

THE DEVELOPMENT OF AN INTERNAL TECHNOLOGY STRATEGY ASSESSMENT FRAMEWORK WITHIN THE SERVICES SECTOR UTILISING TQM PRINCIPLES

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ABSTRACT

Technology is generally accepted as one of the key factors that influences society and business in an unmistakable manner. Current literature is not singular in its views and methods of technology strategy development, the interface between technology strategy and business strategy and how technology strategy is executed and assessed internally. This article proposes an internal technology strategy assessment framework for the services sector. The framework is developed by merging the disciplines and current models of technology management, business architecture, strategic performance measurement and total quality management. The model is presented in the text in flowchart form. The required data was gathered by means of case study protocol. Three case studies were conducted in the services sector and the tabulated results are presented.

OPSOMMING

Tegnologie word algemeen aanvaar as een van die mees deurslaggewende drywers wat besigheid en die samelewing onomkeerbaar verander. Verskillende opinies bestaan in die literatuur oor die metodes van tegnologiese strategie-ontwikkeling, die raakvlak tussen tegnologiese strategie en besigheidstrategie en hoe tegnologiese strategie uitgevoer en geassesseer moet word. Die artikel fokus op 'n interne tegnologiese strategie assesseringsmodel, spesifiek vir die dienstesektor. Die assesseringsmodel word ontwikkel deur die dissiplines en beskikbare modelle van tegnologiese bestuur, besigheidsargitektuur, strategiese prestasie-meting en totale kwaliteitsbestuur te integreer. Die model word in die teks in die formaat van 'n vloei-diagram aangebied. Die nodige data vir die model is ingesamel deur gebruik te maak van gevallestudieprotokol. Drie gevallestudies is uitgevoer en die getabuleerde resultate gelys in die teks.

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1. INTRODUCTION

Technology is accepted as being “..the most pervasive force influencing human lives today..” [1]. It “..plays a pivotal role in the interactions among individuals, society, and nature..” and has been identified as a key driver in the evolutionary development of man. It has always played a major role in the creation of wealth and is generally accepted as a key source of competitive advantage [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 combined pressures of scale, scope and integration (world class competitiveness factors) place a tremendous burden on the local organisation in terms of its mode of operation and the resources it employs to deliver its offerings to the market [3].

With the aftermath of the \$1.7 trillion dot.com lesson [4] 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 the correct strategy, cannot be over emphasised. The services sector with its cut-throat, “faster-better-cheaper” paradigm, finds itself knee deep in this scenario. Of all sectors it must ensure the optimum investment in its core technologies to constantly protect its leading market position.

Chanaron and Jolly [5] state that Management of Technology (MOT) is yet still an evolving discipline. Phaal *et al* [6] concur, “no particular textbook or approach to technology management has achieved wide acceptance”. Gaynor [7] refers to this as “a collection of disparate views on technology management”. Vernet and Arasti [8] state that “the models for selecting the strategic field of technological development have been poorly presented and discussed in the literature”. Although Van Wyk [9] agrees that the notion of MOT is evolving all the time, he observes “a sharper definition of MOT that begins to emerge”. He builds his definition of MOT on the description of the Task Force for the Management of Technology: “MOT 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”. 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. The development of an internal technology strategy assessment framework within the services sector, utilising total quality management principles, resides within these parameters.

2. RESEARCH PROBLEM AND OBJECTIVES

As stated above, 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 from overall organisational-wide strategic positioning right down to the assessment and alignment of technology artefacts / building blocks. The research problem necessitates investigation into the following aspects to develop such a model:

- The current 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 to establish the base from which all further discourse will be extrapolated.
- A theoretically founded method must be established in order to view (model) the internal organisational composition, 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 strategic alignment must be identified and analysed for completeness, granularity and applicability.

The aim of the research endeavour was set 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,
- decide upon a suitable technique for viewing the manifestation of business and technology strategy upon the typical services organisation,
- decide upon a suitable method or framework to assess technology strategy, and
- evaluate the workability of such an approach and its accompanying technique set by means of multiple case studies within the services sector.

The research covers the major disciplines of

- Technology Management and more specifically the sub-discipline of *Technology Strategy*,
- Business Architecture and specific business architecture frameworks with their corresponding modelling methods,
- Strategic Performance Measurement and specifically strategic measurement models, and
- Total Quality Management and more specifically the manifestation thereof in quality models such as the European Foundation for Quality Management (EFQM) and the South African Excellence Foundation’s (SAEF) Excellence Models.

