The availability, applicability and utility of Information Systems Engineering standards in South African higher education

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by
Andy Bytheway

Supervisors:

Professor Isabella Venter
Professor Grafton Whyte

Bellville
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Declaration of Authorship

I declare that 'The availability, applicability and utility of Information Systems Engineering standards in South African higher education' is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

10 January 2016

Abstract

Higher education institutions in South Africa have invested heavily in information technology and information systems, with variable outcomes. Organisations in other sectors, such as engineering, the defence industry, public administration and business, have developed and adopted standards and guides to good practice for the development and operation of software-based systems.

In the history of standards-making there was an early vision of the need to extend standardisation beyond software engineering into the world that acquires and uses systems, and yet the overall scope of available standards is still limited. Seeing slow progress in the international committees that develop nationally-endorsed standards (such as ISO-IEC/JTC1/SC7) practitioner communities moved to develop good practice guides such as COBIT and ITIL, that have found considerable interest in progressive organisations. Hence a range of potential guidance is available.

In order to assess the extent to which standards and good practice guides might assist higher education, the four tertiary institutions in the Western Cape were approached and a representative range of academic, administrative and managerial individuals agreed to contribute to the study as respondents. Interviews were organised in two parts: the first an open conversation about their involvement with systems, and the second a structured examination of systems-related events that they considered significant. By inspection of those events, bipolar scales were developed by which respondents were able to characterise events (for example as 'challenging' or 'easy', or as 'functional' or 'dysfunctional'). Respondents rated events on those scales. Repertory Grid analysis was applied so as to investigate which scales correlated with event success. 30 scales (out of 170) proved to be adequately correlated with success, and by principal component analysis they were combined to form nine 'success scale' groups, indicating nine areas where the deployment of standards or good practice guides might be expected to lead to more effective use of improved information systems.

The study adopted an abductive approach to the work, keeping open the question of what might be the contribution to knowledge. In the event, a new Reference Model emerged from the data analysis that contributes to the effective choice and management of standards and good practice guides.

A review of available standards and good practice guides using the new Reference Model concludes that the good practice guides are more applicable than the internationally developed standards, and in some areas management models and frameworks have a contribution to make. The utility of standards, good practice guides and management models will depend on the circumstances and context of use, which are extremely variable. A portfolio approach to the management of information systems provides a means to deal with that variability. It is further found that the IMBOK[1] can be used to assess the linkages between information technology, information systems, business processes, business benefits and business strategy.

The new Reference Model has a role to play in resolving the need for standards in the four junctions between those five IMBOK domains. Selected standards are assessed in that way, and an illustrative commentary is provided showing how projects and other systems-related initiatives can be assessed using the new Reference Model and the IMBOK.

[1] Information Management Body of Knowledge (UWC, 2003)

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The very first deployment of the IMBOK took place in the Library Auditorium at UWC, and it was done (of course) by our students. My heartfelt thanks go to all those students that I have had the privilege to work with here in South Africa; I hope that their learning still serves them well. More recently I have worked with post graduate students and researchers who have encouraged me in different ways and helped with the development of our collective research capability. I have to acknowledge Laban Bagui and Edward Dakora in particular, for their encouragement and support as we explored qualitative methods together, and experimented with technology in education and with ideas of Africanisation. Thanks to both of you, and to the many others I have been privileged to work with.

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Glossary of terms

ACM	Association for Computing Machinery
ANSI	American National Standards Institute
BB	Business benefit
BP	British Petroleum
BP	Business process
BS	Business strategy
BSC	Balanced Score Card
CEN	*Comité Européen de Normalisation* (European Committee for Standardization)
CEN TC 311	CEN Committee for Information Systems Engineering
CEO	Chief Executive Officer
CIO	Chief Information Officer
CMM	Capability Maturity Model
COBIT	Control Objectives for Information and Related Technology
CPU	Central Processing Unit
DoD	Department of Defense (USA)
DoE	Department of Education
ERP	Enterprise Resource Planning
HEAT	A commercial package for “Hybrid Service Management”
HEI	Higher Education Institution
ICT	Information an d communications technology
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IMBOK	The Information Management Body of Knowledge
IS	Information system
ISACA	Information Systems Audit and Control Association
ISE	Information Systems Engineering
ISES	Information systems engineering system
ISET	Information systems engineering technology
ISO	International Organization for Standardization
ISO-IEC/JTC1/SC7	ISO-IEC Joint Technical Committee 1, Sub Committee 7, “Software and systems engineering”
IT	Information technology
ITIL	IT infrastructure library
LMS	Learning Management System
MIT	Massachusetts Institute of Technology
MOOC	Massive Open Online Course
OASIS	Open standards for the Information Society
OS	Organisation system
OSI	Open Systems Interconnection

PC	Personal Computer
PCA	Principal Component Analysis
PLATO	Programmed Logic for Automatic Teaching Operations
PMBOK	Project Management Body of Knowledge
PRINCE	Project Management in a Controlled Environment
RepGrid	Repertory Grid (a method of data collection minimising researcher bias)
RIMS	Research Information Management System
RIS	A standard for metadata developed by Research Information Systems
SABS	South African Bureau of Standards
SANS	South African National Standard
SEI	Software Engineering Institute
SQL	Structured Query Language
SWEBOK	Software Engineering Body of Knowledge
TOGAF	The Open Group Architecture Framework
UNESCO	United Nations Educational, Scientific and Cultural Organization
USB	Universal Serial Bus
UWC	University of the Western Cape
WG	Working Group
XML	Extensible Mark-up Language

Chapter 1 Introduction and background

This chapter provides a context and chronological background for standards and information systems engineering. The study is positioned in the wider realm and the research problem and research aims are summarised, as are the research methods that are used. The content of the remainder of the thesis is summarised.

1.1 Introduction

There is a long and interesting history of difficulty concerning the delivery of benefits from information technology and information systems investments. Recurring evidence shows that failure is common, even after more than six decades in which to learn the ways in which these software engineering and change management difficulties can be obviated.

In the defence industry in the United States of America, a total of US$ 37 billion was invested in software delivered as 'finished' code, of which only 2% was used without change; 75% of what was delivered was never used (Larman & Basili, 2003). In the United Kingdom, public sector IT projects costing £26 billion over 11 years delivered no useful outcome whatsoever (The London Independent, 2010).

But it is not all bad news: in business there is some confidence that successful systems *can* be delivered, and standards and norms are now established that purport to help organisations 'do things properly'. Examples include: a range of international standards from ISO and the IEC (ISO-IEC/JTC1/SC7, n.d.), the Capability Maturity Model from Carnegie Mellon University (Paulk et al., 1993), the IT infrastructure library known as 'ITIL' (ITIL, n.d.), methods for Project Management in a Controlled Environment known as 'PRINCE' (Cadle & Yeates, 2004), and governance and management of enterprise IT using what is now the fifth version of 'COBIT' (ISACA, 2012). In many organisations, the adoption of Enterprise Resource Planning systems ('ERP' systems) has been reported to be particularly successful (Scheer & Habermann, 2000), partly because the reach of modern core operational systems extends far beyond the boundaries of a single organisation; in local government, ERP systems even offer benefits to large cities such as Cape Town (Bagui, 2013); in education, 'COBIT' is guiding the ways in which IT is managed (Khther & Othman, 2013).

This study is concerned with higher education in South Africa. For those who have responsibility for managing information technology in South African higher education in the future, questions about such standards therefore arise: do these norms and standards have any potential to assist South African Higher Education, as education moves rapidly into a highly digitised milieu?

1.1.1 A context for norms and standards

A context is needed in order to deal with these questions, and the context has to deal first with the rapidly changing nature of information technology and its use *in all circumstances*, not just in education, because education is affected by many of the forces for change that are evident in society, and it is an increasingly international business. This is a highly connected world and information systems reach ever further across organisational, national and regional boundaries.

Just as the scope of operational information systems now extends beyond individual organisations, the scope of standards for software engineering extends far beyond simple issues of program design, coding and testing. There is a trajectory that describes these movements: understanding the context is concerned with understanding that trajectory over time:

- The emergence of software engineering as a discipline.
- The emergence of standards for software engineering practice.
- The extension of software engineering standards to embrace 'information systems engineering', and
- The emergence of professional good practice guides.

1.1.2 The emergence of software engineering as a discipline

Behind the introduction of every new information system is the software and systems engineering activity that produces it. Those experts leading the effort to understand the problems of systems implementation, to improve software and systems engineering practice, and to deliver the benefits that systems investments promise, have worked for more than 30 years to bring things under better control (Zmud, 1980; Mumford, 1983; Fagan, 1986; Henderson & Venkatraman, 1993; Paulk et al., 1993; Thornton & Bytheway, 1993; CEN/TC 311 PT01, 1996; Rehesaar, 1996; Tripp, 1996; Baldo Jr et al., 1997; Land, 1997a; Reel, 1999; Luftman, 2000; Noll et al., 2010; Zelazny et al., 2012; Turner et al., 2012; Schmidt et al., 2012; Atkinson & Benefield, 2013). There are many reviews of this history from the technical and engineering points of view. Larman and Basili's compact but authoritative review (Larman & Basili, 2003) traces the history of how systems have been conceived, designed, tested and implemented over the years. It describes early work at IBM, the adoption of the 'waterfall' model, the use of 'pilot' projects and 'spiral' methods, and then the emergence of iterative methods that they judged the most appropriate for complex projects; in their review the waterfall model is deemed suitable only for very simple projects and its unfortunate predominance in practice for many years is blamed on the United States Department of Defense's military standard DoD-Std-2167 (DoD, 1979), which included the waterfall model as a standard contractual requirement of DoD projects.

Standards for software engineering soon extended well beyond the military requirement, of course.

1.1.3 The emergence of standards for software engineering practice

The existence of DoD-Std-2167 (and other standards lurking in the shadows of military software engineering) reminds us that as well as exploring generalised software and systems engineering practice there is the question of specific industry standards that are intended to help deal with large, high risk, and complex projects. Experts have come together at different points in time to develop standards that would reduce uncertainty and provide a common understanding of how things might be done, and exactly what needs to be produced. Whether committees can establish what is 'good practice' is arguable, but it is sometimes said that a bad plan or strategy *well* executed is better than a good one *badly* executed (Martin, 2010) – the worst case is when there is no strategy, when people are simply doing their 'own thing', and when there is no communication of ideas and no co-operation in the execution of those ideas.

Early co-operative work on software engineering standards began in the 1970s. A retrospective review (Tripp & Voldner, 1995) noted that the software engineering discipline itself was established in the 1960s, but it was not until 1987 that the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO) formed a joint technical standardisation committee ('JTC1') to deal with standards for 'Information Technology'. This committee was specifically tasked with:

> *'Development of guidelines for the management techniques and standardization of supporting methods and tools necessary for the development and testing of software' (Tripp & Voldner, 1995, p.105)*

In a little more detail, Tripp and Voldner saw the purpose of the work as:

- guiding the development and organization of international software engineering standards,
- positioning those standards in relation to standards for quality management and systems, and
- promoting the adoption of software engineering standards in the marketplace.

As will be seen shortly, their market-oriented vision of customers, organisational processes and products did not really materialise in the world of formalised international standardisation. But well after the initial launch of ISO-IEC/JTC1, Tripp and Voldner still held on to a view of standards that explicitly included customers, processes and products:

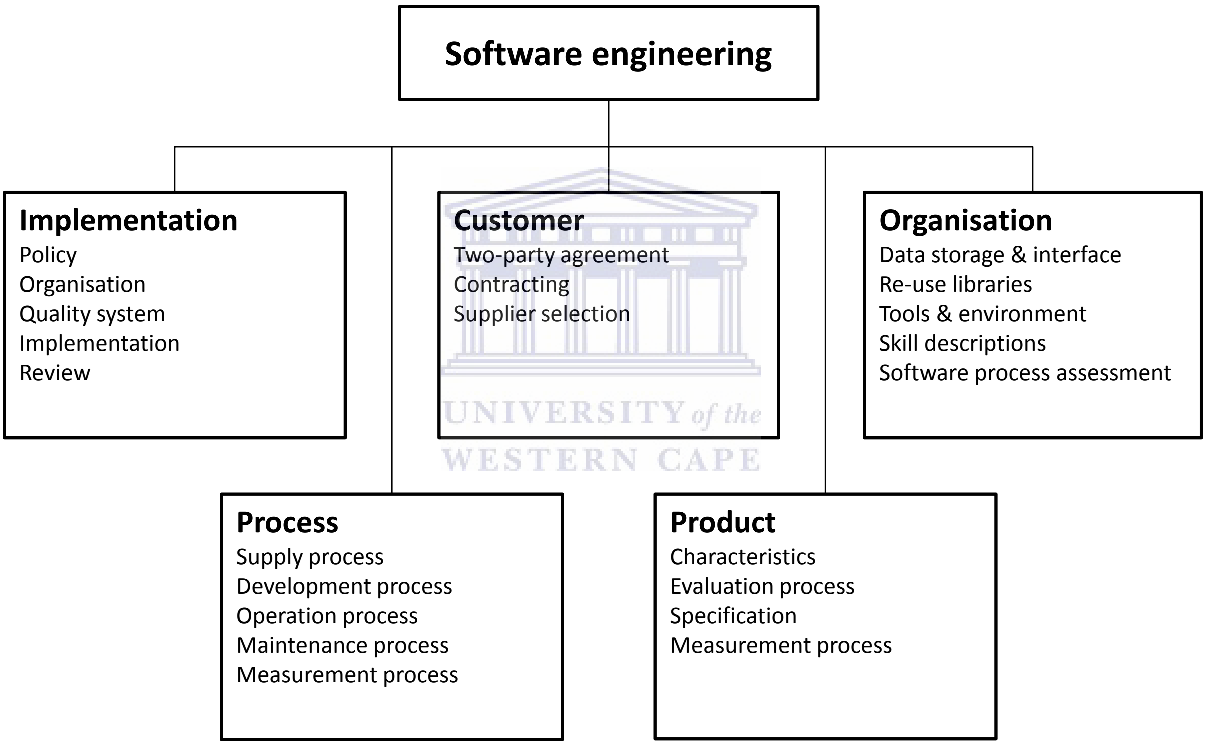


Figure 1 An early 'architectural' view of software engineering standards
(Tripp & Voldner, 1995, p.113)

In Figure 1 it is interesting to see the extent of their perceived need for standards, not just at the level of coding, documentation and technical reviews but including contractual, contextual and policy issues as well. This architectural view was aimed at achieving better communications between standards developers and users. Whether this high-level view successfully anticipated the actual needs of the following decades would be interesting to examine, but suffice it for the moment to note that later, in 2004, a 'Software engineering body of knowledge' emerged (that has been adopted as a SANS technical report in South Africa) which identifies Leonard Tripp as the project 'champion' (SANS, 2007). On inspection, it becomes clear that this 200-page document is actually an *overview guide* to the very many sources of standardisation and guidance to be found elsewhere, originating from the IEEE (the Institute of Electrical and Electronics Engineers), covering, in a very hierarchical arrangement of ideas:

- Software requirements
- Software design
- Software construction
- Software testing
- Software maintenance
- Software configuration management
- Software engineering management
- Software engineering process
- Software engineering tools and methods and
- Software quality

This is not quite the same high-level vision that was envisioned earlier, and much more complex in its content.

