in literature and practice for the assessment of strategy and strategical alignment must be identified and analysed for completeness, granularity and applicability.

1.3 - OBJECTIVE

It is the aim of this research dissertation to:

- revisit and delineate the knowledge domain of technology strategy in relation to business strategy as well as within the classical context of technology management (MOT),
- to decide upon a suitable technique for *viewing* the manifestation of business and technology strategy upon the typical services organisation,
- to decide upon a suitable method or framework to *assess* technology strategy
- and moreover, to evaluate the workability of such an approach and its accompanying technique set by means of multiple case studies within the services sector.

1.4 - GOAL

The goal of this research is to show that:

- strategically derived critical success factors combined with functional modelling can assist in the identification of strategic focus areas in the typical services organisation,
- strategically balanced functional models combined with procedural definitions of function execution can assist in the qualitative identification of strategic important technological artefacts / building blocks and that
- an assessment scorecard based upon industry accepted excellence models, and the South African Excellence Model in specific, can assist in the strategic balancing of key technological focus areas and technological artefacts / building blocks

ultimately resulting in an operational method of strategic technological assessment for the services sector.

1.5 - SCOPE

This dissertation covers the mayor disciplines of

(a) **Technology Management** (MOT) and more specifically the sub-discipline of *Technology Strategy*,

(b) **Business Architecture** and specific business architecture frameworks with their corresponding modelling methods,

(c) **Strategic Performance Measurement** and specifically strategic measurement models, and

(d) **Total Quality Management** (TQM) and more specifically the manifestation of it in quality models such as the European Foundation for Quality Management (EFQM) and the South African Excellence Foundation's (SAEF) Excellence Model.

1.6 - CONTRIBUTION OF RESEARCH

This research instance endeavours to contribute to the above mentioned disciplines in the following manner:

- to expand the current theoretical understanding with regards to the modelling and representation of strategy, and technology strategy in particular,
- to expand the current utilisation of business architecture into the field of MOT,
- to expand the current paradigm of the utilisation of excellence models into the field of MOT and
- to merge the disciplines of TQM with MOT.

1.7 - DISSERTATION STRUCTURE

Figure 3[14] depicts a generic dissertation structure:

[14] Mathews, E.H. and Taylor, P.B., 1998, *Making the researcher's life easier with Research Toolbox*

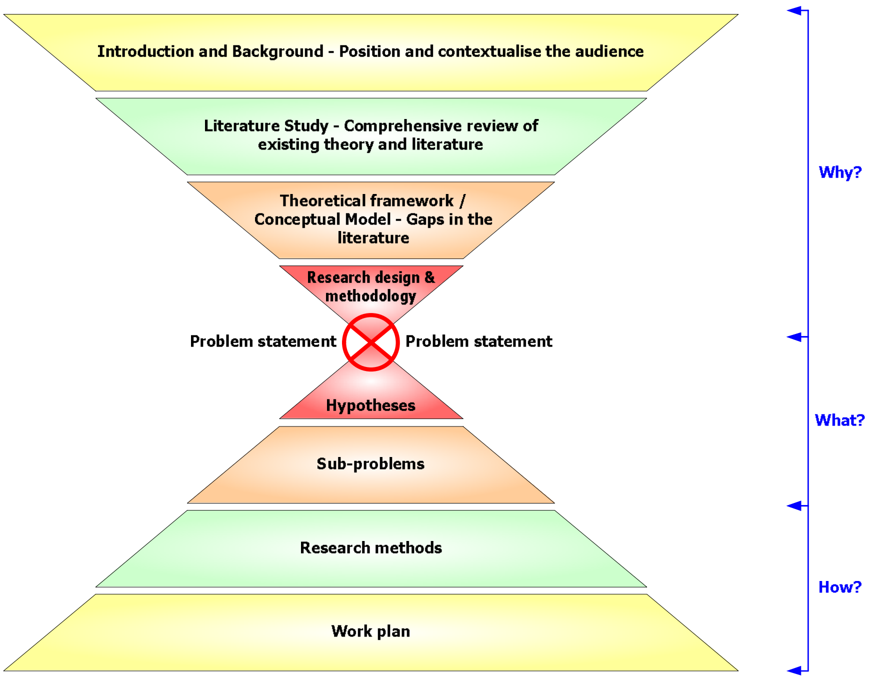

Figure 3: Graphical depiction of a generic dissertation structure

The above mentioned approach, as suggested by Mathews and Taylor(1988)[14] was also followed in the construction of this research:

- *Chapter 1* elucidates about the motivation of the intended research on the hand of the current state of business and society, and the critical role that technology plays in it. It links the current need in the market with the present state of MOT resources so as to establish the research problem. The objectives and goals of the research endeavour are furthermore stipulated and the scope and expected contribution is also established.
- *Chapter 2* ventures into the theoretical foundation necessary in order to advance to a position where a proposed model can be established. It does so on the hand of a three tier approach. The first tier/domain focuses on technology strategy and establishes a research paradigm how to think about and view it. The second domain focuses on business architecture, its value proposition and the evaluation of appropriate architecture frameworks for the research problem. The third and last domain focuses on performance measurement, strategic measurement models and the evaluation of business performance models.
- *Chapter 3* steps in to deliver the proposed research model. It firstly reiterates the core reference models, as presented in the theory, and then

builds upon the arguments to develop the proposed research model, which it discusses in a step-by-step manner.

- *Chapter 4* discusses the theoretical under-wiring of case study methodologies and advances to propose a qualitative research design methodology to address the execution of the proposed research model.
- *Chapter 5* elaborates on the research findings in a step-by-step manner, in-line with the research model's sequential steps. On each step the text focuses each time on the three unique case study candidate's results and highlights key anomalies.
- *Chapter 6* concludes the research endeavour by critically examining the proposed model and its accompanying methodology. It provides critique and recommendation for future study.

CHAPTER 2 - THEORETICAL BACKGROUND AND LITERATURE STUDY

"There is much pleasure to be gained from useless knowledge."
- Bertrand Russell

The conjecture is made that current literature is not singular in its *views* and *methods* of technology strategy, its *interface* with business strategy, and *how* technology strategy is *executed* and *assessed*. This chapter is the representation of a literature study to determine, amongst other things, the validity of the above mentioned conjecture. This literature study also serves as the reference base from which the substance, extent, and context of the mayor subject matter constituents of the intended research is established. These being the disciplines of

- technology management and technology strategy
- business architecture frameworks and their representation methods
- strategic performance measurement and
- total quality management and its sub-set of excellence models

A logical 3-tiered knowledge domain expository approach was constructed and used as the logical backbone for the compilation of this chapter. Refer to *Figure 4* below for a graphical representation.

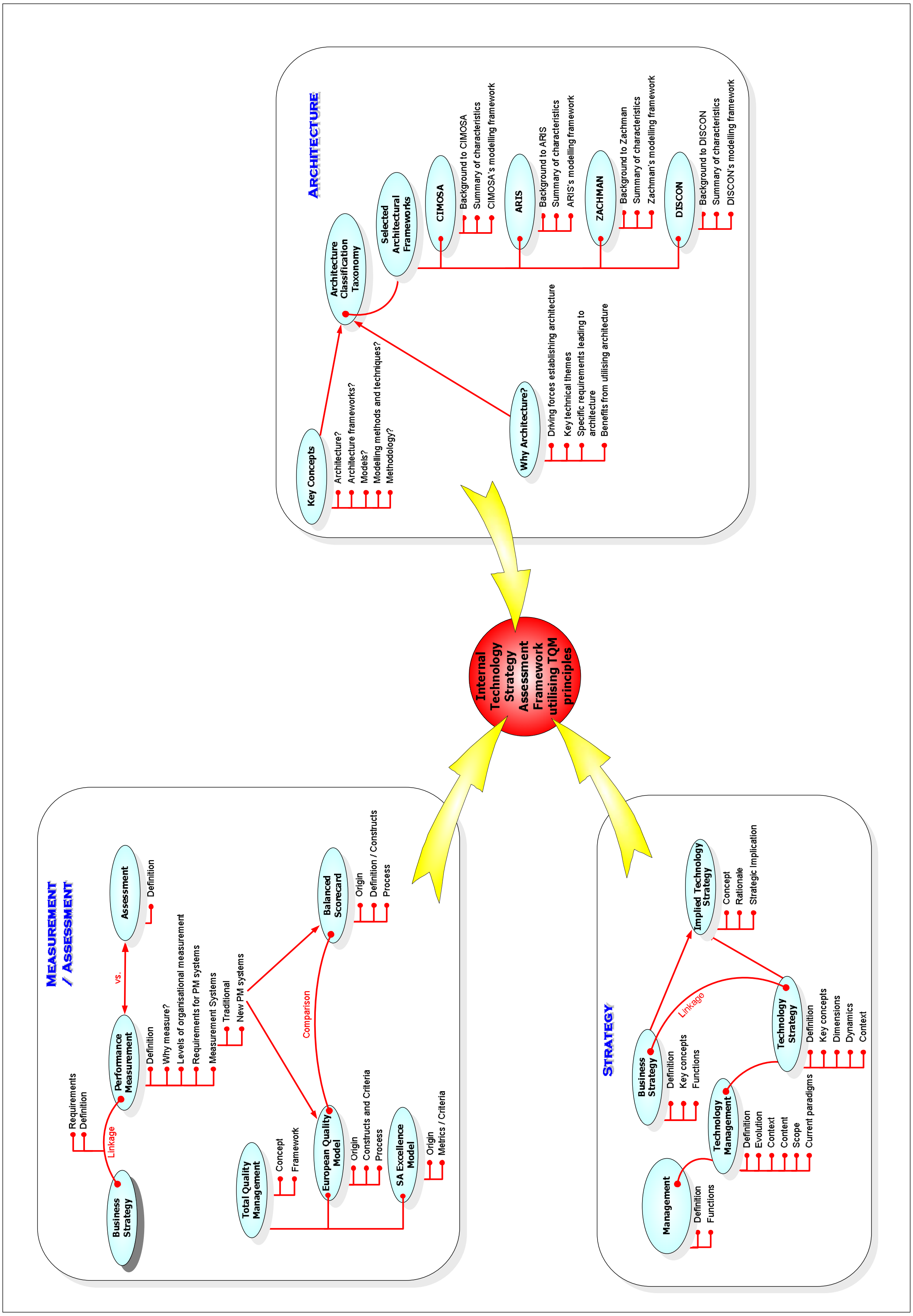

Figure 4: 3-Tier Graphical depiction

- *Tier one* or *knowledge domain one* is aptly called the strategy domain. It focuses on the theoretical understanding of concepts and constructs needed to establish a thorough understanding of technology strategy. It defines technology, management and strategy. It then continues by merging these definitions to arrive at definitions for MOT and technology strategy. It briefly discusses the linkage between business and technology strategy and ends off by establishing the concept of the implied technology strategy.

- *Tier two* is the architecture domain. The text starts off by defining the concepts of architecture, architecture frameworks, modelling formalisms and modelling methodologies. It establishes the reason for existence of architecture frameworks, continues on to the benefits of architecture and proposes a classification taxonomy for evaluating different architectural frameworks. The text for this domain ends off by discussing and evaluating a few selected architecture frameworks as deemed appropriate for the research problem.

- *Tier three* is the final domain in the theoretical background and is concerned about the function of measurement. It starts by defining the concept of performance measurement and measurement systems. It then discusses traditional measurement systems and establishes the need for more comprehensive and representative measurement systems. This requirement is fulfilled by means of the proposition of two business performance measurement systems. The text ends of the chapter by discussing both systems and evaluating the suitability of each.

2.1 - TOWARDS AN UNDERSTANDING OF TECHNOLOGY STRATEGY

This section deals with the first domain, as depicted in *Figure 5* below, of the 3-tier approach:

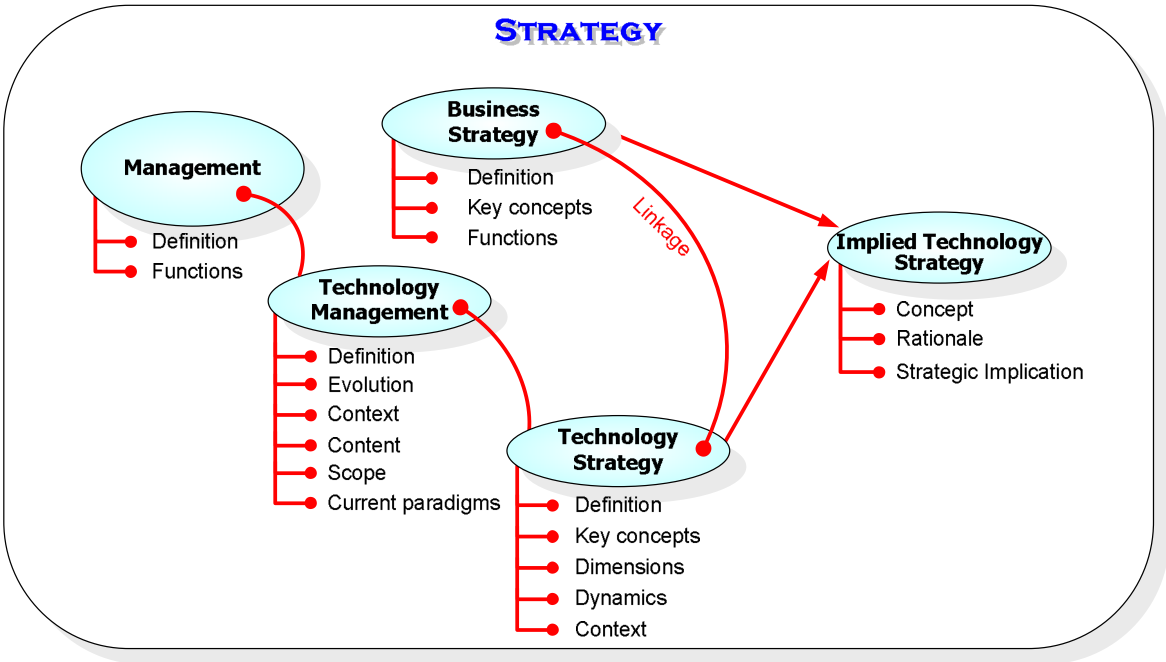

Figure 5: Domain 1 – The strategy domain

The rationale behind the structure of this first section is to dissect and evaluate each term or component that comprises and plays a role in the understanding of *technology management* and *technology strategy*, as depicted in *Figure 5*. This is of no idle significance, since the theoretical formulation of a technology strategy assessment framework necessitates the concept of technology strategy to be exactly defined, before any attempt can even be made to advance towards a proposed assessment framework. If applicable modelling techniques are to be selected which must ensure the overall achievement of the stated research objectives, it also presupposes that the knowledge exists as to what is to be modelled and what is required of the modelling technique. Thus the comprehensive understanding of the full meaning of *technology strategy* in all its capacities is at the core this research endeavour.

The aim of this first domain is thus to establish a thorough understanding of the scope, content, and context of the contemporary view of the discipline of technology management and the position of technology strategy within this field. The purpose of the first knowledge domain is to establish a theoretical base from which to address research objective number one, which is namely:

- to revisit and delineate the knowledge domain of technology strategy in relation to business strategy as well as within the classical context of technology management (MOT).

Special attention is taken to view and assess conventional definitions on the major constructs of this first domain. Although laborious to work through, each construct and its organically derived definition forms a building block that lays the foundation for the logical establishment of the research paradigm.

As *Figure 5* indicates, this section starts with the establishment of an understanding of technology and management. These two concepts are then consolidated to form a framework for the understanding of MOT. This is expanded upon further with current literature and here the text elaborates in-depth around the scope, content and context of MOT. This is important since the ground has to be prepared for a discussion of technology strategy and its function and position within the MOT discipline.

Continuing from the concepts of MOT, the classical views on strategy are examined and a working definition of business strategy is formulated. This definition is utilised as a springboard to launch into the bulk of the theory, namely to investigate literature surrounding technology strategy. Here again the text elaborates in-depth around the concept of technology strategy, the dimensions and substance of technology strategy, the dynamics and process of technology strategy and its context. The theoretical study is finally completed when the link is established between conventional business strategy and technology strategy. The text elaborates upon the alignment of the two strategies and derives the concept of an implied technology strategy.

The section is concluded with a consolidated, research specific working definition of technology strategy.

2.1.1 - What is technology?

It is of the utmost importance to start with a clear definition of technology before any endeavour is undertaken to establish an understanding of the discipline of technology management and technology strategy. Such a common understanding is fundamental since it permits the building of arguments within the text.

Pieterse (2001)[15] and Pretorius (2001)[16] both adopt a fundamental definition of technology when they refer to the "technology triangle", depicted in *Figure 6.*

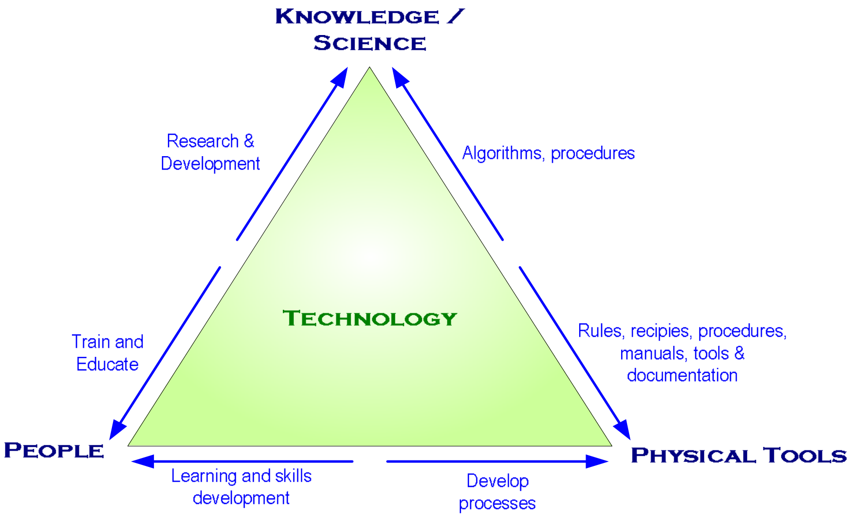

Figure 6: A Diagrammatic Definition of Technology (The technology triangle)

On the hand of the "technology triangle", they describe technology as the integration of people, knowledge, tools, and systems with the objective to improve people's lives. Van Wyk (1988) supports this view and refers to technology as created capability manifesting in artefacts with the purpose of which is to augment human skill.[17]

Khalil (2000)[2] continues and refers to technology as hardware, software, brain-ware and know-how. He elaborates further on technology as all the knowledge, products, processes, tools methods, and systems employed in the creation of goods or in the provision of services. Burgelman *et al* (2001)[18] agree along the same line by stating that technology can be embodied in people, materials, cognitive and physical processes, plant, equipment, and tools. Elsewhere they also state that "in today's competitive environment, technology is a *resource* of primary importance...". Vernet and Arasti

[15] Pieterse, H., 2001, *Telecommunications Technology Transfer/Diffusion Model Into Rural South Africa*, University of Pretoria

[16] Pretorius, M.W., 2001, *Technology Assessment in the Manufacturing Enterprise: A Holistic Approach*, International Association for Management of Technology (IAMOT) Paper Archive, http://www.iamot.org/paperarchive

[17] Van Wyk, R.J., 1988, *Management of technology: new frameworks*, Technovation 7, pp.341-351

[18] Burgelman, R.A., Maidique, M.A. & Wheelwright, S.C., 2001, *Strategic Management of Technology and Innovation*. Third Edition, McGraw-Hill

(1999) utilise an integrated definition reading: "Technology is a combination of scientific and technical knowledge and know how that is embodied in a product, service, process, information system or management method"[13]. In another publication they break it down into four components:

- Technoware, referring to machines, tools and equipment;
- Humanware, referring to human skills and experience;
- Infoware, referring to information, standards and procedures; and
- Orgaware, relating to business infrastructure and managerial systems.[19]

Bone and Saxon (2000)[20] alternatively view technology as a functional capability which is activity based and can be managed as an integral part of a business's processes in a bottoms-up, core competency manner. This view is supported by Porter (1985)[21] who states that the term technology "encompasses the entire set of technologies employed in the sequence of activities that constitute a firm's value chain"[18]. He continues and discusses technology on the hand of his five force model, as previously shown in *Figure 1: Forces driving industry competition*.

Thus to synopsise: technology is technical by nature rather than commercial. It is embodied in cognitive or physical artefacts in a codified or non-codified manner with the express goal of aiding human endeavour in the achievement of a specific objective[18]. Taking a less puristic stance: it is a functional capability which plays an integral part in successful companies' business processes and the management thereof is like any other organisational resource[20].

Of value to this research is the fact that technology is:

- technical
- goal orientated
- delivers a functional capability
- is manifested in processes
- and is similar to other organisational resources

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[19] Arasti, M.R. & Vernet, M., 1997, *Business Process Reengineering: A Systematic Approach to Link Business Strategy and Technology Strategies*, Proceeding of the Portland International Conference on Management Engineering (PICMET '97), Portland, USA

[20] Bone, S. and Saxon, T., 2000, *Developing effective technology strategies*, Research Technology Management, Volume 43 Issue 4

[21] Porter, M.E., 1985, *Competitive Advantage*, Free Press, New York

2.1.2 - A framework for classifying technological artefacts

Now that the text has established its definition of technology it still requires a framework according to which it can position and relate individual technological artefacts. For this purpose technological artefacts can be classified according to a number of general features: function, performance, physical principle, composition material, size and even structure[17]. Van Wyk[17] proposes a classification schema based on technological function whereby the three categories of mayor output is combined with the three mayor manners of handling. *Figure 7* below illustrates:

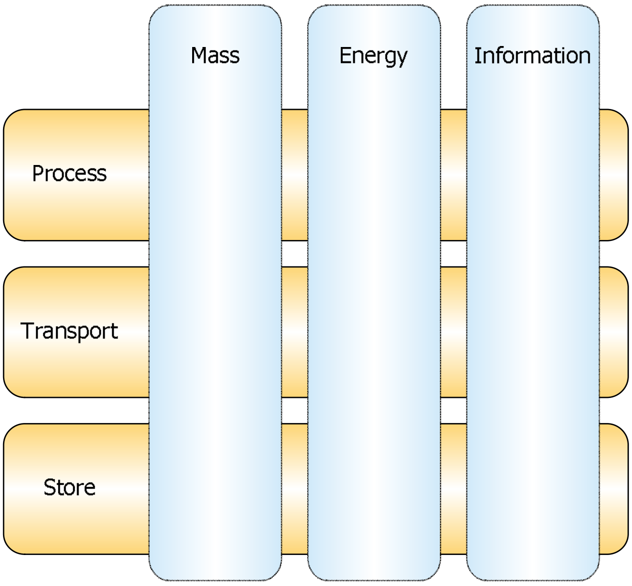

Figure 7: Nine cell technology classification framework

2.1.3 - Towards a definition of technology management

Now that a line has been drawn to ring fence what technology is and how to classify it, the argument must be extended towards the concept of management. Only once both the concepts of technology and management have been defined, can an attempt be made to reassess afresh the conventional definition and understanding of technology management.

2.1.3.1 THE MANAGEMENT FUNCTION

The debate is still active as to whether the pure function of management is an art or a science. Khalil (2000)[2] even ventures so far as to state that management is a technology to some extent: "Management is also a technology, as it is the means by which the desired goals of an enterprise are achieved" [2]. He defines the management function further as involving the directing and controlling of the organisation and steering it toward achieving its objectives.

Nicholas (1990)[22] in his authoritative textbook on project management defines the classical role of management as that of integrating resources and tasks to achieve organisational goals, as *Figure 8: The functions of management*, depicts.

Figure 8: The functions of management

Here we see that the four generic management functions of planning, organising, directing and controlling being integrated for the purpose of goal realisation and change management. The constructs of resources, integration and goal achievement in this definition should not be noted idly. As the text will show shortly, this is of core importance towards a specific delineated definition for technology management for this instance of research.

Wild states that "technology is having an increasing major impact on the nature of management. The usage of technology is a major challenge to managers"[23]. This merge between the fields of management and technology is thus a growing concern, and this is exactly where MOT steps to the fore. The next section discusses this merge in more detail.

[22] Nicholas, J.M., 1990, *Managing Business and Engineering Projects: concepts and implementation*, Prentice Hall, New Jersey
[23] Wild, R. 1990, *Technology and management*, Nichols Publishing Company, New York

2.1.3.2 TECHNOLOGY MANAGEMENT TODAY – EVOLUTION AND CONTEXT

Chanaron and Jolly (1999)[10] take a historic view towards the understanding of MOT and trace its evolutionary growth to its current state. They first note the Task Force on Management of Technology and the National Research Council of the United States of America's definition:

> The management of technology links engineering, science and management disciplines to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organisation.

This definition is of course inline with the classical broad definition of MOT as supported by Khalil (2000)[2] and depicted in *Figure 9: The interdisciplinary nature of MOT*[2].

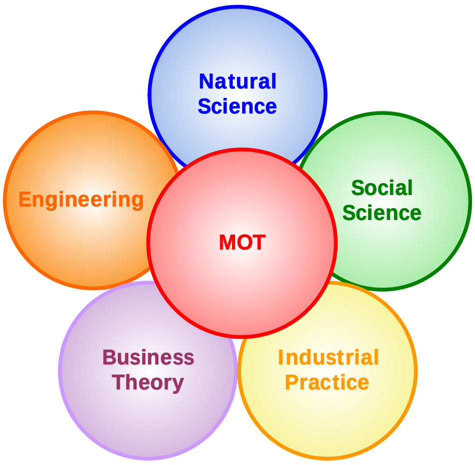

Figure 9: The interdisciplinary nature of MOT

Khalil indicates that MOT is a hybrid, interdisciplinary field that draws upon knowledge from existing fields such as engineering, management, accounting, finance, economics, production, and political sciences. Chanaron and Jolly (1999)[10] continues by quoting Bayraktar's narrower definition of MOT. Bayraktar (1990)[24] puts forward that MOT covers

- The creation of new technologies and the effective and efficient utilisation of existing technologies;
- Responding to and coping with the impacts and effects of technological change on individuals, organisations, society and nature;

[24] Bayraktar, B.A., 1990, On the concepts of technology and management of technology, Proceedings of the Second International Conference on Management of Technology

- The development of methods, techniques and procedures for dealing with technological issues and problems.

2.1.3.3 TECHNOLOGY MANAGEMENT TODAY – CONTENT

Both definitions up to this point focus on the technological capabilities and technology resources, i.e. the technology portfolio, of the organisation and the management thereof in relation to the external and internal stimuli of the business environments. This is in exact agreement with *Figure 10: The elements of management of technology*[25].

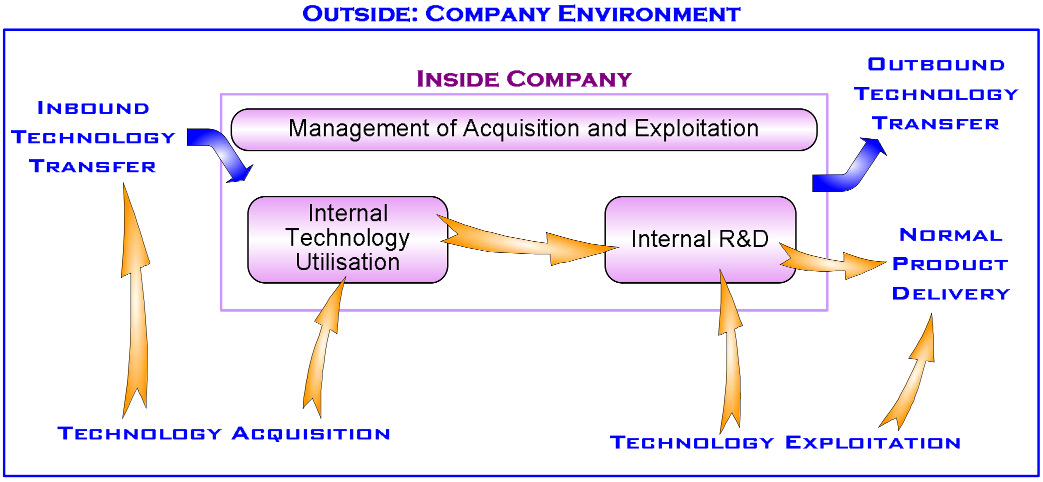

Figure 10: The elements of management of technology

Here the definition adopts a process construction in the sense that input activities (acquisition), transformation activities (management and utilisation) and output activities (transfer end delivery) constitute the MOT extent within an operating (organisational and external) environment. This is a useful but much aggregated definition. The strategic undertone of MOT activities relative to an external scenario should however not be overlooked.

Burgelman *et al* (2001)[18] also refers to the activities within their definition of MOT:

> Management of technology involves the handling of technical activities in a broad spectrum of functional areas including basic research; applied research; development; design; construction, manufacturing, or operations; testing; maintenance; and technology transfer. In this sense,

[25] Textual class handouts in *Management of Technology, ITB 783*, 2000, University of Pretoria, South Africa

the concept of technology management is quite broad, since it covers not only R&D but also the management of product and process technologies.

Arasti and Karamipour (2003)[26] classify all MOT activities to reside under four generic functions, namely:

- Identification, which involves the drafting of a list of technologies which are incorporated in the company's products and/or processes;
- Selection, which deals with the choice of technologies in which the firm invests;
- Acquisition, which is concerned about the physical method of technology ascertainment; and finally
- Exploitation, which is concerned about the utilisation of acquired technology for commercial and/or competitive gain.

Although there is no accepted, definitive list of formally agreed upon technology management activities, a permeating set of MOT activities has been identified and practised over time. These MOT activities can be viewed in *Appendix A: Core Knowledge of MOT*. Although the list is by no means exhaustive and researchers such as Chanaron and Jolly constantly push for the expansion of the boundaries towards a "…transversal and integrated vision…."[10], effective technology management must answer a few fundamental questions. According to Khalil these questions are:

- To what extent is technology relevant to the business?
- Which business strategies require technology?
- Where will we get it?
- What are our core technologies for the business?
- In which technologies should we focus our research effort?
- What new strategic options could they provide?

Stacey and Ashton(1990)[27] suggest their set of fundamental MOT questions:

- How successful is the firm in meeting organisational goals and what are the strengths and weaknesses that will determine its future prospects?

[26] Arasti, M.R. and Karamipour, A., 2003, Identification of a Firm's Strategic Technologies: A Process-based Approach, IAMOT 2003, Nancy, France

[27] Stacey, G.S. and Ashton, W.B., 1990, A structured approach to corporate technology strategy, International Journal of Technology Management, Vol.5, No.4, pp.389-407

- What are the important market-place needs and opportunities for technology in products and processes that the firm should target?
- How should a fundamental technology game plan to meet the future business and technological environment be prepared and what should it contain?
- What specific criteria should be used for technology acquisition or development investments by the firm?
- How can favourable technology candidates be identified and evaluated to implement its fundamental business strategy?
- How should both financial and non-financial resources be allocated and committed in execution of the programs identified in the technology plan?
- What are the methods for using the results of technology investments and capturing the returns in the form of new products, production processes and other applications?
- How does the firm use information to manage its business goals and technology approach?

Of particular interest to the text is the listing of Stacey and Ashton's first MOT question, namely how successful is a firm in utilising its technological resources in the attainment of its overall business goals? To state prematurely and as the text will arrive at, the role of technology as a resource by which organisational goals can be achieved, is best illustrated in the adoption of a functional perspective and utilising functional modelling techniques. However these previously mentioned MOT activities will not be discussed in this text, but it should be noted that technology assessment, technology strategy and technology strategy assessment are amongst the activities listed.

2.1.3.4 TECHNOLOGY MANAGEMENT TODAY – SCOPE

Continuing from the previous argument of the strategic undertone of MOT activities: Chanaron and Jolly (1999)[10] too note this strategic influence in their text and point towards a more enlarged MOT definition in terms of strategic intent and activity. They refer to Badawy (1998) who suggested that MOT is the "...practice of integrating technology strategy with business strategy...that such integration requires the deliberate coordination of R&D, manufacturing and other service functions" [28]. Betz (1993) echoes the same definition almost verbatim, but elaborates that this "...integration requires the deliberate coordination of the research, production, and service functions with the marketing, finance, and human resource functions of the firm"[29].

The phrase "integration" might cause misconception when used simultaneously in conjunction with management of technology and other business functions. Confusion must not be allowed to cloud the two types:

(a) The utilisation of technology to manage, and

(b) The management of technology (MOT).

Wild (1990)[30] specifically differentiates between the above mentioned two concepts, shown in *Figure 11: Technology management domains*[30].

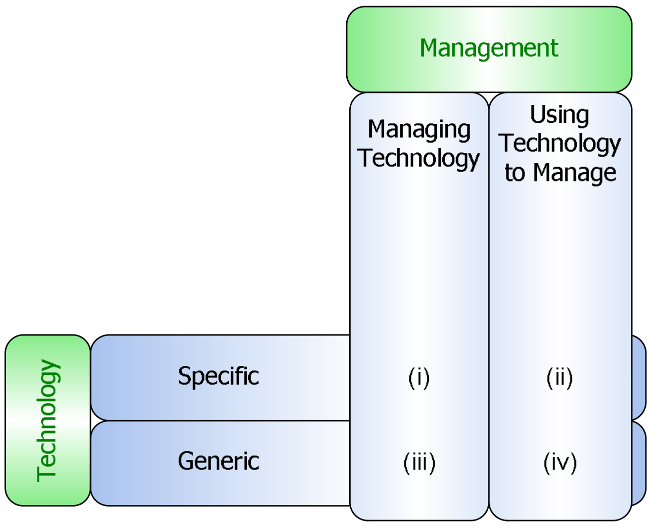

Figure 11: Technology management domains

Wild distinguishes between specific and generic technological artefacts and the utilisation thereof to manage or be managed. As the text will show, this classification scheme is very useful when combined with a technological classification framework.

Khalil pushes the point, inline with Chanaron and Jolly's view, that MOT "transcends manufacturing and service organisations" through a set of enablers. He indicates that

[28] Badawy, M.K., 1998, Technology management education: alternative models, California Management Review, Vol.40 No.4

[29] Betz, F. 1993, Strategic Technology Management, McGraw-Hill

[30] Wild, R., 1990, Technology and Management, Nichols Publishing Co

issues falling under the scope of MOT can be explored in their relation to one of five enabler categories:

- Methods and tools for effective management of resources
- The business environment and the ability to manage the interface between the organisation and the external environment
- The structure and management of organisations
- Management of R&D and engineering projects
- Management of human resources under conditions of rapid technological and social change

As said, this classification agrees with Chanaron and Jolly's view that the new paradigm in MOT is the understanding of the impact of technology on the organisation as a holistic whole.

Clarity is obtained on the specific branch/route of MOT that this instance of research is following, when Wild's technology management domains are combined with Khalil's enabler categories. This research will resultantly occupy itself only with enabler number one, tools and methods for effective resource management, with cell (i) and (iii), which is the management of specific and generic technologies.

2.1.3.5 NEW PARADIGMS IN MOT

Khalil continues and lists several issues, within the field of MOT, which was identified and recommended to the National Science Foundation of America as warranting more intensified research attention. He analysed these issues under the heading of "new paradigms in MOT", according to his five enabler categories. Those issues falling within the above mentioned enabler number one (i.e. Methods and tools for effective management of resources) are of specific interest:

- Methods of performance assessment
- The measure of performance of technology
- The measure of Benefits from R&D activities
- New tools for optimizing decisions
- Alliances as alternatives to rivalry

He elaborates under the heading of bullet one: performance assessment methods, that traditional methods of accounting and financial assessment are biased ***against*** technological innovation. The risks inherent to maintaining the status quo are underestimated and the need exists for a rational approach to identify the performing and non-performing technologies. A more holistic scoring methodology is needed to integrate all the factors driving the modern organisation. Those being[2]:

- Value creation
- Quality
- Responsiveness
- Agility
- Innovation
- Integration
- Teaming and
- Fairness

The text in *section 2.3.3 -Measurement systems,* will cross reference back these specific new paradigm requirements when it addresses them. For now it is useful however to note only that certain total quality excellence models do exhibit measuring criteria that at eye-level will address these scoring requirements.

2.1.3.6 GENERIC GOAL ORIENTED FUNCTIONAL DEFINITION OF MOT

For the purposes of this dissertation, it can be derived from this section and sections (2.1.3.1), (2.1.3.2), (2.1.3.3) & (2.1.3.4) that technology management is about technical, functional artefacts (specific and generic), manifested in business processes, delivering a goal orientated capability that must be management for goal achievement and change, in the context of an operating environment and a determinant business strategy. Refer to Figure 12 below:

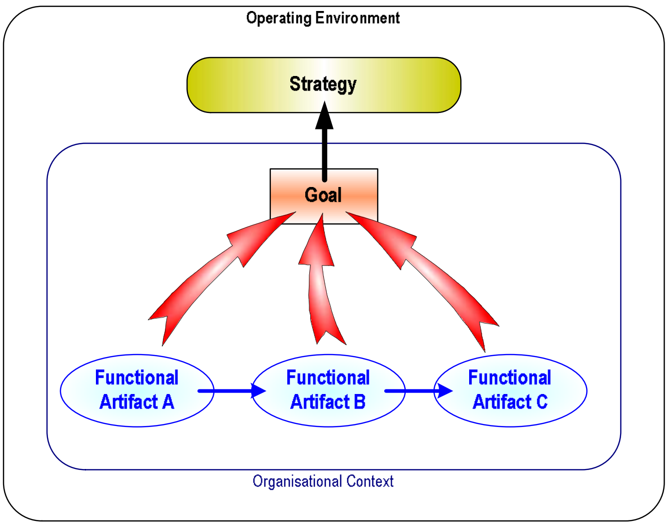

Figure 12: Generic goal oriented functional definition of MOT

2.1.4 - Technology strategy defined

Up to now the focus in the text was on the establishment of a theoretical backdrop for the establishment of an understanding of technology strategy. The discussion centred on the fundamental concepts necessary for such an understanding, these being the concepts of "technology", "management" and the discipline of "technology management". In order to progress towards a definition for technology strategy, the concept of "strategy" itself must first be understood. This understanding must then be coupled with the concept of "technology" in order to arrive at a fresh definition of technology strategy.

In the following sections the text laboriously dissects each relevant facet of technology strategy. It does so for a very specific reason. It painstakingly drives each argument necessary to arrive at the specific definition and delineation of technology strategy it requires to govern the dissertation model in *Chapter 3 -The development* of an internal technology strategy assessment model. The text first reiterates

- the classical definitions of technology strategy as found in literature.

It then moves on to cover the technology strategy concepts of:

- technology strategy substance,
- the dimensions of technology strategy,
- technology strategy dynamics,
- the process of technology strategy,
- the context of technology strategy and finally
- the linking and integration of technology strategy with business strategy.

In conclusion it summarises the findings of each sub-section, and justifies the establishment of the arguments.

2.1.4.1 WHAT IS MEANT BY STRATEGY?

So what comes to mind when the word "strategy" is mentioned? From the outset it must be made clear that there is no quick response to this question. Nickols (2001) quite rightly states that "strategy is a broad, ambiguous topic. We must all come to our own understanding, definition, and meaning"[31]. The American Heritage Dictionary of the

[31] Nickols, F., 2001, Strategy-Definitions and Meaning, http://home.att.net/~nickols/articles.htm

English Language[32] defines strategy as a plan of action intended to accomplish a specific goal.

Mintzberg (1994) in his book, *The Rise and Fall of Strategic Planning*[33], highlights the utilisation of the word "strategy" being common to four concepts:

- strategy as a *plan*; a means of getting from here to there,
- strategy as a *pattern* in actions over time
- strategy as *position*; that is, it reflects decisions to offer particular products or services in particular markets and
- strategy as *perspective*; specific vision and direction.

Andrews (1980) a respected author, and Harvard Business School professor presents his definition of corporate strategy as:

> Corporate strategy is the pattern of decisions in a company that determines and reveals its objectives, purposes, or goals, produces the principal policies and plans for achieving those goals, and defines the range of business the company is to pursue, the kind of economic and human organization it is or intends to be, and the nature of the economic and non-economic contribution it intends to make to its shareholders, employees, customers, and communities.[34]

Khalil agrees with this definition when he states that strategy entails the definition of goals, deciding on the way these goals are going to be achieved, the setting of actions plans for specific tasks, and the following up of these plans to ensure goal achievement. Khalil further on in his authoritative chapter on business and technology strategy abstracts these aforementioned concepts and defines the business strategic management process as consisting of three interrelated components or functions:

- **Strategic planning** which is the process of strategy formulation
- **Strategic implementations** which is the implementation of operational action plans and strategically spawned projects

[32] *The American Heritage® Dictionary of the English Language: Fourth Edition*, 2000, http://www.bartleby.com

[33] Mintzberg, H., 1994, *The Rise and Fall of Strategic Planning*, Basic Books.

[34] Andrews, K., 1980, *The Concept of Corporate Strategy*, 2nd Edition, Dow-Jones Irwin.

- **Strategic evaluation** which refers to the management feedback mechanisms, the broad organisational learning process and refinement and improvement initiatives.

Strategy also manifests itself at, and is distinguished by the various levels of the corporation: corporate level, business unit level and functional level[35]. It can also further be differentiated by the time horizon, specificity and participants

Numerous other sources were consulted: Khalil[2] elaborates extensively on the formulation and methods used in strategic analysis. Mintzburg and Lampel (1999)[36] analyse the evolution of strategy in terms of ten distinct schools of perspective. Eisenhardt (1999)[37] examines strategy as a decision making process and the dynamic requirements it places on the company. Although the subject of strategy is a study field in its own right with underlying philosophies, schools of thought, management styles and numerous techniques for deriving it, the text will not be examining the *process* of strategy and neither the *mechanisms* of strategy. The *existence*, *manifestation* and *expression* of strategy is of more concern.