3. THEORETICAL FRAMEWORK

A 3-tier knowledge domain expository approach was utilised as the basis according to which literature and the core theoretical fundamentals were assessed. This approach addressed the domains of strategy, architecture and measurement. Figure 1 graphically depicts the theoretical framework. Each of the elements in Figure 1 was analysed in the literature and a working definition for the major components of each domain established.

3.1 Knowledge domain 1: Strategy domain

The strategy domain focuses on the theoretical understanding of concepts and constructs needed to establish a thorough understanding of technology strategy. According to literature technology can be defined to be technical by nature rather than commercial. It is embodied in cognitive or physical artefacts in a codified or non-codified manner with the goal of aiding human endeavour in the achievement of a specific objective [10]. 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 [11].

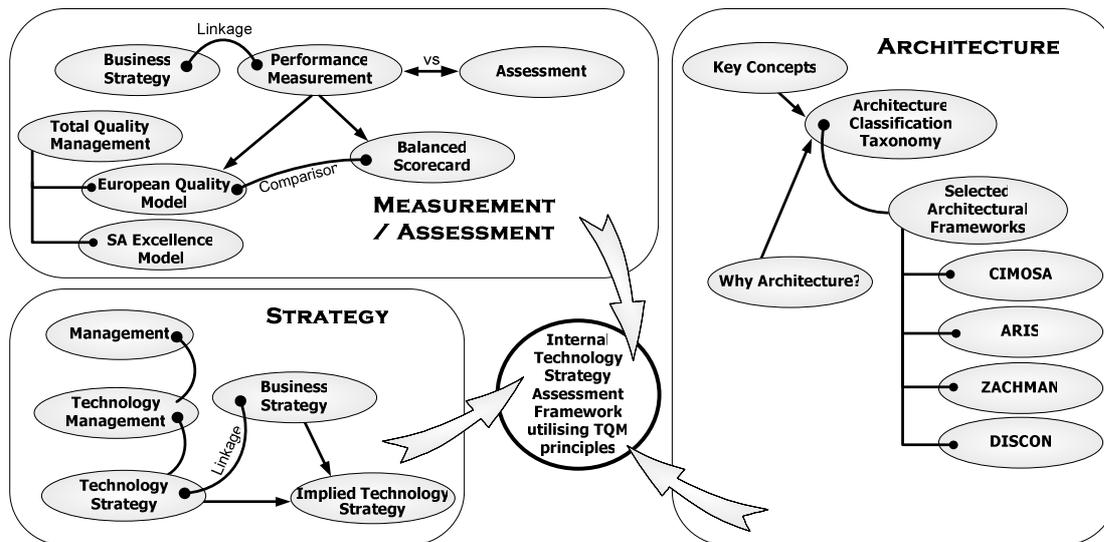


Figure 1: 3-Tier knowledge domain theoretical approach

Taking cognisance of the theoretical evolution of the Management of Technology (MOT) and how literature presents the context, content and scope of it, the above definition of technology can be extrapolated toward a specific definition for MOT. Thus technology management is about technical, functional artefacts (specific and generic), manifested in business processes, delivering a goal orientated capability that must be managed for goal achievement and change, in the context of an operating environment and a determinant business strategy.

3.2 Knowledge domain 2: Architecture

The goal of the second domain is 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.

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. In this context the concept of architecture can be defined 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.

Four architecture frameworks (CIMOSA, ARIS, Zachman and DISCON) were evaluated according to their (i) management of change, (ii) scope, (iii) legacy incorporation, (iv) business benefits, (v) approach to enterprise integration and (vi) respective life-cycles.

3.3 Knowledge domain 3: Strategic performance measurement

Clarke [12] appropriately states: "If measurement, by itself, had that much impact on human behaviour, anyone that had a weighing scale would never get fat!". This is unfortunately also true for organisations: very few actually know what they measure, and if they did, fewer still use what they measured! If technology strategy is to be represented by means of architecture formalisms, then strategic measurement systems need to be evaluated for their contextual fit, inherent biases (if any) and their embedded requirements. McAdam and Bailie [13] differentiate between two types of organisational measurement systems: 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. Yet McAdam and Bailie also state that accounting measures are inadequate and too insensitive for decision-making in regard to strategy alignment, and emphasise the need to establish a more comprehensive view of performance measures that are indicative of the overall health of the business. According to them the recent resurgence of the quality movement has resulted in numerous business improvement models seeing the light. These models focus on (i) business dynamics, (ii) performance measurement and (iii) alignment with strategy as common key constructs. On the hand of this the text evaluated two "new generation" strategic measurement systems, namely (i) the Balanced Scorecard and (ii) the Excellence Models of the European Foundation for Quality Management (EFQM) and the South African Excellence Foundation (SAEF).