Today the international software engineering standardisation work resides in a sub-committee of JTC1 (JTC1/SC7 – 'Information Technology Standards') and has a slightly extended purpose relative to the original scope as given earlier:

> *'Standardization of processes, supporting tools and supporting technologies for the engineering of software products and systems'. (ISO-IEC/JTC1./SC7, n.d.)*

Most national and regional Software Engineering standards bodies now mirror the work of ISO-IEC/SC7 closely and, as will become clear, this work is often dominated by the IEEE working groups led (to all intents and purposes) out of the United States. A complete list of currently published SC7 standards is available in Appendix 1 'ISO-IEC/JTC1/SC7 Published Standards'. JTC1/SC7 now has more than 100 standards listed as publically available and one might judge that in terms of output (if not outcome) the committee has done well to cover such ground. However, this begs the question of whether the standards are actually used and whether their scope is actually matched to needs.

1.1.4 The extension of software engineering standards to embrace 'information systems engineering'

An initial search for evidence of the use of software engineering standards produced only limited results. BTG Delta Research, a US-based systems and consulting company, published an early survey of the use of IEEE software engineering standards in 1997 (Land, 1997a), and a Korean team undertook a very limited study of international standards for software quality later, in 2004 (Jung et al., 2004). The Land survey simply provided survey results, with no discussion and no conclusions. The descriptive statistics that are provided by Land show evidence that IEEE standards at that time were not generally seen as usable, nor even clear – although one standard (concerned with software engineering reviews and audits) did better than others (concerned with project management and quality management). Nevertheless, there were interesting comments from respondents that provide useful insight:

> *'While we are known as 'Software Engineering' within our corporation, and the titles of our people are variations on 'Software Engineer', [our people are] largely comprised of computer programming professionals who have hacked their way around programs of various kinds for many years in many diverse operating systems … it has been difficult to move this organization toward a common home-grown process let alone an IEEE standard process.'*

> *'We use comprehensive proprietary standards developed to fit both our environment and contractual requirements. These standards can be traced back, far back, to IEEE standards.*
>
> *For the last 13 years [we have] been developing software using US Military Standards. Beginning in 1994 we begin to work towards reaching SEI CMM Model Standards. We are currently at Level Two and working towards [Level] Three. Our market place is expanding and we are looking to become certified under other standards. Part of my goal in submitting this form is to gather as much information as I can concerning IEEE standards.'*
>
> *'We use our own, which effectively translates into 'none''.*
>
> *'Our results reveal ambiguities in the way that ISO/IEC 9126 is structured in terms of characteristics and sub-characteristics. Although the results also provide evidence of much of that structure's validity, additional empirical work is necessary for clarity.'*
>
> *(Land, 1997a, p.249 et sec)*

Hence, it becomes evident that for organisations to implement standards 'as published' can be difficult, but industry standards can provide a foundation for internal standards. Military standards clearly have had a strong influence in certain sectors of the industry and no doubt contracting with the military will require that they are adopted. However, where there is no external pressure to adopt standards it is likely that no standards will be used, either because they are not clear or they may be ambiguous.

The final comment from the Land survey about ISO/IEC 9126 (software quality) is interesting, because that was the subject of the more focused study by Jung *et al* (2004). The generic ideas of software quality have been (and still are) championed consistently by the Japanese (Azuma, 2011) and they are of course under continuous if tortuously slow development (Suryn et al., 2003; Dutil et al., 2010). Jung et al confirmed that there are inconsistencies in the way that ISO/IEC 9126 deconstructs the concept of 'software quality' that echo what is said above. Considering the effort and cost involved in international standards, this is worrying.

In seeking a way forward, there is great significance in the final words of Jung *et al*'s analysis:

> *'Systematic sample surveys can provide meaningful and widely generalizable statistical results at a moderate cost. However, the survey data should be augmented with more comprehensive measures of product quality in future studies. Replications of our study using other statistical analytic methods such as confirmatory factor analysis are also necessary to substantiate or clarify the present results.' (Jung et al., 2004, p.92)*

This acknowledgement of the limitations of quantitative surveys sows the seed of an idea: more than simple survey data is needed to understand how standards for software and systems engineering processes and products can be established. There are too many different contexts, too many different industries, and too many kinds of user for 'one size to fit all'. A careful, considered, open and *interpretive* investigation of the role of standards in a homogenous context is likely to deliver more useful outcomes. However, opening up and understanding the perspectives held by key actors and role-players takes us far beyond the limited scope of software engineering.

In the literature, over time, increasing references can be seen to 'information systems' and 'information systems engineering'. A frequently-cited paper from Stanford sets out a complex set of ideas for 'future' information systems, based on the need for 'mediators', a completely new idea at the time, that failed to anticipate the World Wide Web. The Web emerged almost immediately afterwards (Wiederhold, 1992); more recent work (also frequently cited) uses the term 'Information Systems Engineering' as a more useful indication of the necessary scope of our work with information technology; in their concluding comments, Castro *et al* explain:

'We have proposed a development methodology named Tropos, founded on intentional and social concepts, and inspired by early requirements analysis. The modeling framework views software from five complementary perspectives:

- ***Social****—who are the relevant actors, what do they want? What are their obligations? What are their capabilities?*
- ***Intentional****—what are the relevant goals and how do they interrelate? How are they being met, and by whom ask dependencies?*
- ***Communicational****—how the actors dialogue and how can they interact with each other?*
- ***Process-oriented****—what are the relevant business/computer processes? Who is responsible for what?*
- ***Object-oriented****—what are the relevant objects and classes, along with their inter-relationships?*

We believe that the methodology is particularly appropriate for generic, componentized systems like e-business applications that can be down loaded and used in a variety of operating environments and computing platforms around the world.' (Castro et al., 2002, p.386)

Clearly, this is an attempt to combine issues of organisational behaviour with some of the fundamental ideas of systems thinking, and at the same time accommodate ideas related to stakeholders, goals and objectives, and managerial responsibilities.

'Information systems engineering' is a phrase that is now commonly seen in the literature, in curricula in higher education, and in business. There is even a well-established journal of 'Business and Information Systems Engineering'.

1.1.5 The emergence of professional good practice guides

There has been a parallel process that has been driven by practitioners and consultants, possibly necessitated by the tortuously slow processes of ISO and IEC standardisation but certainly motivated by the opportunity to undertake remunerative consulting. TOGAF[2], COBIT[3] and ITIL[4] are examples of good practice guides that are widely discussed by practitioners, but which are not extensively referred to in the academic literature. There is also a range of academic text books that attempt to collect and present the facts about information systems engineering and related subjects, some of which will be referenced here.

1.2 This project

This study is concerned with higher education in South Africa and the potential for norms and standards to assist as education moves into the digital age. It is concerned with the broader scope of information systems engineering within higher education, not just software engineering, at a time when ubiquitous information technology, information systems and digital content are not just changing educational activities, but even redefining what 'education' is. It is becoming very international, and it takes on new forms (Boyle et al., 2012).

At its inception, the project adopted a number of axioms (see the next chapter for details of how the literature informs these axioms):

[2] http://www.opengroup.org/subjectareas/enterprise/togaf

[3] http://www.isaca.org

[4] https://www.axelos.com/best-practice-solutions/itil

- Software engineering organises and programs[5] information technology so as to produce information systems intended for use by organisations.
- The use of information systems affects the processes of organisations, so as to make them more efficient or effective (in successful cases), or less efficient and less effective (in unsuccessful cases).
- The concept of information systems success is informed by the strategic intentions of the organisations that choose to use them.
- There is a chain of dependency that links the work of software engineers (and its cost) to the performance of organisations that use their information systems (and the benefits that are thereby derived).
- The adoption of standards within this chain of dependency can reduce the costs and increase the benefits.

Examples of information systems include core institutional systems such as for student administration, learning management and research management; however, use of the World Wide Web, personal productivity software and 'cloud' services are seen as equally important to include within the scope of the study.

1.2.1 A contextual model for the study

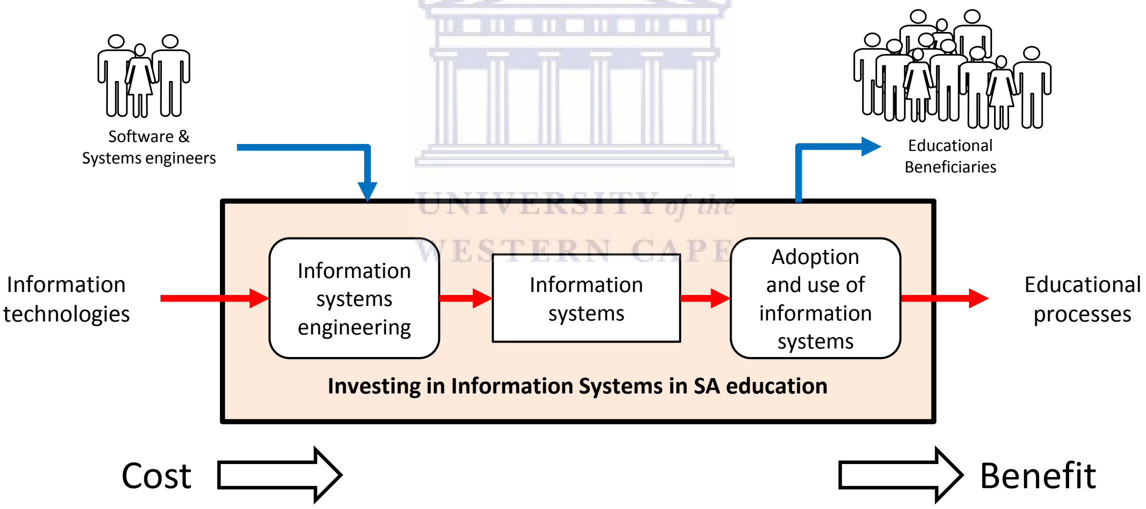


Figure 2 The research model provides context

This project takes on some aspects of a study of *costs* and *benefits*, and how these are affected by the use of standards (see Figure 2). Any adoption of standards carries a cost, which should be more than offset by the value of the benefits. But this is not seen as a situation where simple cost and financial reward can be used to come to a conclusion – partly because the benefits from the use of information systems are by no means confined to financial benefits, but also because the project is located in the world of education, where outcomes are generally not profit motivated but concerned with learner performance and (ultimately) the contribution to society. Further, the point at which a decision is made to embark upon the process of change is not always ideal – an old idea of

[5] As in 'computer program', not as in 'project programme' or 'curriculum programme'

'satisficing' has found some currency in recent work on the management of information technology and information systems investments (Peppard et al., 1999; Winter, 2000; Lamb & Kling, 2003); it relates to the situation where 'enough is enough' and any further effort will have a diminishing return.

1.2.2 The role of standards

On hearing the word 'standard', an engineer or designer would probably think of an industry or national standard that specifies 'fitness for purpose'. The widely-used quality management standard ISO 9000 (Guler et al., 2002) would be one commonly-known example, the software engineering standard SANS 19759 (SANS, 2007) is another, less well known. In addition to international standards such as these there is a plethora of industry- and organisation-specific standards, and while there are *de jure* standards that are mandated, there are also *de facto* standards that emerge and are adopted by convention or consensus.