Nickols (2001)[31] defines strategy as the bridge between policy or goals and tactics or concrete actions. He continues to state that strategy and tactics together provide the gap between ends and means, and that strategy has no existence apart from the ends it seeks.

So what is strategy then? For the relevance of the text, strategy can be summarised to be

- objective orientated,
- relative in terms of its organisational position,
- a continuous process consisting of phases, and not a single activity and
- ultimately results in an operational manifestation with action plans and metrics

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[35] Pearce II, J.A. and Robinson Jr.,R.B., 1982, *Strategic Management – Strategy formulation and Implementation*, Irwin, Illinois

[36] Mintzburg, H. and Lampel, J., 1999, *Reflecting in the Strategy Process*, Sloan Management Review, Spring 1999

[37] Eisenhardt, K.M., 1999, *Strategy as Strategic Decision Making*, Sloan Management Review, Spring 1999

2.1.4.2 THE CONCEPT OF TECHNOLOGY STRATEGY

What is a technology strategy then? Ford(1988)[38] defines technology strategy as "that aspect of strategy which is concerned with exploiting, developing and maintaining the sum total of the company's knowledge and abilities". Burgelman *et al* state that technology strategy is a foundation where questions relating to technological competencies, investment levels, technology sourcing and specific technology selection can be answered from. Vernet and Arasti (1999)[13] refer to technology strategy as the firm's priority in technology development orienting the firm's future actions in technology issues. Technology strategy thus occupies itself with the strategic handling of technologically related issues with the sole purpose of enabling the attainment of the firm's established vision.

What is the existential reason for technology strategy? The answer lies in the same reason why business strategy exists. A company's mission and vision is an expression pertaining to the inherent reason behind the company's existence and its core values. A business strategy, and its accompanying action plans, is purposefully developed to design a route and a vehicle that that would take the company from its current position, to a position of potential attainment of its vision. Given the current capitalistic economical age, the sole purpose of a business strategy is thus to gain a sustainable economical advantage. The purpose therefore of a technology strategy is to gain a sustainable technological advantage that will provide a competitive edge[2].

The text has up to this point defined and delineated the field of MOT and its tangents with other disciplines. The text now builds upon that understanding in order to position the sub-discipline of technology strategy within MOT.

2.1.4.3 A POINT OF DEPARTURE - THE DIMENSIONS AND SUBSTANCE OF TECHNOLOGY STRATEGY

The discipline of technology strategy has evolved over time and it is important to establish a cognitive framework about how to think about technology strategy. One of the first pillars of such a conceptual framework is to understand the substance of technology

[38] Ford, D., 1988, Develop your technology strategy, Long-Range Planning, Vol.2, No.5, pp.85-94

strategy. Burgelman *et al*[18] in their insightful paragraph on the substance of technology strategy, refer to the four substantive dimensions of technology strategy. They state that a view towards technology strategy can be taken based upon any one of four stances. Since the text is positioned in terms of these particular stances, it is worthwhile to briefly discuss these four perspectives.

- Competitive strategy stance

  This view takes the perspective that technology strategy is but only a component of a more comprehensive business strategy. This view is strongly supported by Porter (1988)[3], who in his authoritative article on competitive strategy, indicates that a technology strategy is but one element of a broader, more generic competitive strategy. The business dictates in a manner the role that technology, as a competitiveness driver, should play and thus utilises technology as either a defensive or an offensive instrument in its execution.

- Value Chain Stance

  Porter is mainly credited for this stance's view. He advocates that a firm's final offering is a result of a series of value adding functions stringed together in a value chain. Each function of the firm has a unique role to play in the establishment of the final offering and consequently adds to the overall cost and value proposition of the offering. This view is closely related to the competencies and capabilities-based views. The competency-based view in essence proclaims that a firm's competitive advantage is founded on a limited number of core capabilities manifesting in a number of core technologies, which in turn form the backbone of the firm's products.

  The concept of a technological core competence has in recent years re-emerged in literature. Burgelman *et al* contributes this mainly due to Prahalad and Hamel (1990)[39], building on the work Selznick(1957)[40] and

[39] Prahalad, C. and Hamel, G., 1990, *The core competence of the corporation*, Harvard Business Review, 68, 79-91

[40] Selznick, P., 1957, *Leadership in Administration*, Harper and Row, New York

Andrews(1981)[41]. It is defined that a company's core competencies are those characteristics that form the underlying base for their offerings, differentiate themselves from their competitors and are hard to imitate[2]. Khalil continues that cognisance of the company's core competence is of fundamental importance in the formulation of a technology strategy. The exploitation of these competencies entails that "each of these technologies be identified and categorised appropriately as to their relative importance to the company's activities"[2]

Porter combines his competitive strategy stance with that of the value chain paradigm. He advocates the optimisation of the internal value chain of an organisation in order to pursue an overall generic cost leadership, differentiated or focused position strategy. The attainment of the aforementioned is achieved by means of executing the activities of the business processes in the most efficient and effective manner. The technology strategy is thus utilised as a "potential powerful vehicle with which the firm can pursue each of the three generic strategies"[3].

- Resource commitment stance

  This stance reflects the intensity of the company's resource commitment towards technology, which is directly linked to the depth of the technology strategy. Such a strategy typically originates from the need to have a broad base of available technological options. Greater technological options lead to greater flexibility, which translates into enhanced agility of response and enhanced competitiveness.

- Management stance

  This instance is where companies deliberately structure themselves in terms of their management approach and organisational design, to easily embrace certain strategies. Their functional composition and management structure are deliberately designed in such a manner as to promote rapid execution of specific operational options. This operational advantage

[41] Andrews, K., 1981, *The concept of corporate strategy*, Irwin, Illinois

ultimately translates into enhanced, accelerated responsiveness and potential cost savings.

2.1.4.4 THE DYNAMICS OF TECHNOLOGY STRATEGY

Burgelman *et al* also refer in their text to the concept of evolutionary forces acting in upon and shaping the development of technology strategies over time. They highlight the fact that a firm's technology strategy at a given time is not entirely endogenous, but is "significantly affected by the evolution of broader areas of technology that evolve largely independently"[18]. They firstly identify the generative forces of technology evolution and the company's own strategic action. Secondly they identify the integrative or selective forces of the particular industry context and the firm's organisational context. They suggest a graphical framework, as depicted in *Figure 13: Determinants of technology strategy*, to conceptualise and discuss these forces.

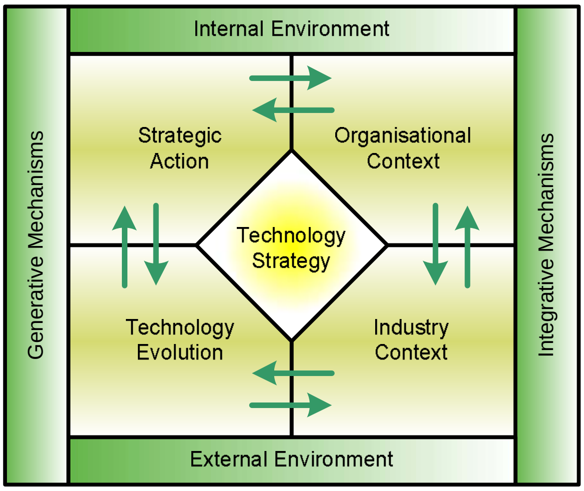

Figure 13: Determinants of technology strategy

Each of these forces is briefly discussed below:

- Industry context

  This force relates to aspects such as dominant designs, additional requisite assets needed for commercialization, industry standards, the industry structure as understood in terms of Porter's five force model and particular competitive effects as caused by interplay between social systems and technological change

- Technology evolution

  This force drives the fact that any technology strategy is a function of a broader technological evolution that "transcends the strategic actions of any given firm"[18]. Aspects of inclusion here are S-curve evolution trajectories, product-process technology interaction, emerging new technologies and competence enhance or competence destroying consequences of new technologies.

- Organisational context

  This force relates to the administrative approaches and cultural aspects of an organisation that influences its internal capability to deal with strategic related, technological challenges. Certain organisations due to their inherent conservative culture, will not adopt radical technologies which in turn will force them to reinvent themselves. Such companies rather opt for incremental technological improvements and a smoother technological transition.

- Strategic action

  The inertia that is embedded in a firm's current strategic direction frequently impedes the adaptation of a strategic change. This phenomena is rooted in the organisational knowledge that is captured in a firm's strategic direction due to past and current successes. This paradigm resembles that of the Abernathy productivity trap-paradigm[42] in the sense that companies become so effective in their execution and management of their current strategy, that adoption of a new strategy would be counterproductive. This strategic inertia is a strong management force which impacts the adoption of a technological option.

The above mentioned discussion is fundamentally governed by the acceptance of a *learning framework of technology strategy*. This framework is in turn based upon one of the four strategic stances, as discussed previously, namely that of a capabilities-based stance. Burgelman *et al* state that a given technology strategy is a function of the quantity and quality of technical capabilities that feed it, and that the experience gained from enacting the strategy, feeds back into the learning process. Refer to *Figure 14* below:

[42] Abernathy, W., 1978, *The productivity dilemma*, Johns Hopkins University Press, Baltimore

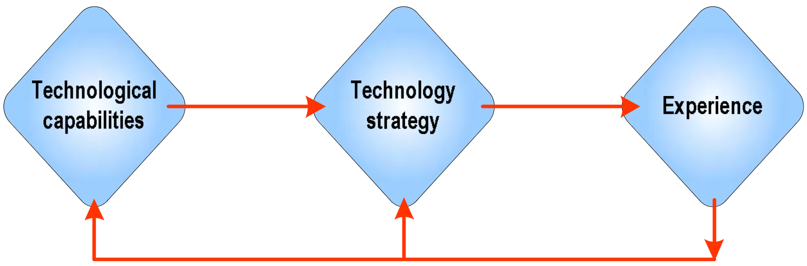

Figure 14: A capabilities-based organisational learning framework of technology strategy

To recapitulate: the text acknowledges that a firm's technology strategy at a given point in time is always a function of certain dynamic forces acting upon the firm. The substance of the technology strategy is formed by these forces which are internal and external, integrative and generative. The resultant technology strategy, and the enactment of it is then but an end-instance and learning experience for the formation of yet a new technology strategy. This process is captured within the boundaries of a learning framework of technology strategy.

Such a learning framework however presupposes that a *technology strategy process* exists which governs a cyclic behaviour such as this. This presumption leads the text into the discussion of the process of technology strategy.

2.1.4.5 THE PROCESS OF TECHNOLOGY STRATEGY

Stacey and Ashton proposed a structured approach for technology strategy management. Refer below to *Figure 15: Structured approach to develop and implement a technology strategy*.

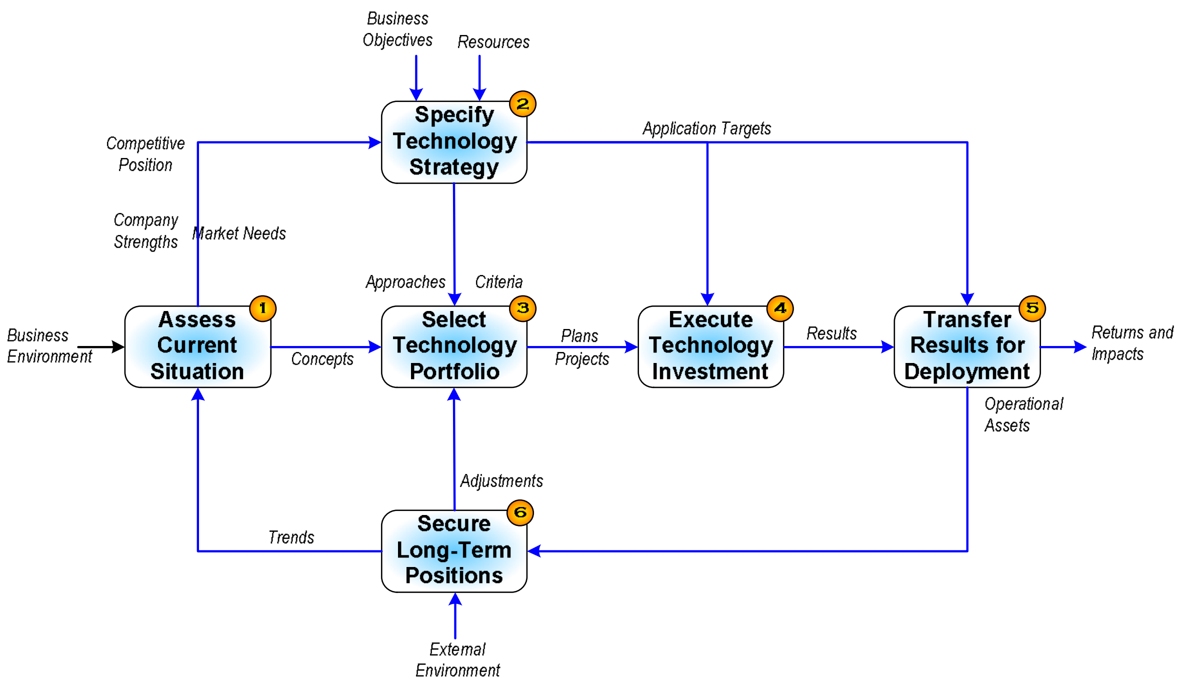

Figure 15: Structured approach to develop and implement a technology strategy

The following paragraphs will briefly discuss this structured approach. Refer to the numbered steps (1 through to 6) in *Figure 15* for reference.

- Step 1 - Assess the current situation

  Here the firm establishes a full understanding of its current position and performance. It is also necessitated to develop a full understanding of the future business and technology environments in which the firm foresees it is going to operate in. Typically in light of these environmental factors the goals of the organisation are questioned and re-evaluated. The strategic technology areas (STA's) are consequently identified and reviewed in line with the re-evaluated organisation goals.

- Step 2 - Specify the technology strategy

  Here the broad organisational goals are translated into operational and tactical plans. The technology plan, which is generated here, must address and support the four main elements of any generic strategy, namely customers, competitive approach, investments and organisational culture. The generated technology strategy must be consistent and in line with the business strategy and the other functional strategies. Refer to section *2.1.4.6-Technology strategy – context*, for a discussion of the context of the technology strategy within the overall business strategy. A formal plan must be drawn up depicting the actions and human resources responsible for the execution and achievement of specific technological milestones.

- Step 3 - Select the technology portfolio

  Based upon the technology plan, appropriate technology candidates are selected to populate the required technology portfolio. Reference can be made to the anticipated future technologies and artefacts as sources from the technical environmental review in step one. Selection criteria are formalised and the screening process is initiated.

- Step 4 - Execute technology investments

  The resource commitments to the selected technological investments are made and the project management function takes over the execution management of the technology plan. Performance milestones are identified and the process is measured, managed and reviewed periodically.

- Step 5 - Transfer results for deployment

  This step entails the technology transfer process. The logical result from steps one to four is the realisation of the specified technological objectives. The technology investments must resultantly be measured and assessed for pay-off and contribution within products and processes. As Wild quite rightly states: "It is in achieving the objective of profit that technology makes its contribution, embodied in the product or the process by which it is provided"[30].

- Step 6 - Secure long-term position

  The final step involves the monitoring, review and feedback functions. These are critical functions since they ensure alignment and relevance of technologies and objectives alike.

The above mentioned process is very similar to that of *Figure 16: Technology strategy in the business context*, as referred below:

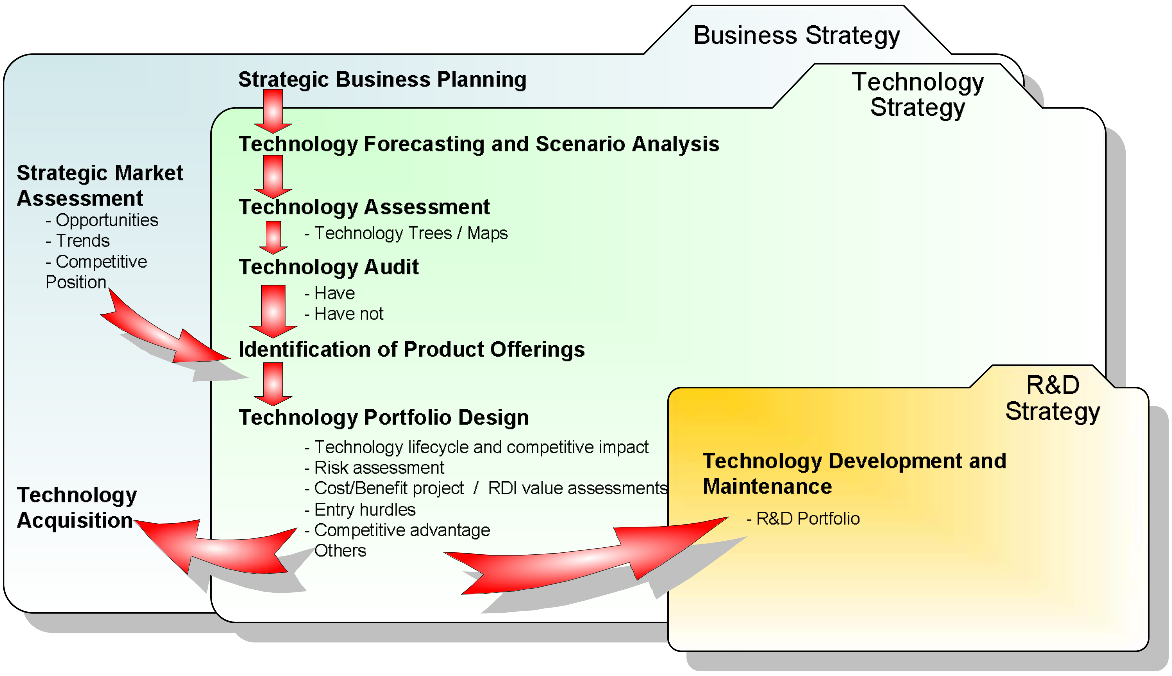

Figure 16: Technology strategy in the business context[43]

The technology strategy-business context model, *Figure 16*, differentiates between business, technology and R&D strategy. As the text will reflect in *section 2.1.4.6-Technology strategy – context*, the context of technology strategy in terms of the overall business strategy is very important since it is a subservient strategy enabling the realisation of the business strategy. This proposition, as a discussion topic on its own, is however not under scrutiny now, but the relative activities from a process point of view, is however significant. The text is not so much concerned about the overall process of determining the technology strategy, but it is more interested in specific activities within the process life cycle. The text acknowledges the fact that technology strategy is a continuous process with definite functions and activities; it is however more interested in the function of assessment and measurement (steps five and six collectively in Stacey and Ashton's structured approach).

The functions of the technology strategy-business context model as depicted in *Figure 16* can be directly mapped into the main steps of Stacey and Ashton's structured approach, as shown in *Figure 15*. *Table 2* below graphically illustrates the mapping of functions between the two models:

[43] Class handouts for Management of Technology ITB 783, 2000, *Technology Strategy Model*, University of Pretoria

Stacey and Ashton's structured approach	**Technology strategy-business context model**
Assess Current Situation	**Strategic Business Planning** **Technology Forecasting and Scenario Analysis** **Technology Assessment** **Technology Audit**
Specify Technology Strategy	**Strategic Market Assessment**
Select Technology Portfolio	**Identification of Product Offerings** **Technology Portfolio Design**
Execute Technology Investment	**Technology Acquisition** **Technology Development and Maintenance**
Transfer Results for Deployment **Secure Long-Term Positions**	

Table 2: Function comparison between Stacey and Ashton's structured approach and the technology strategy model

Interestingly to note is the lack of a feedback and assessment function in the technology strategy-business context model, which correlates to steps five and six collectively in Stacey and Ashton's structured approach. This is a matter of concern since it is also not consistent with the learning framework of technology strategy as depicted in *Figure 14* and discussed in *section 2.1.4.4 The dynamics of technology strategy*. *Figure 17: Technology strategy model*[25], as shown below, however does indicate the feedback function.

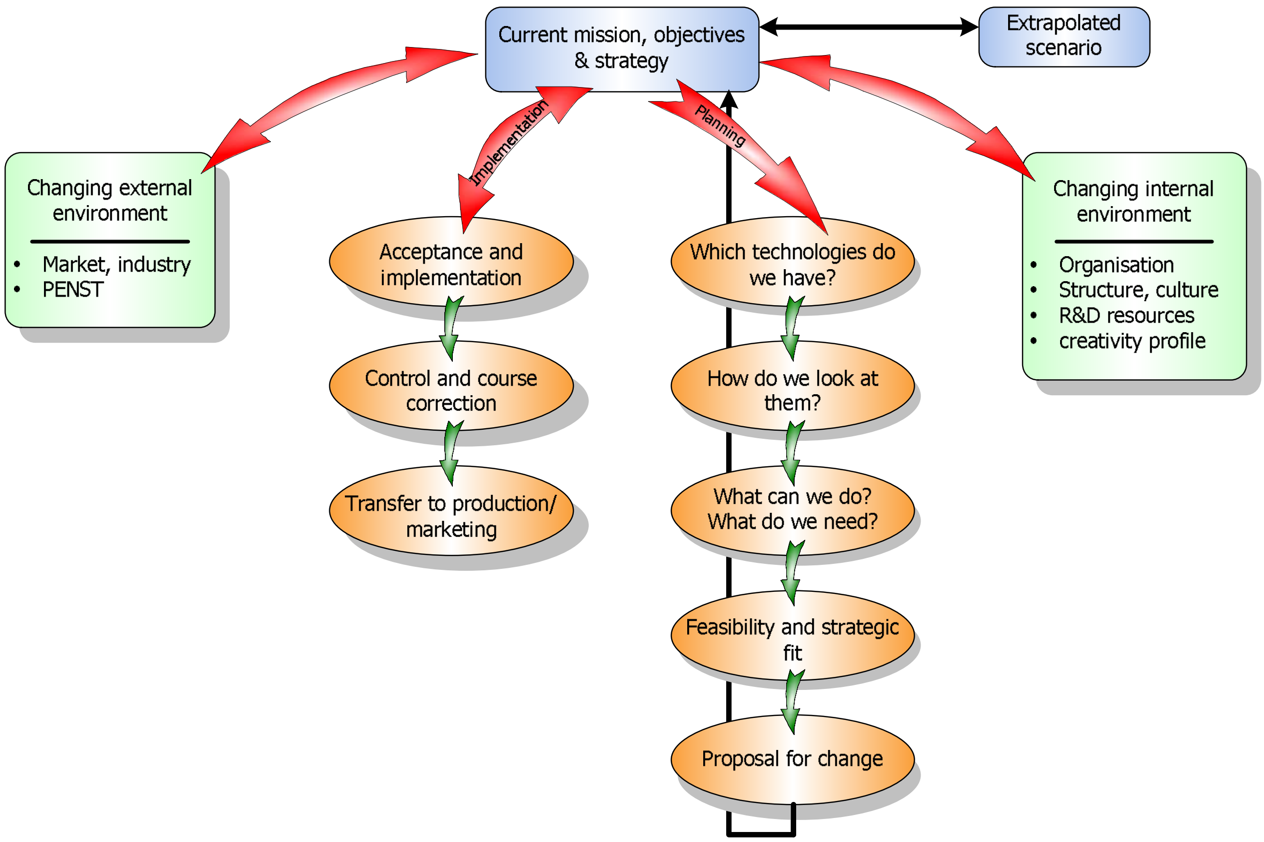

Figure 17: Technology strategy model

From a process perspective, the primary focus of this dissertation is to concentrate on the measurement and assessment function within the technology strategy life cycle, i.e. the “Feasibility and strategic fit” and “Proposal for change” functions in *Figure 17*.

The issue of context has been lightly touched in the preceding paragraphs. This is important since general systems theory necessitates the definition of the boundary of the system under inspection[44]. Only once clarity is obtained on the context of the system, can analysis be undertaken on the behaviour of the system itself.

2.1.4.6 TECHNOLOGY STRATEGY – CONTEXT

As stated in the previous section, the concept of a technology strategy context must not be missed. Porter strongly declares that that the starting point for analysing a technology strategy, is the cognisance of a broader concept of overall competitive strategy[3]:

[44] Schwarzenbach, J. and Gill, K.F., 1985, System modelling and control, Halsted, 2nd edition

"Technological strategy is but one element of an overall competitive strategy". Stacey and Ashton expound that "technology strategy must be a consistent part of overall business strategy"[27]. Badawy in his report, *Technology management education: alternative models*, refers to technology management as having a "...strong strategic orientation relating to the role of technology in corporate strategy"[28]. Even Wild[23] corroborates the aforementioned when he states that "...technology is implicitly regarded as playing a supportive or subservient role and is confined within boundaries determined from the hierarchy of strategies". Wild elaborates on this observation by means of *Figure 18: Hierarchy of strategies*.

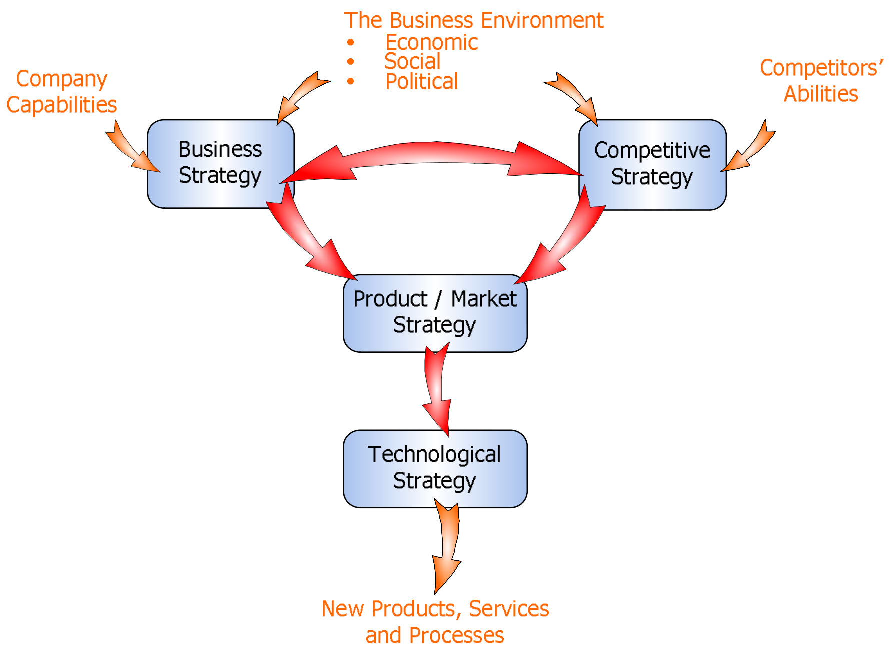

Figure 18: Hierarchy of strategies

He explains this "hierarchy of strategies" on the fact that a technology strategy is but a vehicle to deliver and enact a specific product/market strategy. Such a product/market strategy is in its turn a subset of a more encompassing business and competitive strategy. This notion is of course inline with Porter who advocates that a technology strategy contributes to three generic competitive strategies, namely (1) overall cost leadership, (2) overall differentiation and (3) a focussed strategy combination of both. De Wet(1996)[45]

[45] De Wet, G., 1996, Corporate strategy and technology management: creating the interface, 5th International Conference in Management of Technology, Miami, pp. 510-518

implicitly also supports this view when discusses the concept of the technology balance sheet, refer *to Figure 19: The technology balance sheet*.

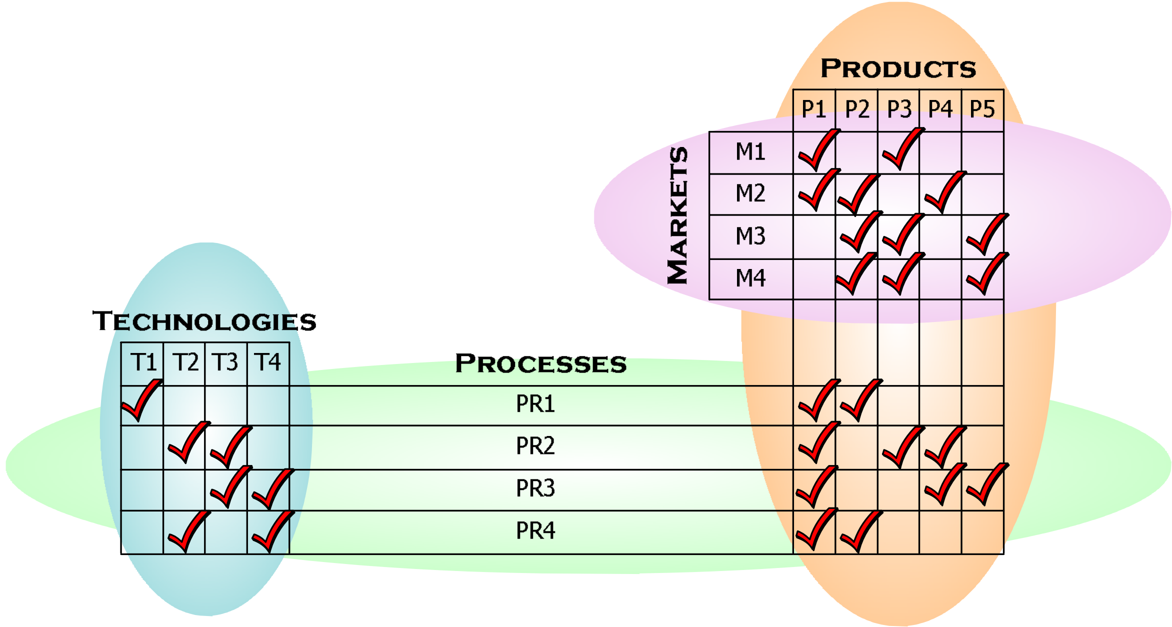

Figure 19: The technology balance sheet

Referring to *Figure 19*, De Wet states that a "vital interface between corporate strategy and the technology management function" is necessary. He utilises the classical product/market mix morphology to represent the embodiment of the corporate competitive strategy. Per market specific offering, he establishes the link per offering delivering process, per process enabling technology. He thus implicitly corroborates that the technology strategy function serves the "higher" competitive strategy.

Referring back to *Figure 16: Technology strategy in the business context*, the model also clearly shows the R&D strategy serving the technology strategy, serving in turn the broader business strategy.

Although the previous mentioned evidence might prove to be overwhelming convincing, there however does exist literature that contradicts this view. Khalil in his internationally acclaimed textbook *Management of technology – The key to competitiveness and wealth* *creation*, quotes from G.R. Mitchell's lecture notes that two philosophies exist. Refer to Figure 20: Framework for *formulation of business* and *technology* strategies[46] below:

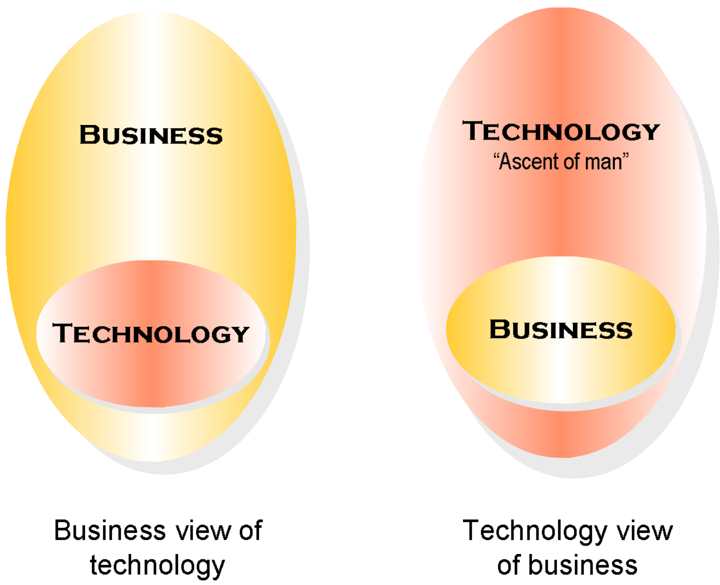

Figure 20: Framework for formulation of business and technology strategies

Mitchell argues, as it is depicted in *Figure 20*, that the "business side perceives technology as a subset of business, while technologists perceive business as a subset of the general technological ascent of human beings"[2]. This is a very valid argument! On the one hand business identifies technologies that are relevant and in support of its strategies, so as to create and take hold of opportunities to satisfy market needs. On the other hand, technology evolves independently, but inline with human beings and actually creates strategic business opportunities. The mere fact that businesses can utilise technology in its operations, is a benefit to the business and actually a dependant position of sorts. Khalil closes the argument:

> For optimal results both sides must be integrated into one organisational strategy. Metaphorically speaking, integrating technology strategy and organisational strategy can be thought of as two sides of a coin: Either side is worthless without the other.

The text acknowledges that the argument of business strategy vs. technology strategy is not an academically one sided debate. It does however side with the majority of the

[46] Mitchell, G.R., 1995. In Khalil, T.M., 2000, Management of Technology - The key to competitiveness and wealth creation, McGraw-Hill

literature for the sake of strategy only, as apposed to the argument of independent existential reason. The text thus adopts the view that businesses select technologies that are in support of its strategies and which does not dictate or constrain its vision.

So to summarise: the text within this section has thus now proven strongly that:

- a technology strategy is not an isolated, lone standing strategy,
- but is in broad terms determined by and is a derivative of the overall business strategy and,
- actively contributes to the realisation of the business objectives,
- by means of providing technological artefacts in the context of business processes, with a strategic reason for existence.

2.1.5 - Linking and integrating technology strategy with business strategy

Taking cognisance of the context of technology strategy within the broader competitive strategy is but a theoretical and mental exercise. Actually applying it in everyday business proves to be somewhat more of a practical challenge. “Effective technology management is based on successfully linking business and technology strategies”[2]. “Organisations that know how to link their technology strategy with their business strategy will be more competitive in the global market place”[2].

These above mentioned statements hold significant truth for the management function of the firm. Roberts(1995)[47] in his insightful market survey, although maybe a bit out dated for academic purposes, showed that as little as fifty percent of US companies have strongly linked their technology and overall corporate strategies. The survey further corroborated this gap when it stated that as little as thirty four percent of US company CEO’s were at some point involved in technology strategy development activities. It thus seems to be that although management is aware of the strategic and operational pressures to align these two strategies, they find themselves stranded as to how to go about actually doing it. Mitchell(1995)[46] consequently emphasises that the first step towards integrating these two strategies, is to get the business and technical sides of corporate management to agree on a common set of priorities and objectives. It is

[47] Roberts, E.B., 1995, *Benchmarking the strategic management of technology-1*, Research Technology Management, Vol.38, Issue 1, pp.44-56

worthy to highlight at this point, that this statement is of critical importance. As the text will point out later on in *section 2.2.3.3-Specific requirements for this dissertation*, this statement is an important selection criterion in the specific choice of modelling method whereby corporate goals and objectives are visually represented.

2.1.5.1 THE RELATIONSHIP BETWEEN BUSINESS AND TECHNOLOGY STRATEGY

Business can, according to Vernet and Arasti (1999)[13], choose between two distinct approaches when it comes to aligning and bridging the divide between business and technology strategy: (a) either the *current* technological competency must be capitalised upon to elaborate or implement a *new* competitive strategy, or (b) *new* technological competencies must be developed to support the *current* competitive strategy. This "crossroads" is depicted in *Figure 21* below:

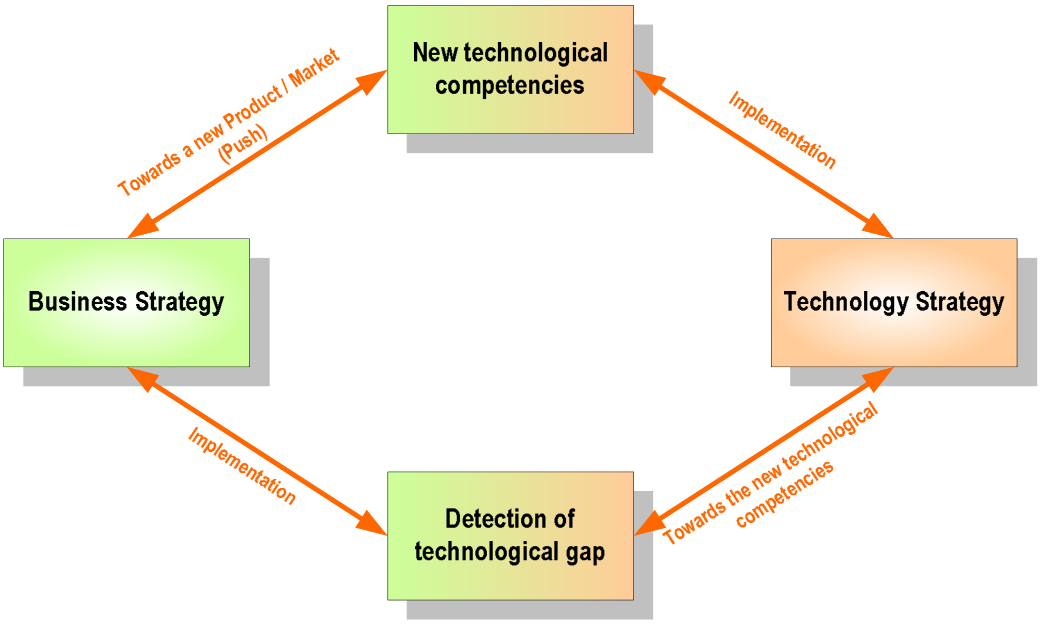

Figure 21: Two directions in bridging technology and business strategy

This dissertation is only focused upon the "strategic management of technology"-route, rather than the "technology-based strategic planning"-route; in other words, the utilisation and improvement of the current technology base to support the business strategy. In this instance the business strategy leads and dictates to a certain extent the technology strategy, which in turn follows.

2.1.5.2 ALIGNMENT MODEL #1: FEURER ET AL'S BUSINESS ALIGNMENT FRAMEWORK

All of these aforementioned definitions, constructs and deductions are theoretically very beautiful, yet Stacey and Ashton[27] state that "there are very few formal tools that are directly applicable to the *production* of a technology strategy other than general guidelines, conceptual matrices and checklists". Focussing more on the specific area of IT, Feurer *et al*(2000)[48] suggest a framework for practically linking strategy to actions. They advocate that strategies:

- be formulated by closely examining the role of technology as an enabling source and that it
- be translated into actions through highly interactive processes that consider all current and future business factors.

They consequently suggest the adoption of a business alignment framework, as depicted in *Figure 22*:

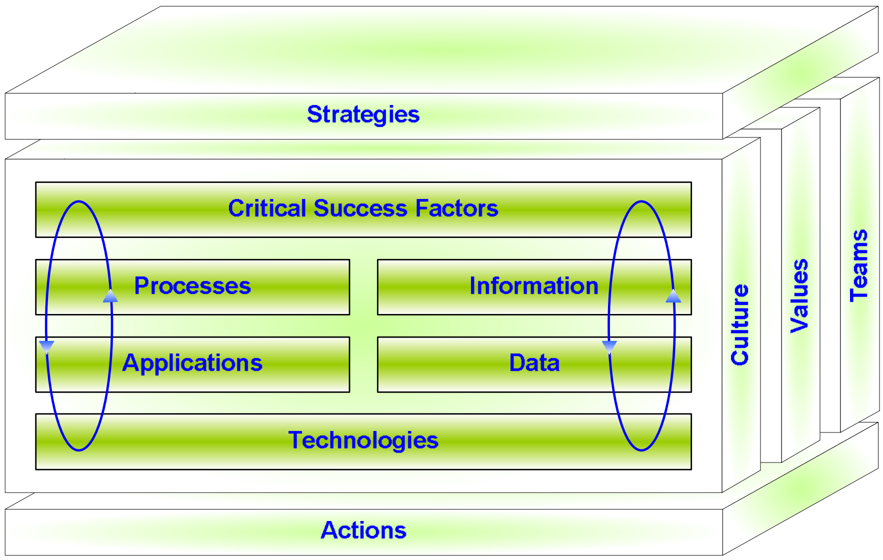

Figure 22: Business alignment framework

They advocate that critical success factors (CSF's) reflect the business strategies and that these in turn are the determining force for the necessary business processes and their corresponding information needs. They state:

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[48] Feurer, R., Chaharbaghi, K., Weber, M. and Wargin, J., 2000, Aligning strategies, processes, and IT: a case study, Information Systems Management

> The availability, cost and flexibility of different technologies may limit their selection and therefore business processes must be translated into feasible application models while information requirements are translated into workable data models. In this way, the gap between the ideal and workable solutions can be minimised while ensuring a logical linkage between strategy and optimised actions.[48]

The aim of the framework is twofold: (1) to make process changes without being restricted by or limited to existing technology, applications, and suboptimal data structures, and (2) to make visible the impact of new technologies on processes and visa versa. They even consider the cultural and value impact of such changes:

> The business alignment framework takes into account the necessary process changes resulting from changes in the environment as well as potential advancements in technology. Because any change in strategy and technology potentially results in a change in the value system, culture, and team structures of the organisation, it is vital to include these additional factors within the overall framework.[48]

Feurer *et al* suggest that the framework is implemented in cross-functional teams which define business processes and information needs in parallel with technology enablers and models, which are then linked throughout the alignment process. They furthermore suggest that the approach should include the following modules:

- breakthrough objectives and process links,
- business models,
- technology enablers and models,
- solution mapping and selection and
- functional mapping.