4. AN INTERNAL TECHNOLOGY ASSESSMENT FRAMEWORK

The development of an internal technology assessment framework draws from the core concepts of the previous discussed three domains and builds upon the business process re-engineering (BPR) based model of Vernet and Arasti [8] (refer to figure 2). The 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. As indicated in figure 2, the model presupposes a known strategic intent as verbalised in a number of strategic objectives. It assumes the correctness of these strategic objectives and does not

contest or verify them. It utilises specific techniques and modelling rationales of the DISCON architecture framework to govern the content and sequence of each individual step:

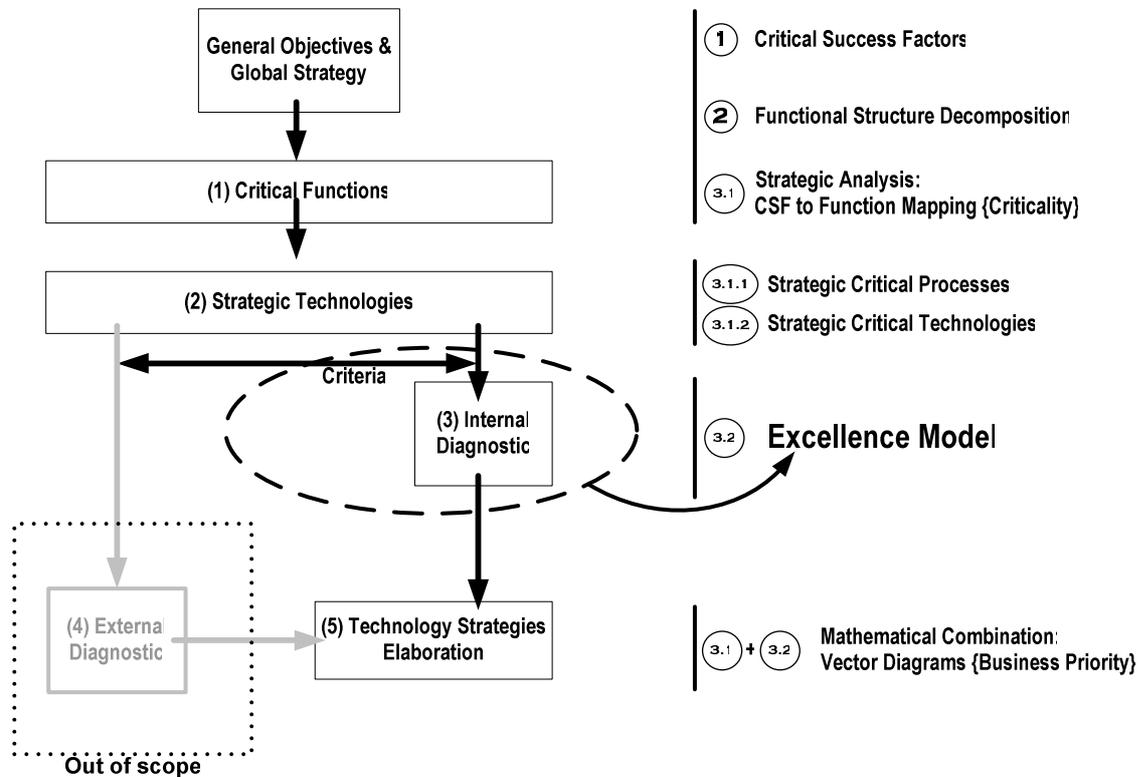


Figure 2: The 5-stage BPR model elaborated by the DISCON and Excellence models

- Step 1 Determination of the department’s critical success factors (CSF’s);
- Step 2 Decomposition of the department’s functions in a structured, hierarchical manner;
- Step 3.1 Execution of a function to CSF mapping to determine:
 - Step 3.1.1 The department’s critical processes
 - Step 3.1.2 The department’s critical technology artefacts employed in the critical processes.

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 and technology artefacts of the organisation. This result is an inherent strategically biased end result, and does not take into consideration the operational state of the department

- Step 3.2 Execution of an operational excellence assessment utilising the SA excellence model. The internal / operational measurement perspective is

attained by utilising the SA excellence model's eleven criteria to assess the excellence of the department at a functional level. This delivers a subjective, yet quantitative assessment of the operational condition of the department

- Step 4 (Step 5 in the original Arasti and Vernet model):
Mathematical combination of the results from the strategic and operational assessments to arrive at a mathematical balanced view of the true business priorities. If the magnitudes of the strategic and operational scalar assessments (steps 3.1 and 3.2) are of the same order, then a Pythagorean summation will deliver the true vector length. The vector result delivers a quantitative indication of the balanced priorities of the department. Extrapolating the quantitative vector result to the technology artefacts embedded in the processes (as ascertained in step 3.1.2), the true technology artefact priorities are delivered.