To illustrate more clearly the role of standards, an early example from software engineering is helpful. The 'Fagan inspection' is a defined process that tests the quality of software design and coding that has dramatically improved delivery. In this disciplined approach *dependency* and *enablement* are axiomatic to making connections between project role players and project tasks. It is now 30 years since the technique was introduced at IBM:

> *'Since we introduced the [Fagan] inspection process in 1974, we have achieved significant improvements in quality. IBM has nearly doubled the number of lines of code shipped for System/370 software products since 1976, while the number of defects per thousand lines of code has been reduced by two-thirds' L. H. Fenton, IBM Director of VM Programming Systems, addressing a user group meeting' (Fagan, 1986, p.744)*

This is an example of a standard for a *process*. Other standards – for example standards for data interchange – are standards for *product*.

In practice, the role of standards has to be seen in the cycle of innovation, product development, and product obsolescence. In the early stages of innovation standards can be an inhibition, if they are formulated at a time when the new idea or new product has not completely stabilised. Consider the case of digital media, which is controlled by standards originally intended for *printed* distribution that are inappropriate to the digital age: digital media need new standards and a new approach to patent protection (Rabne et al., 1999). When a new family of products comes to market, suppliers are more concerned with competitive advantage than with standardisation, and they are not always willing to invest the additional time and money in negotiating universal standards, as in the case of VHS and BetaMax video tapes, where consumers were left struggling to know which was the right one to acquire (Cusumano et al., 1992). Then, in the later stages of a product lifecycle, who cares when there is no margin of profit left?

Of course, there are other situations where standards are needed for reasons of safety and security, and in the history of standardisation in software engineering, safety-critical software has been a recurring feature of discussions at meetings and industry writings (Bowen & Stavridou, 1993).

Choosing the right time to argue for consensus in standards is important – too soon and nobody wants to admit what they know, too late and nobody cares any more. More important is to choose the right forum in which to work: within the business, within the industry, within the country, or within the world. There is also a question of level: there are functional standards that are pitched at a low level for the purposes of production, there are project management and quality management standards that are pitched at the middle levels, and there are meta-standards that are written to prescribe how other kinds of standards shall be written. In the real world (as distinct from the world of standards committee meetings and technical standards documents) there is the notion of 'best practice' where – without any authority – organisations and communities develop a way of working that best serves their strategic objectives, without thinking of that best practice as a 'standard'. But good practice is a standard and one can anticipate that in education (where there is no history of routine military product development or life-threatening situations, and only a limited history of formal quality management) then the idea of 'best practice' will be far more agreeable than highly structured and minutely detailed written specifications of what can and cannot be done, and what can and cannot be produced.

Hence, here the use of the word 'standard' will be liberal and unconstrained by common usage in any other context. The study hopes to find out something about what the word 'standard' *could* mean in the context of information technology usage in South African higher education.

1.2.3 The role of systems in South African higher education

It is widely believed in South Africa that the introduction of information technology will assist and contribute to the efficiency and effectiveness of education (Higgins, 2003; SA Government, 2006; Khanya, 2008) – it is therefore not surprising that information technology artefacts are widely used in education as well as in organisations of many other kinds, but (as already argued above) the educational benefits of efficiency and effectiveness (and possibly other kinds of benefit) are only to be seen through the impact of information systems on educational processes, and the expression 'the introduction of information technology' must be used with caution – the study is concerned with far more than the technology alone; it is concerned with the way that education works, in order to make sure that the *potential* benefits of information technology and information systems are fully understood, and more easily realised.

The tendency to refer only to information *technology*, avoiding the issue of the *software-based information systems* that use that technology, is understandable. The development of technology artefacts advances rapidly but organisational change often advances very slowly; change in education is driven by many factors other than information technology, but for some time, new technology has been predominant in research into global educational change (Demitriadis et al., 2003; Christou et al., 2004; Cheng-Chang et al., 2004; Bitan-Friedlander et al., 2004).

Economic factors also stimulate and engender the need for educational change. In South Africa, the availability of a conducive and efficient context for business is a high priority, because the country competes with other countries to attract and accommodate international businesses, whether for production (as in the case of the automotive industry) or sales (as in the case of the information technology industry). Hence effective education is critical to the future of the nation, but the standard of educational delivery varies widely across the country and from school to school (Herselman, 2003). Learners in disadvantaged areas receive a relatively poor education that is not presently benefiting from the effective use of IT (Bytheway et al., 2010).

Hence, it is not just worthwhile, it is *essential* to investigate the effective deployment of information technology artefacts in representative parts of South African higher education, in detail. It is important to understand fully how the benefits of information technology investments in education depend on the engineering, acquisition and implementation of the information systems that sit at the centre of the chain of dependency.

1.3 Positioning the work

The reader may wonder about the scope and positioning of this work. To fling 'systems engineering' and 'education' and 'standards' together into the same sentence suggests departments of computer science, all wondering what to teach students, about the tools and techniques of software engineering, and at what level. That is not what is intended here.

As already explained, this work sets out to investigate how process and product standards (and any other kind of standard) can contribute to the efficacy of engineered information systems that are deployed in higher education. This is justified by the rapid advancement of the digitisation of education, which is changing what learners expect, what educators do, and what education actually is. The scope of interest therefore extends from technology and its inherent capability, right through to organisational (that is, *educational*) success – so why is the work embedded in a department of computer science, and will the tenets of computer science be central to the work?

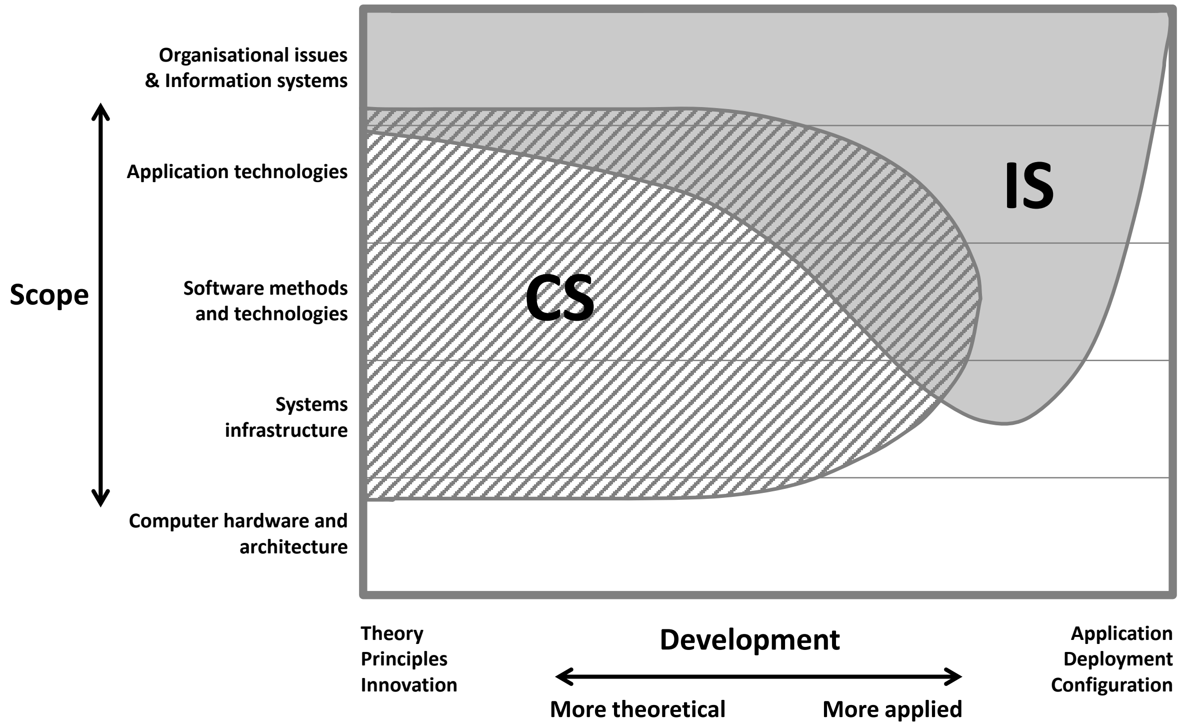
The relationship between computer science, software engineering and information systems has been the subject of much discussion, and even confusion. If one looks first at the information systems side, in the emergence of the information systems discipline there is specific reference to the links with computer science during the 'first era' (the mid-1960s to the mid 1970s:

> *'Organizations began to realize that many individuals hired for IS jobs did not have the formal educational background adequate for their positions … These individuals did not have an understanding of the integration between technology and organizations ... Even though other academic disciplines at that time offered courses related to computers, these courses were too specific in nature. For example, while computer science departments offered courses that emphasized algorithmic problem solving and management departments offered courses on decision making based on the available data, neither of these programs was designed to equip students with both the technical and the organizational knowledge required to perform an IS job.' (Hirschheim & Heinz, 2010, p.203)*

Since then, there have been many examples of computer science departments reaching out to the world beyond the teaching of algorithms, including local departments of computer science in South Africa (Thinyane et al., 2006; Tucker & Blake, 2008).

Information systems studies are often seen as inclining to the management issues, and it is interesting to see that 'management' does emerge in an analysis of curriculum concepts for computer science, although only for *advanced* computer science studies (Zendler & Spannagel, 2008).

Computer science extends from the 'software that enables devices to work' to 'the information systems that help organisations to operate' (Joint Task Force for Computing Curricula 2005, 2005). In a detailed analysis of related curricula including information technology, computer engineering, software engineering, computer science and information systems (see Figure 3) curricula content is mapped according to its scope and its degree of theory or application; the merging of their graphical summaries for computer science and information systems falls out thus, indicating a high degree of overlap and implying a continuum that allows for easy transition from one domain to the other:



Joint Task Force for Computing Curricula 2005 (ACM, AIS, IEEE-CS). 2005.
Computing Curricula 2005 : The Overview Report.
http://www.acm.org/education/curric_vols/CC2005-March06Final.pdf.

Figure 3 An analysis of the curricula for Computer Science and Information Systems

This work concerns people's experiences with the application and deployment of information technology and information systems, and it is hoped that there will be a contribution to the theoretical underpinning of the processes and practices involved; the scope of what is done that affects the contribution of information technology to organisational need cannot be constrained, it must embrace everything in between technology and educational success. As noted, this study takes an open approach.

1.4 Research problem

The full benefits of IT investments in South African higher education are not being realised, thus the problem is: ***to understand the potential for Information Systems Engineering standards to deliver improved benefits in higher education.***

Experience with IT in South Africa is very varied and a range of approaches to the engineering of information systems has been adopted. There have been some famously difficult projects (Anon, 2008) as well as some more successful (Anon, 2010). In education, some institutions have purchased commercially available systems, sometimes at great cost; others have developed their own systems in-house, involving a great effort; at the time of writing, a significant national investment is slowly developing new systems that are intended to support the national research effort (RIMS, 2012).

1.5 Research questions

The research questions concern the extent to which the adoption of standards for processes and products might ease the problems of implementation and inter-operability. This is investigated in four stages:

1. What kinds of systems are being developed and used?
2. What events are significant in developing and using systems?
3. What are the qualities and characteristics of those events?
4. What standards are available that might usefully improve the outcome of events?

An extended version of the research model (Figure 2) shows how standards might provide guidance as to the desired or required qualities and characteristics of information systems, at the level of the technical processes that produce them and at the level of the educational processes that use them:

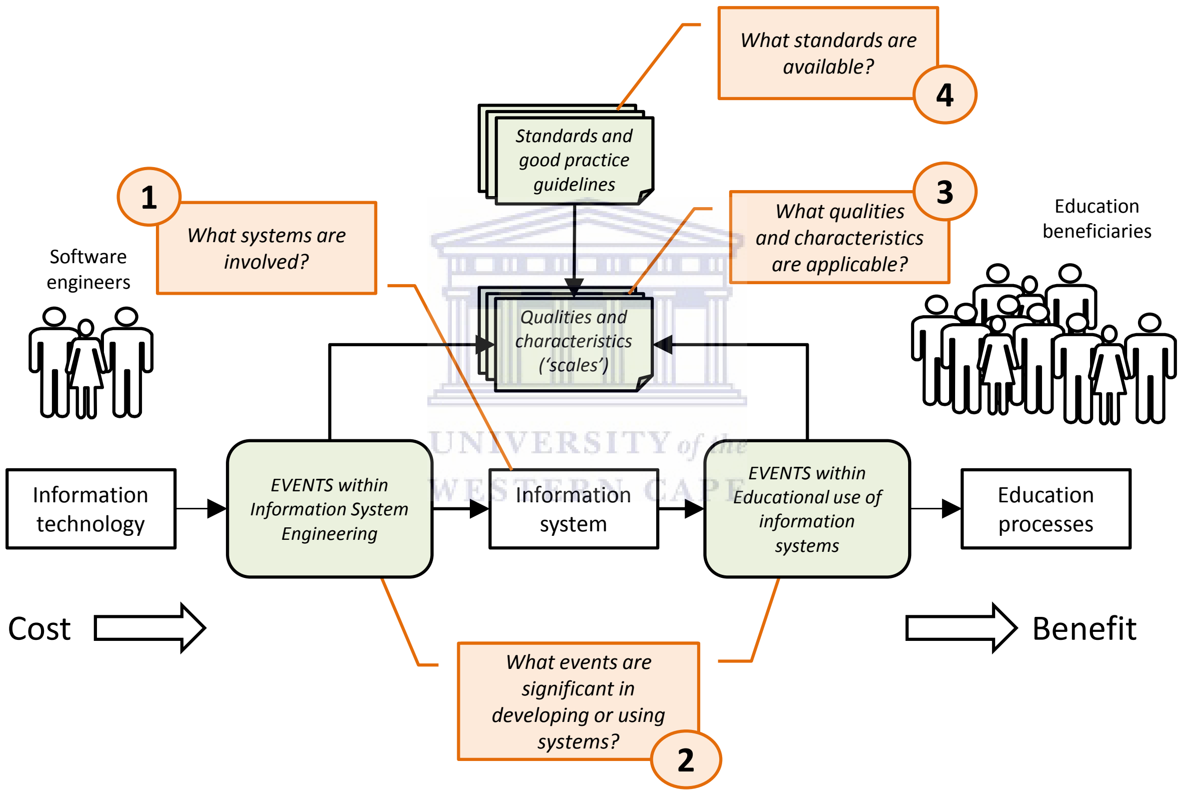


Figure 4 The research questions in an extended research model

The four research questions are positioned in Figure 4 to show that while the information systems are the focal point of the study, the study will also address the work that is done to acquire information systems, the work that is done with them, the ways that role players characterise them, and the standards and guidelines that are available to make them better.