They illustrate the above mentioned modules on the hand of *Figure 23*:

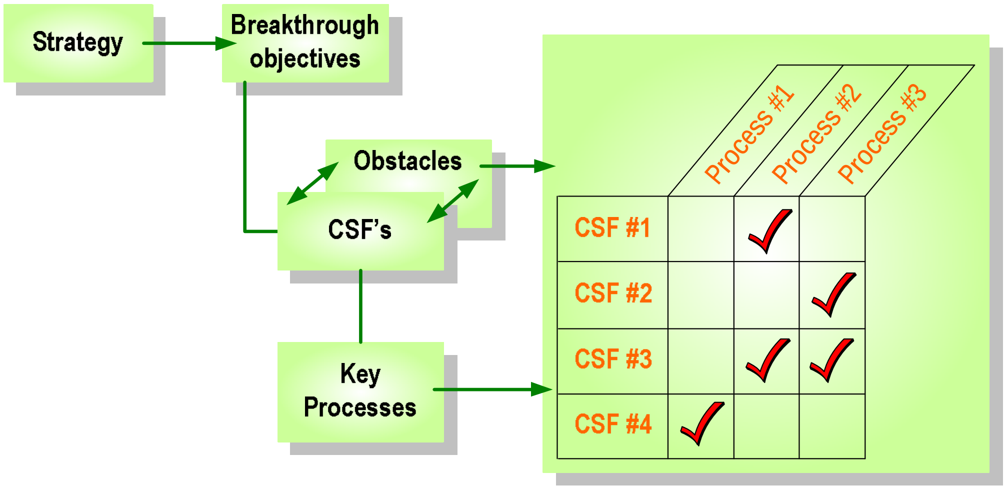

Figure 23: Breakthrough objectives, CSF's and key processes

Figure 23 indicates that strategy drives the identification of CSF's who in turn implicate the key, strategic processes. Technology enablers and information needs are then addressed inline with the above identified key processes and thus ensure alignment between the strategy and the actions on technology level. This practical implementation method is of core importance and the text will refer back to this method in *section 3.2* when it proposes its internal technology strategy assessment framework.

2.1.5.3 ALIGNMENT MODEL #2: ARASTI AND VERNET'S BPR-BASED MODEL

Another model to consider when endeavouring to link business and technology strategies, is that of Arasti and Vernet (1997)[19]. They propose BPR as not only a means to *link* technology strategy to business strategy, but also as a systematic approach to actually *accomplish* the business strategy. They propose the five stage BPR model, but with an emphasis on identifying key, strategic processes so as to arrive at what they call "critical technologies". Refer to *Figure 24* below:

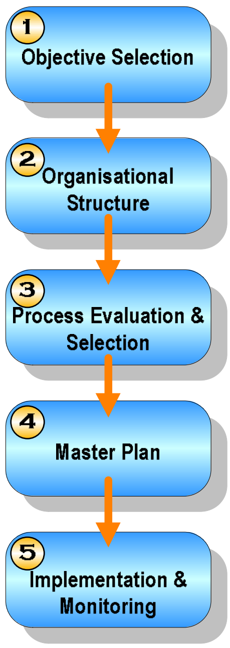

Figure 24: The five stage BPR model

They define the concept of "critical technologies" as follows:

> The "critical technologies" are those used or candidates to be used in "strategic processes", and the "strategic processes" [are those selected] by [the] BPR approach".

In a later text they define "strategic or critical processes" as the "internal activities which are the basic elements of competitive advantage; key elements to achieve firm global strategy"[13].

In Vernet and Arasti (1999) the five stage BPR model is then implicitly "plugged" into their proposed "five stage technology strategy elaboration"-model, which is depicted below in *Figure 25*. The BPR approach thus provides the analysis methodology to identify and deliver the strategic processes and strategic technologies.

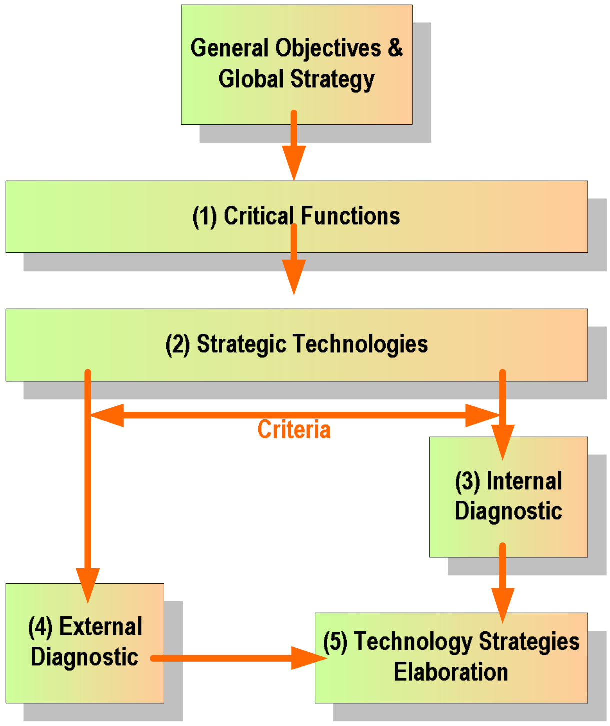

Figure 25: Five steps of technology strategy elaboration regarding the firm overall strategy

The five steps are defined to be the following:

- Establish an inventory of firm critical activities / processes;
- Identify candidate technologies for each critical activity / process (strategic technologies);
- Execute an internal diagnosis to assess the firm capabilities with respect to each strategic technology;
- Execute an external diagnosis to assess the industry attractiveness of each strategic technology; and
- Elaborate on the resultant technology strategy according to the general outlook of the technology portfolio.

As the text will show in *section 3.1,* this model in combination with Feurer *et al*s concept of utilising CSF's, will deliver the building blocks required for the development an internal technology strategy assessment framework.

2.1.6 - The concept of the implied technology strategy

The text has up to now indicated *what* strategy is and *how* one should go about thinking about it. The text, in *section 2.1.4.1-What is meant by strategy?*, has also indicated that strategy "ultimately results in an operational manifestation with action plans and metrics". In other words, strategy is manifested and enacted in the processes of the business. In layman's terms: strategy comes alive in common day-to-day activities. This deduction is in line with the previous section's discussion and in particular with *Figure 22* and *Figure 23*, which indicates that certain processes in particular contribute to the realisation of specific strategically derived CSF's.

If the above mentioned statement is true, as the text indeed indicated, then the converse is also implicitly true: business processes reflect an implied strategy. To phrase the statement differently: the processes that are enacted on a day-to-day basis reflect and contribute to an implied strategy, be it articulated or not. This means that any process contributes to an unspoken organisational goal. The implication of this logical deduction is that if one is to assess business processes in a framework that enables a strategic, goal-oriented reflection, then the sum of individual process contributions towards an organisational goal will result in a total organisational goal depiction of all processes. This collective organisational goal depiction is in itself nothing more than an alternative expression of the implied collective organisational strategy.

Extending this logical reasoning onto the technology layer would mean that technological artefacts, as deployed in organisational processes, contribute to the realisation of an implied technology strategy. This means that certain technological artefacts are indirectly contributing to the realisation of certain organisational goals, through their manifestation in specific organisational processes. Measuring this implied contribution would thus also imply measuring the implied technology strategy.

2.1.7 - The strategy domain – a summary

In conclusion: the concepts of technology and strategy have been analysed in isolation in *sections 2.1.1* -and *2.1.4.1* respectively. The text has also revealed in-depth the current status of literature on the various aspects of technology strategy as a subject. If cognisance is thus taken of all of these individual elements and definitions, the integration of them will resultantly deliver a specific, integrative definition of technology strategy. This integrative result defines technology strategy to be a

- specific goal or objective orientated plan,
- as viewed based upon a fundamental strategic paradigm, whereby
- technical functional resource capability (technological artefacts),
- that reside at relative levels of the firm
- and manifested in various processes,

- is continuously evaluated and assessed,
- through a multi-phased process,
- for its operational alignment and strategic contribution
- in order to learn and adjust and thus
- ultimately attain the vision of the organisation.

2.2 - UNDERSTANDING BUSINESS ARCHITECTURE

This section deals with the second domain, as depicted in *Figure 26* below, of the 3-tier approach:

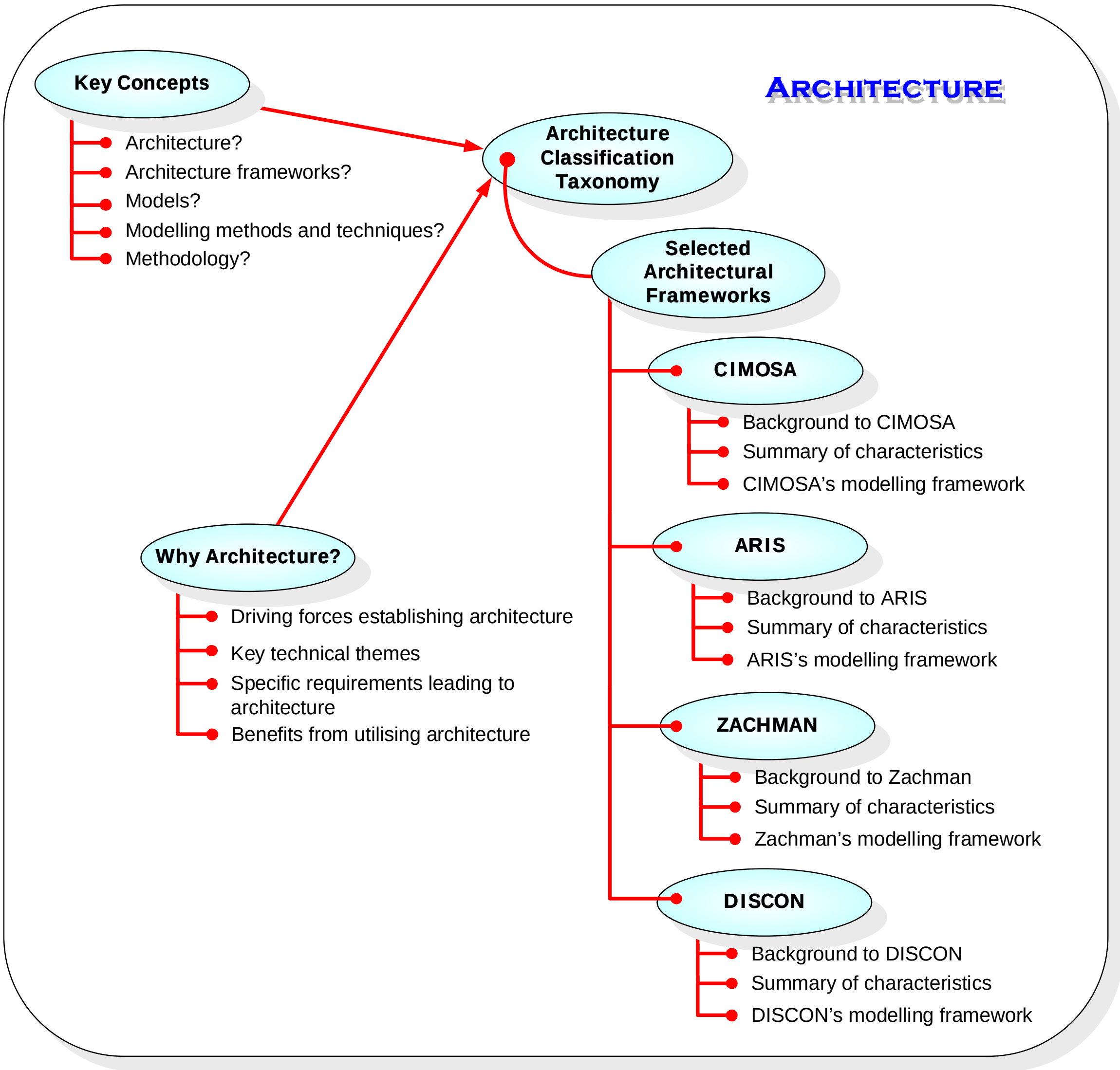

Figure 26: Domain 2 – The architecture domain

As stated in *section 1.2 -Problem statement*, the research problem necessitates a mechanism and/or technique which will facilitate the viewing of the organisational composition, the impact of strategy and technology, and the combination thereof on the typical services organisation. It thus requires a tangible mechanism to represent the intangible. In other words it requires a model of the organisation. The logical follow-up question thus begs to know which model must be selected utilising what technique?

Various modelling methods, standards and techniques exist in theory and in practice, each with its own following of proponents. The selection is thus rather wide and erring in the selection of the appropriate technique might not deliver the anticipated result. As the text will show in this section, a modelling method is a simplified, concrete mechanism to represent the complex and abstract. It is always in the context of a particular methodology and relevant to an architectural framework. It is thus as such always limited to the limitations of its framework. As the text will also show, the key to selecting a technique and a method set therefore lies in the selection of the underlying architectural framework.

The rationale behind the structure of this second section is to establish a theoretical knowledge base from which to select a specific architectural framework and its associated modelling methods, which will enable the achievement of research objective number two, which is namely:

- to decide upon a suitable technique for *viewing* the manifestation of business and technology strategy upon the typical services organisation.

The goal of this second domain is thus to establish a thorough understanding of architectural frameworks and their value proposition when it comes to representing complex systems, so as to select an appropriate framework with which to model the organisation and its unique manifestation of strategy.

2.2.1 - In defence of architecture

The world class competitiveness factors of scale, scope, and integration require organisations to assure (1) faster response to customers' requirements, (2) higher quality of offerings and (3) increased flexibility in terms of producing new, integrated offerings. Combine these requirements with the pressures to (4) increase bottom line margins, (5) decrease environmental impact, (6) increase operational safety and (7) improve working conditions and job satisfaction[49], and any organisation is doomed to fail. In order to survive, organisations must become more in control of their operations than ever before. To state it more bluntly: organisations must establish control over change. This implies that organisations must have the right information at the right place at the right time so as to facilitate efficient and effective decision making and change management actions.

[49] Bernus, P., Nemes, L. and Williams, T.J., 1996, *Architectures for enterprise integration*, Chapman & Hall, London

Organisations simply cannot rely on slow, manual reporting streams anymore, especially when technology is available to enable fast and accurate response. The same can be said for the establishment of technology strategy. Organisations cannot afford to traverse repeatedly through time and resource consuming strategic positioning exercises, every time a technology investment decision has to be made. The timeous availability of technological related strategic information, as impacting the operation execution of the specific value chain under investigation, is of the utmost importance.

The volume and complexity of data required in order to facilitate these unique information requirements for each individual point of need, at its appointed time, in its appointed format, is tremendous. This increases exponentially even further as the data still need to be managed through its life cycle phases of initiation, manipulation and delivery. Unless a *standard*, *integrated* and *holistic management* and *reference* mechanism exists to govern the development, enhancement, maintenance and decommissioning of operational and strategic activities, the organisation will bleed to death in its own haphazard and disorganised manner of operation. As the 1833 Webster's translation of the Bible prophetically corroborates in Matthew twelve verse twenty five: "every kingdom divided against itself, is brought to desolation; and every city or house divided against itself, shall not stand". That which is not governed, is by default free reined!

The concepts of enterprise integration, enterprise architectures and architectural frameworks were born and founded out of the above mentioned needs and threats. Enterprise architecture frameworks and information architecture frameworks provide the standardised basis from which to classify, store, extract, represent and reference data. In this specific context data entails everything from processes, strategies, organisational structures, resources, goals right down to the very information bits that represent the aforementioned. It is thus a vehicle for organisations that endeavour to manage and operate themselves in a holistic, optimised and integrated manner.

2.2.2 - Key concepts defined

Now that the reason for existence of architecture and architecture frameworks has been established, it requires the text to move towards defining the basic concepts and terminology. The text following is once again boring in the degree to which it describes and defines the relevant concepts. Special attention was once again taken to view and assess conventional definitions and to arrive at a very comprehensive and correct definition of the applicable term. Although once again laborious to work through, each term and its organically derived definition forms a building block in the research paradigm.

Each building block lays the foundation so as to arrive at a justified and convincing argument for the utilisation of a specific architecture framework and its corresponding models. This selected framework will ultimately represent the organisation, the manifestation of organisational composition, the impact of strategy and technology, and the combination thereof. All of this is done for the realisation of research objective number two; refer to *section 1.3 - Objective*.

2.2.2.1 WHAT IS ARCHITECTURE?

The Random House Webster's electronic dictionary and thesaurus defines architecture the noun as "the profession of designing buildings, open areas, communities, and other artificial constructions and environments". More on a generalised basis it also defines it as "the structure of something".

Engelbrecht(2000)[50] in his unpublished manual on business engineering defines architecture as the term that refers to the "framework, structure and style that is used to mastermind, design, engineer and create something with". Note that the concept of the architecture framework is a subset of the broader definition of architecture. This is important to the understanding of the architectural framework itself as discussed in the next section. This notion is echoed by Bernus *et al* [49] who define architecture as "any method for giving the structure or framework showing the interrelationship of all of the parts and/or functions of a device, system or enterprise". Later on in the context of the computer integrated manufacturing (CIM) environment, they state that CIM architecture can be defined as "a structured set of 'models' which represent the invariant building blocks of the whole CIM system...a basis for the design and the implementation of CIM systems".

[50] Engelbrecht, B., 2000, unpublished manual titled <u>*Business Engineering, the Object Oriented Framework*</u>, Version 3.0, www.discon.co.za

Whitman's(1997)[51] definition is that it is "an organised set of elements with clear relationships to one another, which together form a whole defined by its finality".

Another definition, according to Reijers and Van der Toorn(2002)[52], reads that an architecture can be defined as the fundamental organisation of a system embodied in its components, their inter-relationships, the relations to their environment, and the principles guiding its design and evolution.

Finally Scheer(1998)[53] defines IT architecture as describing the

- type,
- functional properties and the
- interrelationship among

the individual building blocks of the information system.

It is important to note that the discipline and concept of architecture not only relates to the classic context of buildings, but it is an important concept as well in the fields of business engineering, manufacturing and information systems. The text will show that the architecture concept in all three of the last mentioned fields is closely related and virtually synonymous.

The text thus defines and views architecture as a

- formal discipline or paradigm
- governing or guiding
- by means of methods
- the establishment, interaction or functioning of
- entities or building blocks
- thus providing reference or structure as to the
- entities' relation to the purpose of the whole.

[51] Whitman, L.E., 1997, *Enterprise Engineering*, Wichita State University, www.webs.twsu.edu/enteng/enteng7/enteng7.ppt

[52] Reijers, H.A. and Van der Toorn, R.A., 2002, *Integrating Business Process Reengineering with Application Development under Architecture*, Eindhoven University of Technology, http://tmitwww.tm.tue.nl/staff/hreijers/H.A.%20Reijers%20Bestanden/bprad.pdf

[53] Scheer, A.W., 1998, *ARIS-Business process frameworks*, second edition, Springer, Germany

2.2.2.2 WHAT IS AN ARCHITECTURE FRAMEWORK?

Once again the Random House Webster's electronic dictionary and thesaurus is consulted. It defines the noun *framework* as "a skeletal structure designed to support or enclose something" and also as "a frame or structure composed of parts fitted together".

Whitman defines a framework as "a collection of elements put together for some purpose".

Combining the above mentioned definitions with that of the definitions for architecture, one would arrive at the integrated definition for an architectural framework. For the purposes of this instance of research as manifested in this dissertation, an architectural framework is defined as the

- skeletal structure
- in which the manifestation of architecture, i.e. the entities, artefacts or elements
- is enclosed
- and inter-relationally referenced
- for a specific purpose.

2.2.2.3 ARCHITECTURE MODELS ANS MODELLING FORMALISMS

Bernus *et al* define a model as an abstract, simplified representation of reality. They continue to state that "a good model amplifies the important characteristics and conceals the details which are considered to be of low or no importance at a given abstraction level". They later also state that a "modelling formalism is a means to represent pieces of knowledge that have to be transmitted unambiguously. It allows one to build models according to a set of associated concepts".

The Random House Webster's electronic dictionary and thesaurus defines a model as "a representation, generally in miniature, to show the construction or appearance of something" and "a simplified representation of a system or phenomenon"

Models are thus only a means to

- represent the more complex reality
- in an abstracted,

- consistent and
- simplified, scaled down manner,
- at a specific abstraction level,
- utilising a specific technique
- to convey a piece of knowledge
- in an unambiguous manner.

2.2.2.4 MODELLING METHODS OR TECHNIQUES

The Random House Webster's electronic dictionary and thesaurus defines the word *technique* as "any method used to accomplish something" and also as "the body of specialised procedures and methods used in any specific field".

The same dictionary defines the word *method* as "a procedure, technique, or planned way of doing something", an "order or system in doing anything" and an "orderly or systematic arrangement, sequence, or the like".

A modelling method or technique is thus a

- specific,
- specialised
- manner of producing models
- related to a specific field or system, i.e. framework
- in an ordered or systematic type of arrangement

2.2.2.5 METHODOLOGY

Bernus *et al* define the word *methodology* as the "set of methods which involve the use of: modelling formalisms and their associated graphic tools; models and reference architectures; and structured approaches.

The Random House Webster's electronic dictionary and thesaurus defines the noun *methodology* as "a set or system of methods, principles, and rules used in a given discipline".

Moving ahead towards a *modelling* methodology, the text thus defines a modelling methodology as a

- set or compilation of
- related techniques or methods,
- which produce specific and specialised models
- as utilised in a formalised and structured manner
- within a specific field or discipline, i.e. framework

2.2.3 - Why business architecture frameworks?

The text has up to now defined, in detail, the utilisation of modelling techniques to produce models in a methodological manner, given the context of an architectural framework. It will now elaborate more formally into the reasons behind the existence and development of architectural frameworks. The following discussion takes off and formalises the debate as briefly started in the introductory paragraph *"In defence of architecture*".

As the text will indicate it firstly touches the *driving forces* behind the development of such architectural frameworks. It then moves on towards a discussion on the *technical themes* as encountered for the establishment of architectural frameworks and finally closes by discussing the specific *architectural framework requirements* of this research endeavour as stated in the research problem, -objectives and –goals.

2.2.3.1 DRIVING FORCES

- Changing markets

The ever tightening noose on production costs and the ever present pressure on margins demand of organisations to adopt manufacturing practises such as JIT, "make-to-order" and direct marketing strategies. The production process is pulled closer to the consumer and the marketing and distribution functions are trimmed to the minimal. Certain operating models even franchise the above mentioned functions to the consumers themselves, as in network marketing and direct marketing strategies. This implies exact procurement and production figures and a distribution function that can adopt and change on a daily basis. Error and time intensiveness is out of the question.

- Customer orientation / flexibility

The global requirements of customers have evolved from an institutionalised and culturally uniform need, which was satisfied by mass produced goods, to that of highly individualistic, niche requirements satisfied only in “make-to-order” and single unit production manufacturing paradigms. A global footwear company specialising in running shoes has for example adopted a four season per year design and manufacturing process, so as to keep abreast of international trends and similar competitor produced products. These requirements demand of companies to be able to change and adopt their offering delivering processes and the offerings themselves, at a competitive and cost effective rate.

- Environmental requirements

The regulator has also not left itself unheard. The pressures from international conservation organisations and national regulation lobbyists on topics such as resource conservation, environmental pollution, sustainable development and greener products, all demand a flexible and cleaner operating model.

- Human & social requirements

The hierarchical management models of previous years has made place for flatter and cross functional, project driven organisations. The global increase in working hours, the growing need of employees for entertainment and fulfilment at work and the break-up of the tradition family structures have all placed a growing burden on the peripheral organisational structures. In-house canteen facilities, medical dispensaries, gymnasium facilities and even employee overnight facilities have become mandatory rather than optional company bonuses. All of these place a tremendous overhead burden on operating margins and the value-add of such facilities are not reflected on traditional measurements such as share price and annual financial statements.

- New technologies & paradigms

The growing pace of technological development in the areas of information and telecommunications and the growing technological capacity to handle larger quantities of information have all contributed to the revolution in the IT industry. The geographically distributed and virtual organisations have stepped to the fore. Virtual companies selling virtual products over the information highway on an international scale on a twenty four hour basis have become the norm. The new economy has settled in and operational change is as certain as the coffee you drink every morning.

2.2.3.2 TECHNICAL THEMES

- Virtual / extended companies or the locality influence

As touched in the previous section under the heading of "new technologies and paradigms", the concept of the integrated, virtual company has proliferated. This specifically relates to the concepts of (1) information exchange and integration over geographically distributed areas, (2) the required architecture for such integrated information support and engineering cooperation and (3) the implied management and operational models required supporting such a company. The architectural dimension of locality has forced frameworks to start considering the possible incorporation of a locality view into their design.

- Total life cycle or holism

Here the paradigm of integration has infiltrated requirements for (1) future developments, (2) decommissioning, (3) environmental protection and even (4) financial models over time. Every activity must be executed in full partnership and total integration of the whole system across the full life cycle: from cradle to grave.

- Strategy planning and strategy design tools

The concepts of (1) business process re-engineering, (2) total quality management and (3) strategic repositioning have created the architectural requirement to incorporate these into an integrated, holistic framework. A single reference base is necessary if all strategic actions and activities are to be aligned to all other operational and management views.

- The time dimension

Since the market became a global delivery area, the international time implication has impacted the operation of the organisation. Specific concepts such as (1) time dependant monetary values, (2) balancing of resources over time and (3) synchronisation of specific operational activities on different time scales, have all necessitated the need for reference frameworks to incorporate the impact of time on its design.

2.2.3.3 SPECIFIC REQUIREMENTS FOR THIS DISSERTATION

In the preceding paragraphs and sections the general, evolutionary forces and technical themes were discussed that led to the growing need for formal, structured reference bases, i.e. architectural frameworks. This is of historical and theoretical value, but the question still begs asking: what specific aspects of *this* dissertation require the utilisation of architectural frameworks? The answer is unintentionally and superficially answered in the problem statement as stated on *page 7*, but the text however will address in more detail *why* exactly it requires the utilisation of a specific architectural framework. The answer is provided on the hand of two concepts discussed below, namely *integration* and *representation*.

- Integration

When probing literature and practise for reference to modelling methods, one comes across a multitude of different techniques that are documented and utilised. The discipline of functional design modelling has been established and recognised in the systems engineering process[54]. The modelling method of entity relationship diagramming has its origins in the IS development methodologies[55]. Flowcharts were developed by John von Neumann as far back as 1945[56] and are still widely utilised today, even in this dissertation report! (Refer to the dissertation model in *Chapter 3 -The development* of an internal technology strategy assessment model) Organisational charts are utilised to depict the management structure of a firm and process modelling methods are utilised in re-engineering exercises to map and restructure organisational processes.

All the above mentioned modelling techniques are valid and accepted in their own right, but as indicated in *sections 2.2.2.4* and *2.2.2.5*, a modelling method is always related to an implicit framework or paradigm. The question thus needs asking: are these separate techniques based on the same reference framework? An even more probing question would be: can these techniques be applied in a consistent, methodological manner? A last definitive question would be: is the correct modelling technique being utilised to obtain the required or anticipated result? In other words, can the technique even deliver the required result?

As the value of the definitions in *section 2.2.2 - Key concepts defined,* now come to the fore, the text is thus justifiably concerned with the correct utilisation of the correct

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[54] Blanchard, B.S. and Fabrycky, W.J., 1997, Systems engineering and analysis, third edition, Prentice Hall, New Jersey

[55] Zachman, J.A., 1987, A framework for information systems architecture, IBM Systems Journal, Vol.26, No.3

[56] Sowa, J.F. and Zachman, J.A., 1992, Extending and formalising the framework for information systems architecture, IBM Systems Journal, Vol.31, No.3

modelling method to deliver the required result. Not adhering to these heuristic rules will cause haphazard modelling and resultantly incorrect information representation. In the light of these fundamental discoveries, it might be worth while to reiterate the problem statement as initially stated in *section 1.2 - Problem statement*. The problem statement thus requires that

- a theoretically founded method set must be established in order to view (model) the organisational composition, view the impact of strategy and technology, and the combination thereof on the typical services organisation.

The concept of integration is thus of vital importance. If an organisational composition viewpoint, a strategic viewpoint and a technology viewpoint is required and the assumption is made that all these viewpoints examine the same organisation, then it is implicitly required that the various modelling techniques stem from the same integrated technique set, based upon a common reference framework. Furthermore, as indicated from the theory in *section 2.1.5 --Linking and integrating technology strategy with business strategy*, the first step for business and technology strategies to be aligned, it is required to have a single common set of business priorities and objectives on which management agree. If the modelling technique, as a base requirement, cannot even deliver this, then an alternative method set must be sought which can. More clearly it cannot be stated.

- Representation / viewing

The representation requirements of the to-be employed method set have actually been touched upon in the previous bulleted paragraph. It is none the less still a requirement which on merit necessitates it to be discussed separately.

The problem statement requires the technique set to be able to deliver three separate views, those being (1) an organisational viewpoint, (2) a strategy impacted organisational viewpoint and (3) a technology impacted organisational viewpoint. The base minimum that the framework and its accompanying modelling method set must thus be able to deliver, is these three viewpoints. As a consequence it requires a specific model, such as those mentioned in the previous bulleted paragraph, to deliver these requirements.

2.2.4 - Benefits from utilising and exploiting business architecture

Above and beyond the explicit requirements of this text and the benefits as stipulated which it alone can deliver, industry will do well to take cognisance of the to-be stipulated value added paybacks of architecture. The text purposefully now ventures into this discussion so as to prove beyond all doubt that architectural frameworks do indeed provide significant value to the business.

Engelbrecht and Bernus *et al* both discuss various benefits which arise when an architecture framework is selected and implemented in the organisation or the extended enterprise. These are the following:

- it helps to better understand the business
- it defines the business' processes, needs and relationships
- it ensures natural boundaries between business processes
- processable descriptions of function and behaviour of all activities are available for simulation and control
- it enables the business to contain and manage the effect of change
- it provides flexibility of all business processes and organisational structures
- document configuration management is implicit
- system re-development and maintenance are optimised
- it provides availability of the right information at the right place
- it provides a foundation on which to apply appropriate technologies
- it enables the most economic use of information technology
- facilitates more accurate selection of third party packages

2.2.5 - Architecture classification taxonomy

Now that the argument for the selection and incorporation of architectural frameworks into the organisation has been dealt with, all that remains is to select *which* architecture will be utilised. In the sections to follow, the text will analyse and discuss in-depth a few selected architecture frameworks. This is done in order to progress towards a point in the text where an educated and theoretically founded decision can be made as to the selection of the applicable architecture which will be utilised to model the case studies in this research report. Although much theory regarding architecture has already been covered in the text, there still remains a gap as to an overall classification structure. If individual architectures from different disciplines are to be evaluated on merit on equal grounds, a standard, generalised structure is required into which all architectures are able to be mapped into. The text consequently now moves to discuss just such a classification structure.

A joint task force was formed, during the course of 1990 through to 1993, to study, compare and evaluate the different available architectures for enterprise integration. The task force was sponsored by the International Federation of Automatic Control (IFAC) and International Federation for Information Processing (IFIP) with the explicit brief to study available architectures and make recommendations for the future and identify one existing architecture as best. The textbook *Architectures for enterprise integration*[49], as compiled by Bernus *et al*, was the result of the task force's findings. In this textbook they propose a taxonomy for classifying architectures, refer *Figure 27: Classification of architectures* below.

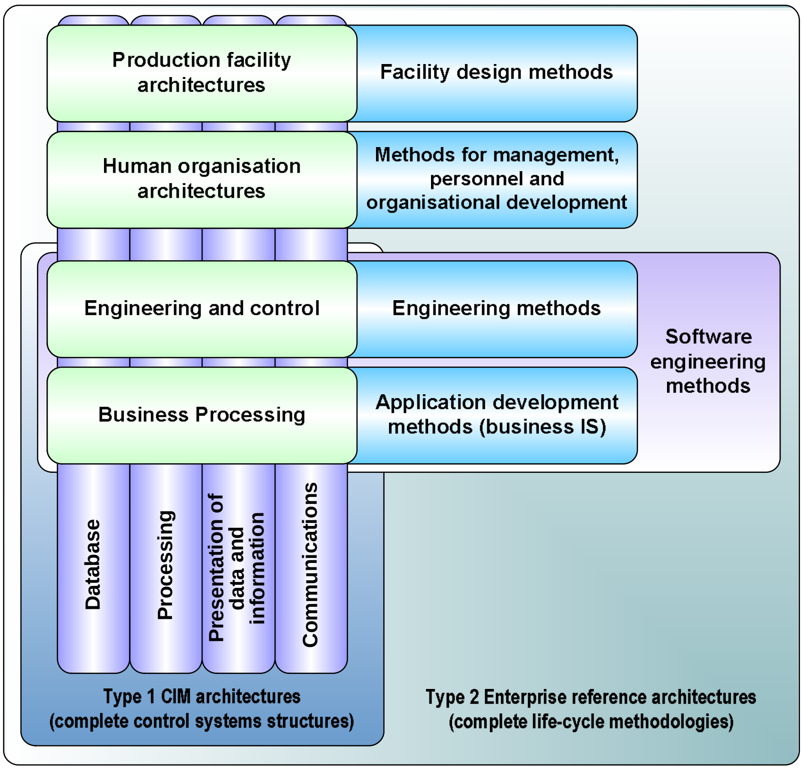

Figure 27: Classification of architectures

The two super sets of architectures are, according to the above mentioned classification, Type 1 and Type 2 architectures. These respectively refer to complete control systems structures as apposed to complete life-cycle methodologies.

Type 1 architectures describe the physical structure of some component or part of the integrated solution[57]. These architectures comprise only those aspects involved in the computer-based information technology of the enterprise, which include those frameworks which relate to total software and hardware engineering methodologies. These methodologies cover the regimes of business processing and total engineering control systems[49].

Type 2 architectures are those which model or describe the structure of the integration process or program. In other words those frameworks that illustrate and describe the life cycle of the project developing the integrated enterprise[57].

Important is to note here that although the task force's composition was made up of manufacturing engineers and information specialists, their findings were published to be of value to information technology experts, proprietary architecture developers, developers of control systems, developers and users of life cycle methodologies and policy makers and funding agencies.

2.2.6 - Selected architecture frameworks evaluated

2.2.6.1 THE CIMOSA ARCHITECTURE FRAMEWORK

- Background to the CIMOSA architectural framework

The ESPRIT program, which was funded by the European Union (EU), resulted in various research projects for developing an architecture for CIM systems. Project AMICE, which involved participants from manufacturing, IT and research institutes, delivered the Open Systems Architecture for the manufacturing industry (CIMOSA). Although the project focus was on the delivering of a CIM system, the mission was none the less to provide input to general enterprise modelling. The main goal of CIMOSA is to (1) support process oriented modelling and (2) execution support for operation of enterprise systems. CIMOSA is therefore more a modelling support for the business users rather than for modelling specialists[49].

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[57] Williams, T.J. and Li, H., 1998, _PERA and GERAM-Reference architectures in enterprise integration_, Information infrastructure systems for manufacturing II, http://iies.www.ecn.purdue.edu/IIES/PLAIC/diism98.pdf

CIMOSA is a Type 1 generic architecture and methodology, refer to *Figure 27: Classification of architectures* on page *67*. It thus allows for the integration of the information technology regimes with the engineering regimes of life-cycle descriptions and particularisation descriptions.

- Overall summary of CIMOSA characteristics

Management of change

Active management of change is one of the most significant requirements for successful enterprise integration[49]. Decision support is an essential part of the management of change. This implies timely access to the right information and the distribution of the decision making process results to the right places[49]. CIMOSA facilitates decision support through up-to-date models and BPR ease.

Scope of the architecture

Any organisation consists of internal and external operational "components". Internal operations are those sets of processes needed to market, develop, manufacture, distribute and sell offerings. It also includes those processes necessary to administer and manage the organisation itself. External operations, which intimately link to the internal operations, envelop those processes with suppliers, customers, financial institutions, governmental agencies and any other third party stakeholder. CIMOSA provides a means to consistently describe internal and external operations and their information needs.

Legacy incorporation

Organisations virtually never have the privilege to re-engineer their operations afresh with new systems. Cognisance has always to be taken of existing infrastructure. This implies that any new methodology and technology employed in the process of business engineering must provide for a means to incorporate the existing infrastructure. The concept of object definition and sharing facilitates the common definition of shared resources in an organisation. CIMOSA enables the identification and definition of re-engineered and legacy systems.

Business benefits

CIMOSA will provide benefits for the enterprise by (1) improving organisational flexibility and efficiency by the re-engineering and simplification of business processes, (2) supporting the management of change by evaluation of alternatives through simulation, (3) reducing operational costs through better business management and (4) reducing lead times through the sharing and reuse of relevant information, modelling and systems components[49].

CIMOSA's approach to enterprise integration

Enterprise modelling and business re-engineering should not be conducted all at once as a single, all encompassing venture. A modular structure with various levels of abstraction is needed to support strategic, tactical and operational decision making. CIMOSA provides such a modular, domain approach for business modelling by identifying three modelling levels combined by four views, all part of a single, open set[49].

CIMOSA's two integrated life-cycles[49]

As stated in the previous paragraph, CIMOSA employs the concept of domain and business processes for its modular structuring. Is also employs the concepts of system and product life-cycles for the time domain. The product life-cycle structures the different phases of a product's life. These are typically the phases of design, manufacture, distribute, sell and maintain. The activities of the system life-cycle are concerned with the definition, description, creation and updating of the procedures and system components which govern and support the tasks of the product life-cycle. Refer to *Figure 28: CIMOSA's relationship between system and product life-cycle* below:

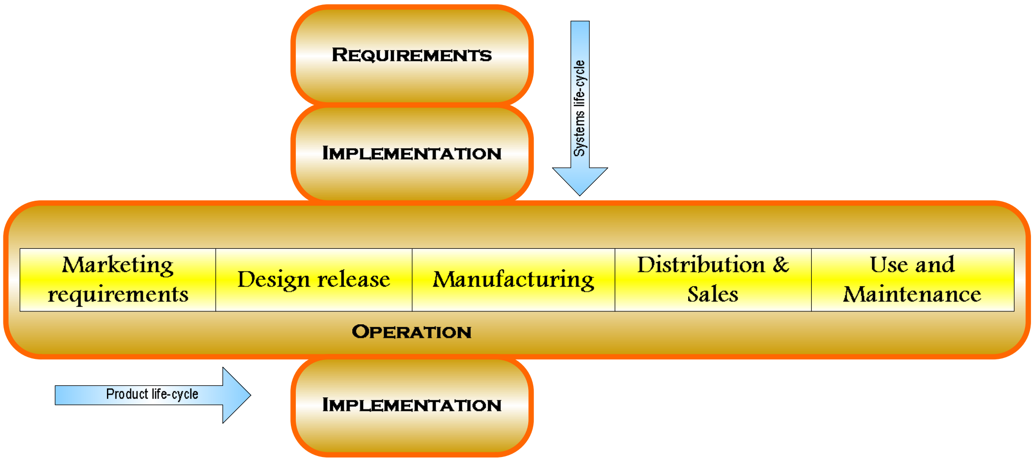

Figure 28: CIMOSA's relationship between system and product life-cycle

Enterprise integration

CIMOSA covers three levels of integration: (1) business integration, (2) application integration and (3) physical systems integration. The business integration level is concerned with the supervisory control functions which manage, control and monitor business and operational processes. The application integration level is concerned with the integration of data processing applications. The physical systems integration level is concerned with the integration of the shop floor system.

- CIMOSA's modelling framework

CIMOSA identifies a three dimensional framework offering the ability to model different aspects and views of the organisation within a single, integrated reference framework. These three different dimensions are described by the three axes of (1) generation, (2) instantiation and (3) derivation. Refer to *Figure 29: The CIMOSA modelling architecture* below for a full graphical depiction of the CIMOSA cube.

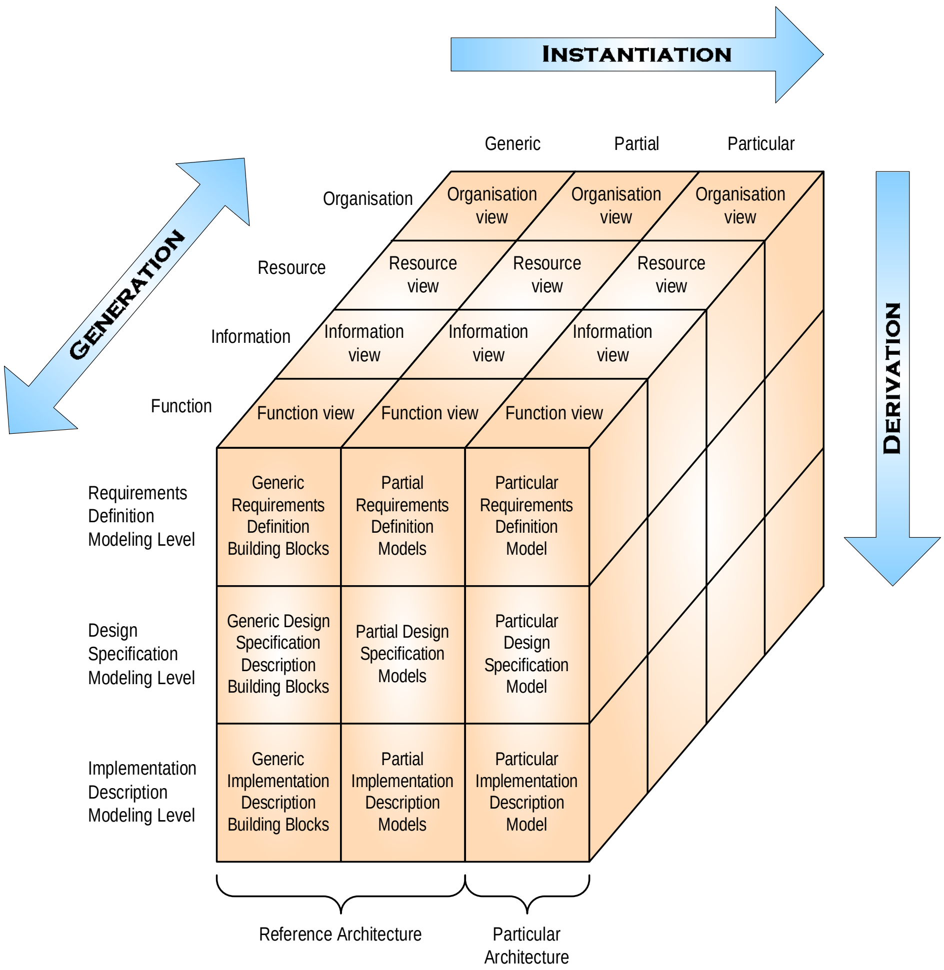

Figure 29: The CIMOSA modelling architecture

The instantiation dimension is concerned with the degree of particularisation. First basic, general requirements defined. These are then refined or particularised into industry specific requirements and finally into organisation specific requirements[53].