5. RESEARCH DESIGN AND METHODOLOGY

5.1 Case study protocol

The research model was elaborated and translated into a stepwise flow diagram as depicted in Figure 3. The model was tested using a qualitative, multiple case study design. The case studies were designed in accordance with standard case study protocol design principles [14], namely:

- Determine the study's questions,
- Establish its propositions,
- Derive its units of analyses,
- Stipulate the logic linking the data to the propositions, and
- Stipulate criteria to interpret the findings.

The protocol was subsequently utilised in three case studies within the South African services sector. The candidates were evaluated on their (i) organisational context, (ii) core functions, (iii) size and (iv) determinant technology strategy. The resultant case study candidates were:

- Case study candidate #1:

Retail development department within a large, multi-national footwear and apparel manufacturer. Headcount for the department is approximately twelve people.

- Case study candidate #2:

Financial administration department within a large, top five, South African national bank with approximately eighty-five people.

- Case study candidate #3:

Credit reporting department within a South African national bank with approximately twenty people.

5.2 Data gathering instruments / technique

The required information was gathered in line with the research protocol by means of

- A functional decomposition diagram,
- Process models in support of the functional structure, and
- A technology artefact analysis per each modelled process.

The results of the above mentioned data gathering techniques were tabulated and the strategic and operational assessments were executed on the tabulated results. The resultant findings, post strategic and operational assessment, typically represents itself in a tabular expression resembling the following example (NOTE: The values are only for illustrative purposes as space does not allow the printing of the full tables):

Table 1 endeavours to indicate the waterfall-type depiction of each technology artefact embedded with a specific process, which in turn contributes to a specific departmental function. Functions can of course have one or many processes, which in turn can have one, none or many technology artefacts embedded within them.

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	5.01	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	6.28	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 1: Example of strategic ranked technology artefacts according to vector length (non-duplicated)