1.6 Aim of the study

The overall aim of the study is to improve the potential contribution of IT to the needs of South African higher education through better management, based on a better understanding and implementation of standards across the whole chain of activity: from information technology acquisition, through information systems implementation, all the way to the achievement of educational objectives.

1.7 Research approach

Burrell and Morgan provide a widely cited arrangement of ideas (Figure 5) about possible approaches to research (Burrell & Morgan, 1979):

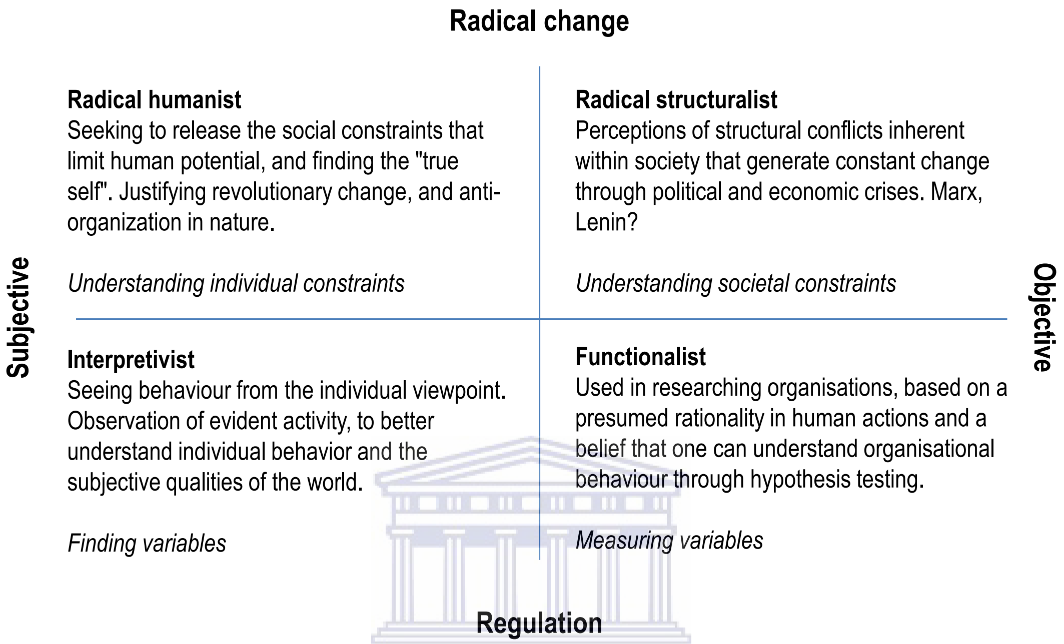


Figure 5 Burrell and Morgan's quadrants

This study will take place in a context of potentially ***radical change***, itself potentially hampered and constrained by ***regulation***; it will be ***subjective***, in that it sets out to understand the views of individuals and to accelerate the pace of useful, potentially revolutionary, change; hence, it will be ***interpretivist*** moving to ***radical humanist*** (in the terms used by Burrell and Morgan).

1.8 The thesis

This thesis comprises eight chapters as follows:

- Chapter 1 Introduction and background

  The context and approach to the study is provided.

- Chapter 2 Literature review

  Existing work concerning Information Systems Engineering, Information Systems Management and Education is reviewed and a synthesis is developed.

- Chapter 3 Research design

  The choice of the approach to the study is explained, and the research questions, conceptual model and unit of analysis are discussed.

- Chapter 4 ISE in higher education – the 'Landscape'

In this chapter the qualitative data from open conversation with respondents is analysed for evidence of themes that can guide the research. The variety of viewpoints held by different role players is analysed and there is an analysis of co-occurring patterns of data.

- Chapter 5 ISE in higher education –the 'Inside story'

  Here the structured data collected by the triadic method is presented and reviewed for frequencies and analysed using the Repertory Grid technique.

- Chapter 6 The availability of standards

  A review of available standards suggests that four are representative, and they are reviewed in some detail.

- Chapter 7 The applicability and utility of standards

  The research questions are revisited and answered by an analysis of the systems respondents are involved with, the ways in which their development and usage is characterised by respondents, and the potential for the adoption and application of standards.

- Chapter 8 Development of a candidate Reference Model

  The results of the study are brought together to formulate a reference model that will assist in the choice and management of standards.

- Chapter 9 Conclusions

  The results are reviewed according to the aims and objectives of the study, and conclusions are drawn about the potential to improve the benefits of information systems in higher education.

Chapter 2 Literature review

The literature review presented in this chapter looks at representative published work in three domains: information systems engineering, information systems management, and education. A synthesis of the reading indicates that we are concerned with 'good practice' rather than with standards, and also with the contextual differences that are evident within higher education and individual institutions, together with complexity, dependencies and enablements, and management discipline.

2.1 Approach to the Literature

In approaching any research project it is important to have a structured approach to the literature that will properly inform that research (Vom Brocke et al., 2009).

For this work, potential contributions were anticipated from the literature of computer science, software engineering, information systems management, project management, strategic management, and education. The approach to the literature search was therefore organised as follows:

- **Information systems engineering** (including software engineering), in order to establish trends in software and systems engineering practice, and the availability and application of existing standards at the 'engineering' level.
- **Information systems management** (generic tools, techniques and methods with which to manage the investment in information technology and systems), in order to establish non-engineering trends and to identify selected tools and frameworks that might be applicable in this study at the 'management' level.
- **Education** (the management and practice of education, and the impact of technology on education), in order to examine and compare education practice with practice in other generic areas of business and management.

The combination of these reviews informs the four research questions: the systems that are used in education, the impact on those who use them, the attributes or systems that relate to successful outcomes, and current thinking about standards and good practice in education.

2.2 Information Systems Engineering

2.2.1 Introduction

Consideration of information systems engineering starts with the deeper technical and engineering issues that are often seen as the natural candidates for standardisation. Search terms including 'software', 'information' and 'system', applied in conjunction with the word 'engineering', were used to find useful material directly connected with standards at the engineering level, and with research into the tools and techniques for systems specification and development. 'Software engineering' is a term that is frequently heard; 'information systems engineering' is a term that is more appropriate to the project and is incorporated into the title of the work, but it is in limited use. 'Software engineering' and 'systems engineering' are much more common. To illustrate this (at an early stage in the study, without presuming too much about its significance) a search of Google Scholar for these three phrases produced the following results:

'Software engineering':	1,380,000
'Systems engineering':	954,000
'Information systems engineering':	33,600

In the present context, the term 'information systems engineering' will be used to embrace software engineering, systems engineering, project management, systems implementation, and the redesign of organisational processes and the consequential management of business change. A key current source, firmly based in software engineering but taking an open approach to a wide range of associated topics, is the Software Engineering Body of Knowledge, published by the IEEE and available in South Africa as a standard (SANS, 2007). It includes sections on some of the wider issues, such as configuration management, process management and quality management, all of which extend beyond the simple construction of software and demand consideration of *information* and the *systems* that organisations use. Hence, the term 'information systems engineering' will be used here in a broad and inclusive way.

This study is not entrenched in traditional computer science or software engineering. It began there, but it quickly became exploratory and extended its scope in an endeavour to understand the potential for the benefits of information systems standardisation within education. From initial thoughts in the engineering disciplines the study set out to find the linkages – the 'dependencies' and 'enablements' – that make an investment in building and implementing software-based systems in education worthwhile at the organisational level. Hence, the review of the literature here that is labelled 'information systems engineering' has flexibility, and draws on other narratives that try to reach across the divide between the worlds of engineering and organisational management.

2.2.2 The rise and demise of standardisation

As the capability to engineer systems has developed over the decades, the complexity of engineered products has increased. For example, there was a moment in the late 1960s (not recorded in the literature, regrettably) when the complexity of mainframe computers and their application systems first went beyond the capability of a single human to understand, and the need to *model* complexity in ways that rendered systems comprehensible, through structuring and abstraction, became pressing.

At one level, experts from around the world convened standardisation committee meetings that strove to develop standards that would match the complexities and render them manageable. One example of this approach to standardisation is the OSI Reference Model (The 'ISO Model of Architecture for Open Systems Interconnection', see: Zimmermann, 1980) which at its height drew literally thousands of experts to huge international 'committee meetings', developed standards so complex that the ability of those standards to co-work and co-exist faltered, and then led to the development of 'meta-standards' that attempted to identify which standards were in fact compatible. All this happened shortly before the emergence of the World Wide Web, and – tragically for all those who were hoping to make their reputations in the OSI movement – relatively little has been heard about it since; a short history of events (ISO/IEC JTC1, n.d.) indicates that the responsible committee was disbanded in 1997, although selected projects were moved to other committees. The same source summarises the changing nature of the world in which standards were being made:

> *'As a consequence of the restructuring of ICT (and other) companies in the late 80s and early 90s, drastic reductions took place in corporate standards units within many companies as part of the movement of*

> *profit and loss responsibility to discrete units in the companies. Such corporate standards units had generally coordinated and facilitated participation by their company's experts in formal standardization activities.*
>
> *Virtually simultaneously with this development, the Internet and World Wide Web took off, essentially banishing to the history books the work that JTC 1 and ITU had been doing on Open Systems Interconnection, leaving just a few useful remnants applicable to the Internet environment.*
>
> *Then in the early 1990s, stimulated by a change in US antitrust law, industry consortia started to emerge as fora for addressing particular standardization issues within the ICT industry. This trend has increased ever since, and estimates exist that currently in the order of 600 consortia / fora exist each addressing particular standardization needs in different corners of the ICT field. ' (ISO/IEC JTC1, n.d.)*

Support for international standardisation work like this diminished but the problems and frustrations of the users of standards, and the economics of coalitions and committees that excluded those who just wanted to 'have a say' about what standards should be developed (Foray, 1994) caused many role players to seek other places to operate. It is in the work of these 'consortia' and 'forums' that some of the more interesting models can be found, not standards as such, rather the guides to good practice already referred to, and frameworks that render complex issues tractable by breaking them down in coherent ways.

The history of efforts to standardise at the level of software engineering is interesting – it is from here that much of the 'bigger picture' emerges.

2.2.3 A short history of software engineering standards

Although the term 'software engineering' can be traced back to 1976 and earlier (Naur et al., 1976), interest in standards for software engineering did not emerge immediately. US Military standards that prescribed software development methods were promulgated in 1979 (DoD, 1979) but it was only in 1984 that there was an earnest proposal concerned with all developers and users of software:

> *'These [software engineering] standards will ultimately define the norm of professional practice in all aspects of software development and maintenance from requirements definition through acceptance testing and beyond. They will be widely employed because they have been arrived at in an open process of professional discussion and debate. At any point in time, they represent the professional consensus on what should be done to produce the type of software our society now depends on.' (Buckley, 1984, p.106)*

Note the reference to '*… testing and beyond*', and the needs of '*our society*'.

Later it became clear that these optimistic expectations would be more difficult to realise than Buckley had anticipated. Nevertheless, industries around the world (especially in the USA) realised that there needed to be a discipline for the specification and development of software, especially in life-threatening or safety-critical contexts, and the effort to develop useful standards emerged.

2.2.3.1 Software engineering standardisation begins in earnest

Leonard Tripp, a senior software engineer from Boeing Computer Services in Seattle, became one of the champions of a new community of involved people. He promoted both the *processes* of standards development (Tripp, 1991; Tripp, 1992), and later the need for a broadly based *market* or *customer-oriented* viewpoint (Tripp & Voldner, 1995; Tripp, 1996). His argument for a 'market driven architecture' was succinct and persuasive:

> *'A major reason to adopt a market driven architecture for standards is to provide the basis for:*
>
> *1 moving away from a purely technical dependency,*

> *2 increase communications with the users of standards,*
> *3 help determine the priority for standards development, and*
> *4 allowing standards to better address the new challenges faced by the SE discipline.'*
> *(Tripp & Voldner, 1995, p.106)*

However, the necessary and worthwhile focus on the customer and the customer's needs was also difficult. In fact the standards makers (working in their technical committees) drove the standardisation effort in quite specific directions, such as *safety critical systems* (Bowen & Stavridou, 1993), *software metrics* (Fenton, 1994) and *software process improvement and capability management* (Emam et al., 1997). Such moves as these tended to maintain the inward-looking view of those experts who were involved, and (as already noted) there is some evidence from a survey (Land, 1997) that the 'customer' was not served at the levels expected by Tripp. It was therefore inevitable that new formations would come together to reflect on what had been achieved, and what problems and opportunities had to be addressed, and what alternative approaches might work better.