The derivation dimension describes the generic stages of the systems engineering process. These are the phases of requirements definition, design specification and implementation description.

The last dimension of generation describes the various views of an information system. The (1) function view describes the events and processes, the (2) information view refers to the data or object definition, the (3) resource view describes the IT and production resources and the (4) organisational view describes the hierarchical organisation[53].

2.2.6.2 THE ARIS ARCHITECTURAL FRAMEWORK

- Background to the ARIS architectural framework

The ARIS framework, which stands for the Architecture of Integrated Information Systems, was first published in 1992[58] by Professor August-Wilhelm Scheer of the Institute for Business and Computer Sciences in Saarbrucken, Germany. It is an architecture intended to describe aspects of the integrated business process and has since then enjoyed unprecedented support and popularity. *IDS Scheer* , the company that was founded by Professor Scheer in 1984, develops the ARIS Toolset which is the total package delivering the ARIS architecture and methodology. *IDS Scheer,* the company, earned revenues of over 181 million euros in 2002 and employs approximately 1450 employees[59].

The ARIS architectural framework is a Type 1 generic architecture and methodology, refer to *Figure 27: Classification of architectures* on page *67*. The ARIS toolset has been specifically designed to support the creation and usage of best practice industry reference models and standard software reference models. The framework has primarily two major thrusts, namely (1) the development of a model for business processes utilising four

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[58] Scheer, A.W., 1992, *Architecture of Integrated Information Systems - Foundations of Enterprise-Modelling*, First Edition, Heidelberg: Springer-Verlag, Berlin

[59] http://www.ids-scheer.com/

specific views (organisation, function, information and control) and (2) the utilisation of the life-cycle approach as the phases of development.[51]

- Overall summary of the ARIS architectural framework's characteristics

Management of change

ARIS framework facilitates the creation and maintenance of models in typical re-engineering engagements. This implies that typical "as-is" and "to-be" models are created and that the migration between them is managed.

Scope of the architecture

The ARIS framework follows a structured way of building models, which allows a re-engineering project to proceed in a disciplined way, aligned to its objective. The concept of process hierarchical decomposition ensures that a model is constructed for each process object, for each architectural view, detailing exactly that object. This results in a detailed key-processes hierarchy structure whereby the hierarchy of the models is reflected in a group structure. This causes that every model of a different view is placed on a corresponding level in a different group.

Legacy incorporation

As previously stated, the ARIS toolset does make provision for the modelling of typical "as-is" and "to-be" models, thereby incorporating legacy structures and systems.

Business benefits

ARIS, and more specifically the ARIS toolset, does provide various benefits to the organisation. (1) It reduces the complexity of information modelling so business managers can quickly identify areas in need of change or improvement. (2) ARIS uses a common language enabling each area of a company to describe its part of the business in a manner understandable to other areas. (3) The ARIS toolset is compatible with many existing enterprise management systems such as *SAP*, *BAAN* and *TRITON*. (4) Existing industry specific reference models are available to help the user get started. (5) The toolset software provides a quick method of completing activity-based cost analysis, workflow management studies, and interfaces to CASE tools.

ARIS's approach to enterprise integration

ARIS, like CIMOSA, makes provision for a modular approach for business modelling. It does so by identifying three modelling levels combined by four views, all part in the single, reference framework. The ARIS toolset includes three modules: an analysis component, a modelling component and a navigation component. In the modelling component the organisation with all its processes, functions, data and information flows are modelled. The navigation component allows the user to navigate through all the modelled information with relations all cross-linked between processes, data and functions. The purpose of the analysis component is to execute a time- and cost analysis of an entire process, a so-called index-analysis, and to compare two different models to execute a gap-analysis. The gap analysis can be done either for different time and cost attributes, in an average, minimum or maximum, or simply for the existence of an object.

ARIS's life-cycles

The ARIS architecture describes its models by various levels in each of the previous mentioned ARIS views. The (1) business or conceptual level describes the processes purely from the business perspective without regard to information technology. The (2) design specification or technical level translates business concepts in a technology-related language, such as an entity-relationship model. The (3) implementation or physical level models the physical expression of implemented processes with respect to the information technology in uses. These levels represent the life cycle of a process, which must be supported by an information system[60].

- The ARIS modelling framework

ARIS framework divides a business process into its constituent parts by creating three static views: (1) the data view, (2) the organisation view and (3) the function view. The dynamic part of a process is created in the last view, (4) the control view, which combines the three other views to model the dynamics of the company. Such dynamisms are typically information flows between functions, process input/output data, process organisational units, responsibilities of employees and business rules. The *ARIS House*,

[60] Cameira, R.F, Caulliraux, H.M. and Santos, R.P.C., 2002, *Processes and IT: methodological impact on net integration*, Centre for Technology - Federal University of Rio de Janeiro, www.gpi.ufrj.br/pdf/artigos/

as shown below in *Figure 30: The ARIS Architecture*[61], depicts the above mentioned four architectural views.

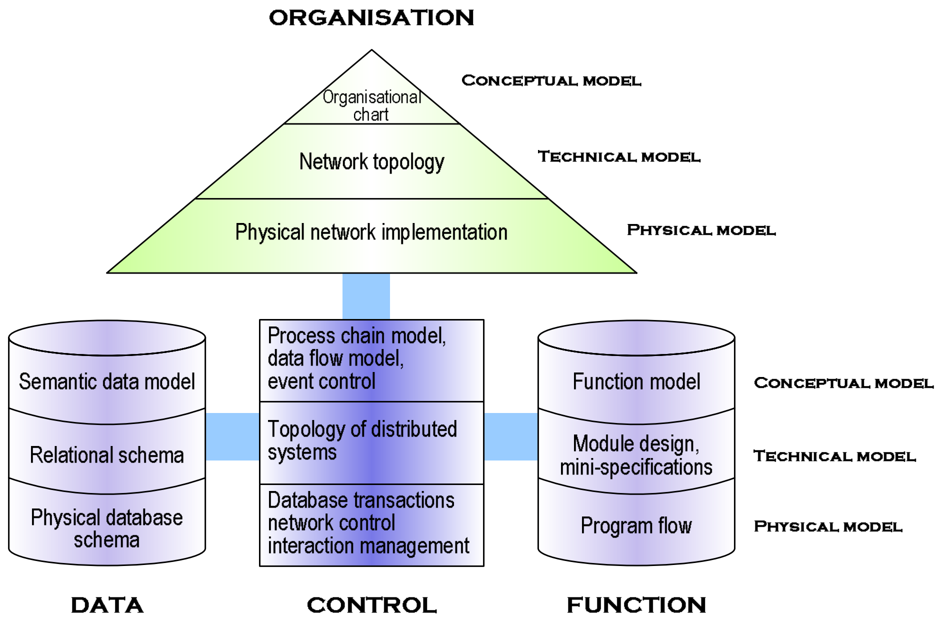

Figure 30: The ARIS Architecture

ARIS framework provides the capability to model all business rules of a company directly into the processes in a way which shows exactly *when* each rule must be enacted, *what* to do when a decision has taken place, *who* must execute the rules, and *which* data are required.

2.2.6.3 THE ZACHMAN ARCHITECTURAL FRAMEWORK

- Background to the Zachman architectural framework

The advent of the distributed computing environment during the 1980's and the rapid development of the then supportive technologies, resulted in increased pressure on the design function of information systems. Isolated techniques existed, but an integrative framework was still lacking. The information systems architecture (ISA) of *IBM*[58] was designed as a taxonomy to rationalise and order the systems design formalisms of the time. It later became known as the Zachman framework, synonymous to its developer, John Zachman. It was first publicised with only the three views of data, function and

[61] ARIS, http://www.pera.net/methodologies/ARIS/ARIS.html

network[55], but was later expanded to include the additional views of people, time and motivation[56].

It is, as its description suggests, an information systems architecture framework and not an enterprise reference framework. The Zachman architecture framework is thus a Type 1 generic architecture, refer to *Figure 27: Classification of architectures* on page *67*.

- Overall summary of the ZACHMAN framework's characteristics

  Management of change

  The Zachman framework facilitates the establishment and modelling of an information system. It describes, by means of its various views, the development of the information system through the development cycle. The framework can facilitate the evolutionary development of the system when coupled to a database

  Scope of the architecture

  The architecture is formal and has the ability to describe all facets required when designing an information system. It has no structured process although development logic dictates the sequence of the cell population. The framework is a logical framework and thus can be utilised to describe anything that has an owner, designer and builder's perspective. It has been found to be applicable in the product, enterprise, information systems and CASE tool manufacturing environments.

  Legacy incorporation

  The Zachman architecture is a non-discriminative framework and nothing in the framework itself or the modelling formalisms indicate that it should not be applicable for the modelling of legacy systems.

  Business benefits

  The framework facilitates the unambiguous articulation of precise, individual information components as part of the broader information system. It thus facilitates the integration of the various disciplines in the development life cycle and ensures a seamless construction when applied consistently throughout.

  The Zachman framework's approach to enterprise integration

  Although the framework itself is not an enterprise integration reference framework, it does facilitate the integration of the information systems backbone throughout the enterprise. It thus services only the information needs of the system itself and not the other functions of the enterprise. Refer to *Figure 27: Classification of architectures* on page *67* for a graphical depiction of the position of the framework.

The Zachman framework's life-cycles

As stated previously, the Zachman framework, by means of its various views, describes the development of the information system through its various development stages. It thus covers the engineering life cycle from conceptual initiation to the delivery of the actual system itself.

- The ZACHMAN modelling framework

The Zachman framework is as previously stated an information systems framework and consists of six description levels over six perspectives. It derives its description levels from the different artefacts produced by an architect when constructing a building. When applied to an information system, the word *architecture* is thus a metaphor that compares the construction of a computer system to the construction of a house[56]. These six description levels are the (1) scope (the architect's bubble chart), (2) enterprise or business model (the architect's drawings), (3) system model (the architect's plans), (4) technology model (the contractor's plans), (5) components (the shop-floor plans) and (6) the functioning system (the final building itself).

The framework's has six perspectives which are that of data, function, network, people, time and rationale. In layman's terms they ask the fundamental questions of what, how, where, who, when and why[62]. The framework is governed by its seven framework rules. These are (1) columns have no order, (2) each column has a simple, basic model, (3) the basic model of each column is unique, (4) each row represents a distinct view, (5) each cell is unique, (6) combining cells in one row forms a complete description from that view and (7) the logic is recursive.

[62] Department of Veterans Affairs, USA, 2003, *A Tutorial on the Zachman Framework for Enterprise Architecture*, www.va.gov/oirm/architecture/EA/theory/tutorial.ppt

Perspectives / Focus	What (DATA)	How (FUNCTION)	Where (NETWORK)	Who (PEOPLE)	When (TIME)	Why (RATIONALE)
Scope (Planner)	Entity List	Process List	Location List	Organisation List	Major Event List	Objective List
Enterprise Model (Owner)	Enterprise Entity Enterprise Rule Enterprise Entity	Enterprise Process Resource Enterprise Process	Enterprise Location Enterprise Channel Enterprise Location	Organisation Work Organisation	Enterprise Event Enterprise Cycle Enterprise Event	Objective Strategy Objective
System Model (Designer)	Entity Type Relationship Type Entity Type	System Process User View System Process	Site Link Site	Role Presentation Role	System Event System Cycle System Event	Criterion Choice Criterion
Technology Model (Builder)	Data Structure Referential Integrity Data structure	Application Device Format Application	Connection Point Communication Line Connection Point	User Technical Interface User	Technical Event Technical Cycle Technical Event	Condition Action Condition
Components (Sub-contractor)	Data Container Acquisition Data Container	Module / Object Couple / Message Module / Object	Address Protocol Address	Individual Transaction Individual	Component Event Component Cycle Component Event	Sub-condition Step / Task Sub-condition
Functioning System (User)	Information Integrity Integrity	Procedure Request Procedure	Client / Server Access Client / Server	Worker Work Session Worker	Operating Event Operating Cycle Operating Event	Target Option Target

Figure 31: The Zachman architecture

New extensions where introduced to the framework in 2002[63]. An additional third dimension, the topical axis, was introduced. The framework's depth is thus composed of topics detailing the original framework. These topics are (1) development, (2) metadata, (3) documentation, (4) responsibility, (5) life cycle and (6) purpose. The development segment of the cube describes what will be performed for each artefact; the metadata segment is the description of the information to be captured; the documentation segment shows where the information will be located; the responsibility segment specifies what member(s) of the team will perform the work; the life cycle segment places the artefacts alongside the project timeline and the purpose segment reflects the reason for the work required to be performed. Refer to *Figure 32: A 3D information architecture framework.*

[63] Jucan, G., 2002, A 3D software architecture framework - a formal representation, Journal of Conceptual Modelling, www.inconcept.com/jcm

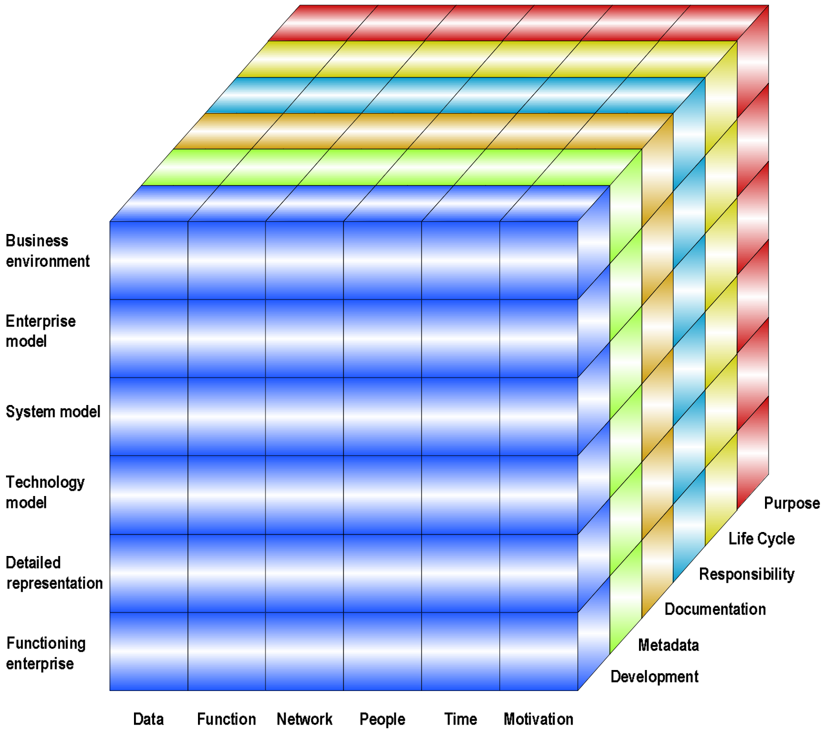

Figure 32: A 3D information architecture framework

2.2.6.4 THE DISCON ARCHITECTURAL FRAMEWORK

- Background to the DISCON architectural framework

The DISCON architectural framework is a hybrid conglomerate of all the salient features of amongst other the Zachman and the ARIS architectural frameworks. It is propagated as a business engineering framework, but has strong roots in the IS methodologies of Infomet and IBM. It is a framework which's mission is to enable the business community to pro-actively change their businesses through the implementation of a business specific methodology, whilst continuously ensuring a competitive edge. The framework is currently documented in various in-house unpublished texts and is proprietary property of the holding company, Discon Specialists[64].

- Overall summary of the DISCON architectural framework's characteristics

  Management of change

  The framework supports three rigorous methodologies: (1) a business engineering, (2) change management and (3) a project management

[64] http://www.discon.co.za

methodology. The framework and its technological support base were explicitly designed to manage change and guide the business through traumatic change initiatives. The framework thus supports the modelling of as-is and to-be future states, all aligned and referenced to a single base.

Scope of the architecture

The framework is designed to cater for the information needs of all three above mentioned methodologies from strategic positioning phase right through to the package evaluation and implementation phase. It is a sector unbiased framework and is thus not restricted to the manufacturing industry or IS industry.

Legacy incorporation

As stated earlier, the framework and its technological support base were explicitly designed to manage change and thus supports the modelling of as-is and to-be scenarios. It is thus capable of handling and incorporating legacy information and artefacts.

Business benefits

The framework espouses the belief that control over architecture enables control over change. It thus delivers a concise grip on the architecture of the firm so as to enable the correct selection of change initiatives given the environmental factors and strategy of the firm. The framework is a holistic framework and thus enables the central integration of all information needs from strategic positioning, master business planning, benchmarking, package selection and implementation and decommissioning.

DISCON's approach to enterprise integration

The business engineering methodology, as supported by the architectural framework, advocates the integration of the extended value chain. It thus believes and strives for a total market repositioning of the firm which enters into such a business engineering exercise. It strives to execute such a repositioning in full partnership with supplier, partner and customer entities.

DISCON's life-cycle

Although the framework itself does not specifically reflect any life cycle phases, the technology repository that supports the framework, enables the capturing and referencing of architectural models through the phases of identification, specification, implementation, maintenance and decommissioning.

- The DISCON modelling framework

The framework is manifested in the depiction of heptagonal pyramid across three architectural layers:

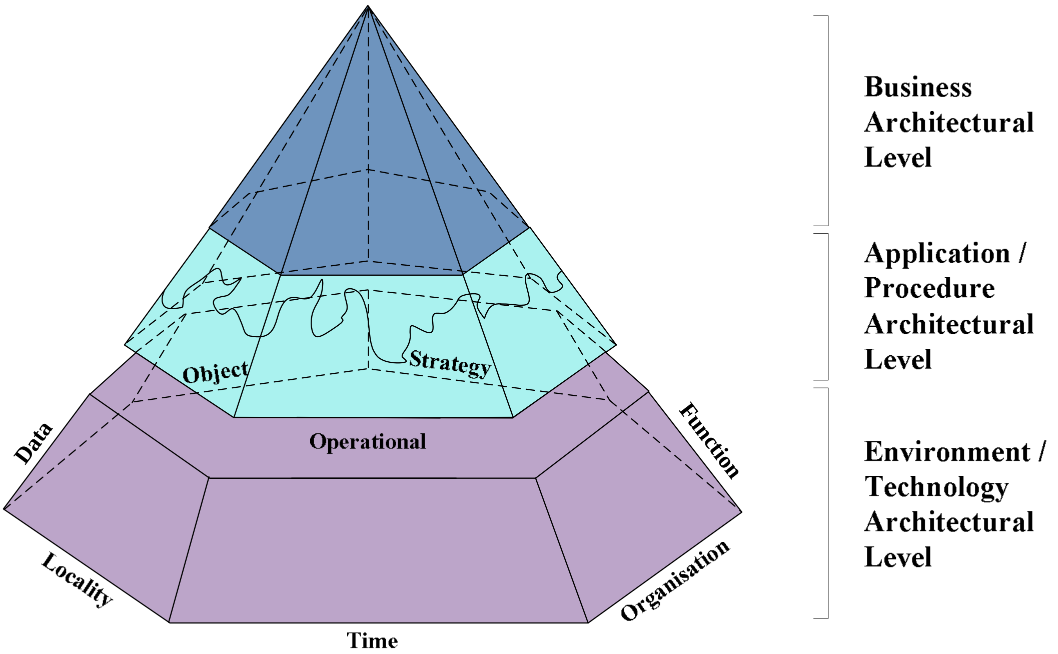

Figure 33: The DISCON business engineering architectural framework

The seven sides of the heptagon each reflect a view and cover *data*, *object*, *strategy*, *function*, *organisation*, *time* and *locality*. The eighth dimension is in the centre of the heptagon and represents the integration of all eight of the previous dimensions. This eighth dimension is called the *operational* view.

All of these above mentioned views stretch across three architectural layers or paradigms. (1) The business architectural level represents the logical design of the business. It is specific to the functions performed to conduct business. (2) The procedure architectural level represents the mapping of the functions of the logical business design onto the functionality of the constituents from the operating environment, i.e. the processes of the business functions. (3) The technology/infrastructure architectural level represents the technology domain of the business. It is made up of all infrastructural components necessary to operate the procedural architectural level.

2.2.7 - The architecture domain – a summary

In conclusion: the text started out defending the existence of architecture and moved to define the concepts of architecture, architecture frameworks, models, techniques and modelling methodologies. It discussed the reasons behind the formation of architecture frameworks as well as the potential benefits for organisations venturing into employing it. The text suggested a classification taxonomy and on the hand of it discussed several prominent architectural frameworks.

The text executed the above with the express goal to establish a theoretical base from which to select an appropriate framework which would facilitate the representation of the organisation and the impact of strategy upon it.

2.3 - UNDERSTANDING STRATEGIC PERFORMANCE MEASUREMENT

This section deals with the third domain, as depicted in *Figure 34* below, of the 3-tier approach:

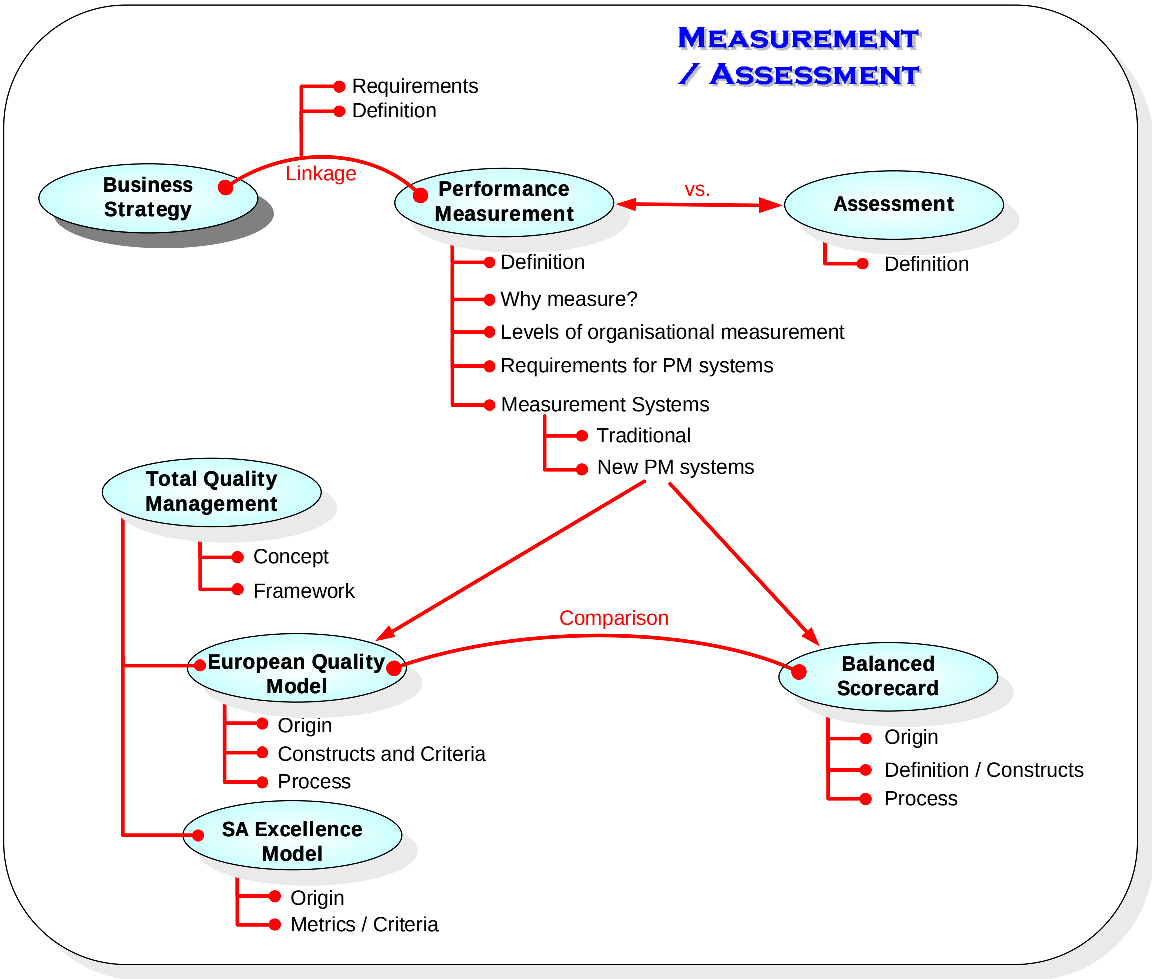

Figure 34: Domain 3 – The measurement/assessment domain

The first section of this chapter, *section 2.1 - Towards an understanding of technology strategy*, laboured on business strategy, the discipline of MOT and more specifically the field of technology strategy within that domain. No effort was spared to define and discuss the substance of technology strategy, how it should be understood, how it is derived and where it fits into the overall management function.

The second section of this chapter, *section 2.2 - Understanding business architecture*, started afresh by discussing business architecture and the concept of architecture frameworks. It defined in an organic manner every construct pertaining to architecture: what it is, what modelling formalisms are, what is meant by technique sets and even what a modelling methodology is. It discussed the evolution behind architecture frameworks, suggested a taxonomical structure how to classify different architectures and finally discussed and evaluated different architecture frameworks.

This third section draws on the knowledge foundation laid in these previous sections. Now that (1) strategy, and more specifically technology strategy, is understood and (2) a means has been found to represent the organisation and the manifestation of strategy on it, the text moves on to discuss *how*, in relation to *what* and *with what* can it be measured. The problem statement with regards to this aspect of the text states that:

- the accepted frameworks that are available in literature and practice for the assessment of strategy and strategical alignment must be identified and analysed for completeness, granularity and applicability

The rationale behind the structure of this third section is thus to establish a thorough understanding of the domain of measurement. If an attempt is to be made to measure strategic performance, it suffices to examine and discuss *how* and *with what* this can be accomplished. The purpose of this third knowledge domain is consequently to establish a theoretical base from which to address research objective number three, which is namely

- to decide upon a suitable method or framework to *assess* technology strategy

2.3.1 - Towards an understanding of 'performance measurement'

2.3.1.1 WHAT IS 'PERFORMANCE MEASUREMENT'?

The *American Heritage Dictionary of the English Language* defines *measure* as the "dimensions, quantity, or capacity as ascertained by comparison with a standard or to estimate by evaluation or comparison"[65].

[65] The American Heritage® Dictionary of the English Language: Fourth Edition, 2000, http://www.bartleby.com

Ward(1996)[66] states that *measurements* themselves are "quantified observations of some aspect or attribute of a process, product or project". He continues by stating that "useful measures provide insight as a basis for action by supporting effective analysis and decision making".

McAdam and Bailie (2002)[67] describe *performance measurement* as the development of indicators and collection of data to describe, report on and analyse performance. They continue and quote Neele *et al.*(1995)[68] who see performance measurement as the process of quantifying the efficiency and effectiveness of action.

Van Schalkwyk(1998)[69] advocates that a *performance measurement system* is a means of "gathering data to support and co-ordinate the process of making decisions and taking action throughout the organisation".

What is the difference then between *measurement* and *assessment*? The *American Heritage Dictionary of the English Language* defines *assess* as "to determine the value, significance, or extent of; appraise"[65]. Another online internet dictionary also defines *assessment* as "a valuation made by authorised persons according to their discretion, as opposed to a sum certain or determined by law"[70].

Out of the above definitions it can be simply stated that assessment is a qualitative exercise, whilst measurement is a quantitative exercise. The mechanism of performance measurement is thus colloquially stated the organisational ruler with which organisational performance, in which ever area, at whatever level is applicable, is *measured*. The opposite: performance assessment is the qualitative gauging of the organisational performance, in which ever area at whatever level is applicable.

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[66] Ward, J.A., 1996, *Measurement management – what you measure is what you get*, Information Systems Management,

[67] McAdam, R and Bailie, B., 2002, *Business performance measures and alignment impact strategy – the role of business improvement models*, International Journal of Operations and Production Management, Vol.22, No.9, pp.972-996

[68] Neely, A., Gregory, M. and Platts, K., 1995, *Performance measurement system design – a literature review and research agenda*, International Journal of Operations and Production Management, Vol.15, No.4, pp.80-116.

[69] Van Schalkwyk, J.C., 1998, *Total quality management and the performance measurement barrier*, The TQM Magazine, Vol.10, No.2, pp.124-131

[70] http://www.dictionary.com/

2.3.1.2 WHY MEASURE?

Albert Einstein said: "Not everything that counts can be counted, and not everything that can be counted, counts". The fundamental preposition when it comes to measurement is that "what gets measured, gets done"[71]. This is due largely to the fact that modern organisations couple their incentive and rewards programmes to the achievement of certain stated objectives[72]. As Clarke(2000) so appropriately quips: "If measurement, by itself, had that much impact on human behaviour, anyone that had a weighing scale would never get fat!". The actual fact of the matter is that few organisations actually get what they measured[71]. A national survey during 1996 of 203 executives in the USA showed that only six out of every ten executives place confidence in the data that is available to them, refer to *Figure 35* [73] below.

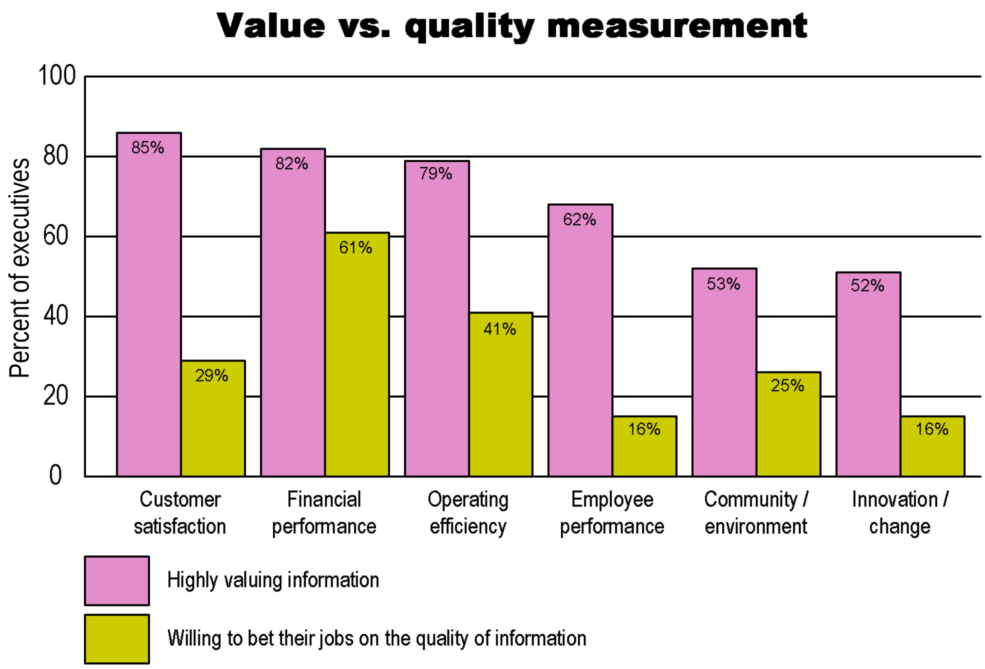

Figure 35: Do you get what you measured?

Although a bit old for academic purposes, the survey is indicative of the symptoms that exist with regards to the value of measurements. So the question is asked again: why measure?

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[71] Clarke, P., 2000, Keeping Score, Accountancy Ireland, Vol.32, Iss.3

[72] Eccles, R.G., 1991, The performance measurement manifesto, Harvard Business Review 69, pp.131-137

[73] Lingle, J.H. and Schiemann, W.A., 1996, From balanced scorecard to strategic gauges: is measurement worth it?, Management Review

Various reasons and themes can be provided from literature. "You can't control what you can't measure" states Ward. Lingle and Schiemann(1996)[73] echo Ward by stating that measurement is a critically important management tool: "you simply can't manage anything you can't measure." Johnson(1992)[74] on page 105 in his book, *Relevance regained: from top-down control to bottom-up empowerment*, even ventures so far as to state that "what you measure is what you get – measures...drive what people do and shape the results they achieve". Ward also says that measurement is essential to any quality improvement effort. Lingle and Schiemann later on state that measurement plays "a crucial role in translating business strategy into results". Van Schalkwyk also supports this view when he states that "measurement provides the link between strategy and action".

In the same survey which provided the figures for *Figure 35*, Lingle and Schiemann also found that measurement-managed companies outperformed those which were less disciplined (non-measurement-managed companies). *Figure 36: The value of measurement*, indicates that measurement-managed companies tend to have better success than their non-measurement-managed counterparties.

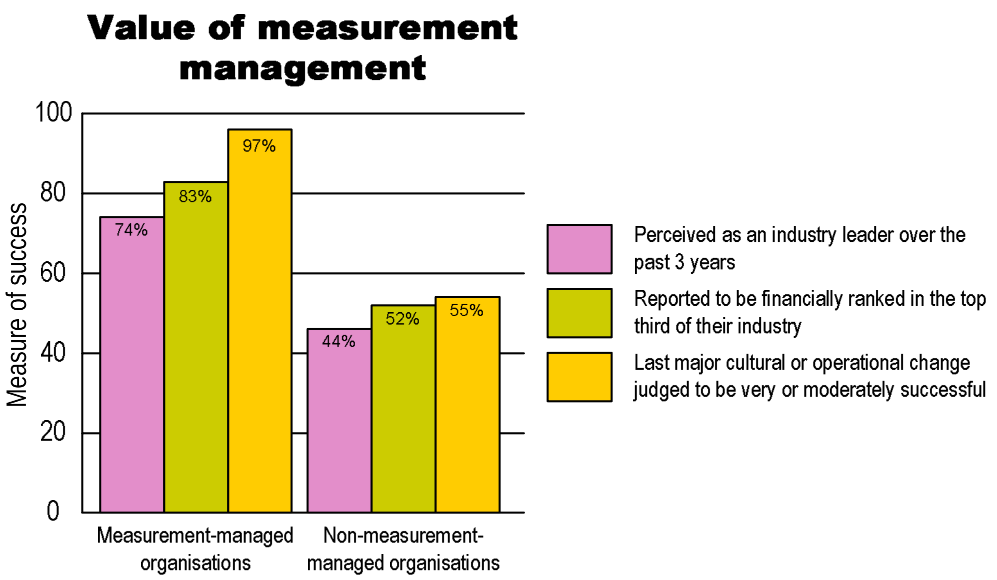

Figure 36: The value of measurement

[74] Johnson, H., 1992, Relevance regained: from top-down control to bottom-up empowerment, Free Press, New York

Lingle and Schiemann's data pointed to four mechanisms that contributed to the measurement-managed companies' success. These were found to be (1) agreement on strategy, (2) clarity of communication, (3) focus on alignment efforts and (4) organisational culture or collective attitudes.

To close the discussion, the text found the *raison d'être* for measurement thus to be sevenfold:

- it provides a mechanism for control and is thus one of many management tools,
- it acts as a catalyst for motivation and performance,
- it also acts as an alignment mechanism,
- it links strategy with actions,
- it helps obtain agreement on strategic issues,
- it acts as a clear medium of communication and
- it helps mould the permeating culture of the organisation

2.3.1.3 WHERE TO MEASURE?

It was stated earlier that performance measurement is the organisational ruler with which organisational performance, in which ever area is applicable, is measured. So what organisational areas are applicable when it comes to performance measurement? Leonard and McAdam(2002)[75] indicate that three conceptual management levels exist within the organisation: (1) the strategic, (2) the tactical and the (3) operational level. Refer *Figure 37* below:

Figure 37: The three management levels of the organisation

[75] Leonard, D. and McAdam, R., 2002, The role of the business excellence model on operational and strategic decision making, Management Decision, 40/1, pp.17-25

Management at the strategic level is primarily concerned with the vision and mission of the organisation: *what* it is and *what* it wants to be. In other words, it focuses on the proliferation of the company within its competitive environment, its identity and the way it envisages itself into the unknown future. The tactical level is more concerned with the translation of the aforementioned into tangible roadmaps, objectives and targets. It is the process of enacting the strategy and it is thus more concerned with *how* to deliver the strategic goals. The operational level is where all of the above mentioned initiatives are implemented. Management at the operational level is resultantly more concerned about *with what* the tactical objectives are going to be met. It focuses on the resources the company employs and how to optimally utilise and manage them, given constraints imposed, to deliver the tactical objectives.

Performance measurement at these aforementioned levels, is thus about gauging how close or how far the organisation is from realising its respective objectives.

2.3.2 - Strategic performance measurement: the linking of strategy with measurement

Out of the discussions on performance measurement in the previous section, the questions were asked as to *what* performance measurement is, *why* it is necessary and *where* typically one would execute it. The text has hinted to and lightly touched on the concept of strategic performance measurement, but it has not formally made the transition to discussing *strategic* performance measurement.

2.3.2.1 STRATEGIC PERFORMANCE MEASUREMENT DEFINED

Clark states that an organisation's mission is its basic function in society. He continues to say that the objectives that a company establishes for itself, are mission-aligned, precise statements of purpose for specified periods of time. Strategy is thus a different articulation of *how* the organisation is envisioning achieving its mission. Performance measures thus allow managers and employees to understand what the strategy is and how their performance is linked to the realisation of it. *Figure 38: Mission, objectives, strategy and performance measures* graphically depicts these relationships:

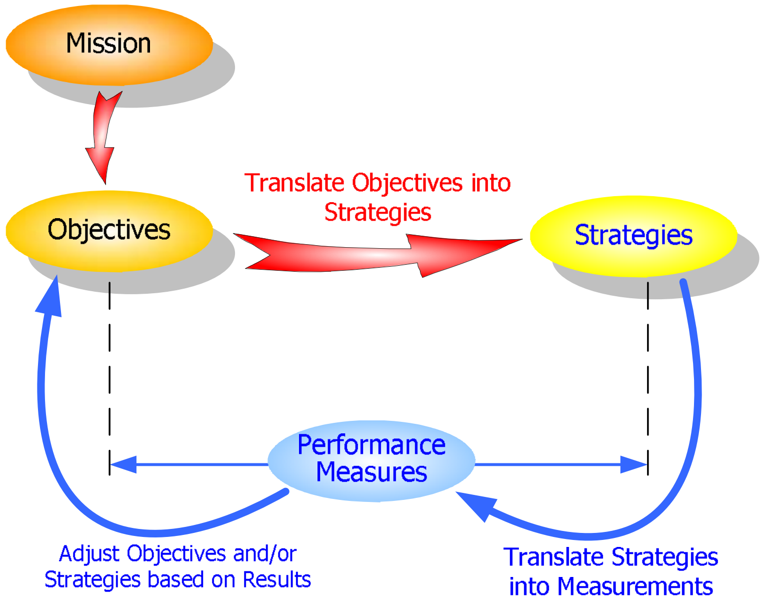

Figure 38: Mission, objectives, strategy and performance measures

McAdam and Bailie[67] support this view and claim that the main function of performance measurement in a strategic context, is "to provide the means of control to achieve the objectives required, to fulfil the company's mission/strategy statement". They also continue to quote Neely *et al.*(1994)[76] again who view performance measurement as a key part of strategic control.

Drawing from the current discussion and those of the previous paragraphs, the text thus defines *strategic* performance measurement as

- the continual act of
- observing, identifying and developing
- indicators and attributes, that
- reflect and translate the organisation's reason for existence, i.e. its mission,
- so that data can be collected by
- applicable techniques or methods
- to support effective analysis and decision making and thereby
- enabling and providing control of the realisation of the organisation's mission

[76] Neely, A., Mills, J., Platts, K., Gregory, M. and Richards, H., 1994, *Realising strategy through measurement*, International Journal of Operations and Production Management, Vol.14 No.3, pp.140-52

2.3.2.2 UNDERSTANDING THE REQUIREMENTS OF STRATEGIC PERFORMANCE MEASUREMENTS

So if performance measurement is the link between and the result of objectives and strategies, it logically follows to say that in order to fully understand strategic performance measurement, one must understand the concepts of organisational objectives and strategies, as reflected in *Figure 38*. The text adopts the same approach is that of McAdam and Bailie to discuss the significance and substance of strategic performance measurement, on the hand of objectives and strategies as reflected under the two headings, globalisation and alignment, below:

- Globalisation and diversification

Increasing competition and the globalisation of markets has forced organisations to differentiate themselves from their competitors. In times past this was solely achieved through cost differentiation, but now organisational focus and objectives have shifted to excel themselves in other forms of value: quality, customer service, response and environmental friendliness, to name but a few. This specific change in organisational focus has created the need for performance measures to facilitate the control of these new attributes[67]. The implication of this, as mentioned in the previous section, is that management now has to communicate the organisation's strategy across a wider base. Financial targets are not sufficient anymore and therefore management must adopt an appropriate measurement system that will facilitate the measuring of these new objectives and strategies.

- Aligning performance measures with strategy

It has been discussed previously that performance measurement in a strategic context, is to provide the means of *control* to achieve the stated objectives of the organisation. The concept of control is thus a crucial requirement in any performance measurement system. Control is however only active if it is manifested in decisions that lead to actions. Neely *et al.*(1994) argue that one of the key factors of alignment, is that of consistency of both decision making and action. "To achieve this consistency, and hence alignment, there must be a broader and more holistic approach to devising and using performance measures"[67].

In linking up with the previous discussion of understanding the concepts of organisational objectives and strategies, the text has thus now shown that traditional objectives and strategies of cost differentiation our outdated in the new market place. The complex business environment, in which companies are operating in these days, is demanding more holistic value propositions with more finely tuned delivery strategies. Globalisation and diversification have increased the management need for finer control mechanisms to steer the organisation with. These control mechanisms must be aligned one hundred percent with the strategy if companies are going to survive.

The call is thus made for more holistic, representative measurement systems that will enable control over this increased measurement base and thus facilitate the increased requirement of strategic performance measures.