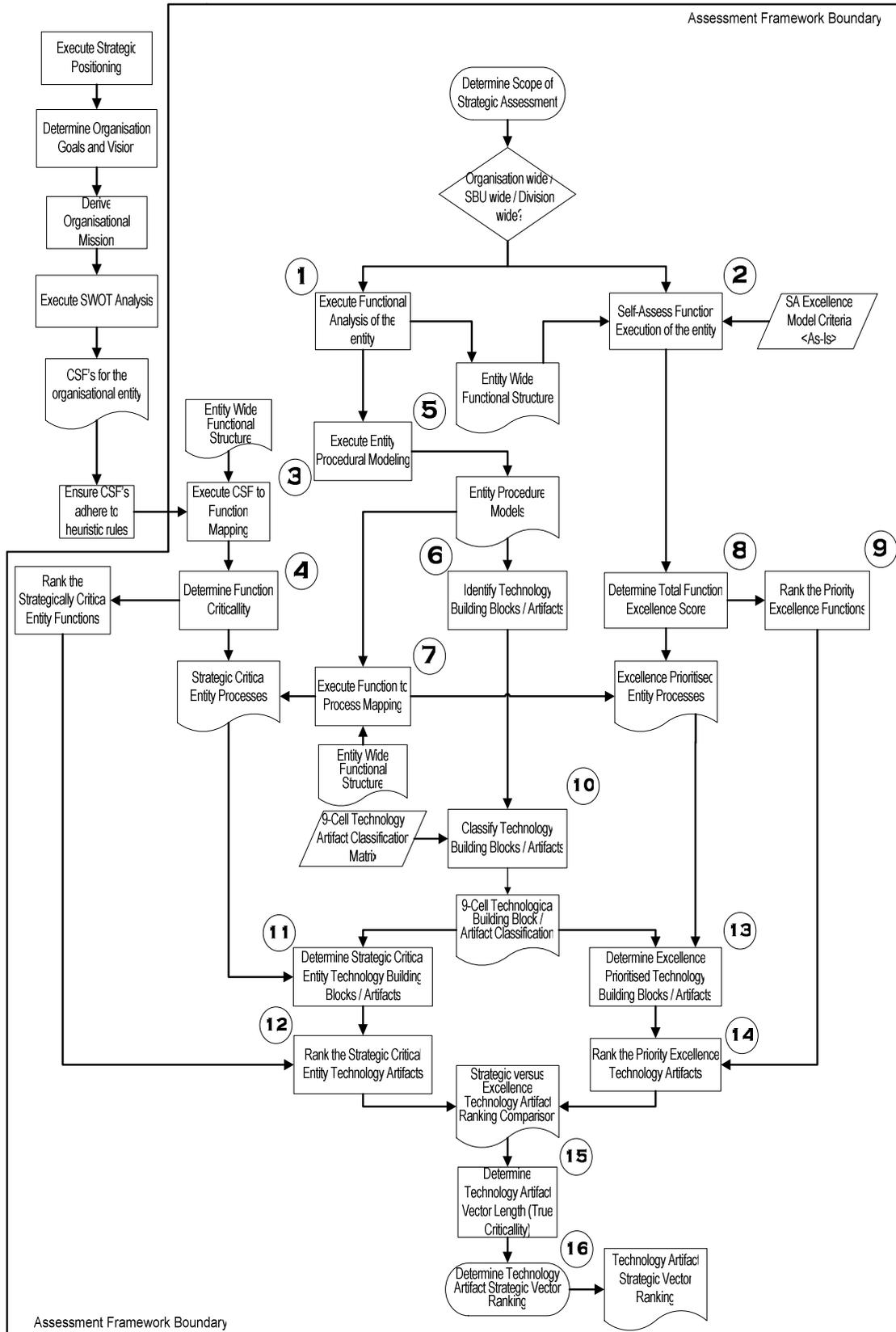


Figure 3: An internal technology strategy assessment framework utilising TQM principles

6. FINDINGS

The net results of the individual case studies are briefly discussed below. Space does not permit the printing of the “Function” and “Process” columns as depicted in Table 1. Only the technology artefact is listed with its associated rankings, where “criticality ranking” specifically indicates the strategic priority, and “weighted excellence total ranking” the operational priority.

- Case study candidate #1

Twenty-seven unique technology objects were identified across the 34 process models. Rationalised according to Van Wyk’s [15] nine cell technology classification framework, these technology objects are of the classes (i) Energy Store, (ii) Information-Process, (iii) Information-Process & Information-Store combined, (iv) Information-Store and (v) Information-Transport & Information-Store combined. The final vector ranking of the technology artefacts for case study candidate #1 are represented in table 2.

- Case study candidate #2

Thirty-six unique technology objects were identified across the 127 process models. Rationalised according to the nine cell technology classification framework, these technology objects are of the classes (i) Energy Store, (ii) Information-Process, (iii) Information-Process & Information Transport combined, (iv) Information-Process & Information-Store combined and (v) Information-Transport & Information-Store combined. The final vector ranking of the technology artefacts for case study candidate #2 is represented in table 3.

- Case study candidate #3

Eighteen unique technology objects were identified across the 27 process models. Rationalised according to the nine cell technology classification framework, these technology objects are of the classes (i) Information-Process, (ii) Information-Process & Information-Store combined, (iii) Information-Process & Information-Transport combined, (iv) Information-Store and (v) Information-Transport & Information-Store combined. The final vector ranking of the technology artefacts for case study candidate #3 is represented in table 4.

The results from the three case studies indicate that the balanced vector ranking of the technology artefacts differ slightly from either the pure strategic ranking or the pure operational / excellence ranking. The net result is thus a mathematical indication of technology artefact priority as based upon the combined views of strategy and operations.

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 2: A comparison of case study candidate #1's top 20 vector length ranked technology artefacts

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 3: A comparison of case study candidate #2's top 20 vector length ranked technology artefacts

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 4: A comparison of case study candidate #3's top 18 vector length ranked technology artefacts

7. CONCLUSION AND RECOMMENDATIONS

The research endeavour was initialised with the goal in mind to (i) revisit technology strategy, decide upon a suitable method for viewing and assessing technology strategy within a services organisational context, and (ii) evaluate the workability of such an approach. To this end an internal technology strategy assessment framework, utilising total quality management (TQM) principles, was proposed for utilisation within the services sector.

The study indicated that utilising the concept of strategically derived critical success factors, enabled the business to assess its operations for strategic focus. 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.

The study also indicated that the underlying rationales of architecture frameworks in general are useful for the identification and modelling of organisational structures. The formalisms of function and process modelling were proved to be of value, especially in the light of individual technology artefact identification.

The results of the research can also cross-benefit the disciplines of enterprise modelling and -design and project management.

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