2.2.3.2 International involvement increases

At this time, a more international scene developed and a wider software engineering community began to consider how to best choose and deploy the newly emerging standards. However, the IEEE maintained a leading role[6] and at a meeting in Denver more than 100 people came together, reviewed the situation and attempted to develop a new agenda (Bytheway, 1994); one problem that had already emerged was that there were so many standards, so poorly co-ordinated, that experts began to debate and advise how to choose *combinations* of standards that would work well and to design frameworks that would guide future standards development (Thornton & Bytheway, 1993).

Questions as to how better standards might be developed became dominant. The practical merits of standards began to be challenged as some argued that they were too 'theoretical', and others began to note the cracks between one standard and another. Descriptions and analyses of 'the processes' of standardisation were promulgated:

> *'An international standard is by its very nature both descriptive and prescriptive. It is descriptive because it reflects the common beliefs and processes of a large number of experts throughout the world. If the area under standardization is mature, then the standard will likely also reflect common practice. It is prescriptive because these common beliefs and processes are intended to be adopted by all others.' (Rehesaar, 1996, p.127)*

Leonard Tripp notes the mounting concern and chooses to dig in with an argument for *integrity* in standards and makes proposals as to how this might be achieved (although not in great detail):

> *'The goal of the [integrity] program is to establish a consistent, risk-sensitive product 'methodology' that recognizes the interdependence of software and systems, and that is based on international, harmonized standards that contribute to product value while meeting customer needs and applicable regulations.' (Tripp, 1996, p.147)*

Tripp deserves credit for maintaining his concern for systems and the software within them, and for the customer's needs.

[6] The IEEE is an international organisation but it is grounded in the USA; it has taken the lead in software engineering standardisation there and internationally, and it is in effect a proxy for the American National Standards Institute (ANSI), the 'official' standardisation body in the USA.

2.2.3.3 A survey reveals limited interest

Soon, the Land survey of the usage of IEEE standards (Land, 1997) would confirm that these standards are by no means 'harmonised' and what users actually tended to do was to just use them for project planning, or as a baseline for adaptation for in-house use. Some respondents admitted that they did not use IEEE standards at all:

> *'Of the respondent's reasons why IEEE software engineering standards are not used: 37.14% said that the standards are not available at their facilities, 37.14% use other standards, 11.42% said that the standards were not fit for their needs, 5.72% cited contract requirements, 5.72% stated that the standards do not cover what they need, 2.86% cited poor standard quality.' (Land, 1997, p.249)*
>
> *'These users indicated that they view IEEE standards primarily as reference material to develop internal plans that document their software engineering procedures. Implementation difficulties include a lack of understanding of the standards' benefits and a deficiency in the useful examples provided by the standards..' (Land, 1997, p.268)*
>
> *'Users suggest that it is difficult to apply IEEE standards because of inconsistencies that exist within the IEEE standards set and inconsistencies with non-IEEE standards. Users point to a need for a software process architecture explaining the IEEE methodology. Users' comments indicate frustration with standards' tailoring and the establishment of a minimum set of requirements, particularly for smaller development maintenance efforts.' (Land, 1997, p.268)*

There is little evidence that this kind of survey has been repeated since, which is surprising. It is also interesting to see the emerging argument for a more *architectural* view of what had already become quite a complex mix of standards, for different parts of software engineering processes and products – an inevitable outcome of the failure to maintain strong cohesion between the published standards that came from the early years. Nevertheless, it was argued that it is still 'early days' and at the heart of standards making, devotees pushed on with arguments for yet more standards, for example for software 're-use' (Baldo Jr et al., 1997). In parallel, the shift to what might be termed 'practitioner based methods' begins in earnest – the first release of the COBIT guidelines was published in 1996, and earnest promotion of COBIT from independent sources soon followed (Lainhart IV, 2000).

2.2.3.4 A quiet period

There follows a period when little published work emerged concerning standards, although there are occasional pieces, for example an interesting and early commentary on the need for software-related standards in education, based on what are the traditional expected benefits of standards (cost reduction and open sharing):

> *'By having a well-implemented and supported standard we lower the development costs for creating and using online materials and encourage the development of market incentives for distributing online materials. By facilitating the creation and compensated (ie by paying for small-scale developments) distribution of learning materials, the implementation of standards will increase the quantity of materials available and the methods for locating these materials.' (Owen, 1999, p.8)*

Customer needs prevail, this time in education rather than in the military or in the aerospace industry; the potential benefits are seen at different levels.

This was a time (2000 onwards) when the open source movement began to be taken more seriously, raising issues of open standards that would avoid vendor lock-in and ease document sharing. Casson and Ryan provide a detailed and authoritative summary, describing the experiences of large organisations that chose to adopt open source technologies and standards, including the city of Munich, the country Brazil, and the administration of Massachusetts in the USA (Casson & Ryan, 2006). This was an early report, and they were able to provide only a hint that these hugely significant decisions to 'leave' Microsoft and go 'open' were not actually easy to implement, and that the savings were actually marginal at best. At the time of writing this still seems to be the prevalent position – going 'open' is by no means the obvious way to go and researchers still seek reliable ways to inform such a decision, for example by building on existing theories of IT adoption (Sarrab & Rehman, 2014).

But open standards are not only concerned with personal productivity software such as the 'Office' suites, they are about the Internet and the World Wide Web. Tim Berners-Lee, widely acknowledged as the founder of the World Wide Web, felt it necessary to clarify the scope of open standards in an article published in Scientific American:

> *'By 'open standards' I mean standards that can have any committed expert involved in the design, that have been widely reviewed as acceptable, that are available for free on the Web, and that are royalty-free (no need to pay) for developers and users. Open, royalty-free standards that are easy to use create the diverse richness of Web sites, from the big names such as Amazon, Craig's list and Wikipedia to obscure blogs written by adult hobbyists and to homegrown videos posted by teenagers. ' (Berners-Lee, 2010, p.2)*

In the article he points out that the web is maturing into more than just a huge but simple repository, it is beginning to *link data* in a way that emulates knowledge management – and as the 'intelligence' of the web develops it will be critical to maintain the openness of its content. This has implications for education, which now relies more and more on the web for content; somehow, the software engineering idea that is the 'computational object' has migrated into education, and there is considerable interest in managing learning resources as 'learning objects' – already the subject of further standardisation efforts (Learning Technology Standards Committee of the IEEE, 2002). There are many different schemes for organising and managing metadata (data about documents and pages on the web) and while many of us are (at the time of writing) happy to battle with Google Scholar and formats such as BibText and RIS, higher education will soon be hoping for a more orderly regime and for less difficulty in moving our thinking around different and sometimes alien environments. Hatala and his colleagues comprise one group of experts that has challenged us to think about this, but they seem to have mixed feelings (Hatala et al., 2004):

> *'In a perfect world there would be only one metadata protocol and we would need only one repository and one search mechanism. However, this would be a rather bland world. The reality of e-learning is a hodge-podge of legacy repositories, protocols, special interest groups and self-serving communities.' (Hatala et al., 2004, p.26)*

Quite so, but it really is going to get more difficult and more challenging if there is no attempt at standardisation. It is only 'fun' to struggle with multiple standards for some people, and only for a short while.

2.2.3.5 Searching for harmonisation and specialisation

And so, in terms of our timeline in this brief history, everything seems to have been relatively quiet on the technical committee-based standardisation front for a while, since 1999, but then comes the second generation of standards (Suryn et al., 2003; Azuma, 2011). Unfortunately, the details look like a half-hearted attempt to pump some kind of structure into the current portfolio of published standards:

> *'Something that is measurable can be controlled and software product quality is no exception. On the other hand, there is no single measure that indicates overall software quality, because some software products are security critical, while others may be reliability critical. Therefore, it is necessary that*

> *various quality measures are prepared and used … in a Quality Model. ISO/IEC TR9126-2 provides External Quality Measures, TR9126-3 provides Internal Quality Measures, and TR9126-4 provides Quality-in-Use Measures. WG6 decided to revise these Quality Measures by new projects.' (Azuma, 2011, p.2)*

Again, it might be remarked 'quite so …' but where are the social 'quality measures', for the 'social web', for 'blogging', for 'big data', and for 'MOOCs' (Massive Open Online Courses)? Perhaps the technical committees must declare more clearly that they are only really interested in (or capable of) dealing with legacy systems, or those that are safety-critical or mission-critical.

There are one or two review papers in this interim period that assess the merits of these traditional standards, for example from Wichansky, who talks about the problems of working with standards organizations:

> *'Creating an international standard is a long and arduous process … Standards-making requires a long-term perspective, keeping in mind that standards today may not reflect the technologies of tomorrow ... The best contents [topics] for standardization are well-researched topics that are not likely to change between product generations. These include human factors, methodologies, and reporting parameters. Standards also tend to reflect well-established and generally accepted knowledge about a domain. Sometimes the latest research is not reflected in the standard, because it does not yet have sufficient verification or a track record of the application to be included.' (Wichansky, 2007, p.39)*

It can be concluded that standards-making is 'not for sissies', and certainly not for lazy, slow-thinking sissies. Small businesses generally have learned to move quickly to survive, and they feel excluded:

> *'In a time when software quality is a key to competitive advantage, the use of ISO/IEC systems and software engineering standards [in small businesses] remains limited to a few of the most popular ones. Research shows that VSEs [very small entities] can find it difficult to relate ISO/IEC standards to their business needs and to justify the application of the standards to their business practices. Most of these VSEs can't afford the resources - in number of employees, cost, and time - or see a net benefit in establishing software life-cycle processes.' (O'Connor & Laporte, 2010, p.4)*

Quite recently there has been yet further evidence of the need for a fresh and quite careful analysis of harmonisation issues, based on a perceived lack of cohesion in the available standards:

> *'Standards organizations are often reticent to take on board recent research results for a number of reasons. They may feel the results are too esoteric, too 'hard' to understand; they may feel there is no practical validation of the ideas; or they just prefer the status quo. For some standards' meeting attendees, the products of the company they represent may be the most influential element in their contribution to new and revised standards; for others, it may be a wariness of a loss of power and influence when they have been the prime mover of a key standard for many years that the new research threatens to upset. However, as software engineering standards participants, I would suggest our prime responsibility, beyond that of nation or company, is to the increasing safety and wellbeing of a globalizing society increasingly dependent upon top quality software' (Henderson-Sellers, 2012, p.160)*

2.2.3.6 The situation today

And so there is a pattern in standards-making over the last 40 years: a somewhat chequered history, limited success, and a strong suggestion that there is now a new realm of possible standardisation concerned with specific sectors (such as the Internet, small businesses and education), with the social web, and with radical new systems architectures driven by 'big data' (Schumpeter, 2011; Chen et al., 2012; Gardner, 2012).

In the background, firmly based in software engineering but taking an open approach to a wide range of associated topics, there is the 'Software Engineering Body of Knowledge', published by the IEEE and available in South Africa as a standard (SANS, 2007). This is a extended listing of standards and publications about software engineering, and about related topics. It stands as an excellent summary of recent history. But evidence from the practitioner literature makes clear that the average information technology or information systems manager is now more interested in the broad sweep of management 'methods' and 'frameworks' than in the detail of how software can be tested and how it must be documented. It is no longer just about the *software engineering*, it is about the way *information systems engineering* is done.

2.2.4 Selected frameworks and methods of working

The involvement of technical and business personnel in the management of information technology and systems investments was not always balanced, and for a period it was believed (in some organisations) that the 'IT Department' could analyse, re-specify and re-engineer *the whole business*, without business involvement other than as an information source (Iyamu, 2004).

Despite this extraordinary presumption and the uncertain results of many major investments in engineering 'enterprise architectures', it has been found that the performance of organisations of all kinds can be enhanced by good strategic management of information systems investments (Ward & Daniel, 2005); elsewhere it is argued that success is intimately dependant (amongst other things) on the quality of the work of the software developers who originate, integrate and support the program code that systems, and therefore organisations, use (McLeod & MacDonell, 2011). In addition, it has been determined that organisational performance depends on organisational management and the strategies that managers adopt in order to assure the outcomes of investments in systems and technology (Ward & Peppard, 2002). Thus, it has been established that there is a trail of *dependency* from raw engineering practice through to organisational management, that has to be seen all together in order to understand what processes and enablements are involved and at what points the use of standards might help to assure the desired investment outcomes. This is not just about standards for engineering; it is also about standards for project management, business change management and strategic management.

It is therefore not surprising that 'methods of working' and 'frameworks' have emerged that do much more than the typical technical standard would do. Eight such schemes have been selected to provide an overview of how higher-level thinking has emerged since 1989; they are presented chronologically:

- ITIL (1989)
- Zachman (1987)
- Capability Maturity Model (CMM) (1992)
- Henderson and Venkatraman seek simplicity
- Jacobs' ladder (1995)
- COBIT (1996)
- The CEN Model (1997)
- The Information Management Body of Knowledge (2004)

2.2.4.1 ITIL (1989)

The IT Infrastructure library was an initiative of the United Kingdom government to specify the services that were required in order to successfully deliver information technology benefits. The rights were sold to the private sector so that it could be promulgated internationally without the constraints that might have arisen from government 'ownership', and it was first published as such in 1989. In the 20-plus years that followed, it has been extended to become more holistic and there are now volumes dealing with:

- ITIL Service Strategy
- ITIL Service Design
- ITIL Service Transition
- ITIL Service Operation
- ITIL Continual Service Improvement

These are just five out of a total of 21 volumes that are offered (at the time of writing). Interest in ITIL seems to have been sustained over the decades and it has attracted the attention of academics and researchers. One study looked at the way that ITIL worked with ISO/IEC 15504 (a standard for software process assessment) in a small business context (Barafort et al., 2002). At the time of writing, the official ITIL web site reveals quite vibrant activity, including surveys intended to garner better information about actual user experience (ITIL, n.d.); there are copious references to ITIL in recent academic literature. This was a European initiative and, as might be expected, there were other ideas emerging in North America.