2.3.2.3 A FRAMEWORK FOR STRATEGIC PERFORMANCE ASSESSMENT

The text has thus now shown *what* strategic performance measurement is and *why* it is required. If any one person would however walk into a mayor corporate company at any given time and analyse the different improvement initiatives, measurement systems and management tools that are currently being employed, they would soon be at a loss as to which of them are for strategic purposes[67].

Porter and Tanner(1996)[77] propose a framework or mindset for how to think about and position strategic performance measurement holistically within the organisational context and relative to other improvement initiatives. The framework is suggested from a TQM context, but it takes cognisance of self-assessment systems (to be discussed in *sections 2.3.3.3* and *2.3.4.2*), international quality systems (e.g. ISO 9000), people development initiatives, BPR and even benchmarking activities. The framework is depicted in *Figure 39* below:

[77] Porter, L. and Tanner, S., 1996, *Assessing Business Excellence*, First edition, Butterworth-Heinemann

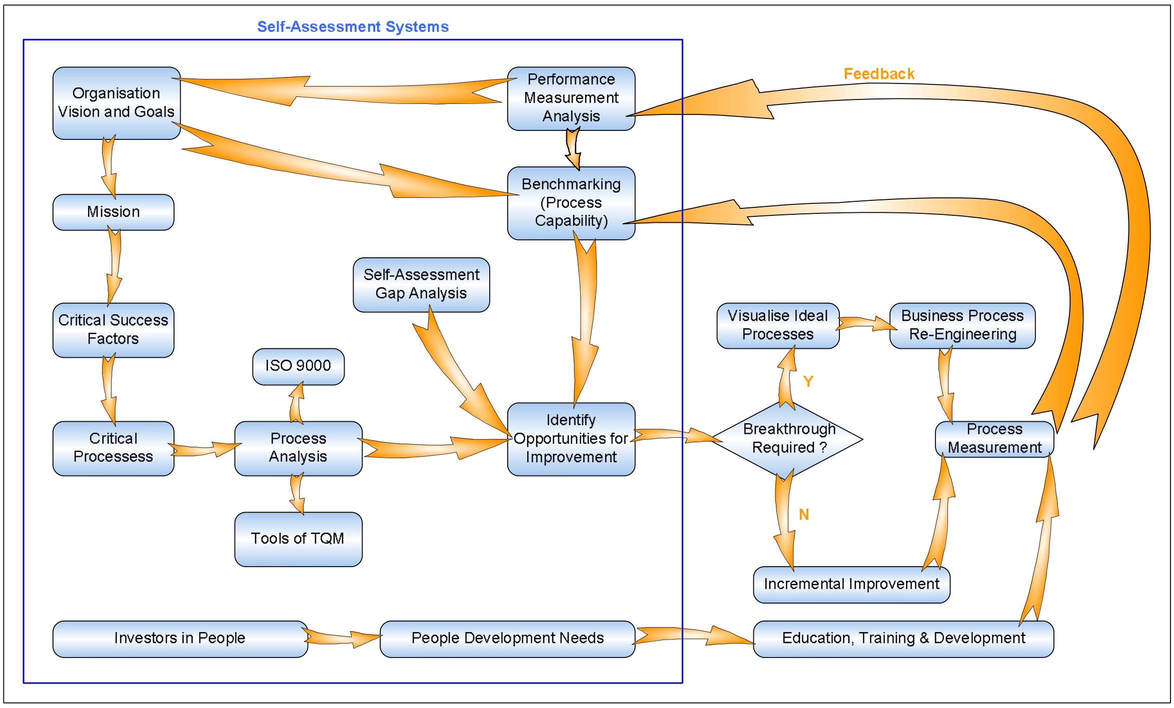

Figure 39: Integrated framework for TQM

Porter and Tanner, as reflected in *Figure 39,* also support the view that the organisational mission and goals be expressed by means of CSF's which then in turn implicate the strategic critical processes. This is in direct agreement with Feurer *et al's* view as discussed in the text in *section 2.1.5 --Linking and integrating technology strategy with business strategy*. The approach is of critical importance and the text will refer back to this section when it constructs its research model in *section 3.2* -An internal technology strategy assessment framework utilising total quality management (TQM) principles.

The framework of *Figure 39* advocates that performance measurement analysis can only be conducted if a measurement activity, based on a process analysis paradigm, can link the organisational CSF's with a measurement tool. In the context of *Figure 39* this measurement is suggested to be TQM-based mechanism, but the text has yet to establish which mechanism it deems feasible.

Figure 39 thus in essence agrees with *Figure 38*, but extends the paradigm to include other measurement mechanisms and activities. It is consequently therefore only logical for the text to move into a discussion of the various measurement systems available.

2.3.3 - Measurement systems

The text has up to now defined the concept of *performance measurement* and has also discussed the *enactment* of it at a strategic level of the organisation. It has also ventured into the discussion of the increased need for more encompassing, representative and holistic measurement systems that will address the management needs of the day. The text thus now logically moves to discuss the different types of measurement systems and what fundamentally drives organisations to perform (and thus require measurement).

2.3.3.1 TRADITIONAL MEASUREMENT SYSTEMS

McAdam and Bailie point out that differentiation can be made between two types of measures: financial and non-financial. Financial measures are statutorily required and have been in existence for many years and all businesses are thus familiar with some form of financial measurement system. Kaplan and Norton(1996)[78] in their international bestseller, *Translating strategy into action - The Balanced Scorecard*, aptly state that accounting has been quipped the "language of business". Yet the actual reason for existence of standard financial measures has evolved from the need for reporting on stewardship of money entrusted to management[67]. The focus therefore on financial measures is on what has happened in the past: "…financial measures are valuable in summarising the readily measurable economic consequences of actions already taken"[78]. Financial measures are however inadequate for guiding and evaluating organisation's trajectories through competitive environments, i.e. evaluating strategy.

Kaplan and Norton point out that financial measures are a critical summary of managerial and business performance, yet they also strongly state that "overemphasis on achieving and maintaining short-term financial results can cause companies to over-invest in short-term fixes and to under-invest in long term value creation…[which] generate future growth". McAdam and Bailie state that accounting measures are an inadequate and insensitive tool for decision-making in regard to alignment with business strategy. True measures must consequently reflect the strategies and capabilities of the organisation and not just the financial results. Van Schalkwyk also reiterates why traditional performance

[78] Kaplan,R. and Norton, D., 1996, *Translating strategy into action – the Balanced Scorecard*, Harvard Business School Press, New York

measurement systems based on financial information is "largely irrelevant"; he lists the following reasons:

- The collection and manipulation of financial data is time intensive and is consequently useless for rapid decision making. Refer to *Figure 40* below:

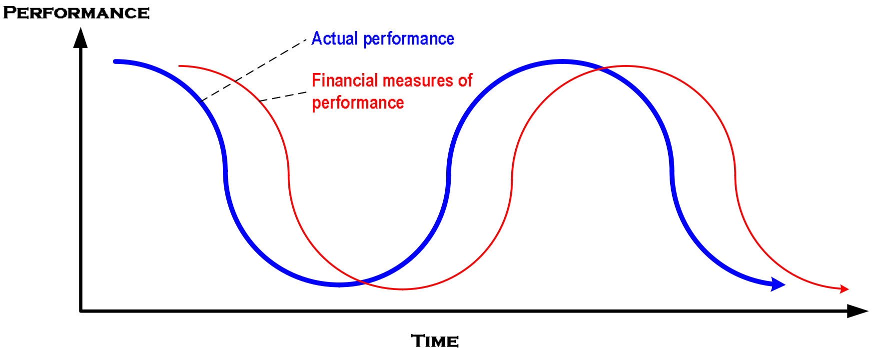

Figure 40: Time delay between performance and financial measures

- The use of financial data to set goals and control actions typically lead to manipulation of output levels to achieve cost targets.
- Top-down financial performance information encourages management by remote control.
- Financial data does not identify unnecessary complexity.
- Many traditional financial performance systems completely ignore the client and
- opportunities for improvements are typically not utilised due to the one-time reduction in financial measures this would cause.

All of these aforementioned statements are in unison with the previous paragraphs which call for more holistic, representative measurement systems. McAdam and Bailie corroborate this plea when they also emphasise the need to establish a more comprehensive view of performance measures that are indicative of the overall health of the business. If businesses resultantly require information across a wider scope than that of traditional, linear financial measures, the quintessential question is thus: which measures are required to measure what attributes?

2.3.3.2 DETERMINANTS OF ORGANISATRIONAL PERFORMANCE

"An organisation's measurement system strongly affects the behaviour of people both inside and outside the organisation"[78]. Is performance measurement only required to ultimately measure and drive the behaviour of people, or are there other attributes that need measuring? In their detailed and comprehensive article on the determinants of organisational performance, Tvorik and McGivern(1997)[79] analysed 166 citations for determinant performance factors. They identified two focus areas within the research stream on organisational performance:

- an economic perspective emphasising the importance of external market factors, and
- an organisational perspective which builds on sociological and behavioural paradigms

These two focus areas' detailed findings are listed below so as to indicate what was identified as driving organisations to perform and what must consequently in turn be measured.

Economic factors

- organisational alignment was proven to be measurable by means of return on sales (ROS),
- organisational capabilities and routines was measured by firm-specific return on assets (ROA),
- industry structure and strategic group influences was measured by the multiple discriminant analysis statistic known as the Altman Z score,
- organisational resource efficiency was measured by return on investment (ROI) and
- return on invested capital was used to measure shareholder wealth creation

Organisational factors

- organisational alignment and culture,
- organisational capabilities and learning,
- industry structure and strategic groups,
- organisational resources and
- leadership and vision was all identified.

[79] Tvorik, S.J. and McGivern, M.H., 1997, *Determinants of organisational performance*, Management Decision, 35/6, pp.417-435

All of the above ten findings are thus drivers of organisational performance and it is consequently therefore required of the modern performance measurement system to be able to cater and measure these attributes. The text has also indicated previously, in *section 2.1.3.5-New paradigms in MOT,* that new paradigms in MOT have also contributed to an increasing need for relevant performance assessment methods. As stated under the previous mentioned section, the text referred to Khalil[2] who elaborated, in his discussion on performance assessment methods, that traditional methods of accounting and financial assessment are biased ***against*** technological innovation, and that a more holistic scoring methodology is needed to integrate all the factors driving the modern organisation. He continued to identify and list these "factors which drive the modern organisation". Although previously listed under *section 2.1.3.5-New paradigms in MOT*, these factors are reiterated here again so as to provide an additional requirement, from the field of MOT, for a holistic, pro-technological, performance measurement system. These required dimensions and attributes which require measurement are:

- Value creation
- Quality
- Responsiveness
- Agility
- Innovation
- Integration
- Teaming and
- Fairness

2.3.3.3 NEW INNOVATIVE PERFORMANCE MEASUREMENT SYSTEMS

The text has up to this point established the notion that there exists a "general dissatisfaction with traditional backward looking performance measurement systems"[67]. Butler, Letza and Neale(1997)[80] highlight four reasons for this growing dissatisfaction and the heightened interest in broader performance measurement systems:

- Companies in Europe and the Far East pay more attention to long-term strategic issues than their 'Anglo-Saxon' counterparties which espouse the narrower financial methods.

[80] Butler, A., Letza, S.R. and Neale, B., 1997, *Linking the Balanced Scorecard to strategy*, Long Range Planning, Vol.30, No.2, pp.242-253

- The rise of the Total Quality Management (TQM) movement has drawn the attention of managers to focus on the customer and the provision of quality offerings.
- The ground breaking text, *Relevance Lost – The Rise and Fall of Management Accounting*, by Johnson and Kaplan propagated the demise of conventional management accounting and
- the revolution in information technology has enabled the collection, manipulation and interpretation of vast amounts of information across many different organisational domains.

McAdam and Bailie[67] in essence support these views. They however contribute the single major reason for the interest in more holistic measurement systems, to be a result of the previously stated reason number two: the rise of the quality movement. They advocate that the quality movement has resulted in numerous business improvement models seeing the light. These models have at the heart of them a focus on (1) business dynamics, (2) performance measurement and (3) alignment with strategy as common key constructs. Van Schalkwyk[69] highlights in his study that TQM based performance measurement systems differ totally from that of traditional measurement systems. He summarises his findings in *Table 3: Traditional versus TQM performance measurement systems*.

TRADITIONAL MEASUREMENT SYSTEMS	TQM MEASUREMENT SYSTYEMS
• Financially driven (past focus)	• Customer driven (future focus)
• Limited flexibility: one system serves both internal and external needs	• Dedicated to repsonsiveness and flexibility
• Not linked to operative strategy	• Linked to TQM strategies
• Focus on shareholders	• Focus on total customer satisfaction
• Goal is to decrease costs	• Goal is improved performance
• Vertical, top-down reporting	• Horizontal, empowering reporting
• Cost, output, quality viewed in isolation (quality of completely ignored)	• Quality, delivery, time and cost evaluated simultaneously
• Focus on individual punishment and incentives: individual learning	• Focus on group incentives and organisational learning

Table 3: Traditional versus TQM performance measurement systems

Van Schalkwyk[69] thus illustrates that the new generation of innovative performance measurement systems have a futuristic, holistic and consolidated perspective not only on the business, but also on the customer and the employee. Within these parameters of "new paradigm measurement system", McAdam and Bailie[67] in their text identified and focused on two specific business improvement models: the balanced scorecard and the EFQM's excellence model. They advocate that these models encourage and facilitate the alignment of performance measures with business strategy, due to their "wide range of performance measures being used".

The text will thus here forth occupy itself exclusively with the discussion of these models as potential candidates for the assessment of strategy.

2.3.4 - Two business improvement models / measurement systems

This text agrees with McAdam and Bailie's findings on the two business improvement models. Both models fall into the category of the new paradigm of performance measurement systems and are briefly discussed below.

2.3.4.1 THE BALANCED SCORECARD

- Background to the balanced scorecard

The Kaplan and Norton balanced scorecard[78] arose out of a one-year multi company research project sponsored by the Nolan Norton Institute, the research arm of KPMG. Twelve companies, which were judged to be at the leading edge of performance measurement, took part in the study. The findings were first published in a Harvard Business Review article, *"The Balanced Scorecard – Measures that drive Performance"* (January-February 1992). The overwhelming response to the article proved that there was indeed a great need in the market for a better system to align strategies, actions and performance measures. A second Harvard Business Review article, "Putting the Balanced Scorecard to work" was published in September-October of 1993, describing their experiences in implementing the scorecard. Since then the industry and academic world has not been able to keep quiet about the value and depth of the balanced scorecard. The model has been utilised extensively throughout the USA. According to Hepworth(1998)[81] the model is gaining ground in the UK and has been utilised in the British hospitality sector, the British Army and as a management device in the real estate sector.

[81] Hepworth, P., 1998, *Weighing it up – a literature review for the balanced scorecard*, Journal of Management Development, Vol.17, No.8, pp.559-563

- Overall summary of the balanced scorecard

The initial research delivered "a set of measures that gives top managers a fast but comprehensive view of the business"[80]. The scorecard is balanced in many ways: firstly it is balanced between internal and external views. It is also balanced between financial and non-financial views. The four views of customer, financial, learning and growth, and the internal perspective, as depicted in *Figure 41*, represent the aspects that are linked in a cause and effect manner.

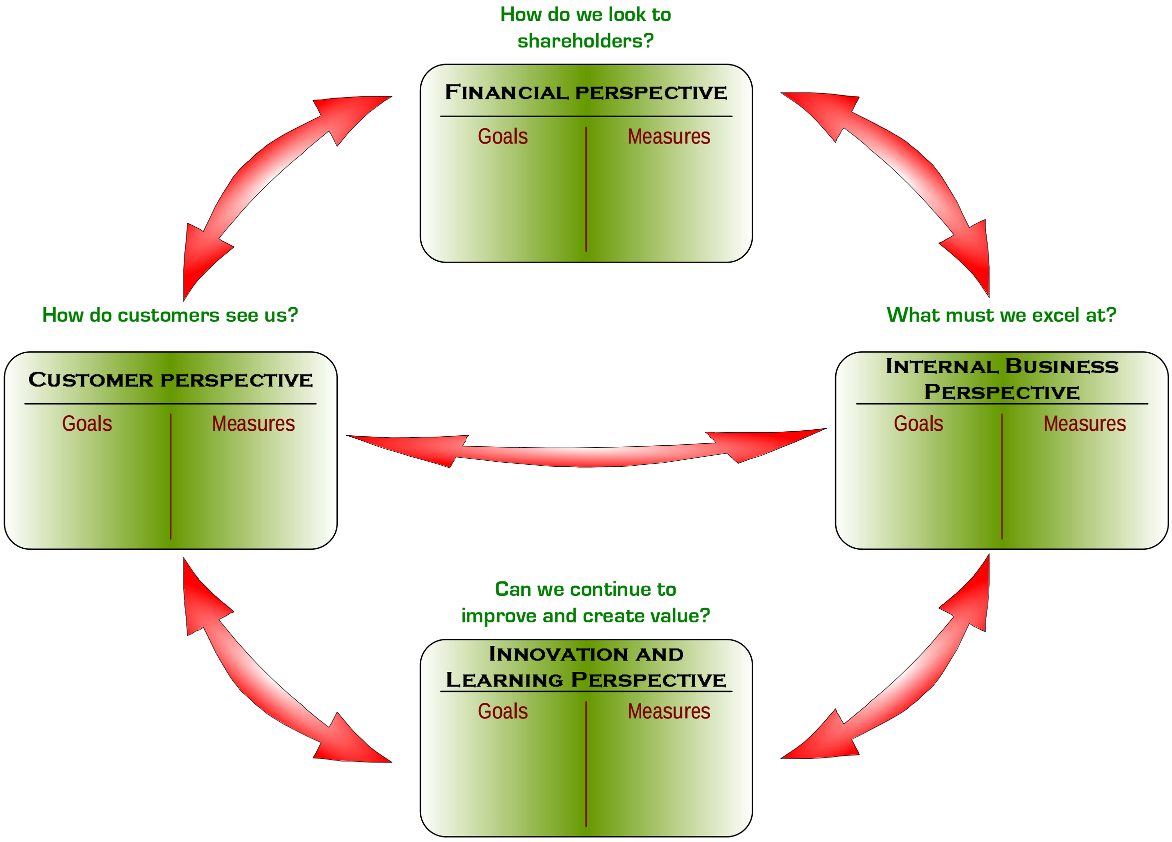

Figure 41: The segments of the balanced scorecard

The balanced scorecard allows managers to view the organisation from four different perspectives while addressing four fundamental questions:

(1) To succeed financially, how should we appear to our shareholders?

(2) To achieve our vision, how should we appear to our customers?

(3) To achieve our vision, how will we sustain our ability to change and improve?

(4) To satisfy our shareholders and customers, what business processes must we excel in?

The balanced scorecard is not only a tactical or an operational measurement system; it is also a strategic management system. It is valuable to (1) clarify and translate vision and strategy (2) communicate and link strategic objectives and measures, (3) plan, set targets and align strategic initiatives and (4) enhance strategic feedback and learning[78].

The scorecard differentiates, as *Figure 41* indicates, between leading (enabler) and lagging (result) indicators. The composition of the scorecard must be in balance and thus ties a driver question, which represents a corporate objective, with an outcome measurement. Kaplan and Norton state very clearly that no scorecard is the same for the next company. It is up to the organisation to derive and build its own scorecard, based on the four perspectives, consisting of measures which are relevant to their own unique circumstances and strategies. They do however give examples of generic measures[78]:

PERSPECTIVE	GENERIC MEASURES
• Financial	• Return on investment and economic value-added
• Customer	• Satisfaction, retention, market, and account share
• Internal	• Quality, response time, cost, and new product introductions
• Learning and growth	• Employee satisfaction and information system availability

Table 4: Generic measures of the balanced scorecard

- The process of delivering the balanced scorecard

Kaplan and Norton differentiate between two distinct phases in the implementation of the scorecard: the building of the scorecard and the utilisation of it. Each phase is of equal importance and must be executed with total executive commitment and a long term vision in mind. Oliveira(2001)[82] identified ten steps towards implementing the balanced scorecard: (1) building the business case, (2) identifying the strategies, (3) identifying the tactical objectives, (4) identifying performance measurements, (5) identifying data sources for calculating the measurements, (6) creating the data warehouse to supply the

[82] Oliveira, J., 2001, The balanced scorecard: An integrative approach to performance evaluation, Healthcare Financial Management, Vol.55, Iss.5, pp.42-46

data, (7) selecting information technology to create the data warehouse, (8) creating the balanced scorecard report, (9) managing the strategy using the balanced scorecard, and (10) refining the tactical objectives in support of the strategy.

2.3.4.2 EXCELLENCE MODELS

- Background to the EFQM's excellence model

The European Foundation for Quality Management (EFQM) was formed on September 15, 1988 by fourteen leading CEO's of leading European companies. This was done with the express goal in mind of enhancing the competitive position of European companies in the world market[77]. The European Model for Total Quality Management, otherwise known as the EFQM excellence model, took life in 1990 when over 1000 people were consulted though a series of workshops in Brussels. The American counterpart, the Malcolm Baldridge Quality Model, was used as a starting point and was adopted into what is now known as the nine criteria parts. The EFQM excellence model is based on the premise that "customer satisfaction, people satisfaction and (favourable) impact on society are achieved through leadership driving policy and strategy, people management and processes leading to ultimately to excellence in business results"[77].

- Overall summary of the EFQM's excellence model

The model, like the balanced scorecard, has two distinct sections: an enabler and a results section. The model itself is divided into nine criteria parts which are positioned as either an enabler or a result criterion part. Like the balanced scorecard, the individual enabler criteria parts also share a cause and effect linkage with relevant result criteria parts. Each criteria part has been assigned an overall weight/score and thus contributes in relational to the overall score. The enabler and results sections have been weighted 50/50. The outcome is as follows:

Enablers: Leadership (10%), Policy and strategy (8%), People management (9%), Resources (9%) and Processes (14%).

Results: Customer satisfaction (20%), Peoples satisfaction (9%), Impact on society (6%) and Business results (15%).

Figure 42 below graphically depicts the above mentioned.

Figure 42: The EFQM Excellence model

Each criteria part is sub-divided into several criterion parts. Under each criterion part there are several ‘areas to address’. All of the criterion parts have an equal weighting within their criterion except for “customer satisfaction”, “people satisfaction” and “impact on society”.

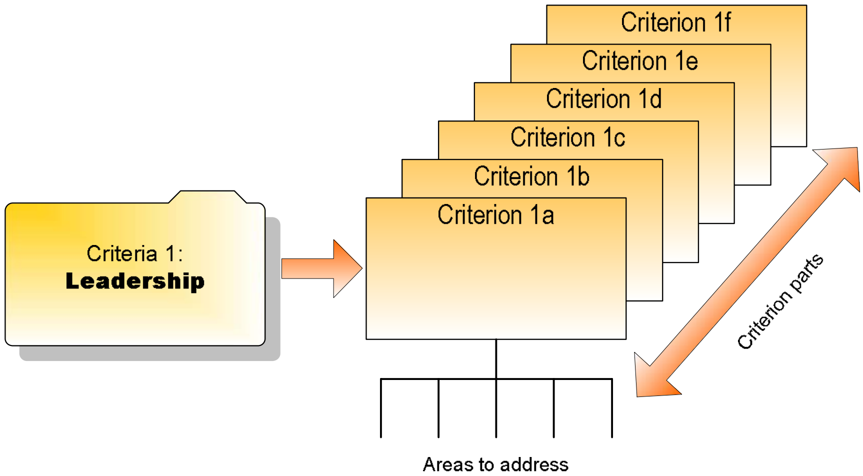

Figure 43: Structure of the criteria, criterion parts and the areas to address

- The process of delivering the EFQM’s excellence model

The model itself is applied and executed through a self-assessment process so as to facilitate the participating companies to enter into the European Quality Award process. It is not compulsory for the companies utilising the model to participate in the awards process; many organisations utilise the model as an internal business improvement tool.

The self-assessment process follows the following steps[77]: (1) Define objectives and scope. This is where the organisation determines the extent to which it is going to utilise the model, and which departments are to be included or excluded. (2) Form the assessment team. Members from the organisation are seconded to act as assessors and drive the process. (3) Plan the assessment. The assessment process can become lengthy and complex, and it is thus necessary to control the process in an effective and timely manner. (4) Collect the relevant data. Here the facts pertaining to the excellence of the company are collected. (5) Assess the data and information. (6) Prepare the feedback. This is the major output from the assessment process wherewith the organisation is shown the areas of strength and those of improvement. (7) Review and action planning.

2.3.5 - Choosing between the balanced scorecard and the EFQM excellence model

"Are the balanced scorecard and the EFQM excellence model mutually exclusive?" "If a choice has to be made between the two models, how can a company choose what is right for them?" These two questions moved Lamotte and Carter(1999)[83] to draft their article on the features, characteristics and value-add of each model. The text exclusively dedicates this section to the comparative analysis of both models in an attempt to establish an opinion for the selection of a particular model. Lamotte and Carter conducted in their text a detailed comparison of the two models and text following is a representation of their analysis and findings:

2.3.5.1 COMPARING VIEWS

Balance scorecard

The balanced scorecard, as previously discussed, has four generic views which are divided into two enabler and two result views. These views are equal in their representation and contribution and reflect more over a paradigm rather than a set of criteria.

Excellence model

The EFQM's excellence model houses nine criteria parts. These criteria parts also reflect "views" and are also sub-divided into enabler and result views. The enabler side has six

[83] Lamotte, G. and Carter, G., 1999, *Are the Renaissance Balanced Scorecard and the EFQM Excellence Model mutually exclusive or do they work together to bring added value to a company?*, EFQM Common Interest Day publication

criteria parts which constitute half of the total weighting, and the result side has four criteria parts which constitute the other half of the total weighting.

Goulian and Mersereau(2000)[84] have however shown that the criteria parts of the EFQM excellence model can be mapped into the views of the balanced scorecard so as to arrive at a more comprehensive scorecard. Their mapping is represented in *Table 5: Comparison of the balanced scorecard and EFQM's excellence model's views.*

BALANCED SCORECARD PERSPECTIVES	EFQM PERSPECTIVES
Financial	Business Results Resources
Customer	Customer Satisfaction
Internal Business Processes	Processes Management Satisfaction
Learning and Growth	Leadership Policy and Strategy Impact on Society

Table 5: Comparison of the balanced scorecard and EFQM's excellence model's views

2.3.5.2 CONTEXT DEPENDENCY

Balance scorecard

The balance scorecard is context dependant and must therefore be developed uniquely every time it is utilised within a company or division. It is fundamentally driven off the organisation's vision and strategy and thus represents the unique strategic position of that particular company at a point in time. It also uniquely reflects the specific identified measures for that specific stated strategy.

Excellence model

[84] Goulian, C. and Mersereau, A., 2000, Performance measurement – Implementing a corporate scorecard, Ivey Business Journal, Vol.65, Iss.1, pp.48-53

The excellence model is context independent and represents a best practise benchmark. The model is designed to evaluate a company against a set of pre-described criteria. It is therefore not industry, sector or strategy specific.

2.3.5.3 NATURE OF THE MODEL

Balance scorecard

The balanced scorecard is in its essence a prescriptive and focused framework. It identifies a set of priorities, as determined by the management, and focuses on the limited key drivers for those priorities.

The balanced scorecard is hypothesis driven and subjective in nature. It operates on the assumptions and value judgments of management as to how to reach the accepted level of performance that is described in the strategy. It also rides on the assumptions of management as to what the drivers of success for the organisation is, given the stated strategy.

Excellence model

The excellence model is descriptive and comprehensive in its view of how processes across the organisation should be managed.

The excellence model is fact based and objective. It forces participants to populate the framework only with facts based on data gathered through an auditable process. The criteria are the same for any organisation and this enables benchmarking.

2.3.5.4 VIEW OF THE FUTURE

Balance scorecard

The balanced scorecard is derived from a vision for a two to five year horizon. It starts from the future and works back so that potential gaps can be identified and the roadmap be established. It defines the strategic change that the company has to make in the present, but it does not analyse the quality of the processes and activities of the present.

Excellence model

The outcome of the self-assessment is a description of the current state of the organisation. It identifies strengths and areas for improvement today, based on the set criteria of the model. It does not force focus, but it rather steers a general, continuous improvement movement across the set of criteria.

2.3.5.5 CAUSE AND EFFECT DIFFERENTIATION

Balance scorecard

The scorecard is built explicitly to drive a focused set of cause and effect objectives. It establishes the whole strategy as a set of interlinked objectives.

Excellence model

The excellence model has a general, implicit cause and effect relationship built into its structure between the enabler and result sections. This is not formally documented between the criteria parts, but each organisation has the freedom, if it chooses, to identify specific linked objectives in the respective criteria parts.

2.3.5.6 THE ADDRESS OF EXTERNAL VARIABLES

Balance scorecard

External impacts such as the environment and society are not systematically addressed in the balanced scorecard. Such factors are only included if they impact or form a part of the strategy.

Excellence model

The impact of society is explicitly addresses within one of the criteria parts. The model's purpose is to lend itself as a benchmarking tool so that comparisons to best in class competitors can be facilitated.

2.3.6 - The South African excellence model

A local variant and direct extension of the EFQM excellence model is the South African Excellence Foundation's excellence model; refer to *Figure 44* below:

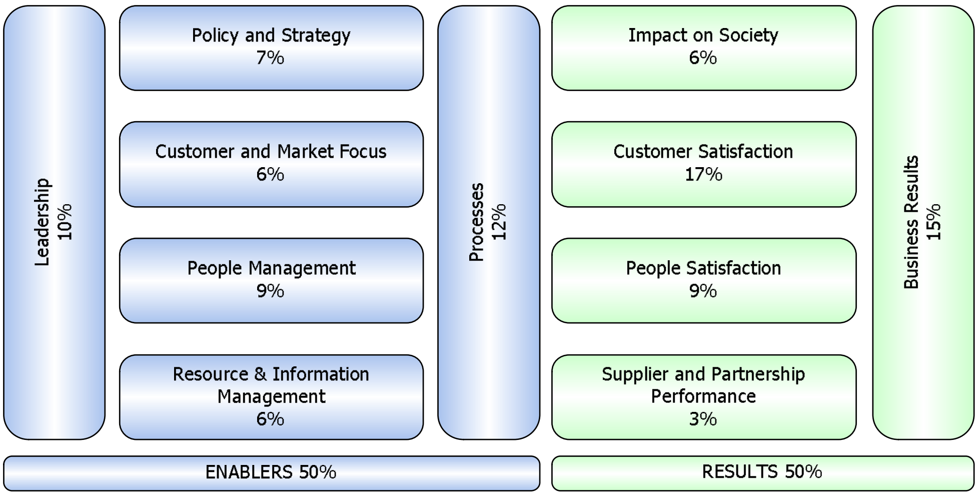

Figure 44: The South African excellence model

The South African Excellence Foundation (SAEF) was established August 28, 1997 by leading South African companies with a passion for quality[85]. It capitalised off the work performed by the US Baldrige National Quality Program as well as the EFQM and established it own local version of the EFQM quality model. It adapted the EFQM model and added two additional criteria, for a total of eleven criteria:

Enablers: Leadership (10%), Policy and strategy (7%), Customer and market focus (6%), People management (9%), Resource and information management (6%) and Processes (12%).
Results: Impact on society (6%), Customer satisfaction (17%), People satisfaction (9%), Supplier and partnership performance (3%) and Business results (15%).

The similarities between the EFQM and the SAEF's models are evident and thus the theory and arguments for the EFQM's excellence model, as stated in *sections 2.3.4* and *2.3.5*, hold true for the SAEF excellence model as well. The SAEF excellence model can thus directly capitalise off the theoretical and academic weight of the EFQM quality model.

The text will be focussing on the utilisation of the SAEF quality model, since the model is native to the same country as that of the case study candidates; refer to *section 5.1 - Case study candidates – an overview* on *page 157*.

2.3.7 - The measurement and assessment domain – a summary

In this domain the text covered the topics of *what* measurement and assessment is, *why* an organisation ventures into it and *where* it is relevant within the firm. The text also covered strategic performance measurement, its definition and its requirements, as well as a potential reference framework for positioning strategic performance measurement relative to other management initiatives. The text then discussed measurement systems and evaluated two prominent internationally accepted measuring systems.

[85] http://www.saef.co.za

CHAPTER 3 - THE DEVELOPMENT OF AN INTERNAL TECHNOLOGY STRATEGY ASSESSMENT MODEL

"Every great advance in science has issued from a new audacity of imagination."
-John Dewey, The Quest for Certainty

The text has up to this point only focused on the establishment of the theoretical base for the research endeavour. It has discussed in great depth on the scope, content and context of the mayor subject matter constituents of the intended research and has at times alluded to the utilisation thereof in the research model. This chapter forms the core of the research endeavour as it extracts from and builds upon the theoretical base it established in *Chapter 2 - Theoretical background and literature study*. It draws from the knowledge domains of

- technology management and technology strategy,
- business architecture frameworks and their representation methods,
- strategic performance measurement and
- total quality management and its sub-set of excellence models.

All of the aspects required from the above mentioned domains for the development of the model, have been discussed in the previous mentioned chapter.

This section is dedicated to show which specific models form the cornerstones of the proposed research model. Various definitive aspects of each of these models are highlighted and combined to propose an alternative, combined model.

3.1 - CORE REFERENCE MODELS

3.1.1 - DISCON architectural framework

By virtue of its ease of use, simplicity and scope, the DISCON architecture framework, as discussed in *section 2.2.6.4*, with its associated modelling formalisms forms the under-wiring of all the *practical* modelling requirements. The utilisation of the formalisms in a re-engineering context is of specific interest, and is borrowed from Engelbrecht's(2000) text[86]. These formalisms are:

- CSF's to represent the strategic objectives;
- Functional structure decompositions to represent the organisational structure;
- CSF to FSD mapping to indicate strategic process priority;
- Object interface diagrams to represent processes;
- Resource ratings to represent operational priority; and
- Vector length calculation to determine the mathematical mean between the strategic and operational functional priorities.

3.1.2 - Arasti and Vernet's BPR-based model

The five stage BPR model of Arasti and Vernet(1997)[19] and Vernet and Arasti(1999)[13], as discussed in *section 2.1.5.3* and illustrated in *Figure 24*, forms the one cornerstone of the research model. The DISCON architecture framework, as discussed in the previous section and *section 2.2.6.4*, together with its associated modelling formalisms, forms the other cornerstone of the research model. The combination of the two results in mapping that is illustrated in *Figure 45* below:

[86] Engelbrecht, B., 2000, unpublished manual titled *Business Engineering Implementation*, Version 3.0, www.discon.co.za

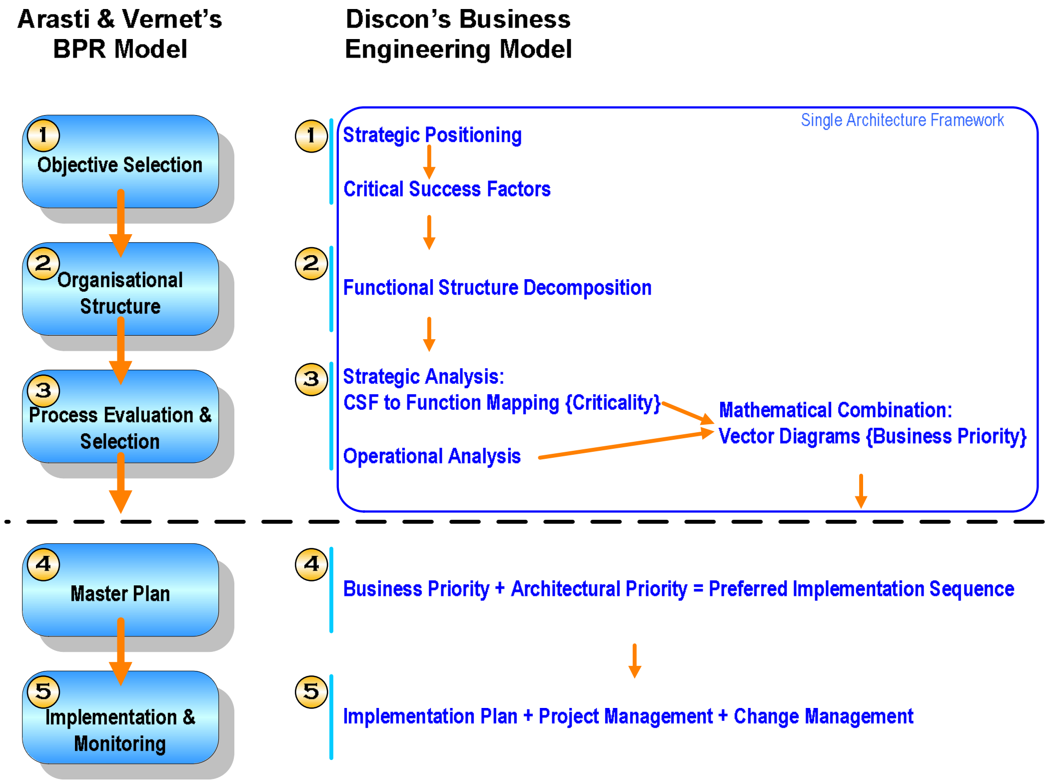

Figure 45: Mapping the DISCON business engineering model into the five stage BPR model

- **Stage one** represents the strategic objective selection. Here the DISCON methodology delivers, in coherence with Feurer *et al*(2000)[48], strategically derived CSF's as an output from a strategic positioning exercise.
- **Stage two** requires the organisational structures to be established. This is achieved on the hand of functional structure decomposition. This approach is directly in-line with (i) the goal-oriented functional definition of technology, refer *section 2.1.3.6*, and (ii) in support of the text's definition of *how* strategy is manifested, refer *section 2.1.4.1*.
- **Stage three** requires the identification of candidate, strategic processes. The DISCON methodology, directly in-line with Feurer *et al*(2000), delivers strategic function criticality by means of a CSF to process mapping. This forms part of the strategic viewpoint of the DISCON methodology. The combination of an operation and strategic viewpoint will deliver the true business priority, and the DISCON methodology accomplishes this by means of vector calculation.
- **Stage four** delivers the BPR master plan which is then implemented in **stage five**. Both stage four and five fall outside the scope of the text,

- **Stage four** delivers the BPR master plan which is then implemented in **stage five**. Both stage four and five fall outside the scope of the text, since the aim of the text is not to execute a re-engineering exercise. Arasti and Vernet(1997)[19] depict the utilisation of the BPR paradigm on the hand of an IDEF0 process:

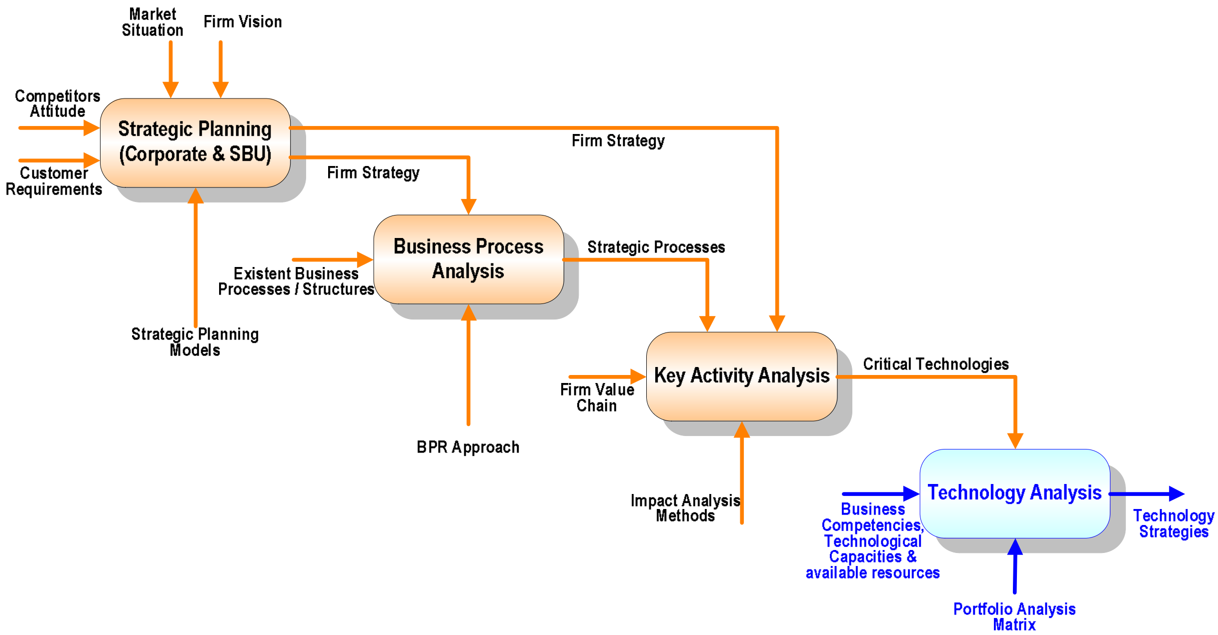

Figure 46: A framework for strategic management of technology through BPR

Figure 46 above requires the delivery of critical technologies as an input into a technology analysis stage and is just a different depiction of Arasti and Vernet's model which was discussed in *section 2.1.5.3*:

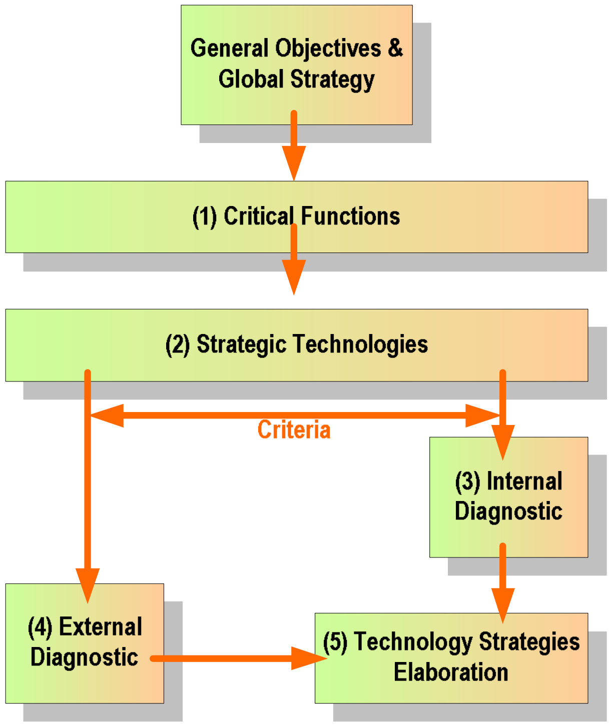

Figure 25: Five steps of technology strategy elaboration regarding the firm overall strategy

The technology analysis stage, step 5 from Arasti and Vernet's model as shown again in *Figure 25* above, requires however an internal and external assessment as input.

3.1.3 - SA excellence model

The SAEF's excellence model, as discussed in *section 2.3.4.2* and more specifically *section 2.3.6*, forms the third and last cornerstone of the research model. The SA excellence model delivers an internal excellence assessment based upon eleven internationally accepted and weighted criteria, to supply step 5 from Arasti and Vernet's model, *Figure 25* above, with its internal diagnostic. The combination of *section 3.1.1* and *3.1.2* is reflected in *Figure 47* below and ultimately delivers an internal technology strategy assessment framework based upon total quality management principles:

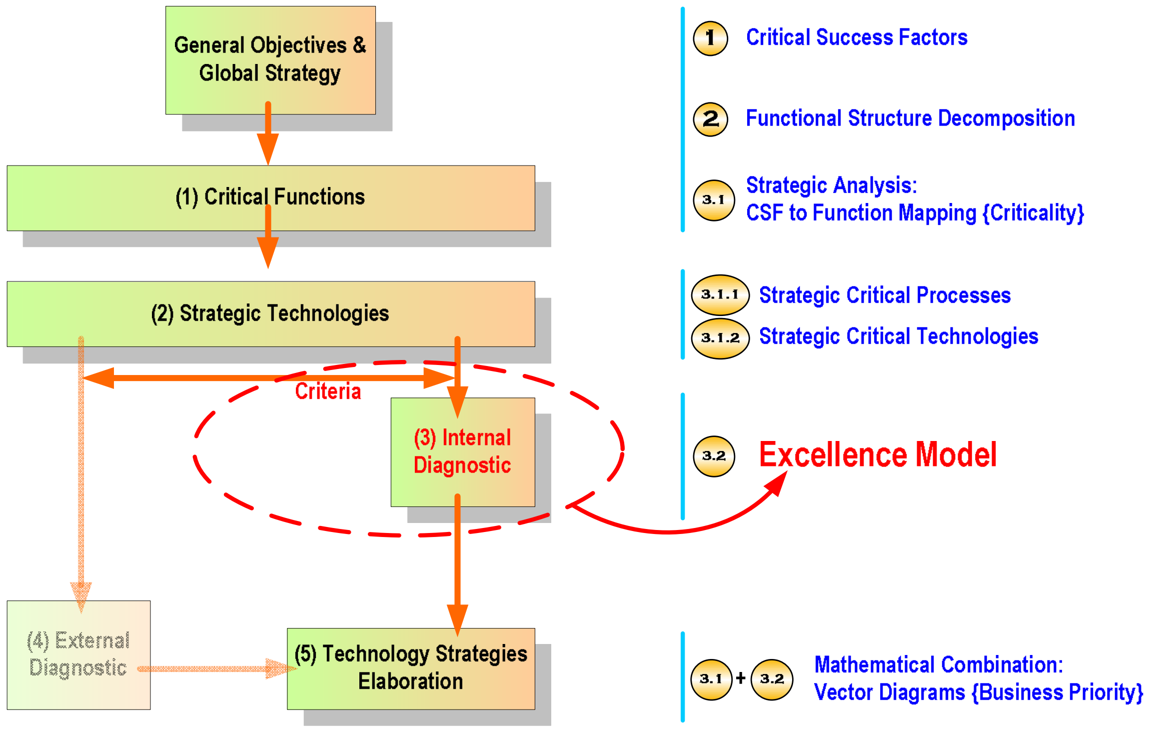

Figure 47: Mapping the SA excellence model into the DISCON five stage BPR model

As shown in *Figure 45*, the combination of the strategic and operational measures according to the DISCON methodology, will deliver the true mathematical vector priority. In the five stage BPR model, as depicted above, the excellence model's ratings will constitute the operational / internal assessment and will be utilised in conjunction with the strategic criticality to determine the technological vector length.

The excellence rating can be defined as the mathematical, weighted sum of the individual criteria scores and represented as a score out of ten. The function criticality can be defined as the number of CSFs' that a function addresses, and is represented as a score out of the total number of CSF's for that division/SBU. In other words: the higher the function criticality, the higher the strategic weight of the function.

As shown in *Figure 47* above, the method described so far only addresses the internal perspective of the Arasti and Vernet technology strategy elaboration model. The research model does not cover the external diagnosis and consequently can not deliver a technology strategy elaboration result, as per the output of the Arasti and Vernet model. This however is not a negative result, since it is not the goal of the research objective.

The research objective is however to utilise the excellence model, according to the Arasti and Vernet model, to deliver a balanced view of key technological focus areas.

The proposed research model is thus (i) founded upon the BPR principles of the Arasti and Vernet technology strategy elaboration, (ii) practically executed by utilising the DISCON modelling formalisms, and (iii) balanced operationally by utilising the output from the SA excellence model. All of this is described in detail in the following section of the text.

3.2 - AN INTERNAL TECHNOLOGY STRATEGY ASSESSMENT FRAMEWORK UTILISING TOTAL QUALITY MANAGEMENT (TQM) PRINCIPLES

Figure 48 on *page 117* depicts the proposed research model. The goal and reason for existence of such a proposed model is nothing less than to address the stated research objectives and goals of the research endeavour. It is the vehicle that is to be used to ascertain data to prove or disprove the validity of the research statements.

Given this fact and the fact that this chapter is solely devoted to the proposed model and its methodology, it therefore becomes worthwhile to revisit the research goals, as stated in *section 1.4 - Goal*, to refresh the mind of the ultimate aim of the proposed model. These aims are, to show that:

- strategically derived critical success factors combined with functional modelling can assist in the identification of strategic focus areas in the typical services organisation,
- strategically balanced functional models combined with procedural definitions of function execution can assist in the qualitative identification of strategic important technological artefacts / building blocks and that
- an assessment scorecard based upon industry accepted excellence models, and the South African Excellence Model in specific, can assist in the strategic balancing of key technological focus areas and technological artefacts / building blocks

ultimately resulting in an operational method of internal strategic technological assessment for the services sector.

The model is in agreement with the text in *section 2.3.1.3,* which illustrates the three levels of an organisation and the performance measurement thereof. The model itself thus follows the natural path of management decision making, namely from a strategic level through a tactical layer and ultimately manifesting in an operational level.

The model thus starts with a known strategic intent as verbalised in a number of strategic objectives. It utilises the techniques and modelling rationales of the DISCON architecture framework, as well as the established theoretical definitions of *Chapter 2*, to govern the content and sequence of each individual step. The result is a logical, stepwise decomposition of strategy, and at the same time a graphically traceable manifestation of each of the individual strategic objectives into the operations of the organisation.

The selected measurement model and criteria, as discussed in *section 2.3.4 - Two business improvement models / measurement systems*, are then utilised to measure the contribution of the implied technology strategy towards overall organisational excellence and its strategic objectives.

The text acknowledges the fact that the model due to its size, as depicted in *Figure 48,* is not legible. It attempts to addresses this predicament by discussing the various steps of the model in an individual manner and utilising contextual extracts from the bigger model. The model is depicted utilising industry accepted flowchart formalisms. The legend for reading the research model (i.e. flowcharts) is set out in *Appendix B*.

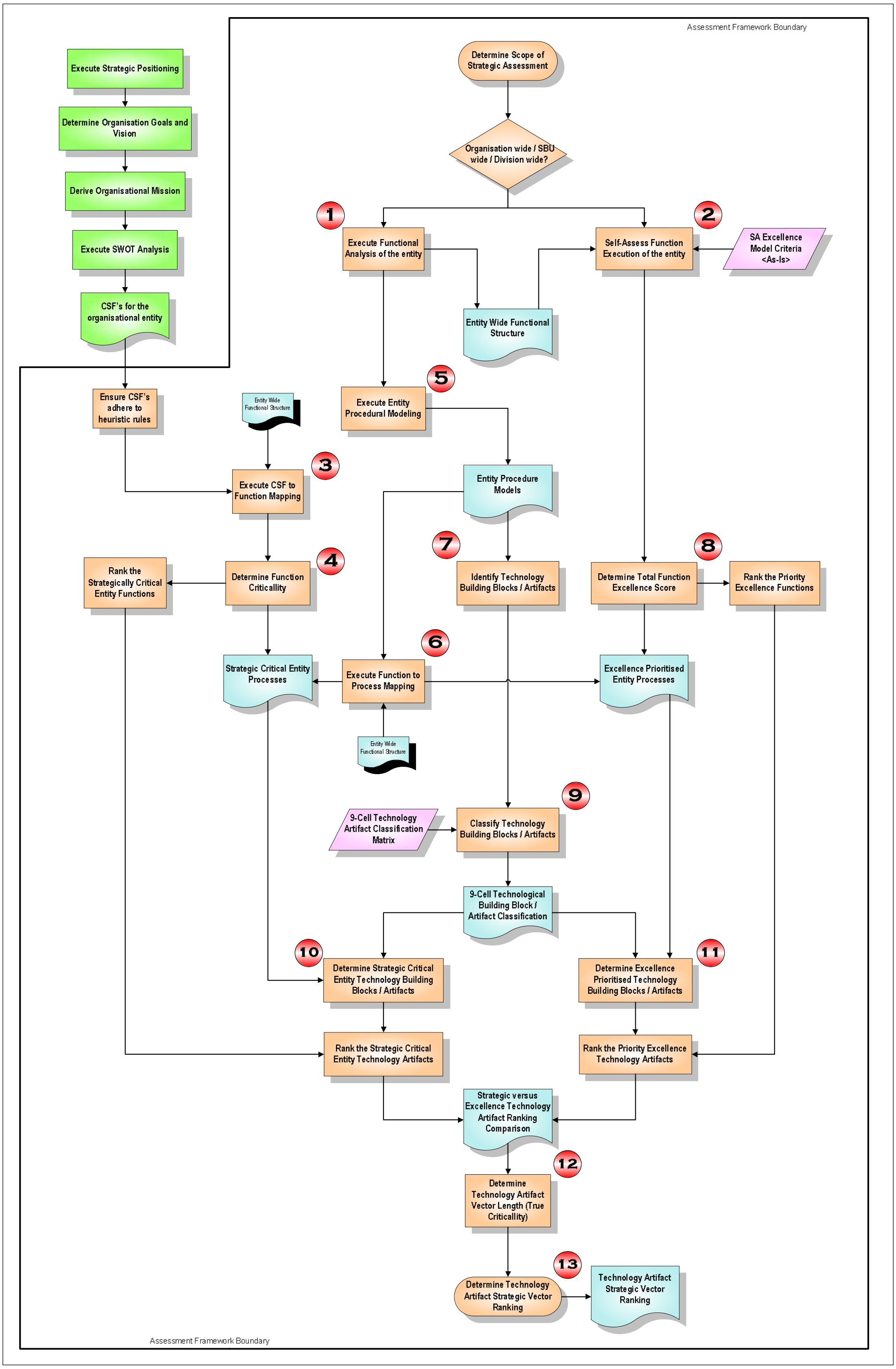

Figure 48: A technology strategy assessment framework utilising TQM principles

3.2.1 - Input required outside the scope of the research model

Figure 49 indicates the first external steps of the research model:

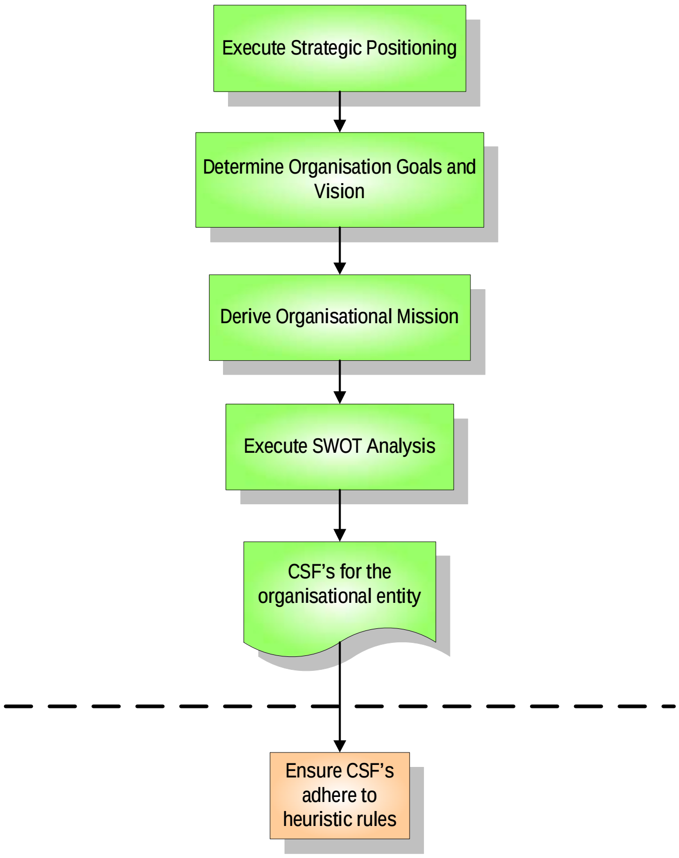

Figure 49: Out of scope model input

The model acknowledges the fact that a strategic derivation or positioning exercise has to take place in order for true strategic objectives and/or drivers to be identified. As stated earlier in *section 2.1.4.1*, strategy is manifested in a set or pattern of objectives, purposes, or goals, which defines the range and nature of business of the organisation[34].

The text agrees with Feurer *et al* (as stipulated in *section 2.1.5* -) and Porter and Tanner (as set out in *section 2.3.2.3*) that CSF's fall within the ambit of the above stated definition of strategic objectives. The use of a set of CSF's is thus a legitimate reflection of the organisation's mission and strategic intent. The text thus assumes the industry common steps of (a) strategic positioning leading to (b) an expression of vision and (c) mission. The various aspects of the mission must then be assessed by means of (d) a SWOT analysis to arrive a balanced set of CSF's which represent strengths and opportunities, as well as weaknesses and threats. The text will not attempt to question the process in which the CSF's are derived and will thus make the assumption that the organisation under scrutiny is capable of conducting its own strategic positioning exercise. The text does however reserve the right to challenge the validity of the CSF's as adhering to the industry accepted heuristic rules. These heuristic guidelines are, as stipulated in Engelbrecht(2000)[86], the following:

- Since any strategy is only relevant for a period of time, a CSF must therefore have a fixed timeframe for which it is applicable.
- It must have a measurable dimension and must conversely be able to be measured.
- A CSF must have no relative weight and also be binary. In other words, no CSF is more important than another and a CSF is either achieved or not.
- For the sake of organisational focus, the total number of CSF's must be in the order of around five to seven.
- A CSF's must cause "certain death". In other words, the organisation must achieve all of its CSF's or it will, for the sake of the exercise, go out of business. The non-achievement of even a single CSF will thus also cause the organisation to go out of business.

The set of organisation CSF's thus form the core strategic starting-block of the whole model and must tested for adherence to the above stated heuristic rules.

3.2.2 - Step 1 – Execute a functional analysis

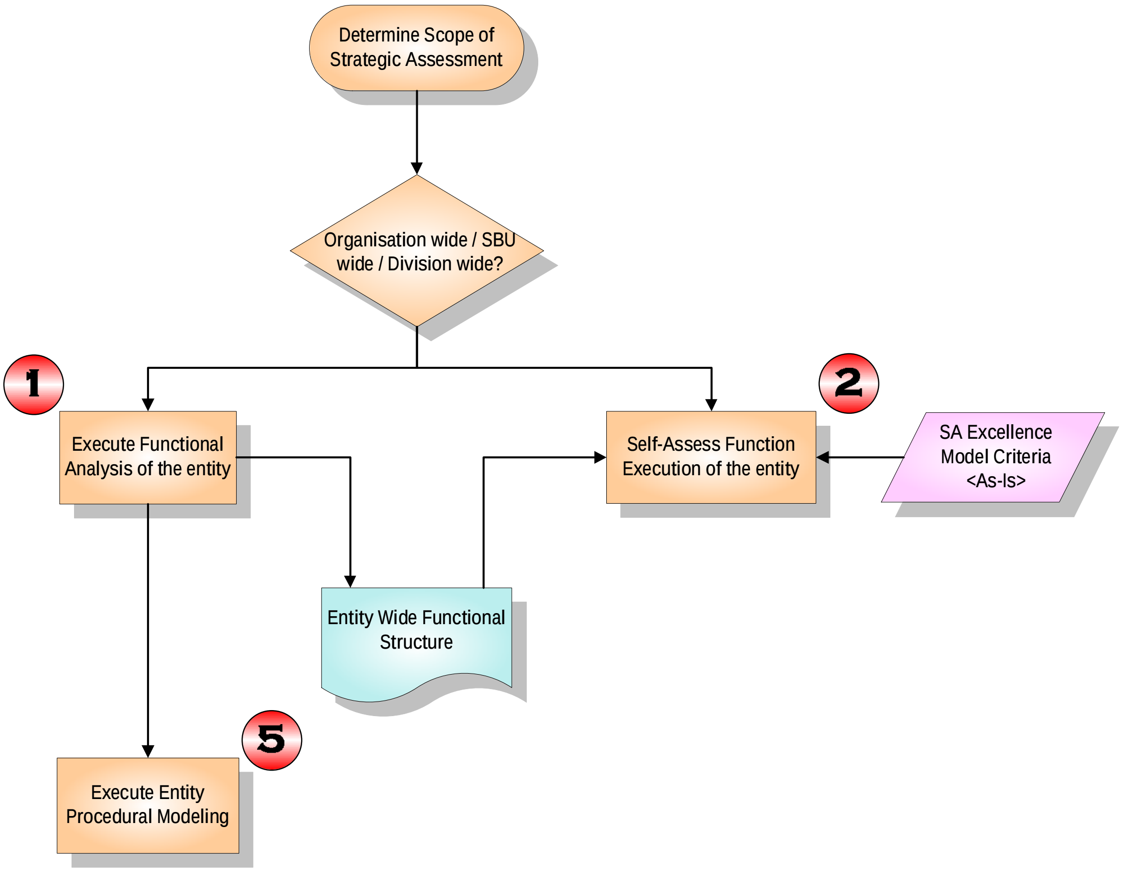

Figure 50: Research model – steps 1, 2 and 5

After determining the scope of the strategic assessment and having received the set of applicable CSF's for that business entity, be it SBU or division, the next step in the model is to execute a functional analysis of the business entity.

3.2.2.1 WHY?

As stated earlier in the text in *section 2.1.4.2*, the reason for existence of an organisation is to realise its vision or some ultimate goal. If this be the case, then why not model the organisation according to its goals and functions? The text is in full support of such a view: strategy is defined as being "objective orientated" (as stated in *section 2.1.4.1- What is meant by strategy?*) and technology is defined as "goal orientated" and "delivering a functional capability" (as stated in *section 2.1.1 - What is technology?*). In order to deliver the above mentioned views, the most appropriate manner of depicting strategy and technology's manifestation would thus be a goal orientated / functional description of the organisation.

The function modelling language, IDEF0, is an accepted international modelling formalism and delivers the following characteristics[87]:

- It is comprehensive and expressive, capable of graphically representing a wide variety of business, manufacturing and other types of enterprise operations to any level of detail.
- It is a coherent and simple language, providing for rigorous and precise expression, and promoting consistency of usage and interpretation.
- It enhances communication between systems analysts, developers and users through ease of learning and its emphasis on hierarchical exposition of detail.
- It is well-tested and proven, through many years of use in Air Force and other government development projects, and by private industry.
- It can be generated by a variety of computer graphics tools; numerous commercial products specifically support development and analysis of IDEF0 diagrams and models.

Utilising the Zachman, ARIS, CIMOSA or DISCON frameworks will deliver a functional viewpoint. All of the discussed frameworks cater for a functional view and thus all of the frameworks are adequate. The differentiation lies however in the modelling formalism of the frameworks: the DISCON formalism for depicting the functional view on the business architectural level is called a goal decomposition diagram. This specific formalism is a scaled down replica of the IDEF0 formalism: it adheres to the same heuristic modelling rules as set out in the standards publication[87], utilises a comparable syntax structure, identical numbering technique and similar graphical representation, but is less formally structured and defined. Refer to *Appendix C - Function structure diagram symbol description* on *page 195* for a FSD symbol description.

[87] Department of Commerce National Institute of Standards and Technology Computer Systems Laboratory, 1993, *Draft Federal Information Processing Standards Publication 183: Integration Definition for Function Modelling (IDEF0)*, Electronic College of Process Innovation http://www.c3i.osd.mil/bpr/bprcd/mlibtiti.htm

3.2.2.2 RESULT

The result of step one is an intra-contextual, functional depiction of the selected business entity. It provides scope to the business or business area and indicates the complete set of parent and children functions, the achievement of which is required to fulfil the business. This structure also serves as a vehicle to assist in the identification of the following:

- context of processes,
- unnecessary duplication of processes,
- misalignment of processes, i.e. processes that should support different parent processes to those that they currently support, and
- completeness of required processes to support specific business objectives

The output of step 1 is thus an entity wide, be it division or SBU, functional structure.

3.2.3 - Step 2 – Assess the excellence of each function's execution

After executing the functional analysis and having produced the entity wide functional structure, the next step in the model is to assess the current execution of the functions, based upon the EFQM and/or SA excellence models.

3.2.3.1 WHY?

The functional structure is only a one dimensional depiction of the current configuration of the organisation's business model. It is only a functional view of the current business and it proposes nothing more: it gives no indication yet as to strategic importance or current capability / excellence of execution.

Section 2.1.4.4 on page 34, *The dynamics of technology strategy*, refers to the organisational context of strategy dynamics, and moreover the "organisation that influences its internal capability". The text thus points to the internal capability of an organisation and the impact such a capability, or lack thereof, has on its strategic realisation capacity.

Referring to the *learning framework of strategy* as depicted in *Figure 14* on page 36, which is a bit further on in the same section mentioned in previous paragraph, also brings the cyclic concept of internal capability to the fore. This cycle of "capability →experience→capability", highlights the need for internal assessment to translate experience gained into new know-how and skills (i.e. new capabilities).

Lastly *section 2.1.4.5* on page 36, refers to Stacey and Ashton's strategy process. This process, as depicted in *Figure 15* starts with an assessment function to "[establish] a full understanding of [the organisation's] current position and performance". Although no direct mention is made to any specific assessment model or method, the importance of an initial assessment function is none the less stressed.

It is evident, out of the above three paragraphs and the previously stated third research goal that before any opinion can be expressed as to strategic alignment, the internal capability of the organisation must be assessed. The text thus opts to utilise the excellence models as a performance and improvement measurement framework, to assess the capability of the organisation on a functional level and more specifically the level of excellence of the said functions. As the third research objective indicates, the text endeavours to utilise the output of this assessment, to assist in the strategic balancing of key technological focus areas.

3.2.3.2 RESULT?

The result of step two is a quantitative yet subjective indication, as all self-assessment exercises always are, of functional excellence relative to the specific excellence model and its criteria weighting.

This quantitative indication provides insight into the following functional aspects of the organisation:

- holistic ranking of functions in terms of their relative level of excellence
- relative indication of strength or weakness
- quantitative indication of where the above mentioned strength / weakness lies in terms of enabler or result
- criteria level, drilled-down indication of functional excellence

3.2.4 - Step 3 – Execute a CSF to function mapping

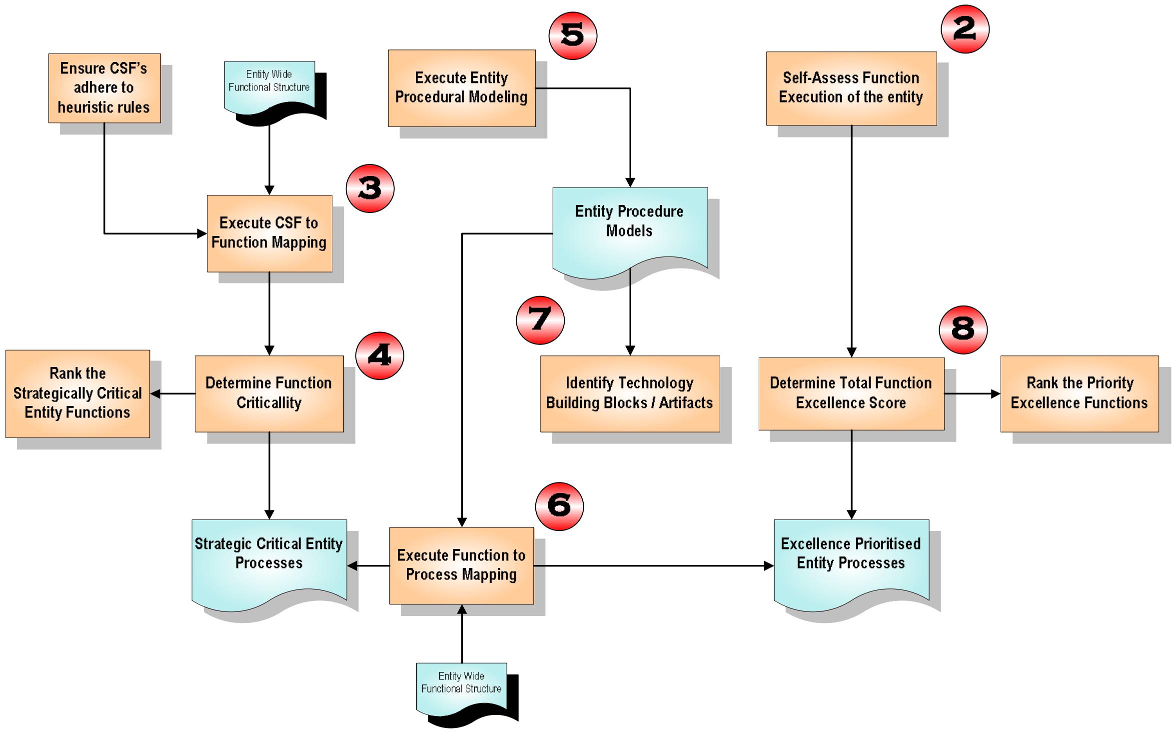

Figure 51: Research model – steps 3 through to 8

As stated in the previous section, step two, the functional model on its own gives no indication as to strategic importance or current capability / excellence of execution. Step two has now established the latter, and thus the former must still be addressed. It is done so on the hand of step three: execute a CSF to function mapping.

3.2.4.1 WHY?

Any organisation is composed of more important functions and lesser important functions. This differentiation, to name but a view, can be based upon a resource view, costing view, turnaround-time view or even a critical chain perspective[88]. The rationale behind all of these perspectives is to facilitate management focus:

- if resource levelling is the focus, then the function with the highest resource load is addressed first
- if cost minimisation is the focus, then the function with the highest rand or dollar value is addressed first

[88] Goldratt, E.M., 1997, *Critical Chain*, North River Press, Great Barrington

- if a critical chain perspective is followed, then the function with bottle neck is addressed first[88]

If the previous step in the research model thus facilitated management focus on a functional level based upon organisational capability / excellence, then step three is intended to deliver management focus based upon the strategic contribution of each function.

As showed in *section 3.2.1 - Input required outside the scope of the research model*, the use of CSF's is a legitimate reflection of the organisation's mission and strategic intent. Thus by overlaying the CSF's onto the functional model, one is able to qualitatively ascertain the strategic importance of the functions. This is no new feat: Feurer *et al* in *section 2.1.5 -* and as reflected *Figure 23*, identified key processes by mapping CSF's to processes based upon their support of the stated CSF's:

> "Processes that support several critical success factors are classed innovative processes. These usually involve multifunctional activities that directly create stakeholder value. They become the focus of [the] business...model"[48].

The first research goal of this dissertation requires that strategic focus areas be identified (refer page 8 or 143). Thus by determining the relative weight of each function in terms of its individual contribution to the achievement of each critical success factor, one is able to achieve such a focus.

3.2.4.2 RESULT?

As allude to in the previous paragraphs, the result of step three is a qualitative indication of functional strategic importance. Functions which address the realisation of all CSF's are of high strategic importance. Conversely, functions which do not address even one CSF are of low strategic importance. So to sum up, the qualitative mapping of CSF's to functions delivers the following benefits:

- it compliments the functional model by adding a strategic perspective
- it facilitates strategic focus by indicating functional areas that are well in support of the strategic objectives

- it delivers an intra-comparable quantitative measure to differentiate between more or less strategic important individual functions

The output of step 3 is thus a strategically assessed functional model whereby each individual child function has been assessed for its strategic contribution.

3.2.5 - Step 4 – Determine the function criticality

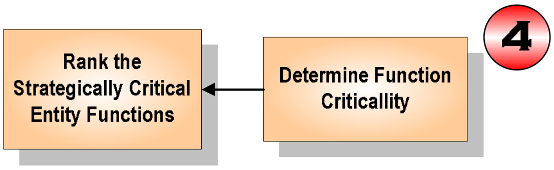

Figure 52: Research model – step 4

After each of the children functions now have been assessed for its individual contribution to the realisation of each CSF, as elaborated in step three, all that is left to do is an elementary mathematical addition. This entails the adding up of the number of CSF's each function addresses. This is executed on a per function basis so as to arrive at a quantitative indication of function criticality. *Table 6* illustrates the concept:

FUNCTION	CSF1	CSF2	CSF3	CSF4	Function Criticality
Function 3.1		✓			1
Function 3.2	✓	✓	✓		3
Function 3.3			✓		1
Function 3.4.1			✓		1
Function 3.4.2	✓	✓			2
Function 3.4.3.1	✓	✓	✓	✓	4
Function 3.4.3.2			✓	✓	2
Function 3.4.3.3					0

Table 6: Example of function criticality

Once the function criticality has been calculated, in order to facilitate focus and priority, the functions need to be sorted according to criticality. This is typically done with the function with the highest criticality first and decreasing to the function with the lowest last; *Table 7* illustrates the principle:

FUNCTION	CSF1	CSF2	CSF3	CSF4	Function Criticality
Function 3.4.3.1	✓	✓	✓	✓	4
Function 3.2	✓	✓	✓		3
Function 3.4.2	✓	✓			2
Function 3.4.3.2			✓	✓	2
Function 3.1		✓			1
Function 3.3			✓		1
Function 3.4.1			✓		1
Function 3.4.3.3					0

Table 7: Example of functions ranked according to criticality

3.2.5.1 WHY?

Contemporary organisations do not have an unlimited budget to their disposal with which to re-engineer and streamline their operations for every time they perform a strategic positioning exercise. Prioritisation needs to take place and attention should be directed to the area where change will deliver the most strategic benefit. Feurer *et al* utilises a similar quantitative mapping indication of process to CSF, to differentiate between innovative, core and supporting processes[48].

Engelbrecht justifies such a mapping and ranking exercise by stating the following:

> The functions, which support the most critical success factors, i.e. with the highest criticality, present the greatest urgency in the business and should receive immediate attention. The outcome of such an exercise will depict the focus of the [re-engineering] project, i.e. this mapping is performed in order to focus the project on those functions which support the most CSF's[86].

3.2.5.2 RESULT?

As already stated in the previous paragraph, the result of such an exercise as described in step four, is a prioritised list of strategic significant functions, ranked according to the quantity of CSF's that each function supports: i.e. from most strategically important to least strategically important. Such an output is typically used as a first indication of re-engineering focus and order of project action.

3.2.6 - Step 5 – Model the processes of each function

Step five follows after step one and takes place in parallel to steps two to four:

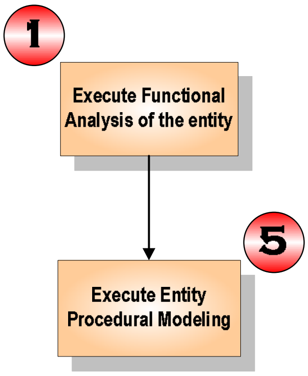

Figure 53: Research model – step 5

3.2.6.1 WHY?

As stated in *section 2.1.4.2* and *3.2.2.1*, the reason for existence of any organisation is to accomplish its stated mission and thereby realise some ultimate goal. In order to achieve these goals, it manifests its intent by means of processes: each designed to produce a specific output and thus realise a specific goal. According to the output required, the input received, the control mechanism employed and the resources available, the configuration of the process will differ. The process is none the less still in support of some goal and exists solely to produce some functional output.

The functional structure decomposition, as established in step one, is thus the purest expression of the consolidated outputs or goals of all the embedded organisational processes. In order to ultimately identify which technology is utilised where to achieve the organisation's stated strategic objectives, it is thus necessary to model the organisation's processes and establish which processes are in support of which functions. As previously stated in *section 3.2.2.2*, the function structure is the ideal framework to assist in the identification of the:

- context of processes,
- unnecessary duplication of processes,
- misalignment of processes,
- and the completeness of required processes to support specific business objectives

When scrutinising the industry, one finds that various process modelling methods and formalism exits. The architectural principles however, as set out in the text in *sections 2.2.2.4*, *2.2.2.5* and *2.2.3.3*, dictate that (a) a modelling method is always related to an implicit framework or paradigm, and (b) when utilising multiple modelling methods caution has to be exercised not to utilise separate techniques based on different reference frameworks.

The various architectural frameworks, as discussed in *section 2.2.6 - Selected architecture frameworks evaluated*, can all deliver a procedural viewpoint. Since a DISCON modelling formalism was however used for function modelling, it necessitates the utilisation of a DISCON formalism for procedural modelling as well. The DISCON formalism for modelling procedures is called the object interface diagramming (OID) technique and is based upon the object orientation paradigm. The OID is a good technique to rapidly identify the scope of a business process, the interfacing to other business processes and the sequencing of events. The procedural definition includes roles and responsibilities within the process, applications utilised, localities of operation and the flow of data between objects, such as between responsibilities and applications.

3.2.6.2 RESULT?

The result of step five is a set of business processes that represent the total scope of operational encompassment of the organisation. Furthermore because the DISCON OID technique is specifically utilised to depict the procedural definition of the organisation, it delivers the following additional benefits:

- a single process reflecting object mappings to other architectural panels such as organisation (responsibility, department and team), time and locality (refer to *section 2.2.6.4* for a discussion on the architectural views / panels of the DISCON architectural framework)
- potential multiple flow descriptions relating to flow classes such as electronic flow, physical flow, capture, communicate, electronic interface and personal interface
- potential multiple object descriptions relating to object classes such as application, tool, equipment, physical form, electronic form or process

3.2.7 - Step 6 - Execute a function to process mapping

Step six is a natural extension of step five and actually occurs simultaneously. For the sake of the research model however, these two steps are discussed separately.

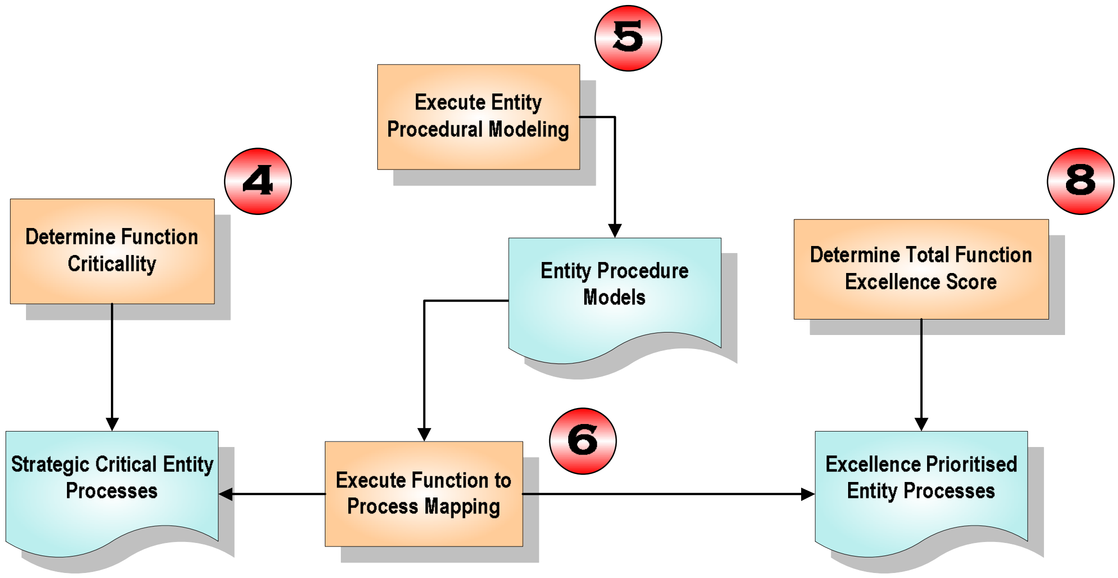

Figure 54: Research model – step 6

3.2.7.1 WHY?

Up to this point the research model has delivered and has at its disposal, four separate deliverables: (a) a functional model, (b) a set of process models, (c) a set of strategic objectives as embodied in critical success factors and (d) an assessment scorecard derived from excellence model criteria. In order to satisfy the research objectives, the model has so far expanded itself by starting to merge and superimpose the four deliverables mentioned above, onto one another.

Research objective number two starts off and requires a "strategically balanced functional model combined with procedural definitions of function execution" (refer *section 1.4 - Goal*). The functional decomposition, as established in step one, represents the total set of goals of the organisation, as structured within a formalised arrangement. This structure indicates the scope, content and context within which the processes of the organisation are to contribute to the achievement of the overall business goal-set.

The CSF to function mapping and resultant function criticality, steps three and four respectively, embody the strategic intent of the organisation as represented and mapped on a functional level. So in order to arrive at a "procedural definition of function execution", and therewith facilitate the identification of potential strategic critical processes, it is required to directly associate the various processes themselves to already defined and strategically weighted organisational functions / goals.

The above mentioned is achieved by qualifying the reason for existence and output of each process. Every process must be able to be related to, and be in support of, at least one or more business goal(s). Conversely, every goal must be realised by at least one or more processes.

3.2.7.2 RESULT?

The result of step six is a business functional model which is directly aligned with its constituent and supporting process models. Such a result ensures the ability to extrapolate and map the findings of the business architectural layer onto the procedural architectural layer (refer to *section 2.2.6.4* for a brief description of the DISCON architectural layers). As *Figure 54* indicates, this facilitates:

- the extrapolation of function criticality onto previous arbitrary processes
- the ability to place a quantitative measure on the relative strategic importance of a process, relative to its neighbouring processes
- the verification and consolidation of the functional model in terms of completeness and accuracy and
- vice versa: the verification and consolidation of the process model set.

It also partially facilitates (dependant on step eight):

- the extrapolation of function excellence, as determined in step two, onto previous arbitrary processes
- the holistic ranking of processes in terms of their relative level of excellence and
- a relative indication of the strength or weakness of the process as a whole.

3.2.8 - Step 7 – Identify the technology building blocks / artefacts per modelled process

Step seven is executed after the processes of the entity, be it division or SBU, have been drawn up (step five).

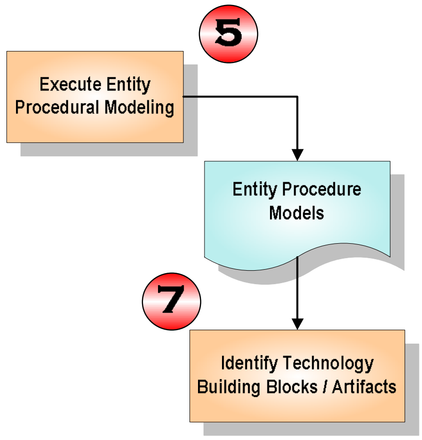

Figure 55: Research model – step 7

3.2.8.1 WHY?

The dissertation title requires that a *technology* strategy assessment framework be developed. Moreover the problem statement stipulates that (a) a theoretically founded method set must be established in order to (b) view (model) the organisational composition, (c) view the impact of strategy and (d) technology, and the (e) combination thereof on the current organisation (refer *section 1.2 - Problem statement*).

Requirement (a) above has been met intrinsically by the utilisation of the DISCON architectural framework and method set; requirement (b) by the organisational functional model and (c) by the CSF to function mapping and the resultant function criticality. Requirement (d) and (e), both relating to the viewing of the impact of technology, have yet to be addressed.

In addition: the second research objective requires the identification of (a) technological artefacts / building blocks which are (b) strategically relevant. The sequence is significant, because before strategic relevance of the artefacts can be proved, the artefacts themselves must first be identified (this rationale justifies the reason for step seven only being able to take place after step five). The identification of technology artefacts can only take place if the technological resources employed are (a) recognised for what they are as well as (b) where they are employed.

To recognise the above mentioned artefacts to be of technological nature, the text refers back to the definition of technology, as previously defined in *section 2.1.1* -. According to this definition technology is defined as being:

- technical
- goal orientated
- delivering a functional capability
- manifesting in processes
- and being similar to other organisational resources

Thus in order to identify these technological artefacts, according to the above stated definition, the processes of the organisation have to be scrutinised for their existence. The technology objects can only be identified on a procedural level and consequently have to be modelled accordingly. Once these technology objects have been identified as contributing to the execution of a specific process, which in turn realises a strategically mapped organisational goal, then only can they be assessed for strategic relevance.

3.2.8.2 RESULT?

The result of step seven is a list of technology artefacts as featuring per operational process. As step ten will show, these artefacts are not limited to a specific class of technology, but can be representative of any of nine types of generic technologies.