2.2.4.2 Zachman reveals complexity (1987)

Based on a long career with IBM, the complexities of information technology management were revealed by John Zachman in a 'Framework for information systems architecture' (Zachman, 1987); Zachman took a broad view of the issues but his ideas were necessarily detailed, and his frequently-cited six-by-six matrix (see below), with layers of modelling and representation down the side, and different perspectives on the business across the top, was too complex for many managers to work with. Thirty six (36) different focal points of concern (the intersection of the six rows and six columns of the matrix) were just too many to handle. After the initial publication of the first simpler framework, this extended version (Figure 6) became the definitive view of what he had in mind.

There have been subsequent references to the Zachman framework (for example, Frankel et al., 2003) and John Zachman himself still travels the world (and South Africa) to talk about his ideas, but the framework seems to have failed to gain currency in the strategic or operational realms of management. Nevertheless, Zachman's seminal paper launched a number of important ideas: it promotes the idea of 'architecture' as a way to deal with complexity (he started the paper using house building as a metaphor), thereby making clear the difference between the representation of a building (or system) in the architect's drawings (or the systems analyst's specifications), and the actual construction (or program coding). He draws an important distinction between the process and data perspectives of a system and the network that allows it to communicate. In his conclusions to the original 1987 paper, he writes:

> *'When the question is asked, 'What is information systems architecture?' the answer is 'There is not an information systems architecture, but a set of them!' Architecture is relative. What you think architecture is depends on what you are doing' (Zachman, 1987, p.291)*

In saying this he reinforced the idea that the program coder had one view of what was to be produced and the database designer (and the network engineer) had another – this is not actually conducive to a mutual understanding of a single aim, unless all concerned can bring these viewpoints or perspectives together. It is not clear how Zachman expected the common understanding to be achieved when each had their own view from a specific place in the framework.

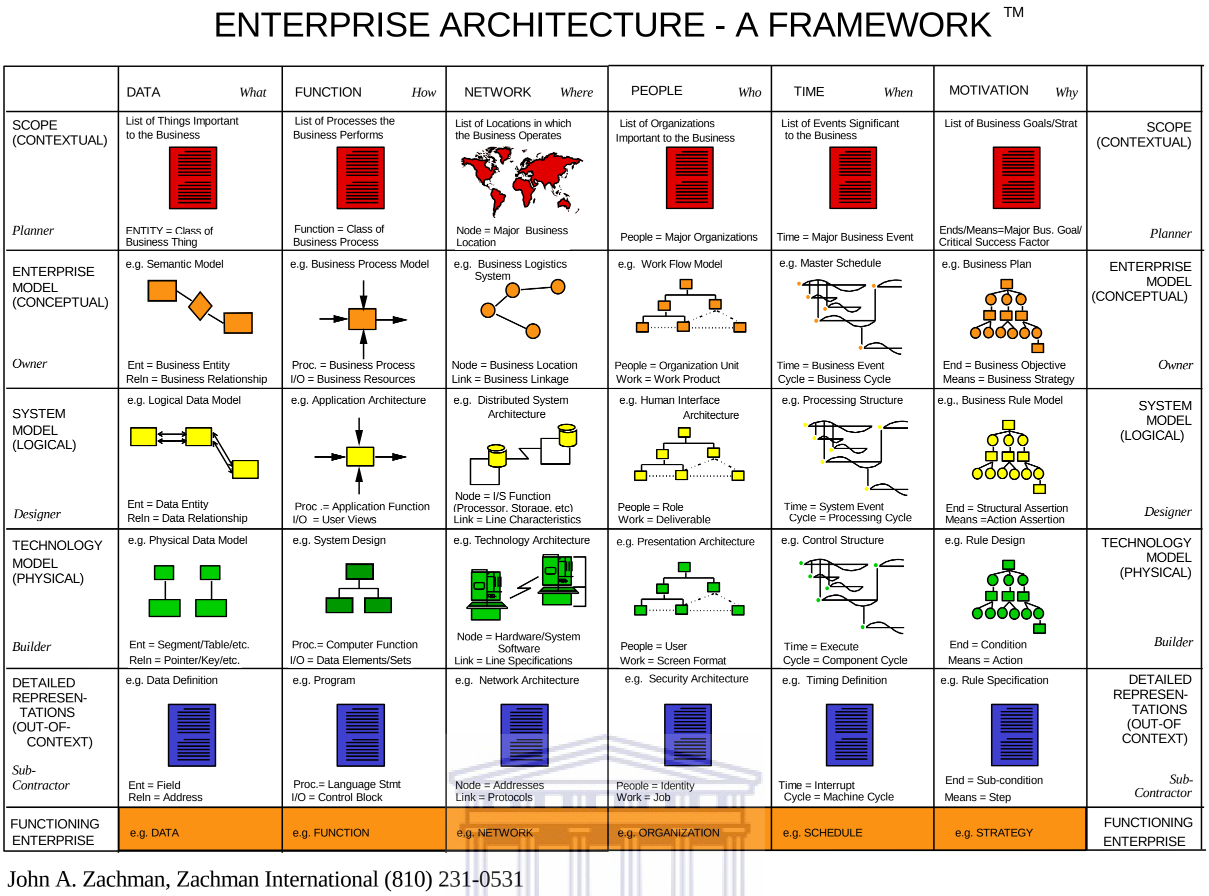


Figure 6 The Zachman Framework (extended version)

2.2.4.3 Capability Maturity Model (CMM) (1992)

The Capability Maturity Model is a frequently cited and early example of good work coming from an academic source: The Software Engineering Institute at Carnegie Mellon University published the first edition of the model in 1993 (Paulk et al., 1993). A second edition was made available in July 2009.

There are many references therein to standards, especially the standardising of the software development process within an organisation, and the way that it is established and managed.

The CMM identifies five stages in achieving software engineering maturity:

- Level 1: **Initial**: Chaotic, unstable, relying on the individual
- Level 2: **Repeatable**: Basic standards and project management in place, QA Group at work
- Level 3: **Defined**: Standard processes across the whole organisation; training and improvement processes in place
- Level 4: **Managed**: Productivity and quality is measured; database of metrics in place to feed the improvement process
- Level 5: **Optimising**: Continuous improvement, leading edge software engineering practices

In its early days, people frequently asked who had achieved the highest level, Level 5. For some time there were only two: Motorola in Bangalore and IBM in Florida (Stremlau, 1996; Parthasarathy, 2004).

What is most interesting about the CMM is that it stands as a very early example (if not *the first*?) of an idea that became very widely adopted in other contexts: in dealing with maturity in personnel assessment, process management and supply chain management, as well as educational computing, many experts have chosen to focus on the shifting capability of organisations to do these different things well and to improve how they do them over time (Ginsberg & Quinn, 1995; Curtis et al., 2002; Lockamy III & McCormack, 2004). Meanwhile, parallel efforts to improve the return on information technology investments continued and focused more carefully on the ways in which business and technology strategies can be more effectively aligned.

More recent empirical work by Luftman took an approach based on the *maturity* of strategic alignment, clearly based on the five levels of maturing in the earlier Capability Maturity Model (Luftman, 2000). His terminology was as follows:

1. Ad Hoc Process
2. Committed Process
3. Established Focused Process
4. Improved/Managed Process
5. Optimized Process

It has been similarly argued (Yayla & Hu, 2009) that alignment is achieved by means of simple steps: strategising processes, increasing the level of communication, formalising policies, and so on – some of this detail can be found in the work of Luftman, but his recommendations are based on the evaluation of maturity by an evaluation team, using pre-defined terms, and they seem to be based on limited empirical work: can this kind of work claim the rigour that would come from an exhaustive analysis of all available literature in the style of Delone and McLean (DeLone & McLean, 1992; DeLone & McLean, 2002), which was based on a reading of more than 180 academic papers concerning 'user satisfaction'? This is yet another perspective on the issues of meeting users' needs by means of careful strategic management.

Hence, a holistic approach is needed to the successful delivery of benefits from information systems and technology investments. 'Alignment' is an appealing word, but its success has to be judged by the *benefits* that are delivered. The management of benefits has been an issue from the very early days (Baets, 1992) right through to recent times; it is now dealt with in detail in standard texts such as those that emerged from work in business schools in the United Kingdom (Ward & Peppard, 2002; Ward & Daniel, 2005), but the kind of simplicity and clarity that busy managers need if they are to be effectively assisted must be understood.

There is a tendency in this kind of work to avoid dealing with *differences*. The CMM is written as if all organisations would display the same critical dependencies at different levels of maturity, but that is not the case. Famous examples of software and information systems success such as Microsoft, Apple and Amazon have never been involved in CMM and yet it is argued that they have delivered world-beating software (Wikipedia, n.d.). It's not just about software development, it's about conceiving new ideas, thinking 'out of the box', running hugely complex and voluminous systems, and *delivering benefits*. The critical success factors for Microsoft, Apple and Amazon were more concerned with innovation, processes for productisation of new ideas, and managing business change, and it is interesting that in Google the 'standard' requirement for hiring new programmers was (at the time of writing) that they had an adequate ranking in the TopCoder community – a crowd-sourced organisation of open but competitive individuals offering systems development and programming services (Dhansay, 2010, p.42) – more a social basis for selection rather than a technical one?

2.2.4.4 Henderson and Venkatraman seek simplicity (1993)

In the search for simpler views of the problem, one frequently cited example is the Henderson and Venkatraman framework. It relates business and IT issues at the internal and external levels using a two-by-two matrix. It suggests that there is a need for 'functional integration' between the business and IT domains, and that there is a need for 'strategic fit' between the internal and external worlds. The four quadrants embodied in the framework are, in turn: *scope*, *competencies* and *governance* in the external portion and *processes*, *skills* and *infrastructure* or *architecture* in the internal portion.

The Henderson and Venkatraman model in Figure 7 is simple at first sight, but it leads to a range of questions and lacks the sort of elegance and symmetry that makes these things memorable. It is interesting to see that *competencies* and *skills* are included, but why are they in different parts of the framework? As is made clear in the CMM, a skill can be seen as a low level thing ('I can work this computer') but a competency is something else ('I can use this computer to reliably produce a useful econometric model'). The implication of 'processes' being in both the internal business and internal IT quadrants is that business processes and IT processes must be functionally integrated, but how is that possible? A single IT process might contribute to a wide range of business processes; conversely a typical business process might depend on many information systems. Why is 'administrative infrastructure' on the left, and 'architectures' on the right?

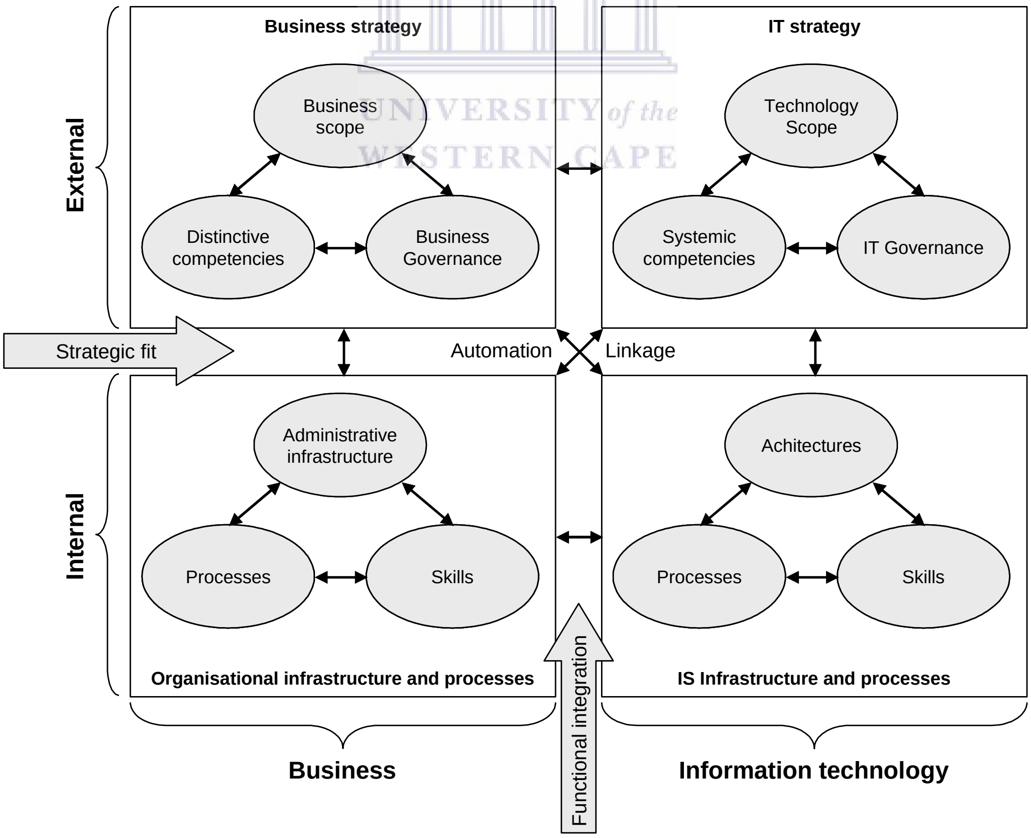


Figure 7 Linking business and IT from the internal and external viewpoints
(Henderson & Venkatraman, 1993)

The model implies dependencies and relationships between its conceptual components, but these are not immediately evident on a first reading. However, their arguments do re-enforce the shifting nature of the problem:

> *'… the Strategic Alignment Model calls for a fundamental shift in the focus of the I/S function from an internal orientation toward one of strategic fit within the I/T domain, namely, recognition of the external I/T marketplace in terms of the scope of the technologies, the desired level of competencies, and the locus of governance. This shift is important if we consider that I/T has the potential to shape business competencies and actions in the product-market arena.' (Henderson & Venkatraman, 1993, p.480)*

In their conclusions they note that it is necessary for others to work with their model and render it applicable, in specific situations, quoting contemporaneous work by Luftman, Lewis, and Oldach (Luftman et al., 1993) that shows how to translate their model into …

> *'… management frameworks and action plans for the transformation of the enterprise.' (Henderson & Venkatraman, 1993, p.482)*

Later, Luftman went further and adopted the CMM way of thinking – based on competency and maturity – in setting out an alternative approach to marrying need with capability in all kinds of organisations, together with a survey (Luftman, 2000). It has been noted conversationally that he found *education* to be a long way behind commercial organisations in achieving software and systems maturity, but there seems to be no published reference to confirm this (Grant, 2011).