If the type of technological artefact lends itself to and manifests itself in multiple processes, then the above list of technology artefacts can be converted to deliver a cross procedural view of every instance where the technology object interfaces. *Table 8* below illustrates the concept:

TECHNOLOGY ARTEFACT	Process 1	Process 2	Process 3	Process 4	Process 5
Technology artefact A – module 1			✓		
Technology artefact A – module 2			✓		
Technology artefact B	✓	✓			
Technology artefact C – module 1				✓	✓
Technology artefact C – module 2				✓	
Technology artefact D	✓	✓	✓		

Table 8: Example of technology artefact interfaces per modelled process

3.2.9 - Step 8 – Determine the total excellence score per each function

Step eight is a direct outflow from step two and takes place in parallel to steps three to seven.

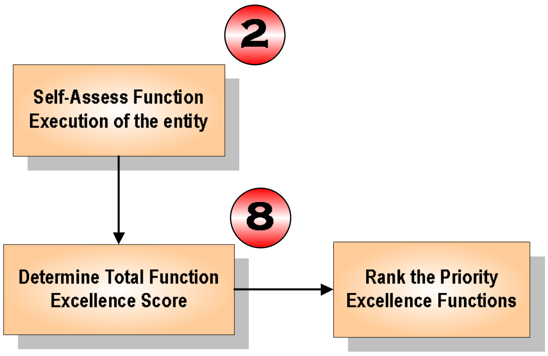

Figure 56: Research model – step 8

3.2.9.1 WHY?

The various children functions were assessed for functional excellence in step two, as *Figure 56* above indicates. The output from that assessment has however not been translated into a meaningful and usable figure, hence the reason for step eight.

As with step four, after each of the children functions have been assessed according to the excellence model criteria for individual functional excellence, all that which is left to do is an elementary mathematical conversion and addition. This is done so as to arrive at a quantitative and comparable indication of functional excellence

3.2.9.2 RESULT?

The various excellence criteria are not weighted equally (refer *Figure 42* on page 103) and so to facilitate easy scoring of the functions in session, the preliminary scoring is executed on an equal scale of ten, irrespective of weighting. The scores are then, after the fact, converted back to their official weighted base and consequently added to arrive at the true total excellence score. *Table 9* illustrates the concept:

Function	Leadership (10)	(10)	People Management (10)	(9)	Policy and Strategy (10)	(8)	Resources (10)	(9)	Processes (10)	(14)	People Satisfaction (10)	(9)	Customer Satisfaction (10)	(20)	Impact on Society (10)	(6)	Business Results (10)	(15)	Total (90)	(100)
Function 3.1	6	6	7	6.3	4	3.2	1	0.9	6	8.4	4	3.6	8	16	0	0	7	10.5	43	54.9
Function 3.2	5	5	7	6.3	3	2.4	1	0.9	6	8.4	5	4.5	8	16	0	0	6	9	41	52.5
Function 3.3	6	6	7	6.3	5	4	4	3.6	6	8.4	6	5.4	8	16	0	0	5	7.5	47	57.2
Function 3.4.1	3	3	6	5.4	6	4.8	7	6.3	6	8.4	5	4.5	7	14	0	0	6	9	46	55.4
Function 3.4.2	4	4	4	3.6	5	4	8	7.2	7	9.8	4	3.6	7	14	0	0	5	7.5	44	53.7
Function 3.4.3.1	5	5	5	4.5	3	2.4	7	6.3	6	8.4	5	4.5	7	14	0	0	6	9	44	54.1
Function 3.4.3.2	7	7	5	4.5	3	2.4	6	5.4	6	8.4	6	5.4	7	14	0	0	6	9	46	56.1

Table 9: Example of functions rated according to the EFQM excellence criteria

In order to ascertain priority and be able to compare function excellence to function criticality, once the excellence scores have been calculated, the functions need to be sorted according to *lack of function excellence!*

If a function is executed in a fairly excellent manner and has a high excellence score, it requires less management attention that another function which has a low excellence score. Such a ranking is then executed with the function with the lowest excellence score first and increasing to the function with the highest last; *Table 10* illustrates:

Function	Leadership (10)	(10)	People Management (10)	(9)	Policy and Strategy (10)	(8)	Resources (10)	(9)	Processes (10)	(14)	People Satisfaction (10)	(9)	Customer Satisfaction (10)	(20)	Impact on Society (10)	(6)	Business Results (10)	(15)	Total (90)	(100)
Function 3.2	5	5	7	6.3	3	2.4	1	0.9	6	8.4	5	4.5	8	16	0	0	6	9	41	52.5
Function 3.4.2	4	4	4	3.6	5	4	8	7.2	7	9.8	4	3.6	7	14	0	0	5	7.5	44	53.7
Function 3.4.3.1	5	5	5	4.5	3	2.4	7	6.3	6	8.4	5	4.5	7	14	0	0	6	9	44	54.1
Function 3.1	6	6	7	6.3	4	3.2	1	0.9	6	8.4	4	3.6	8	16	0	0	7	10.5	43	54.9
Function 3.4.1	3	3	6	5.4	6	4.8	7	6.3	6	8.4	5	4.5	7	14	0	0	6	9	46	55.4
Function 3.4.3.2	7	7	5	4.5	3	2.4	6	5.4	6	8.4	6	5.4	7	14	0	0	6	9	46	56.1
Function 3.3	6	6	7	6.3	5	4	4	3.6	6	8.4	6	5.4	8	16	0	0	5	7.5	47	57.2

Table 10: Example of functions ranked according to their lack of excellence scores

3.2.10 - Step 9 - Classify the technology artefacts according to the nine cell artefact matrix

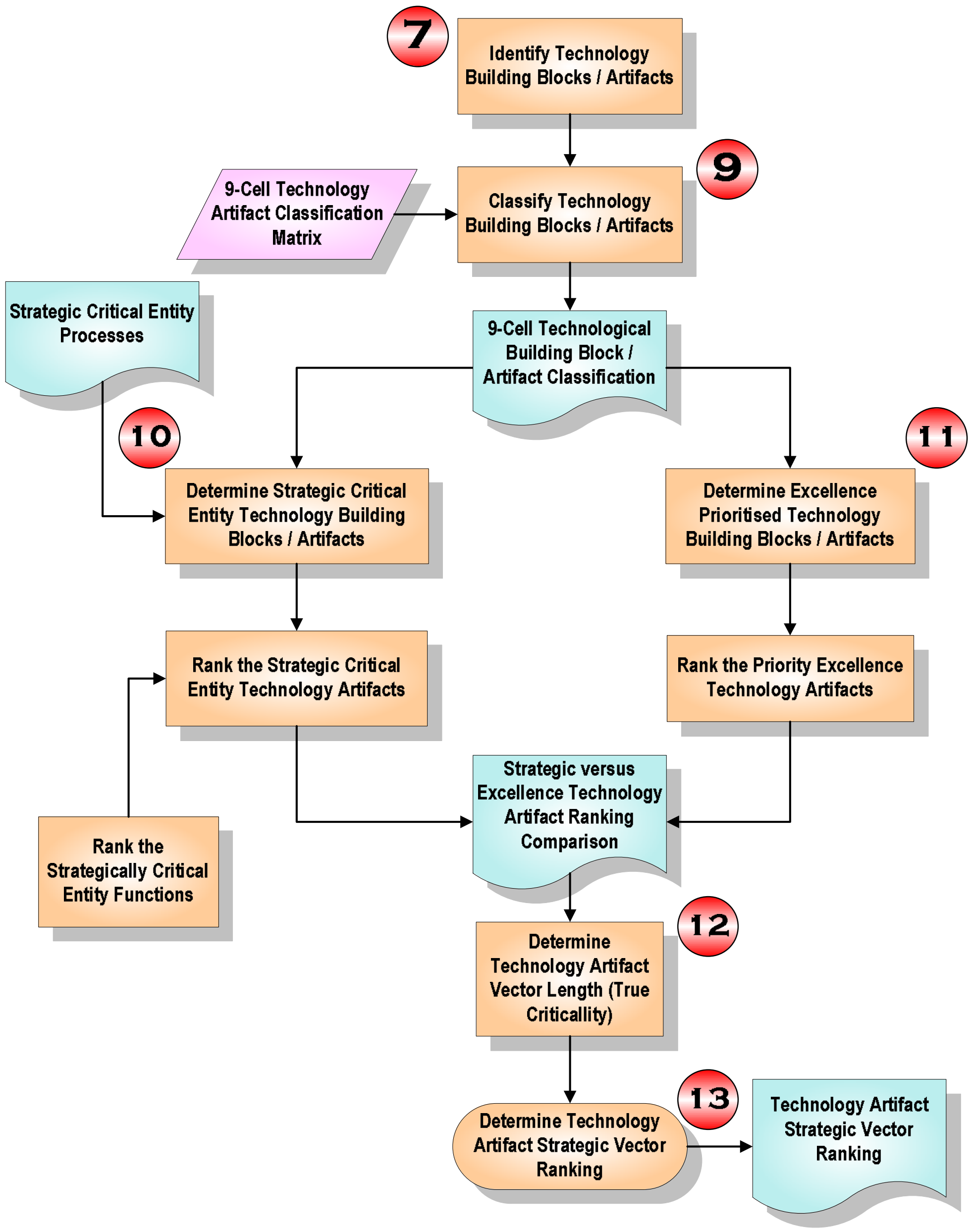

Figure 57: Research model – steps 9 through to 13

3.2.10.1 WHY?

Utilising the output from step seven (refer to *Table 8*) might not prove to be a problem when dealing with manageable quantities of processes and constituent technology objects. The value of classification and abstraction normally only becomes evident when modelling a huge and complex system/organisation and being confronted with unmanageable quantities. The classification of technologies according to Van Wyk's taxonomy (refer to *section 2.1.2 - A framework for classifying technological artefacts*) is introduced into the model in order to facilitate such a potential scenario. Not only does Van Wyk's taxonomy filter complexity and permutation, it also enables generalised handling and assessment, thereby quickly enabling the identification of commonalities and exceptions.

3.2.10.2 RESULT?

The output of step nine is thus a generalised and rationalised view of all technology objects as they manifest in and across the organisation's processes.

The benefit of such a classification is that it facilitates the identification of the pervading type of technology employed. This identification can be executed at a macro organisational level, or at a micro functional / divisional level, depending on the need. As steps ten to thirteen will show, this result can be extrapolated to determine the generalised ranking in terms of excellence and criticality of the common, pervading technology types in the organisation.

3.2.11 - Step 10 – Determine the strategically critical technology artefacts

3.2.11.1 WHY?

The text and research model has up to this point utilised the concepts of architecture, modelling methods and deductive logic to establish a mechanism to view the impact of strategy across the business boundaries of function and process (steps one, three, four, five and six). It has also established the linkage between process and technology (steps seven and nine), but has of yet not established the linkage between strategically ranked processes and technology artefacts.

If such a linkage is established it would result in the manifestation of the organisation's implied and embedded technology strategy, as defined in *section 2.1.6 - The concept of the implied technology strategy*. Such a technology strategy is the result of the current configuration of goals, processes and technologies employed in the organisation.

Step ten is thus merely a mechanistic exercise, but it merges the results from step six and seven with the results from step four. In other words it pulls the golden thread of strategy through from CSF, to function to process and now to technology object. In order to satisfy the first research objective, the linkage between strategically ranked functional and procedural models, must now be expanded to the technology objects within these processes, as identified in step seven.

3.2.11.2 RESULT?

The result of step ten is a qualitative indication of strategically ranked technology objects. Although the strategic ranking is based on a quantitative measure, the measuring method itself is a qualitative measure based on the input obtained from information participants throughout the facilitation process.

This physical output of this step will manifest itself typically in a table depicting the strategic criticality as obtained from function to process to technology object:

Function Criticality	Function	Function Realised by Process	Technology Artefact employed in Process	Associated Artefact Criticallity
4	Function 3.4.3.1	Process 1	Technology Artefact B	4
			Technology Artefact D	4
		Process 5	Technology Artefact C - module 1	4
3	Function 3.2	Process 3	Technology Artefact A - module 1	3
			Technology Artefact A - module 2	3
			Technology Artefact D	3
2	Function 3.4.2	Process 2	Technology Artefact B	2
			Technology Artefact D	2
		Process 4	Technology Artefact C - module 1	2
			Technology Artefact C - module 2	2

Table 11: Example of strategically critical technology artefacts

It must be noted that certain technology artefacts might be employed in multiple processes which are subject to different criticality rankings. In instances such as these, the duplicated lesser critical instances are ignored, because they will be implicitly addressed by their higher ranked instances. So in order to ascertain the true ranked strategic artefact priority the duplication must be removed; *Table 12* illustrates:

Function Criticality	Function	Function Realised by Process	Technology Artefact employed in Process	Associated Artefact Criticallity
4	Function 3.4.3.1	Process 1	Technology Artefact B	4
			Technology Artefact D	4
		Process 5	Technology Artefact C - module 1	4
3	Function 3.2	Process 3	Technology Artefact A - module 1	3
			Technology Artefact A - module 2	3
			Technology Artefact D	3
2	Function 3.4.2	Process 2	Technology Artefact B	2
			Technology Artefact D	2
		Process 4	Technology Artefact C - module 1	2
			Technology Artefact C - module 2	2

Table 12: Example of strategic ranked technology artefacts (non-duplicated)

3.2.12 - Step 11 - Determine the excellence prioritised technology artefacts

3.2.12.1 WHY?

Step ten addressed the technology object ranking in terms of strategic criticality. The excellence ranking output as obtained from steps two and eight must also be considered, as it represents the function's current capability to execute and its level of execution excellence. This priority is the second dimension of the rating system.

3.2.12.2 RESULT?

The result of step eleven is a qualitative indication of excellence ranked technology objects. Although the excellence ranking is based on a quantitative measure, the measuring method itself is a qualitative measure based on the input obtained from information participants throughout the facilitation process.

This physical output of this step will manifest itself typically in a table depicting the ranking as obtained from function to process to technology object, based on the function excellence score:

Function Excellence Score	Function	Function Realised by Process	Technology Artefact employed in Process	Associated Artefact Ranking
7.3	Function 3.4.3.1	Process 1	Technology Artefact B	3
			Technology Artefact D	3
		Process 5	Technology Artefact C - module 1	3
6.2	Function 3.2	Process 3	Technology Artefact A - module 1	2
			Technology Artefact A - module 2	2
			Technology Artefact D	2
4.6	Function 3.4.2	Process 2	Technology Artefact B	1
			Technology Artefact D	1
		Process 4	Technology Artefact C - module 1	1
			Technology Artefact C - module 2	1

Table 13: Example of excellence ranked technology artefacts

Once again the same process as in the previous section must be followed to rid the table of artefact duplication in the ranking.

3.2.13 - Step 12 - Determine the technology artefact vector length

3.2.13.1 WHY?

When two one dimensional metrics / lengths are mapped against another on a Cartesian axis, the resultant vector length will be the true, resultant length as determined by Pythagoras' rule. *Figure 58* below illustrates:

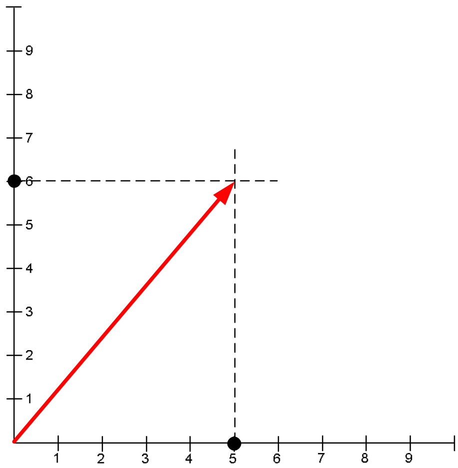

Figure 58: True vector length

If the function and artefact criticality rating then represents the one dimension or axis, and the excellence rating represents the second dimension or axis, then the combination of the two will deliver the true vector length and thus the true priority to focus upon.

3.2.13.2 RESULT?

The result of step 12 is a graphical depiction of vector lengths of all the resultant artefacts. The only difference is that vector origin is not the zero-zero intersection as in *Figure 58* above, but the zero excellence-max criticality intersection. The reason for this is logical: the function with the highest criticality and lowest excellence score, carries the true priority, whilst the function with the lowest criticality and highest excellence score, carries the lowest focus. *Figure 59* illustrates the concept:

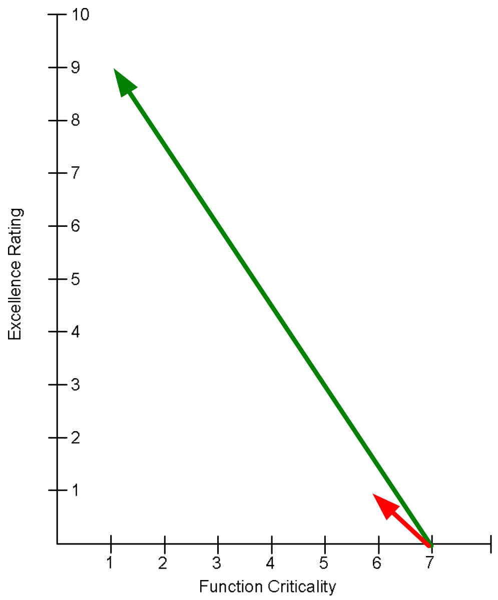

Figure 59: Vector length as a combination of criticality and excellence

3.2.14 - Step 13 – Determine the technology artefact strategic vector ranking

3.2.14.1 WHY?

Step thirteen is a mere mathematical tabular representation to depict the final, true artefact ranking as a result of the two dimensional combination (i.e. vector length) of the criticality and excellence scores as calculated in step twelve.

3.2.14.2 RESULT?

The result of step thirteen is final tabular representation of the vector length and thus the true, balanced priority of the technological artefact. Refer *Table 14* below:

Function	Function Realised by Process	Technology Artefact employed in Process	Function Excellence Score (10)	Function Criticality	Vector Length	Associated Artefact Ranking
Function 3.4.3.1	Process 1	Technology Artefact B	7.3	4	7.3	3
		Technology Artefact D				3
	Process 5	Technology Artefact C - module 1				3
Function 3.2	Process 3	Technology Artefact A - module 1	6.2	3	6.280127387	2
		Technology Artefact A - module 2				2
		Technology Artefact D				2
Function 3.4.2	Process 2	Technology Artefact B	4.6	2	5.015974482	1
		Technology Artefact D				1
	Process 4	Technology Artefact C - module 1				1
		Technology Artefact C - module 2				1

Table 14: Example of strategic critical technology artefacts according to vector length

Once again the duplication must be removed, as in step ten (refer *section 3.2.11.2*):

Function	Function Realised by Process	Technology Artefact employed in Process	Function Excellence Score (10)	Function Criticality	Vector Length	Associated Artefact Ranking
Function 3.4.2	Process 2	Technology Artefact B	4.6	2	5.015974482	1
		Technology Artefact D				1
	Process 4	Technology Artefact C - module 1				1
		Technology Artefact C - module 2				1
Function 3.2	Process 3	Technology Artefact A - module 1	6.2	3	6.280127387	2
		Technology Artefact A - module 2				2
		Technology Artefact D				2
Function 3.4.3.1	Process 1	Technology Artefact B	7.3	4	7.3	3
		Technology Artefact D				3
	Process 5	Technology Artefact C - module 1				3

Table 15: Example of strategic ranked technology artefacts according to vector length (non-duplicated

CHAPTER 4 - RESEARCH DESIGN

"It is the mark of an educated mind to be able to entertain a thought without accepting it."
- Aristotle

This chapter starts off by presenting the case for qualitative research methods with specific focus on the case study methodology. Amongst other things, the text examines the background to case study methodology, the different types of case studies, protocols, sources of evidence and also the required analytical strategy for the findings. Once the theoretical foundation is laid, it then proposes and discusses a qualitative research design in support of the previous chapter's research model.

4.1 - THE CASE FOR QUALITATIVE RESEARCH METHODS - THE CASE STUDY RESEARCH METHODOLOGY

The text has to qualify (a) the manner (how) it proposes to acquire the necessary data and (b) the rationale (why) for selecting such a manner of data acquisition. This section of the text thus first looks at the theory behind case study research and thus addresses the "why" / rationale for the proposed data acquisition method.

4.1.1 - Background to case study methodology

The history of case study research is market by periods of intense use and periods of disuse. The earliest use of this form of research can be traced back to Europe[89]. The methodology was established and gained its popularity when the University of Chicago's Department of Sociology started using and developing the methodology extensively during 1900 and 1935 for its immigration studies of different national groups in the city. The case study methodology was selected and found to very appropriate since it "incorporate[d] the views of the 'actors' in the case study".

The utilisation of this type of research has increased in the past number of years, especially in the education field. Harvard University, for example, has been a leader in

[89] Tellis, W., 1997, *Introduction to Case Study*, The Qualitative Report, Vol.3, No.2, http://www.nova.edu/ssss/QR/QR3-2/tellis1.html

this area and cases developed by the university have been published internationally for use by other institutions[89].

4.1.1.1 CHARACTERISTICS OF CASE STUDY METHODOLOGY

Case studies are multi-perspective analyses. This means that the researcher not only considers the voice and perspective of the actors, but also of the relevant groups of actors and their interaction[90]: "they give a voice to the powerless and voiceless". The case study is an ideal methodology when a "holistic, in-depth investigation is needed"[91]. Tellis states that case studies "strive towards a holistic understanding of cultural systems of action…[where] cultural systems of action refer to sets of interrelated activities engaged in by others in a social situation".

Case study research is not sampling research in the sense that it does not need to have a minimum number of cases, or to randomly select cases: "The researcher is called upon to work with the situation that presents itself in each case"[89]. A case study research design can therefore be a single or multiple-case design. A multiple case design follows replication logic rather than a sampling logic (where a selection is made out of a population for inclusion in the study). Multiple cases only strengthen the results by replicating the pattern-matching, thereby increasing the confidence in the theory[89]. The selection of the cases is however of the utmost importance so that the maximum can be learned in the period of time available. Case studies must therefore always have boundaries[92].

4.1.1.2 CRITICISM OF THE CASE STUDY METHODOLOGY

The issue if generalisation is a frequent criticism of the case study methodology. It is said that its dependence on a single case renders it incapable of providing a generalising conclusion. Yin(1994)[93] refuted this criticism by presenting an explanation between the difference of analytical and statistical generalisation:

[90] Tellis, W., 1997, *Application of a Case Study Methodology*, The Qualitative Report, Vol.3, No.3, http://www.nova.edu/ssss/QR/QR3-2/tellis2.html

[91] Feagin, J., Orum, A., and Sjoberg, G., 1991. In Tellis, W., 1997, *Introduction to Case Study*, The Qualitative Report, Vol.3, No.2

[92] Stake, R., 1995. In Tellis, W., 1997, *Introduction to Case Study*, The Qualitative Report, Vol.3, No.2

[93] Yin, R., 1994. In Tellis, W., 1997, *Application of a Case Study Methodology*, The Qualitative Report, Vol.3, No.3

> In analytical generalisation, previously developed theory is used as a template against which to compare the empirical results of the case study.

He thus points out that generalisation of results, from either single or multiple case designs, is made according to theory and not according to populations.

Tellis[90] continues:

> The inappropriate manner of generalising assumes that some *sample* of cases has been drawn from a larger universe of cases. Thus the incorrect terminology such as 'small sample' arises, as though a single-case study were a single respondent.

Giddens(1994)[94] also states that case study methodology can be considered 'microscopic' because it lacks sufficient number of cases. Yin once again refuted this by arguing that the relative sample, of whatever cases are used, does not transform a multiple case study analysis into a macroscopic study. The *goal* of the study should establish the *parameters* and this should then be applied to all research. This would cause that even a single case could be considered acceptable, provided it met the stated objectives.

4.1.1.3 APPLICATIONS FOR THE CASE STUDY MODEL

Yin also identified and presented four applications for case studies. These are (1) to explain complex causal links in real-life interventions, (2) to describe the real-life context in which the intervention has occurred, (3) to describe the intervention itself and (4) to explore those situations in which the intervention being evaluated has no clear set of outcomes.

Single cases may be used to confirm or challenge theory, or to represent a unique or extreme case. They are also ideal for revelatory cases where an observer may have access to a phenomenon that was previously inaccessible.

[94] Giddens, A, 1984. In Tellis, W., 1997, *Introduction to Case Study*, The Qualitative Report, Vol.3, No.2

4.1.2 - Case study types

Yin also identified three generalised design types which the text will be discussing in more detail. Each of these three case study design types can be utilised in single or multiple case designs.

4.1.2.1 EXPLORATORY

This type of case study is where fieldwork and data collection is undertaken prior to the definition of the research questions and hypotheses. The framework of the study however must be created ahead of time. This type of research typically constitutes pilot projects, as they are very useful in determining the final protocols that will be used. Survey questions can be dropped or added based on the outcome of the pilot study and thus a good instrumental case does not have to defend its typicality[89].

4.1.2.2 EXPLANATORY

The *explanatory* case study type is more suitable for doing causal studies where the reason behind an outcome is sought. The typical outcomes of these types of explanatory studies can possibly be explained on the hand of three rival theories, namely knowledge-driven, problem-solving or social-interaction theory. (1) Knowledge-driven theory means that ideas and discoveries from basic research eventually become commercial products. (2) Problem-solving theory follows the same path, but originates not with a researcher, but with an external source identifying a problem. (3) Social-interaction theory claims that researchers and users belong to overlapping professional networks and are in frequent communication[89]. In very complex and multivariate cases, the analysis can make use of pattern-matching techniques.

4.1.2.3 DESCRIPTIVE

The *Descriptive* case study type requires that the researcher begins with a descriptive theory. The formation of hypotheses of cause-effect relationships is implied in this type of study and hence the descriptive theory must cover the depth and scope of the case under study[89].

4.1.3 - Sources of evidence

Stake identified at least six sources of evidence in case studies:

- Documents

Tellis states that this could be letters, memoranda, agendas, administrative documents, newspaper articles, or "any document that is germane to the investigation".

- Archival records

  This can be service records, organisational records, lists of names, survey data. Tellis cautions the researcher to first investigate the accuracy of the records before utilising them.

- Interviews

  This is stated to be one of the most important sources of case study information. Tellis in his text identifies three types of interviews: open ended, focused or structured. (1) *Open ended interviews* are when key respondents are asked to comment about certain events. (2) The *focused interview* is used when a severe time constraint is placed on the interview and the respondent has a short time to answer a set of questions. This is often used to confirm data collected from other sources. (3) The *structured interview* is very similar to a survey in the sense that detailed, structured questions are developed in advance.

- Direct observation

  This typically occurs when a field visit is conducted. The reliability of such evidence is enhanced when more than one observer is involved in the task.

- Participant-observation

  This specific type of evidence is where the researcher becomes an active participant in the events being studied. Tellis notes that the researcher could alter the course of events as part of the group, and this might not be helpful to the study.

- Physical artefacts

  This is any type of tool, instruments or physical evidence that is collected during the study.

The above mentioned list is by no means exhaustive and not all sources of evidence are relevant for all types of case studies, but it none the less represents the findings of Stake[92].

4.1.4 - Unit of analysis

The unit of analysis is a critical factor in case study analysis: it is the object or system which is being utilised to enact the case study upon it. It can typically be a system of action rather that an individual or group of individuals. Case studies are more selective in nature and they therefore tend to focus only one or two issues that are fundamental to the understanding of the system being examined[90]. Holistic case studies occur when each individual case study is treated as a "whole" study and facts are gathered from various sources and conclusions drawn upon those facts. Embedded case studies also occur when the same case study involves more than one unit of analysis.

4.1.5 - Triangulation

Case study analysis is known as a triangulated research strategy. Feagin, Orum and Sjoberg(1991) identifies four types of triangulation in case studies: (1) data, (2) investigators, (3) theories and (4) even methodologies. *Data source triangulation* is when the researcher look for the data to remain the same in different contexts; I*nvestigator triangulation* is when several investigators examine the same phenomenon; *Theory triangulation* is when investigators with different view points interpret the same results and *methodological triangulation* is when one approach is followed by another to increase the confidence in the interpretation[95].

Tellis states that the need for triangulation arises from the "ethical need to confirm the validity of the processes". He continues to state that in case studies this can be achieved by means of multiple sources of data, but that the problem in case studies are to establish meaning rather than location[90].

4.1.6 - Case study protocols

As discussed earlier in the text, literature has strong criticism for the use of the case study research methodology, because it has been stated as unscientific due to the fact that replication and repetition is not possible. Literature also hosts strong refutations by Yin whose work has resulted in a suggested case study protocol outline. Tellis refers to Yin when he states that "there is more to a protocol that the instrument". Yin asserts that the development of the rules and procedures contained in the protocol enhance the reliability of the case study research. Tellis continues that although it is desirable to have a protocol for a single study, it is essential in a multi-case study. Yin proposes that the following sections must be included in the protocol:

[95] Denzin, N., 1984. In Tellis, W., 1997, *Application of a Case Study Methodology*, The Qualitative Report, Vol.3, No.3

- an overview of the case study project (objectives, issues, topics),
- field procedures (sources of information, access to certain information),
- case study questions and
- a guide for the case study report (outline and format of the narrative)

The discipline imposed on the investigator by the protocol is important to the overall progress and reliability of the study.

4.1.7 - Designing case studies and the components of research design

Yin identified five components of research design that are important for case studies. They are:

- the study's questions,
- its propositions,
- its unit(s) of analysis,
- the logic that links the data to the propositions and
- the criteria for interpreting the findings.

Tellis describes each of these components:

> The study's questions are most likely to be "how" and "why" questions and their definition is the first task of the researcher. The study's propositions sometimes derive from the "how" and "why" questions, and are helpful in focusing the study's goals. Not all studies need to have propositions. An exploratory study, rather than having propositions, would have a stated purpose or criteria on which the success will be judged. The unit of analysis defines what the case is. This could be groups, organisations or countries, but it is the primary unit of analysis. Linking the data to propositions and the criteria for interpreting the findings are the least developed aspects in case studies. Campbell (1975) described "pattern-matching" as a useful technique for linking data to the propositions. Campbell (1975) asserted that pattern-matching is a situation where several pieces of information from the same case may be related to some theoretical proposition. Construct validity is especially problematic in case study research. It has been a source of criticism because of potential investigator subjectivity. Yin (1994) proposed three remedies to counteract this: using multiple sources of evidence,

establishing a chain of evidence, and having a draft case study report reviewed by key informants[89].

Yin also stresses the importance of the type of case study design that should form a backdrop to the type of research that is envisaged. He conversely identifies four basic types of design and represents them in two by two matrix, as *Figure 60* shows:

	Single-Case Designs	Multiple-Case Designs
Holistic (single unit of analysis)	TYPE 1	TYPE 3
Embedded (multiple units of analysis)	TYPE 2	TYPE 4

Figure 60: Basic types of design for case studies

- Type 1 case study is where it is a once-off analysis, due to specific and special circumstances, with only a single unit of analysis. It is holistic in nature "when no logical subunits can be identified and when the relevant theory underlying the case study is itself of a holistic nature"[96].
- Type 2 case study is still a single instance, but it is where the same findings are analysed differently according to additional metrics or analysis units.
- Type 3 and type 4 case studies are the same as type 1 and type 2 case studies, except that the instance of research is now multiple and not limited to a single object or system under scrutiny. As already stated in *section 4.1.1.1 Characteristics of case study methodology*, multiple case

[96] Yin, R.K., 1984, Case study research – Design and Methods, Applied social research methods series volume 5, Sage Publications

study designs follow replication logic rather than a sampling logic. Yin proposes the multiple case study method[96] as set out in *Figure 61* below:

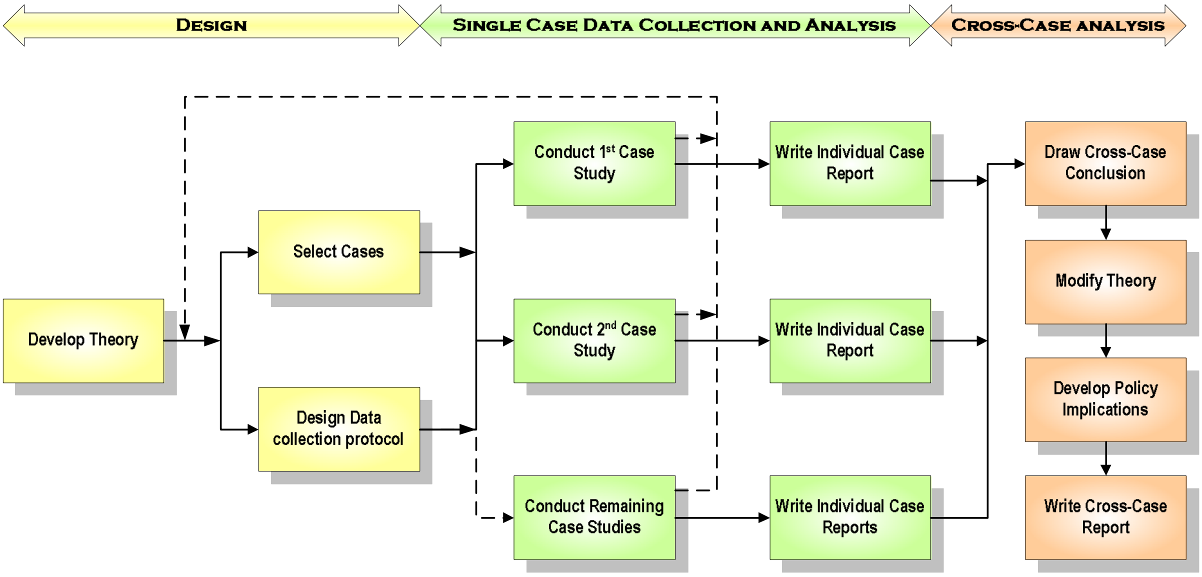

Figure 61: Multiple case study method

4.1.8 - Validity

As mentioned previously in the quotation of Tellis, construct validity is very important in the case study methodology. Aside from the previous mentioned three remedies addressing investigator subjectivity, internal and external validity of the case itself must also be addressed. Internal validity is a concern only in causal or explanatory cases due to the inferences that have to be made. This can be overcome by using the "pattern matching" technique of Campbell(1975)[97] which has also been described above. External validity deals with knowing whether the results are generalisable beyond the immediate case. Yin suggests that the best way to overcome this and elevate the reliability is by means of a robust protocol.

4.1.9 - Analytic strategy

Yin states that "data analysis consists of examining, categorising, tabulating, or otherwise recombining the evidence to address the initial propositions of a study"[90]. Tellis continues and says that the researcher needs to rely on his personal experience and the literature to

[97] Campbell, D., 1975. In Tellis, W., 1997, *Introduction to Case Study*, The Qualitative Report, Vol.3, No.2

help him present the data. In general, the analysis will rely on the theoretical propositions that led to the case study. He suggests that if theoretical propositions are not present that the researcher might consider developing a descriptive framework around which the case study is organised. He continues that not all case studies lend themselves to statistical analysis, and if it did, it might do so to the detriment of other aspects of the study.

Yin suggests that every investigation should have a general analytic strategy. He states that this will guide the decision regarding what will be analysed and for what reason. Yin proposed possible analytic techniques such as *pattern-matching*, *explanation-building*, and *time-series analysis.*

- *Pattern matching*, as mentioned previously in the text, is when an empirically based pattern is compared with a predicted one. If the patterns match, the internal reliability of the study is enhanced. The discretion of the researcher is however still required for the interpretations[90].
- *Explanation-building* is considered a form of pattern-matching, in the sense that the analysis of the case study is carried out by building an explanation of the case. This implies that it is most useful in explanatory case studies, but it is possible to use it for exploratory cases as well as part of a hypothesis-generating process. By its very nature explanation-building is an iterative process. It begins with a theoretical statement which is then refined on the hand of the data. This in turn causes the proposition to be revised and so the process is repeated from the beginning. This is known to be a technique that is fraught with problems for the investigator[90].
- *Time-series analysis* is a well-known technique in experimental and quasi-experimental analysis. It is possible that a single dependent or independent variable could make this simpler than pattern-matching, but sometimes there are multiple changes in a variable, making starting and ending points unclear[90].

4.2 - A QUALITATIVE RESEARCH DESIGN

The text has up to this point in the chapter discussed the theory surrounding the proposed method of research, namely the case study methodology. Taking cognisance of the proposed model in *chapter 3*, this section will now move forward to propose a research design that will facilitate the gathering of data in order to test the proposed research model.

4.2.1 - Case study design

As identified in *section 4.1.7* , the components of the case study research design are the following:

- the study's questions,
- its propositions,
- its unit(s) of analysis,
- the logic that links the data to the propositions and
- the criteria for interpreting the findings.

In the sections to follow, the text will address these above mentioned components and thereby establish the case design.

4.2.1.1 CASE STUDY QUESTIONS

The case study design asks only one question:

> *"How can the excellence model frameworks, and more specifically the SAEF's excellence model, be utilised to assess the strategic alignment of an implied technology strategy within a typical services organisation?"*

4.2.1.2 CASE STUDY PROPOSITIONS

The following propositions are made in order to establish a position from which the study question can be addressed:

> *(a) "A strategically prioritised, typical services organisational functional model, supported by its procedural definitions of function execution, can identify strategically prioritised, implied technology artefacts".*

> *(b) "An assessment scorecard, based upon the excellence models' criteria, and as applied at a functional level, will adjust the strategic priority of implied technology artefacts in line with the applicable function's relative lack of excellence".*

4.2.1.3 UNIT OF ANALYSIS

In order to test the propositions above a suitable unit of analysis must be selected. The unit of analysis must be selected in such a manner so that the variables of size and time are able to be boxed in. For this reason the text defines the unit of analysis to be the following:

> *"A division or SBU, which is part of a larger services organisation, but has its own strategy and utilises technology in its operations to enhance its competitiveness and/or operational effectiveness."*

4.2.1.4 THE LOGIC LINKING THE DATA TO THE PROPOSITIONS

In order to for the case study results to be of any value, it is necessary to establish a logical and/or empirical linkage between the case study prepositions, as set out in *section 4.2.1.2*, and the data set gathered during the actual interaction with the case study object(s).

For proposition (a), as set out in *section 4.2.1.2*, the following logic will be used to link the received data to the proposition:

> *"In order to identify strategic priority on a functional and procedural level, a declining ranking of functions and process must be evident as obtained from direct strategical contribution assessment. "*

For proposition (b) the following a priori results must be visible to link the data to the proposition:

> *For the second proposition to be true the strategic priority of a technology artefact must increase (i.e. the vector length must shorten) as its function's lack of excellence increases (i.e. the excellence score declining).*

4.2.1.5 CRITERIA TO INTERPRET THE FINDINGS

In order to express an opinion as to the validity and meaningfulness of the gathered data and the findings, a set of criteria must be identified per data item produced. Thus utilising the data items identified in the previous paragraphs, the following criteria are thus identified:

> - ***Critical success factors***
>
> *(1) Does management agree that the CSF set truly representative of the whole strategy of the reporting entity?*

(2) Is management satisfied with the wording / expression of the CSF's?

(3) Is management satisfied that the CSF's indicate the right timeframe and metric for each specific CSF?

- Functional model

(1) Was the functional model compiled by a representative forum of the whole division / SBU?

(2) Is the various departmental heads / middle management officials satisfied that their sub-unit's functions and goals are sufficiently represented in the correct context of the larger functional model?

(3) Does management agree that the functional model is truly representative of the operations and goals of the whole division / SBU?

(4) Is management satisfied that the layout reflects the correct scope, content and context of the division / SBU's operations and goals?

- Process models

(1) Was each process model compiled utilising the correct process owner /process expert from the division / SBU?

(2) Is the various departmental heads / middle management officials satisfied that their sub-unit's process is sufficiently documented in the specific process model?

(3) Is the process owner / process expert satisfied that the correct technological artefacts have been identified and correctly accordingly represented?

- Function criticality ratings

(1) Is management satisfied with the resultant function criticality?

(2) Does the resultant function criticality reflect the intuitive functional priority of management?

- Excellence ratings

(1) Was the assessment and excellence ratings compiled by a representative forum of the whole division / SBU?

(2) Is the various departmental heads / middle management officials satisfied with their sub-unit's excellence rating and that it sufficiently represents their current state?

(3) Does the resultant functional excellence rating reflect the intuitive rating of management?

4.2.2 - Case study protocol

The text has indicated in *section 4.1.6 - Case study protocols,* that the development of a case study protocol containing the rules and procedures of how to conduct the case study, is a necessity for multi-case designs. Yin even ventures so far as to state that a solid protocol significantly enhances the reliability of the case study research. He proposes the following sections to be included in the protocol:

- an overview of the case study project (objectives, issues, topics),
- field procedures (sources of information, access to certain information),
- case study questions and
- a guide for the case study report (outline and format of the narrative)

CHAPTER 5 - RESEARCH FINDINGS AND ANALYSIS

"The great tragedy of science - the slaying of a beautiful hypothesis by an ugly fact."
-Thomas Huxley

The text has painted the necessary theoretical backdrop in chapter one and two and evaluated the various facets required to develop an internal technology strategy assessment model. In chapter three the core foundational models were extracted, discussed and combined to propose the research model. Chapter four investigated and proposed a method whereby the data would be acquired and thus established the research protocol.

According to the established research protocol, three individual case studies were conducted. Various elements of data were obtained and thus enabled the text to utilise the data to feed and test the proposed research model. This chapter is the representation and dissection of the results obtained from the protocol, as well as the findings from the output of the research model.

5.1 - CASE STUDY CANDIDATES – AN OVERVIEW

The following three sections contain a brief overview, according to set criteria, of the three case study candidates.

5.1.1 - Case study candidate #1

- Context

  Case study candidate one is a retail development department within a large, multi-national footwear and apparel manufacturer. The department is responsible for the roll-out of off-site outlet stores and the support thereof.
- Core functions

  The department's core functions consist of (i) procuring products for the outlet stores, (ii) marketing the outlet stores, (iii) selling the products via the channel, (iv) servicing the customers and (v) providing general retail support for the outlet store channel.

- Size of the department

  The department is not delineated in physical numbers, but is rather a logical section within the head office structure. It is run and administered by shared head office resources and consequently consists of approximately twelve human resources.

- Technology strategy

  The department, due to its subordinate position within the greater national head office structure, does not derive its own strategy, be it business or technology. As a result of a head office re-engineering exercise, the department however was included and handled separately in the said initiative. The head office in turn is also mandated to align itself to its international holding structure, and this filters through to the technology domain. Consequently all technological architectures (logical and physical) must be tested for alignment, compliance and integration with the international platforms.

- Duration of case study

  The case study was completed in roughly 121 man hours.

5.1.2 - Case study candidate #2

- Context

  Case study candidate two is a financial administration department within a large, top five, South African national bank. The department is responsible for the front-end administration of all internal financial matters and must ensure the smooth operation of the internal financial services.

- Core functions

  The department's core functions consist of (i) the management of certain bank transaction processing functions, (ii) financial administration of fixed assets, (iii) administration of accounts payable, (iv) accounting for certain general ledger financial transactions (v) ensuring compliance throughout and (vi) general administrative support.

- Size of the department

The department itself is staffed by 85 human resources. The number of management staff that participated in the case study itself is far less and equals only about six.

- Technology strategy

  The department is totally subordinate to the broader financial strategies of the head office and group finance function. It does not have a technology strategy of its own and its physical technology needs are totally outsourced to an outside, third party solution provider. The strategic technology architectural requirements are however handled by an intra-bank support function, solely dedicated to the management of the technology architecture.

- Duration of case study

  The case study was completed in roughly 181 man hours.

5.1.3 - Case study candidate #3

- Context

  Case study candidate three is a credit risk intelligence department within a large, top five, South African national bank. The department is responsible for the generation and dissemination of credit related insight with the ultimate goal to pro-actively manage credit risk on an accurate and consistent basis.

- Core functions

  The department's core functions consist of (i) identification of its customer's credit reporting needs (pro-active and reactive), (ii) translation of credit needs into workable, reporting solutions , (iii) conducting research initiatives that underpin credit reports, (iv) generating credit intelligence reports and (v) producing certain compulsory reports.

- Size of the department

  The department is staffed by twenty human resources of which all twenty participated in the case study.

- Technology strategy

  The department, due to its subordinate position within the greater head office credit management structure, does not derive its own strategy, be it business or technology. It does however on a management level participate in the strategic sessions that derive these types of strategies. A recent intra departmental re-engineering exercise was however conducted and consequently the broader credit management strategy was derived downwards to be relevant for the department.

- Duration of case study

  The case study was completed in roughly 160 man hours.

5.2 - KEY FINDINGS – A STEPWISE DISCUSSION

The text will now discuss the key findings on the hand of the guideline steps in the research protocol *firstly*, but also *secondly* on the hand of the proposed internal technology strategy assessment framework, as set out *section 3.2*. This 2-tier discussion method will cause some de-synchronisation between the protocol steps and the research model steps, but will ultimately deliver a full understanding of the method and the model findings.

5.2.1 - Case study protocol results #1&2 / Input required outside the scope of the research model

General comment

Three sets of critical success factors were obtained: one from each case study. The CSF's were tested against the heuristic rules, as set out in *section 3.2.1*, and were found to be compliant. All the criteria with which to interpret the CSF findings, as stated in *section 4.2.1.5*, were met and thus the text accepts the findings to be representative and accurate. Refer to *Appendix D - Case Study Results #1: Critical Success Factors* on *page 196* for a "per case" listing of the critical success factors.

Specific comment

- Case study candidate #1 delivered seven CSF's;
- Case study candidate #2 delivered five CSF's; and
- Case study candidate #3 delivered eight CSF's.

5.2.2 - Case study protocol results #3 / Step 1 – Execute a functional analysis

General comment

Utilising the DISCON architectural framework's functional modelling formalism, three functional models were obtained: one from each case study. All the criteria with which to interpret the functional models, as stated in *section 4.2.1.5*, were met and thus the text accepts the findings to be representative and accurate. Refer to *Appendix E - Case Study Results #2: Functional structure decomposition* on *page 197* for a graphical depiction of each case's functional model. Refer also to *Appendix C - Function structure diagram symbol description* on *page 195* for a FSD symbol description on how to read FSD's.

Specific comment

- For the purposes of the research protocol and to obtain a manageable volume that can be represented textually, the functional model for case study candidate #1 was rolled-up to hide unnecessary detail (refer to the graphical depiction to view the rolled-up detail). This however did not detract from the quality or accuracy of the model: case study candidate #1's FSD still delivered 71 functions which took 30 man hours to complete;
- Case study candidate #2's FSD delivered 85 functions which took 27 man hours to complete;
- Case study candidate #3's FSD delivered 77 functions which took 36 man hours to complete.

5.2.3 - Case study protocol results #4 / Step 3 – Execute a CSF to function mapping

General comment

This protocol result, which is step 3 in the research model, is actually only a forerunner to "Step 4 - Determine the function criticality". Hence the results form this protocol step will be discussed under *heading 5.2.7*.

5.2.4 - Case study protocol results #5 / Step 5 – Model the processes of each function

General comment

Operational process modelling was required according to the protocol, but only to the extent that it delivered the (i) procedural context of technology artefacts, and (ii) functional context of the various processes. Due to excessive volumes, the OID process models are not included in the appendixes. The utilised result of this process modelling step can be seen in *Appendix H, I* and *J*.

Specific comment

- Case study candidate #1 delivered 34 OID process models which took roughly 80 man hours to complete;

- Case study candidate #2 delivered 127 process models which took 156 man hours to complete; and
- Case study candidate #3 delivered 27 OID process models which took roughly 60 man hours to complete.

5.2.5 - Case study protocol results #6 / Step 2 – Assess the excellence of each function's execution

General comment

This protocol result (step 2 in the research model) forms the heart of the research endeavour, since the answering of the case study question, as stated in *section 4.2.1.1*, directly predicates that this action be executed.

Departmental session participants were required to rate the excellence of each function in terms of the eleven SAEF excellence criteria. A preliminary score out of ten was awarded to each criteria-to-function data point, which resulted in the total score being counted out of 110. Each individual criteria score for a function was then mathematically adjusted, according to the SAEF excellence criteria weightings (refer *section 2.3.6*), to result in a weighted score out of 100.

This step did deliver some difficulty due to the unique application of the excellence model within the research model requirement. In the context of a specific function, certain excellence criteria were adjudicated to be not relevant and were conversely not rated. However all the criteria with which to interpret the excellence ratings, as stated in *section 4.2.1.5*, were met and thus the text accepts the ratings that were indeed obtained, to be representative of management's view and accurate in nature. Refer however to *Appendix G - Case Study Results #4: Function excellence* ratings on *page 205* for a detailed per function account of each individual criteria score.

Specific comment

- Case study candidate #1:

  Departmental session participants for this protocol step decided that 105 excellence criteria-to-function intersection points were irrelevant (refer to the yellow cells in case study candidate #1's results within *Appendix G*). This resulted in 18,36% of the total data points for this step being regarded as not applicable. The three largest criteria contributors for this phenomenon was (i) Business results, (ii) Impact on society and (iii) Supplier and partnership performance; refer to *Table 16* below:

SAEF Excellence criteria	Number of data points regarded as not applicable	% contribution
Leadership	1	1.0
Policy and Strategy	1	1.0
Processes	1	1.0
People Management	6	5.7
Resource & Information Management	5	4.8
Customer and Market Focus	5	4.8
Impact on Society	20	19.0
Customer Satisfaction	18	17.1
People Satisfaction	4	3.8
Supplier and Partnership Performance	20	19.0
Business Results	24	22.9
	105	**100.0**

Table 16: Case study candidate #1 excellence mapping breakdown

- Case study candidate #2:

  A total of 726 excellence criteria-to-function intersection points were analysed. Due to some processes still being en route to be implemented, resulted in only 711 data points that could be allocated an excellence score. However departmental session participants encountered no problems with regards to the non applicability of the excellence criteria within these 711 data points. Due to excessive volumes study candidate #2's results are not included in *Appendix G*.

- Case study candidate #3:

  Departmental session participants for this protocol step decided that the "Impact on society"-criteria was in totality not relevant to the operations of the department. Consequently the functions were only analysed on the remaining ten criteria of the excellence model which resulted in a potential 616 data points being reduced to only 560. Of the 56 functions that were analysed and mapped, 5 were analysed on parent-level which resulted in the excellence scores of 23 children functions that needed to be extrapolated. The net effect is that only 58,9% of the mapped functions have unique scores. Due to excessive volumes study candidate #3's results are not included in *Appendix G*.

5.2.6 - Case study protocol results #7 – General questions and information

General comment

This protocol result was primarily used to (1) obtain an understanding of the case study candidates' ability / privilege with regards to deriving, articulating and rolling-out of their own strategies, as well as (2) to ascertain the state of their own technology strategies, if any.

The text can safely say that none of the case study candidates have their own departmental technology strategies and that their strategic processes are largely dictated by the head office strategy calendar. Only on unique instances, such as a once-off re-engineering exercise in the case of candidate #3, do they have the opportunity to derive and articulate their own strategy, and also only in the context of an already set strategy of head office.

5.2.7 - Step 4 – Determine the function criticality

General comment

Session participants were required to qualify the contribution of each function in terms of its contribution to the realisation / achievement of each CSF. If the result was a positive one, it was indicated as such by means of ✓mark. The net result of this step, as discussed is *section 3.2.5*, is the indication of strategic priority reflected on a functional level. Refer to *Appendix F - Case Study Results #3: Function criticality rating* on *page 202* for a non-sorted view of each case study's function criticality.

Specific comment

- Case study candidate #1:

  Due to the fact that case study #1 has seven critical success factors, the highest priority can thus only be seven. Find below in *Table 17* the ten highest ranked functions, of which four of them contribute to all the CSF's:

Function	Criticality
2.5.1 Optimise OUTLET STORE Performance	7
3.1.2.1 Specify Channel	7
4.1 Define Business Strategy	7
4.4 Capitalise on Knowledge Base (Encyclopaedia)	7
3.4.2 (Class) Business Support / Integration	6
4.5 Ensure Finance Component	6

2.1.5 Receive Product in Outlet Store	5
3.2.4.2.2 (Class) POS System	5
3.2.5 Implement Infrastructure as per Requirements	5
3.4.3 (Class) Product Procurement Support (Assortment Planning)	5

Table 17: Case study candidate #1's top ten strategic critical functions

This step as fully executed in protocol step four, took 20 man hours to complete for case study candidate #1;

- Case study candidate #2:

Due to the fact that case study #2 has five critical success factors, the highest priority can thus only be five. Find below in *Table 18* the ten highest ranked functions, of which eight of them contribute to all the CSF's

Function	Criticality
1.3 Classify Request	5
1.6 Solve Request	5
1.8 Monitor / Analyse Requests	5
2.1 Categorise Tasks	5
2.2 Prioritise tasks	5
3.1 Assign / Interpret Transactions	5
3.7 Apply Fraud / Suspend Data Controls	5
5.4 Validate Payment Documents	5
1.1 Receive request for information	4
1.2 Review Previous Communications	4

Table 18: Case study candidate #2's top ten strategic critical functions

This step as fully executed in protocol step four, took 18 man hours to complete for case study candidate #2;

- Case study candidate #3:

Due to the fact that case study #3 has eight critical success factors, the highest priority can thus only be eight. Find below in *Table 19* the ten highest ranked functions, of which eight of them contribute to all the CSF's

Function	Criticality
1.3.3.2.1 Assess the Input Bucket	5
1.3.3.2.2 Route the Request	5
1.3.3.2.3 Action the Request	5
1.3.3.2.4 Close the Request	5
1.3.3.2.5 Measure Resource Consumption i.t.o. Estimate	5
1.3.3.2.6 Explain the Differentials	5
2.9 Fulfil the Request	5

1.3.3.3 Measure the Channel	4
1.5.3 Match Requirement to Solution	4
2.3 (Class) Regulatory Reporting	4

Table 19: Case study candidate #3's top ten strategic critical functions

This step as fully executed in protocol step four, took 16 man hours to complete for case study candidate #3.

5.2.8 - Step 6 - Execute a function to process mapping

General comment

The mapping of function to process was executed only to the extent that it delivered the (i) procedural context of technology artefacts, and (ii) functional context of the various processes. At face value this step seems to be the same as that of "*Case study protocol results #5*" or "*Step 5 – Model the processes of each function*", as discussed in *section 5.2.4*. This step is purposefully executed to ensure that processes that also contribute to other functions, are mapped as such. No separate results of this step were produced, but the utilised results can be seen in *Appendix H, I* and *J*.

5.2.9 - Step 7 – Identify the technology building blocks / artefacts per modelled process

General comment

The step continues where the previous step 6 left off. Once again it is only executed to (1) identify the various technology artefacts per each process and (2) to determine the procedural context of recurring, identical technology artefacts. As with the previous step, no separate results were produced, but the utilised results can be seen in *Appendix H, I* and *J*.

Specific comment

- Case study candidate #1 delivered 27 unique technology objects across 34 OID process models;
- Case study candidate #2 delivered 36 unique technology objects across 127 process models;
- Case study candidate #3 delivered 18 unique technology objects across 27 OID process models

5.2.10 - Step 8 – Determine the total excellence score per each function

General comment

This step was implicitly executed in the execution of "*Case study protocol results #6 / Step 2 – Assess the excellence of each function's execution*". The result from this step is but only the summation of the various individual criteria scores and was already discussed in *section 5.2.5*. Refer however to *Appendix G - Case Study Results #4: Function excellence* ratings on *page 205* for a detailed account of the total excellence score per each function.

Specific comment

- Case study candidate #1

  Though not a perfect solution, it was decided to allocate a full score to the specific function's data points where the excellence criteria were deemed to be not applicable. The effect of this would be to lift the overall excellence score and thus make the function less of an operational priority. This is not a gross incorrect assumption to make, because if three criteria were deemed to be not applicable, it would mean that management have only to focus on the remaining seven relevant criteria, which is indeed less of an operational burden. The total excellence score was thus kept at 110 and weighted down mathematically to 100 throughout all of the functions.
- Case study candidate #2

  No problems occurred with the excellence scores from this case study.
- Case study candidate #3

  Due to the fact that the "Impact on society"-criteria was left out of the excellence scoring exercise as a whole, the total excellence score for all the functions only counted out of 100, as opposed to 110. After the mathematical weighting the total was thus reduced to 94, as opposed to 100. This adaptation did not however affect the ranking, since all the functions were still handled on an equal mathematical basis.

5.2.11 - Step 9 - Classify the technology artefacts according to the nine cell artefact matrix

General comment

As discussed in *section 3.2.10*, the output of this step is a generalised and rationalised view of all the technology objects as they manifest in and across the case study candidate's processes. No separate results were produced, but the utilised results can be seen in *Appendix H, I* and *J*.

Specific comment

- Case study candidate #1

  The 27 unique technology objects which are identified across the 34 OID process models can be rationalised into only five classes. These are listed in *Table 20* below:

Rationalised instances: 9 cell technology matrix artefact classification
Energy Store
Information-Process
Information-Process & Information-Store
Information-Store
Information-Transport & Information-Store

Table 20: Case study candidate #1's rationalised technology classes

- Case study candidate #2

  The 36 unique technology objects which are identified across the 127 process models can be rationalised into only five classes. These are listed in *Table 21* below:

Rationalised instances: 9 cell technology matrix artefact classification
Information Store
Information-Process
Information-Process & Information Transport
Information-Process & Information-Store
Information-Transport & Information-Store

Table 21: Case study candidate #2's rationalised technology classes

- Case study candidate #3

  The 18 unique technology objects which are identified across the 27 process models can be rationalised into only five classes. These are listed in *Table 22* below:

Rationalised instances: 9 cell technology matrix artefact classification
Information-Process
Information-Process & Information-Store
Information-Process & Information-Transport
Information-Store
Information-Transport & Information-Store

Table 22: Case study candidate #3's rationalised technology classes

5.2.12 - Step 10 – Determine the strategically critical technology artefacts

General comment

This step in the research model directly addresses the first of the case study design's propositions as stated in *section 4.2.1.2*, which reads:

> *"A strategically prioritised, typical services organisational functional model, supported by its procedural definitions of function execution, can identify strategically prioritised, implied technology artefacts".*

The findings, as presented in *Appendix H - Case Study Results #5: Strategic critical technology artefacts* on *page 211*, directly show that the logic linking the data gathered to the propositions, is indeed evident and easily visible. Refer to *section 4.2.1.4* to view the stated a-priori logical linkage.

It is important to note that this result represents the technology artefact ranking from a strategic perspective only and is directly a result of the CSF-to-function; function-to-process and process-to-technology findings, as shown in *sections 5.2.7, 5.2.8* and *5.2.9* respectively.

Specific comment

- Case study candidate #1

  The first eleven technology artefacts all exhibited the same priority, followed in second, third and forth by five artefacts each. The findings, as exhibited in *Appendix H*, are rationalised to the top ten artefacts only and listed in *Table 23* below:

Technology artefact	Criticality
Bar-coding technology <Scanning>	7
Enterprise Merchandise System	
POS System <Inventory Management Module>	
POS System <Management information>	
Product Style/Model System < Management information >	
Product Style/Model System <Database module for marketing purposes>	
Project Scheduling Software	
Stock Count System	
Storage System <Stock Control>	
Warehouse Management System <Inventory Module>	

Table 23: Case study candidate #1's top ten strategic technology artefact ranking

- Case study candidate #2

  The first 19 technology artefacts all exhibited the same priority. The second priority was shared by 8 technology artefacts and the third priority by 4. Due to excessive volumes, the findings are not exhibited in *Appendix H*. Find nonetheless the rationalised top ten artefacts listed in *Table 24* below:

Technology artefact	Criticality
Central branch procurement system	5
Electronic communication <e-mail>	
General ledger <Cost centre management module>	
General ledger <Fixed assets register>	
General ledger <Mandates module>	
General ledger <Purchase orders module>	
Intranet <Policy documents>	
Issue Resolution Management & Tracking System	
Signature recognition technology	
Spreadsheet Software	

Table 24: Case study candidate #2's top ten strategic technology artefact ranking

- Case study candidate #3

The first 9 technology artefacts all exhibited the same priority. The second priority was shared by 4 technology artefacts and the third priority by 2. Due to excessive volumes, the findings are not exhibited in *Appendix H*. Find nonetheless the rationalised top ten artefacts listed in *Table 25* below:

Technology artefact	Criticality
Database report generation software	5
Database search and query software <Database interrogation>	
Database software	
Document management software	
Electronic communication <e-mail>	
Electronic projector	
Spreadsheet Software	
Word processing software	
Workflow software <Routing of events>	
e-Campaign management software	4

Table 25: Case study candidate #3's top ten strategic technology artefact ranking

5.2.13 - Step 11 - Determine the excellence prioritised technology artefacts

General comment

The results obtained from this step reflect a technology artefact ranking from an operational perspective only and is directly a result of the weighted excellence score per function, as shown in *section 5.2.5*. This result, as explained in *section 3.2.12*, is necessary because it forms the second dimension of the vector calculation.

It is important to note that the ranking is achieved by sorting the function/artefact excellence scores in an ascending order. The rationale for this is that the lower the excellence score is, the more of an operational priority the function/technology artefact becomes. A lower score thus requires more management attention and effort than a higher score, hence the sorting rationale. Refer to *Appendix I - Case Study Results #6: Excellence prioritised technology artefact* on *page 222* for a detailed account of the excellence technology artefact ranking per each function.

Specific comment

- Case study candidate #1

The first 6 technology artefacts all exhibited the same excellence score. The second priority was shared by 4 technology artefacts and the third priority by 6. The findings, as exhibited in *Appendix I*, are rationalised to the top ten excellence prioritised artefacts only and listed in *Table 26* below:

Technology artefact	**Weighted Excellence Total**
Bar-coding technology <Scanning>	**47.8**
POS System <Management information>	
POS System <Sales Module>	
POS System <Terminals>	
Product Style/Model System < Management information >	
Product Style/Model System <Retail Interface>	
POS System <Planning Module>	**53.4**
Product Style/Model System <Database module for marketing purposes>	
Project Scheduling Software	
Storage System <Stock Control>	

Table 26: Case study candidate #1's top ten excellence prioritised technology artefact ranking

- Case study candidate #2

The first 4 technology artefacts all exhibited the same excellence score. The second priority was shared by 4 technology artefacts also and the third priority by 10. Due to excessive volumes, the findings are not exhibited in *Appendix I*. Find nonetheless the rationalised top ten excellence prioritised artefacts listed in *Table 27* below:

Technology artefact	**Weighted Excellence Total**
General ledger <Accounts payable>	**54.4**
General ledger <Batch processing module>	
General ledger <Cost centre management module>	
General ledger <Mandates module>	
Central branch procurement system	**55.3**
General ledger <Creditor management module>	
General ledger <Transaction / posting management>	

Technology artefact	Weighted Excellence Total
Spreadsheet Software	
Electronic communication <e-mail>	57.9
Electronic communication <Facsimile >	

Table 27: Case study candidate #2's top ten excellence prioritised technology artefact ranking

- Case study candidate #3

  The first 7 technology artefacts all exhibited the same excellence score. The second priority was shared by 3 technology artefacts and the third priority by 2. Due to excessive volumes, the findings are not exhibited in *Appendix I*. Find nonetheless the rationalised top ten excellence prioritised artefacts listed in *Table 28* below:

Technology artefact	Weighted Excellence Total
Database search and query software <Database interrogation>	30.8
Database software	
Electronic communication <e-mail>	
Intranet portal <Front end to customer database>	
Spreadsheet software	
Web services <Interface for information capturing>	
Workflow software <Routing of events>	
e-Campaign management software	34.3
Project scheduling software	
Word processing software	

Table 28: Case study candidate #3's top ten excellence prioritised technology artefact ranking

5.2.14 - Step 12 - Determine the technology artefact vector length

General comment

This step in the research model directly addresses the second of the case study design's propositions as stated in *section 4.2.1.2*, which reads:

"An assessment scorecard, based upon the excellence models' criteria, and as applied at a functional level, will adjust the strategic priority of implied

technology artefacts in line with the applicable function's relative lack of excellence".

This proposition was found to be false on a technology artefact level, but true on a functional level. The results obtained from this step reflect the true technology artefact ranking. It is a vector-based calculation that delivers a mathematically balanced view which is neither biased towards *strategic* importance (highest criticality) nor towards *operational* importance (lowest excellence score). The two previous dimensions are thus combined mathematically to deliver a single, combined priority.

It must be noted that this calculation is executed in the context of a particular process, with in turn is also in the context of a particular function. The implication of this is that apparent, eye-level errors might seem to appear when the weighted excellence totals and the criticality figures are compared on a technology artefact basis. This would be the incorrect manner to compare, since all ratings are done on a functional level. This finding concurs with the second proposition not being true.

The vector calculation is done on the hand of the following equation:

$$\text{Vector Length} = \sqrt{(\text{Number of CSF's for department} - \text{Function criticality})^2 + \left(\frac{\text{Function excellence score}}{10}\right)^2}$$

The reason for the division by 10 in the last term is to bring the excellence score, which is a figure out of a 100, to an equal base with the criticality.

Refer to *Appendix J - Case Study Results #7: Technology artefact vector length* on *page 233* for a detailed account of the technology artefact vector length ranking per each function.

Specific comment

- Case study candidate #1

Technology artefact	Weighted Excellence Total	Criticality	Vector Length
POS System <Planning Module>	54.4	7	5.4
Product Style/Model System <Database module for marketing purposes>			
Project Scheduling Software			
Storage System <Stock Control>			
POS System <Management information>	53.4	4	6.1

Technology artefact	Weighted Excellence Total	Criticality	Vector Length
Product Style/Model System <Management information>			
Bar-coding technology <Scanning>	47.8	3	6.2
POS System <Sales Module>			
POS System <Terminals>			
Product Style/Model System <Retail Interface>			

Table 29: Case study candidate #1's top ten technology artefact vector length ranking

- Case study candidate #2

  The vector equation had to be adapted to cater for the excellence score only counting out of a total of 94, as opposed to the usual 100 of the other two case studies. Resultantly the equation reads as follows:

$$\text{Vector Length} = \sqrt{(\text{Number of CSF's for department} - \text{Function criticality})^2 + \left(\left[\frac{\text{Function excellence score}}{94}\right] \text{x10}\right)^2}$$

Technology artefact	Weighted Excellence Total	Criticality	Vector Length
General ledger <Accounts payable>	54.4	4	5.5
General ledger <Batch processing module>			
General ledger <Cost centre management module>			
General ledger <Mandates module>			
Intranet <Policy documents>	57.9	5	5.8
Spreadsheet Software			
Electronic communication <e-mail>	57.9	4	5.9
Electronic communication <Facsimile >			
Central branch procurement system	55.3	3	5.9
General ledger <Transaction / posting management>			

Table 30: Case study candidate #2's top ten technology artefact vector length ranking

- Case study candidate #3

Technology artefact	Weighted Excellence Total	Criticality	Vector Length
Database search and query software <Database interrogation>	**46.3**	**5**	**5.8**
Database software			
Electronic communication <e-mail>			
Spreadsheet Software			
Workflow software <Routing of events>			
Database report generation software	**49.3**	**5**	**6.0**
Document management software			
Electronic projector			
Word processing software			
Intranet portal <Front end to customer database>	**30.8**	**2**	**6.8**

Table 31: Case study candidate #3's top ten technology artefact vector length ranking

5.2.15 - Step 13 – Determine the technology artefact strategic vector ranking

General comment

Caution must be exercised when analysing the figures below. The criticality ranking, weighted excellence ranking and vector length ranking figures (as obtained in *sections 5.2.12*, *5.2.13* and *5.2.14* respectively), which were derived within the context of a process within the context of a function, were mapped out of context, directly onto the technology artefacts for the sake of this research step. The implication of this is that apparent contradictions and errors might seem to exist when analysing the vector length figures below.

The apparent contradictions rightly show the significant difference that exists when examining technology artefacts (i) only in a strategic context, (ii) only in an operational context, and (iii) in a combined and balanced manner. Refer to *Appendix H, I* and *J* for the separate contextual listings of the technology artefact rankings (within their original procedural and functional contexts) according to strategy, operations and the vector length combination.

Specific comment

- Case study candidate #1

Technology artefact	Criticality	Criticality Ranking	Weighted Excellence Total	Weighted Excellence Total Ranking	Vector Length	Vector Length Ranking
POS System <Planning Module>	7	1	53.4	2	5.4	1
Product Style/Model System <Costing>	5	3	79.7	7	5.4	1
Project Scheduling Software	7	1	53.4	2	5.4	1
Storage System <Stock Control>	7	1	53.4	2	5.4	1
POS System <Management information>	7	1	47.8	1	6.1	2
Product Style/Model System <General Ledger>	6	2	64.9	5	6.1	2
Bar-coding technology <Scanning>	7	1	47.8	1	6.2	3
POS System <Sales Module>	6	2	47.8	1	6.2	3
POS System <Terminals>	6	2	47.8	1	6.2	3
Product Style/Model System <Retail Interface>	6	2	47.8	1	6.2	3
Bar-coding technology <Printer>	4	4	59.7	3	6.7	4
Electronic communication <e-mail>	4	4	59.7	3	6.7	4
Product Style/Model System <Product Master Module>	4	4	59.7	3	6.7	4
Spreadsheet Software	5	3	59.7	3	6.7	4
Warehouse Management System <Picking Module>	4	4	59.7	3	6.7	4
Warehouse Management System <Purchase Module>	4	4	59.7	3	6.7	4
Personal Computers	5	3	62.4	4	7.3	5
Uninterrupted Power Supply	5	3	62.4	4	7.3	5
Cash Drawers	5	3	64.9	5	7.4	6
Product Style/Model System <Database module for marketing purposes>	7	1	53.4	2	7.4	6

Table 32: A comparison of case study candidate #1's top 20 vector length ranked technology artefact

The results from this case study indicate that four technology artefacts share the position for the shortest vector length, i.e. the highest priority. These artefacts are POS System <Planning Module>, Product Style/Model System <Costing>, Project Scheduling Software, and Storage System <Stock Control>. Only the Product Style/Model System <Costing> artefact did however not hold this position before the balanced, vector view.

- Case study candidate #2

Technology artefact	Criticality	Criticality Ranking	Weighted Excellence Total	Weighted Excellence Total Ranking	Vector Length	Vector Length Ranking
General ledger <Accounts payable>	5	1	54.4	1	5.5	1
General ledger <Batch processing module>	5	1	54.4	1	5.5	1
General ledger <Cost centre management module>	5	1	54.4	1	5.5	1
General ledger <Mandates module>	5	1	54.4	1	5.5	1
Intranet <Policy documents>	5	1	57.9	3	5.8	2
Spreadsheet Software	5	1	55.3	2	5.8	2
Central branch procurement system	5	1	55.3	2	5.9	3
Electronic communication <e-mail>	5	1	57.9	3	5.9	3
Electronic communication <Facsimile >	4	2	57.9	3	5.9	3
General ledger <Cheque module>	5	1	57.9	3	5.9	3
General ledger <Claims>	4	2	57.9	3	5.9	3
General ledger <Creditor management module>	3	3	55.3	2	5.9	3
General ledger <Invoicing module>	5	1	57.9	3	5.9	3
General ledger <Payment clearance module>	5	1	57.9	3	5.9	3
General ledger <Payment exception module>	4	2	57.9	3	5.9	3
General ledger <Transaction / posting management>	5	1	55.3	2	5.9	3
Database <Fleet management>	3	3	57.9	3	6.1	4
General ledger <MIS>	4	2	60.6	4	6.1	4
Signature recognition technology	5	1	61.4	5	6.1	4
General ledger <Fixed assets register>	5	1	61.9	6	6.2	5

Table 33: A comparison of case study candidate #2's top 20 vector length ranked technology artefacts

The results from this case study indicate that four technology artefacts share the position for the highest priority. These artefacts are General ledger <Accounts payable>, General ledger <Batch processing module>, General ledger <Cost centre management module>, and General ledger <Mandates module>. All four of these artefacts, and in fact the next two ranked artefacts as well did however hold this ranking prior to the balanced, vector view. In this instance due to the specific procedural context of the technological artefacts, the vector ranking did not significantly alter the pure strategic ranking. Only lower down the ranking order did the vector length later the strategic ranking.

- Case study candidate #3

Technology artefact	Criticality	Criticality Ranking	Weighted Excellence Total	Weighted Excellence Total Ranking	Vector Length	Vector Length Ranking
Database search and query software <Database interrogation>	5	1	30.8	1	5.8	1
Database software	5	1	30.8	1	5.8	1
Electronic communication <e-mail>	5	1	30.8	1	5.8	1
Spreadsheet Software	5	1	30.8	1	5.8	1
Workflow software <Routing of events>	5	1	30.8	1	5.8	1
Database report generation software	5	1	49.3	6	6.0	2
Document management software	5	1	47.6	5	6.0	2
Electronic projector	5	1	44.7	4	6.0	2
Word processing software	5	1	34.3	2	6.0	2
Intranet portal <Front end to customer database>	4	2	30.8	1	6.8	3
Web services <Interface for information capturing>	3	3	30.8	1	6.8	3
e-Campaign management software	4	2	34.3	2	7.0	4
ERP software	4	2	39.4	3	7.2	5
Statistical analytical software	4	2	39.4	3	7.2	5
Project scheduling software	3	3	34.3	2	7.3	6
General ledger software	2	4	62.8	9	9.0	7
Customer relationship management software (CRM)	1	5	56.1	7	9.2	8
Call centre technology	1	5	57.7	8	9.3	9

Table 34: A comparison of case study candidate #3's 18 vector length ranked technology artefacts

The results from this case study indicate that five technology artefacts share the position for the highest priority. These artefacts are (i) Database search and query software <Database interrogation>, (ii) Database software, (iii) Electronic communication <e-mail>, (iv) Spreadsheet Software, and (v) Workflow software <Routing of events>. All five of these artefacts did however hold this ranking prior to the balanced, vector view. The lower down ranking order was dissected a bit finer and the ranking influenced slightly.

CHAPTER 6 - CONCLUSION AND RECOMMENDATION

"There is one thing even more vital to science than intelligent methods; and that is, the sincere desire to find out the truth, whatever it may be."
- Charles Sanders Pierce

This final chapter in the dissertation text takes a critical overview of the findings obtained and also the research endeavour as a whole. It abstracts the results to a higher level in order to arrive at certain high level observations and potential suggestions.

6.1 - RESEARCH OBJECTIVES AND GOALS REVISITED

Before any effort is made to assess and critique the proposed research model, it is a worthwhile exercise to refresh the memory of the stated research objectives and goals. These were set out in *sections 1.3* and *1.4* respectively and are revisited below:

The *objective* of this research dissertation was stated to be the following:

- To revisit and delineate the knowledge domain of technology strategy in relation to business strategy as well as within the classical context of technology management (MOT);
- to decide upon a suitable technique for *viewing* the manifestation of business and technology strategy upon the typical services organisation;
- To decide upon a suitable method or framework to *assess* technology strategy; and moreover
- To evaluate the workability of such an approach and its accompanying technique set by means of multiple case studies within the services sector.

The *goal* of this research was defined to be the following:

- To show that strategically derived critical success factors combined with functional modelling can assist in the identification of strategic focus areas in the typical services organisation;
- To show that strategically balanced functional models combined with procedural definitions of function execution can assist in the qualitative

identification of strategic important technological artefacts / building blocks; and that

- An assessment scorecard based upon industry accepted excellence models, and the South African Excellence Model in specific, can assist in the strategic balancing of key technological focus areas and technological artefacts / building blocks

ultimately resulting in an operational method of strategic technological assessment for the services sector.

6.2 - DISCUSSION

In the previous chapter the specific findings relative to the three unique case studies were discussed in light of the previous mentioned objectives and goals. However there is still room for a further discussion of the more holistic contributions of the research endeavour.

6.2.1 - Modelling of strategy and technology strategy

Before any attempt is made to evaluate a potential modelling method of strategy, it must be said that the domain of strategy is by its very nature not a scientific, empirical field of study, nor does it exhibit quantifiable dimensions. There are broad accepted guiding principles, but there are no hard and fast rules: no silver bullet! Any attempt to quantify any dimension of strategy, is at best, still only "an attempt"! Industry and academia have however distinguished between *better* and *lesser* methods, and thus the text investigated literature to find these methods and extrapolated the proposed modelling method.

The text indicated that utilising the concept of strategically derived critical success factors, enabled the business to assess its operations for strategic focus, i.e. criticality. By deriving a fixed set of core strategic drivers with equal weighting, the individual contributions of each organisational process could be assessed in relation to the strategic drivers. Not only could the contributions be assessed, but they could also be summed and thus quantified to an extent. The text acknowledges that the mechanism according to which the contributions are identified, is subjective by nature (a representative management forum), but this mere fact should stimulate further research into this method to eliminate the subjectivity.

Subject to the specific view of what technology is, the text also indicated that by analysing the modelled processes, individual technology artefacts can be identified. Coupled with the previous paragraph's strategic criticality, an extrapolated artefact priority can be derived. Once again the text acknowledges the fact that the level of detail of artefact identification and extrapolation, is subject to interviewer and management forum bias. Reverting to more of an "outcomes based" view, as opposed to opting for absolute technical accuracy, the text indicated that a sufficient manner of technical detail is able to be observed. This resulted that a fairly low level of artefact strategic prioritisation could be accomplished.

Thus although literature is not overly expressive in its preferences to modelling strategy and technology strategy, the text extended the envelope by utilising and testing a particular less used method.

6.2.2 - Business architecture in the field of MOT

Advances were also made in the field of business architecture and MOT. This first mentioned knowledge domain is more commonly associated with information engineering and information systems design. Literature on the various architecture frameworks echo this view and the text identified single instances where the frameworks were utilised for non-IS peripheral benefits.

The text however indicated that the underlying rationales of architecture frameworks in general are useful for the identification and modelling of organisational structures. In this instance the formalisms of function and process modelling were proved to be of value, especially in the light of individual technology artefact identification. The mechanistic cohesion and wide industry utilisation of the modelling formalisms delivered an accurate and trustworthy depiction of the functional and procedural structures of the case study entities.

By presenting the findings in an easy to understand tabular format, the text also graphically illustrated how the deliverables of the architectural frameworks can be presented to make all-round business sense, without having the detailed knowledge of the specific modelling formalisms.

6.2.3 - Excellence models / TQM in the field of MOT

As the literature indicated, industry is slowly starting to incorporate the balanced, more holistic measurement frameworks of the TQM field. The level of excitement is so high in fact that literature is even comparing the Excellence Models with the widely acclaimed Balanced Scorecard. All of this prompted the text to utilise the measurement criteria of the South African Excellence Model to assess operational excellence in view of strategic objectives.

The text utilised an accepted industry BPR model to justify the *rationale* for an operational measurement, and thus capitalised off the criteria of the SA Excellence Model to deliver a holistic quantification of operational excellence. The use of TQM based excellence models within the broader scope of MOT has thus for the first time been *practically illustrated*. The findings, although numerical, are also still at the heart subjective (a product of a representative management forum). The multiple rating criteria and the excellence model weightings do however significantly reduce and balance the potential subjective input. The final results are thus one step closer to an unbiased and quantified view.

Once again the tabulated presentation of the data *practically illustrates* the utilisation of the SA excellence model, its criteria, and the criteria weightings. The data also practically shows how to incorporate the model output as part of a broader scorecard.

6.3 - BENEFITS TO OTHER DISCIPLINES

The results obtained from the research endeavour can cross-benefit the disciplines of (i) enterprise modelling and -design, and (ii) project management. These are briefly discussed below.

6.3.1 - Research benefits to enterprise modelling and -design

The practical application of enterprise design principles within the South African business sector has been limited to an extent. This does not mean to say that the value proposition of the design principles per se is limited, but rather that the opportunities for exploitation have been scarce. The need therefore exits to (i) enlarge the regime of practical *applications* and (ii) extend the "track record" of practical *implementations* of enterprise modelling frameworks.

The text has illustrated on the hand of the research framework that a specific enterprise framework can be practically exploited to link strategy to key business processes. This is but one of the benefits of utilising enterprise modelling architectures! In *section 2.2* the various other benefits of architecture frameworks were discussed and in advertently the text has therefore established a *theoretical* and *practical* platform for a broader implementation of enterprise design principles.

On the back of the research framework, the opportunity consequently exists to explore the other value propositions / dimensions of enterprise modelling frameworks on, for example, the *location* and *time* dimensions. Some examples of these would be to (i) utilise a specific enterprise framework to investigate and quantify the operational implications of specific technologies on geographically distributed strategic processes (given a specific strategic theme) or (ii) to utilise a specific enterprise framework to prioritise the technological spend to enlarge the time window on strategic, time-constrained processes.

In summary: the research framework's context of measurement, strategy and technology has laid the foundation to further investigate the utilisation of enterprise modelling and -design frameworks to deliver additional benefits to the services organisation.

6.3.2 - Research benefits to project management

The project management body of knowledge is well established in industry and has more or less reached a maturity plateau in terms of its practises, techniques and structures. Key industry voices are however unanimous in their opinion that the body of knowledge is by far not exhaustive and represents only the core fundamental / minimum set of requirements to successfully deliver most projects. They are in agreement that specialist techniques are required in specific instances where the nature of the project calls for it.

The research text focused heavily on the execution of the research framework, but has not touched on the meta-framework required to plan and deliver such an endeavour. If business therefore initiates a project to procure technology, the research framework might prove to be an insightful / useful tool in the armoury of the project office delivering the initiative. A potential avenue therefore exists for future exploration in the project management discipline. An example of such an avenue would be to examine the required technique-set for delivering strategic technology artefacts in service organisations. The focus would rest on the planning and execution phases of the project, as well as the sub-disciplines of cost management and cost-benefit analyses.

In summary: the specific technique set employed in the research framework opens the door for investigation into the incorporation of the techniques into the specific project management armoury delivering similar strategic technological outcomes.

6.4 - RECOMMENDATIONS

A lot of "lessons learnt" can be extrapolated from the research endeavour and the text briefly discusses potential further areas for investigation and refinement.

6.4.1 - Industry scope of the model

The application of the model was limited, by the stipulated objective of the research endeavour, to the services sector: two of the case study candidates are in the financial / banking sector, whilst the third is in the retail / apparel services market. It can be speculated that industry type will have no bearing on the accuracy and applicability of the research model, since the research model's constituent formalisms are industry blind, but only a formal investigation will ultimately determine this.

Thus a potential further area for investigation lies in utilising and testing the model in the other economical sectors.

6.4.2 - Organisational scope of the model

For practical reasons relating to (i) the amount of human resources seconded, (ii) intrusion of "business-as-usual" and (iii) the net associated "disruption factor", the three case studies were limited to departments within a broader organisational context only. This leaves the ground open for further research in the utilisation of the model organisational wide. Intuition suspects that the true, fully representative functional structure coupled with the true organisational specific business strategic drivers will only but enhance the findings of the model.

The amount of data associated with the above mentioned research endeavour will be of significant proportions, but the potential area of application none the less lies bare: ripe for future research.

6.4.3 - Quality model sensitivity

The last potential area for refinement lies with the utilisation of the specific excellence model. The express goal of this instance of research was to utilise the SA excellence model, but nothing prohibits the testing of the research model with the utilisation of the EFQM's excellence model. As literature indicated, both models originate from the same TQM philosophy and share similar criteria bases. It can thus only be presumed that the research model will not be significantly influenced by the substitution of the SA excellence model with the EFQM excellence model.

Thus a final potential further area for investigation lies in utilising and testing the model with other similar excellence models.

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