2.2.4.5 Jacobs' ladder (1995)

This chronologically organised narrative takes us firmly from the world of software engineering into the world of business, and it is appropriate to look carefully to see what senior business managers were thinking in the 1990s, as the technical work progressed in its own way. Persuasive, clear argument concerning the benefits and value to be derived from investments is what senior managers want to hear. Ideas of maturity will be interesting, but then it will be someone else's job to deal with it. Aligning strategy is a much more interesting challenge for the average senior manager.

However, even this can be seen as a time-based migration. Venkatraman introduced the idea of 'eras' (Venkatraman, 1996), concerning the increasing *scope and reach* of information systems, the increasing *degree of business change* that was required to benefit from them, and the increasing *value* to be gained thereby; senior management then began to see that there were matters of scale here: it takes time, it takes strategic reach, and the quantum of benefit achievable from a single strategic increment is constrained.

Inevitably, adopting and adapting new ideas takes time, and practical concerns continued to be reported at about this time (Uchitelle, 1996). But what Venkatraman had articulated was a clear message that is concerned with the management of *systems* and the *information* that comprises the essence of those systems, not just the *technology*.

Progressive organisations understood this and worked along these lines, and references to 'information technology management' were supplanted by references to 'information systems management' and then to just 'information management', as in the case of BP Chemicals (Cross, 1995), and even to 'knowledge management', as in the case of Zeneca and others (Chase, 1997). At BP Chemicals, John Cross dubbed his idea 'Jacob's ladder' – he was seeking a management stairway to a strategic heaven, perhaps?

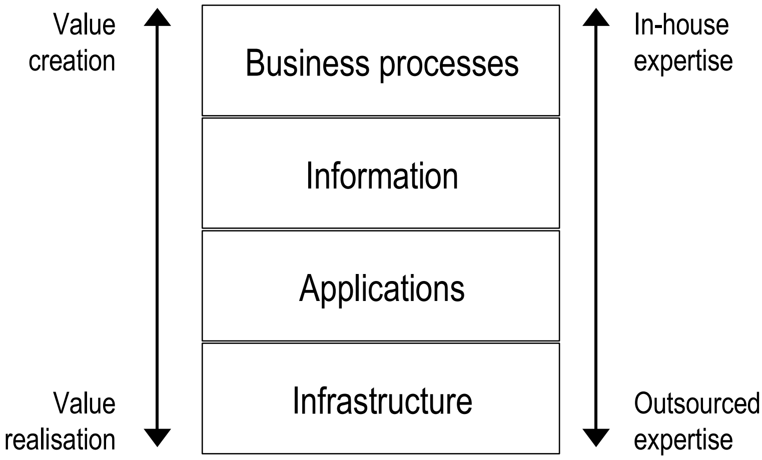


Figure 8 'Jacob's ladder', as used in BP Chemicals

The arrangement of the four steps in BP Chemical's 'Jacob's ladder' is shown in Figure 8: at the bottom is the technology that comprises the infrastructure for systems and for business activity, and at the top are the business processes that serve the business strategy (Cross & Earl, 1997). An important feature of the model is the insertion of 'information' and 'applications' between the two – it is this recognition that the management of information and applications (or more simply, the management of 'systems'?) that begins to construct a chain of value from the infrastructure to the business process. Improved information and improved applications functionality is what begins to improve the quality and effectiveness of business processes. It is interesting that the *creation* of value is seen at the top, with *in-house* expertise; the *realisation* of value is seen at the bottom, based on the use of *outsourced* expertise (outsourcing was one of the principal strategic outcomes for BP Chemicals at this time). These ideas, examined in workshops with working managers (Bytheway, 1996) and extended to reach right through to business strategy, led ultimately to the Information Management Body of Knowledge (IMBOK) framework (Bytheway, 2004). This is presented later in (section 2.2.4.8).

However, this notion of value generation is seen in other work. Zachman had already articulated his six 'levels' and six perspectives, from the *representation* of technology infrastructure (program code and data definitions), through *technology*, *systems*, *enterprise* and *context* of the enterprise (Zachman, 1987); Venkatraman was promoting the idea that *data*, *information*, *knowledge*, *action* and *result* were all related in a similarly progressive way (N. Venkatraman, 1996), and Ward has promoted the idea that benefits from IT investments are achieved at different levels (Ward & Peppard, 2002). The significance of the BP story is that both the CEO and the CIO were absolutely committed to a programme of action to simplify and rationalise the operational costs of information technology and systems.

2.2.4.6 COBIT (1996)

No doubt prompted by the actions of progressive organisations like BP Chemicals, and as noted in the previous chapter, COBIT has migrated through several versions in its efforts to embrace more and more of 'the problem':

- 1996: Audit of IT operations
- 1998: Control of IT and IS operations

- 2000: Management of IT and IS operations
- 2005: IT Governance
- 2007: Enterprise IT governance
- 2012: Consolidation of Risk and Security issues.

This extending ambit reflects the general concern amongst IT managers to reach further and further into the governance and strategic aspects of an organisation.

Lainhart provides an early introduction to COBIT and embellishes his description with quotations from practising audit and control managers; two typical comments are:

> *'CobiT provides tools to communicate with the managers of the business and bridge the gaps among technical issues, control needs, and business risks.'*
>
> *'CobiT is excellent. It is the best benchmark document available in this country; and I recommend using it as a technology framework of policy.'*
>
> *(Lainhart, 2000, p.24)*

This positive move to link technology management to the strategic needs of an organisation is quite in line with the intentions of John Cross at BP Chemicals, and has been well received. Like ITIL, COBIT continues to find support internationally (AbuMusa, 2009) and in education (Khther & Othman, 2013), where it is found to facilitate communications and reduce costs based on the analysis of three cases.

The latest version of COBIT, Version 5, makes clear its intentions and objectives:

> *'COBIT 5 provides a comprehensive framework that assists enterprises in achieving their objectives for the governance and management of enterprise IT. Simply stated, it helps enterprises create optimal value from IT by maintaining a balance between realising benefits and optimising risk levels and resource use. COBIT 5 enables IT to be governed and managed in a holistic manner for the entire enterprise, taking in the full end-to-end business and IT functional areas of responsibility, considering the IT-related interests of internal and external stakeholders. COBIT 5 is generic and useful for enterprises of all sizes, whether commercial, not-for-profit or in the public sector'. (ISACA, 2012, p.13)*

This feels like the beginnings of sound advice and, as with ITIL, there are references to COBIT in recent academic literature.

2.2.4.7 The CEN Model (1997)

Recognising the problems inherent in delivering successful IT based systems to organisations, a widely-supported international standardisation project set out to establish a *reference model* for Information Systems Engineering (ISO-IEC/SC7/WG5, n.d.). In the event it was not adopted by the international 'parent' committee (ISO-IEC/JTC1/SC7), possibly for cultural and philosophical reasons – experts have argued the differences between European and US attitudes to social and technical determinism (Bijker, 1993) and in this case it was the US delegation that vetoed the proposed reference model ('technical determinism rules' in the USA, Bijker argues). However, the model was further developed by a European project team (CEN/TC 311 PT01) and registered as a technical report by the European standards body (CEN TC311, 1997).

The final outcome was a 'Conceptual Model and Taxonomy for Information Systems Engineering' that organises 195 elements of Information Systems Engineering (ISE), at four levels:

- The organisation system that works to deliver the intended outputs of an organisation (OS).
- The information systems that are used to support the work of an organisation (IS).
- The information systems engineering system that produces information systems (ISES).

- The information systems engineering technology system that delivers IT artefacts needed. for information systems engineering (ISET).

In this reductionist way, the model divides the complexity of ISE into manageable domains, or sub-systems, intended to assist the coherency and compatibility of systems engineering standards directed at the successful deployment of information technology in organisations.

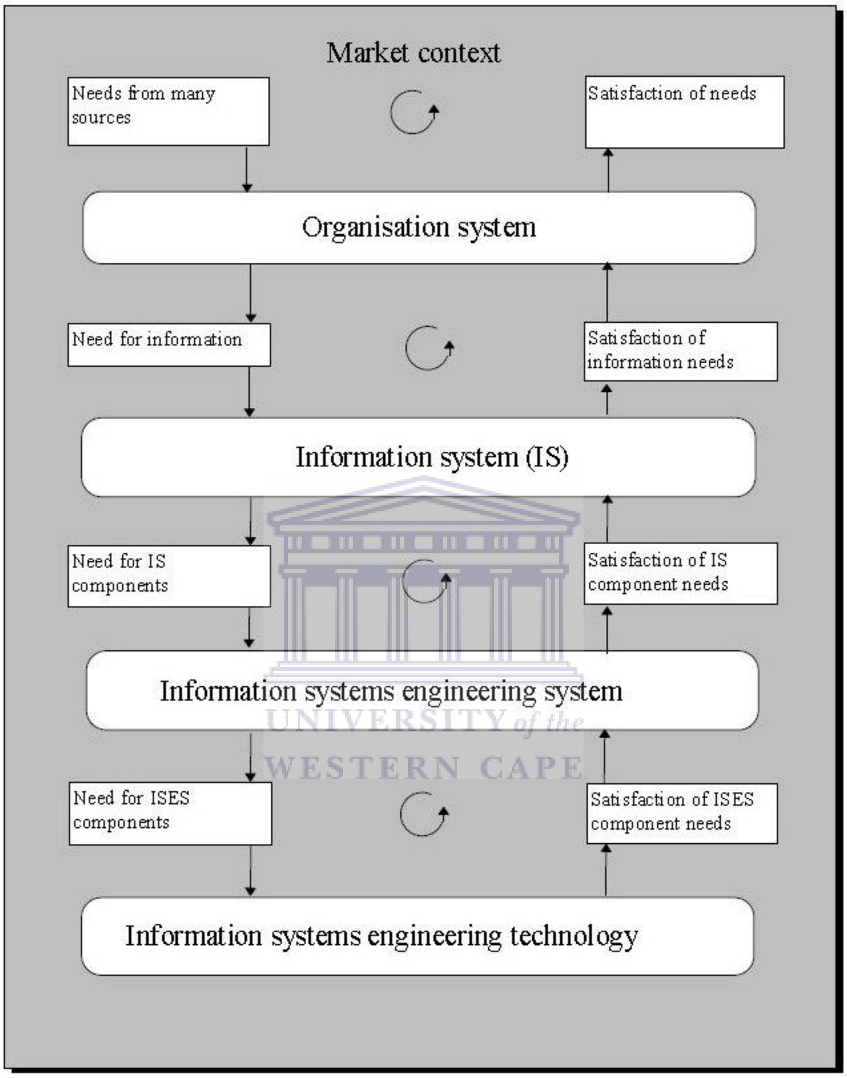


Figure 9 The ISE Model and Taxonomy developed by CEN (CEN TC311, 1997)

Note the introduction of the word 'information ..' as a prefix to '.. systems engineering'; this was an attempt at the time, by the developers of the taxonomy, to make clear the scope of the work *beyond* the engineering of 'systems' (the process paradigm) to embrace also the engineering of 'information' (the data paradigm).

CEN's stated target audience for the ISE Model and Taxonomy included:

- IS procurers and users
- ISE practitioners
- ISE researchers and educators
- Standards makers

- ISE method developers and users

There is little evidence that the ISE Model and Taxonomy has been used in any of these spheres of activity, although there is one example of published work (Thornton & Bytheway, 1993). A graphical overview of the ISE Model and Taxonomy is provided in Figure 9. The 195 elements are organised within this framework, and the way that they comprise the components and sub-components of the model is defined in the document using a formal syntax based on Backus-Naur Form (ISO-IEC, 1996). This ISE model and taxonomy (hereafter simply referred to as 'the CEN model') was one of the inspirations for this work.

2.2.4.8 The Information Management Body of Knowledge (2004)

In a research project in Cape Town, involving all tertiary institutions and funded by the Carnegie Corporation of New York, researchers from the University of the Western Cape and the Cape Technikon (now the Cape Peninsula University of Technology) worked with local representatives of business, government and education to tabulate and address some of the managerial issues associated with technology in organisations, for the purposes of establishing new Master's Degree programmes in the two institutions (Keats, 2003); both these programmes still run today, although inevitably they have evolved in different ways reflecting the different circumstances of the two universities.

A review of 'good practice' was undertaken to gather together contemporary thinking, that incorporated the ideas evident in the models presented above as well as others; the objective was to deliver something around which post-graduate learning and research could be designed. Because it was a collation of knowledge from multiple sources, the new framework was, and still is, referred to as the 'Information Management Body of Knowledge' (commonly referred to as the 'IMBOK'). The handbook that documents this framework has been available under a Creative Commons License since 2004 (Bytheway, 2004), and copies are now in the hands of students, researchers, business people, bureaucrats and the military, all around the world. It has been adopted as a standard course text in South Africa, Europe and North America, and has since been published as a conventional book (Bytheway, 2015).

Pictorially, the IMBOK (Figure 10) identifies five domains of management, and four interfaces between them:

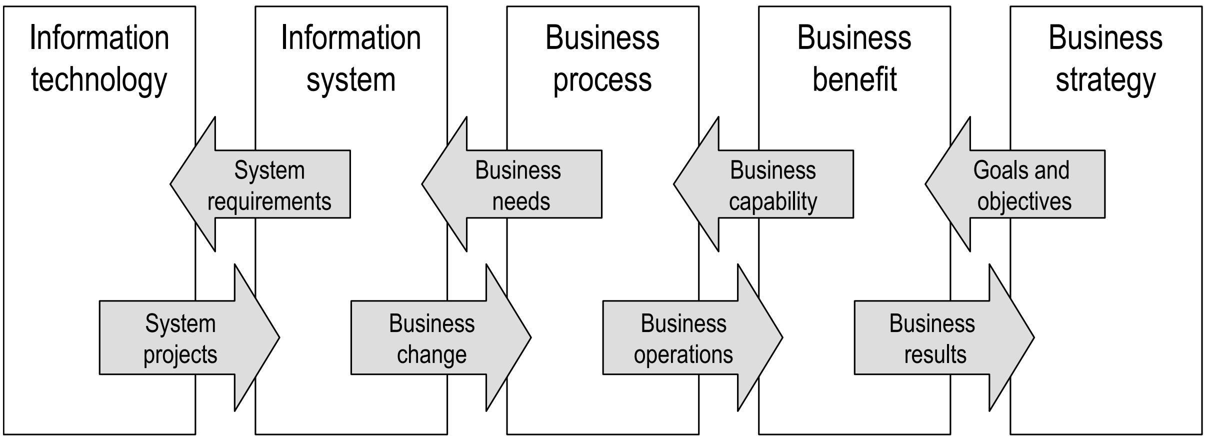


Figure 10 The Information Management Body of Knowledge

It is clear that one of the principal difficulties faced by management is the preservation of the quality and detail of thinking that passes *between* the five management domains, and that there is not just one point of alignment (as is so often argued, even by experts) but *four*. In this sense, Zachman was right – it is more complex that some people would wish to admit; perhaps Henderson and Venkatraman fell short of what is needed at the working level?

The IMBOK makes clear that if information systems projects do not deliver systems that are well supported by the technology, if systems do not support business processes, if business processes do not deliver the performance improvements that are expected, and if those improvements are not what strategy demanded, then all of the time and money will be spent in vain. Hence, the four *interfaces* between the five management domains take on special significance.

The IMBOK framework has proved to be useful because it allows assessment and analysis of the *competencies* that are needed to manage the successful delivery of benefits from information technology investments. From the preceding work, and in particular the review of a very wide range of literature that it accommodates, a set of 144 competencies have been identified that can be organized into nine groups that correspond to the five management domains in the IMBOK and the four gaps between them. These competencies are the substance of survey instruments that have been used to assess the *capability* of organisations to achieve effective information management (Bytheway, 2011).

Other threads of research have informed the development of the IMBOK, including a very extensive review of the literature that established the validity of many of the ideas within it: ideas from work at MIT and at the Cranfield School of Management (Lambert & Peppard, 1993; Venkatraman, 1996; Ward & Daniel, 2005); the guiding principal of *value adding* can be traced back to work by Edwards and Peppard (1997) and to the author (Bytheway, 1996), and ideas about skills, competencies and capabilities were developed in conjunction with working business managers (Bytheway & Lambert, 1998). The concept of value came strongly into focus (Peppard et al., 2001) and is evident in standard works dealing with IS/IT strategy (Ward & Peppard, 2002). However, it was the research partnership in South Africa that melded all these ideas into a stable framework, and then promoted it in the form of the IMBOK (Keats, 2003).

2.2.5 Consolidation

Four of these models share the intention to separate technological and strategic issues. ITIL and COBIT strive to be all-encompassing and CMM is principally concerned with a trajectory over time, but nevertheless it is possible to bring four of these disparate but related ideas together into a single table in order that they might be compared, at a simple high level, and that is done in Table 1 below.

As can be seen in the table, at the heart of the IMBOK is the idea of the *business process*, incorporated by Zachman (with other ideas) in his *enterprise model*, seen by Ward as the level where *business change* is to be found. Zachman's *system model* is echoed strongly in the IMBOK, where Ward chooses slightly different ideas concerning *enabling change*. Whilst a detailed evaluation of the ideas would take more space than is appropriate here, perusal of the table is revealing in that all perspectives align well, even though they see things from slightly different viewpoints and with different vocabularies. The merit of the IMBOK is that it is strongly aligned to the generation of value from an investment in information technology, and it is entirely aimed at fulfilment of strategy as the ultimate objective.

There are two points of significant difference that need to be noted: first, Zachman's 'representation of system' and the CEN 'information systems engineering technology' are really only of interest to technology management, but the other levels show strong empathy with the other viewpoints; second, surprising as it may seem, Cross excluded specific reference to benefits and business strategy in his 'Jacob's ladder' model. Otherwise, one can argue that in all of these ideas there are actually five levels at which management must operate (from the lowest to the highest):

1. Information technology must be acquired, configured, and used to provide the requisite infrastructure so that a business can store its data and operate its …
2. Information systems, some of which will necessitate changes to the way that the business operates its …
3. Business processes, wherein knowledge is deployed in order to initiate the actions that are expected to deliver the desired …
4. Business benefits, that will in turn realise the organisation's …
5. Business strategy, that delivers stakeholder's expectations.

Table 1 Linking information technology to business strategy

	Zachman	**Cross**	**CEN**	**IMBOK**
Highest	Context			Business strategy
	Enterprise model		Organisation system	Business benefit
		Business process		Business process
	System model	Information, application	Information systems	Information system
	Technology	Infrastructure	Information systems engineering system	Information technology
Lowest	Representation of system		Information systems engineering technology	

Hence, the arrangement of ideas in the IMBOK strongly reflects the historical thinking that is available; however, it has never been explicitly tested through research. The fact that it is already 10 years since its first publication means that it takes no specific account of important current needs such as (but not limited to): the need for *agility*, *software analytics*, the *semantic web*, the *cloud*, *crowdsourcing*, *open systems*, and *open links*, all of which might be found to be extremely important in education; nevertheless the comments from users of the IMBOK continue to encourage further work that will improve the management of information technology and information system investments for the best possible return.

2.3 Information Systems Management

2.3.1 Introduction

The above discussion of information systems engineering led quite naturally to consideration of the *management* issues. In order to pull some of the present thinking about information systems together, and before moving to review recent literature about education, it is worth examining some key ideas about information systems management that provide further context for this work.

The information systems management literature reveals a long history of attempts to establish good information systems management practice, once again from the purely technical (in the early days) to the organisational and strategic (first in the 1990s, and on to the modern day). This literature comes from a mixture of academic papers, expert practitioner sources, and books. Notable ideas that have been used to help understand the management challenges, and that were found useful in this study, include:

- The 'Boston box'
- 'Benefits management'
- The 'Value chain'

While there are other ideas that could be presented and described here, these three ideas provide a clear contrast to the level of working that has been found in the operational and technical domains. Busy managers like to have simple ideas that are easy to remember and that work well in difficult situations, and these three illustrate some ideas that have generated wide interest and that have contributed to management practice over the decades (for example: McFarlan, 1984; Ward et al., 1996; Cross & Earl, 1997; Ward & Peppard, 2002)

2.3.2 The Boston Box and the Applications Portfolio

The Boston Box has been a favourite tool in marketing for many decades. It explains how the life cycle of a new product idea can be seen in four stages: innovation (the 'wild cat' or 'problem child'), strategic adoption (the 'rising star'), revenue generation (the 'cash cow') and obsolescence (the 'dog') – for a fuller background see the history written by Morrison and Wensley (1991). What an organisation has to do to successfully manage a product through these four stages varies from one stage to another, and there are famous case studies that illustrate this, such as the 'Post-it note' at 3Ms (Shaw et al., 1997). For any organisation that never realised the importance of the different stages in the life of a product, this simple idea is a revelation – especially as the timescales for product conceptualisation, development and implementation become more compressed.

A graphical representation of this idea, based on present and future importance (the vertical scale) and global or local significance (the horizontal) is shown in Figure 11 (below).

The Boston Box was first related to information systems management in a seminal paper by McFarlan, and then developed by others in the USA (McFarlan, 1984; Porter & Millar, 1985). It has been enthusiastically adopted in the management of information systems, because systems can be seen as 'products': in information systems management, this idea is generally referred to as the 'Applications Portfolio' (Ward & Peppard, 2002, p.42). What is most important about the idea is that there is not only a lifecycle for software development (the Software Development Lifecycle, or 'SDLC'), there is a lifecycle for the very ideas that underpin our systems:

- In the beginning, a new idea for a system is conceived by one person, or just a few people who share certain thinking. At this stage the idea is just a problem – it needs to be tested.
- If the idea is sensible, and if a community tests it and accepts it as having future benefits, then it becomes a strategic opportunity. At this stage the idea imposes change on the organisation but makes for significant competitive advantage.

- When a system is well established then it becomes common within competitive entities in an industry, or a sphere of economic activity, and it becomes critical to present operations. At this stage systems have to be reliable, efficient, and beneficial in terms of cash flow.
- Ultimately, an idea for a system becomes non-critical, or perhaps it was always non-critical other than to a small unit within an organisation. There is no benefit in investing heavily in this fourth stage.

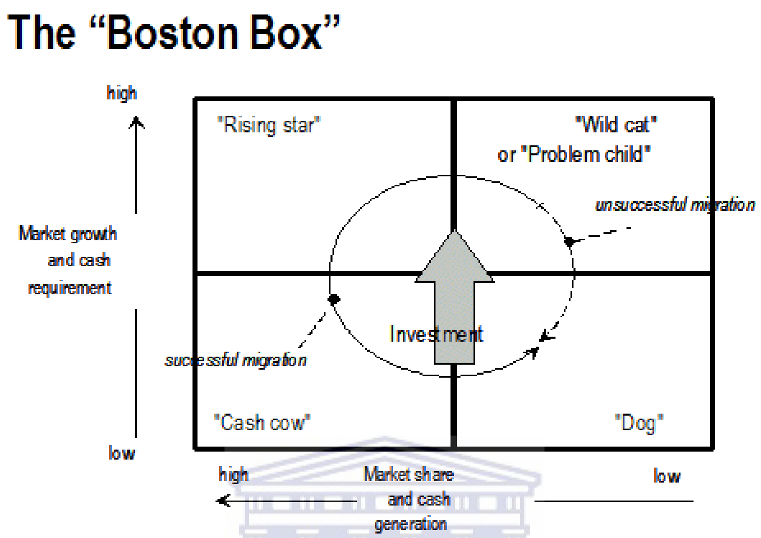


Figure 11 The Boston Box
Source: Edwards et al (1995, p.54)

There are many ways to dissect the management issues in dealing with information systems, but this representation of a lifecycle is critical because it separates out the differences that arise from different organisations, or different parts of organisations, working in different contexts and having different priorities; these different organisations might need to manage information technology and systems investments as early-, middle- or late-stage implementations of the idea. The literature on information systems management has copious detail as to how management must react to these differences, and what competencies are needed. (Ward & Peppard, 2002; Ward & Daniel, 2005; Bytheway, 2011). Re-badging the Boston Box as the 'Applications Portfolio' re-enforces the idea that investment is needed for the future and the present, and should be minimised in dealing with the past.

A simple example would be Internet banking. At the very first expression of the idea of banking on the Internet, at a marketing meeting (in South Africa) of Standard Bank, First National Bank or ABSA, there would have been laughter. But soon Standard Bank implemented Internet banking and after some early difficulties they set the bar for their banking competition; the majority of banking customers began to realise there really are benefits and today no bank is credible if it does not have Internet banking. Moving on, one can imagine a future when nearly everyone is using 'BitCoins' or 'E-Wallets', or some other evolution of digital money, but there may still be a few elderly people anxious to take the familiar route to the bank, via the Internet. The march of technology in banking is already an old story: an early example of telephone banking (*before* the advent of the World Wide Web) followed this exact trajectory (Bytheway, 2004, p.65).

In education, endless similar stories can be found. At the time of writing there is huge interest in interactive whiteboards in classrooms and the ways that they can be incorporated into modern learning – early in their history they were regarded as impossibly expensive and unreachable, but now every progressive teacher in every progressive classroom wants one, pre-service teachers have to be taught how to best use them and (regrettably) older teachers resent having to change the way that they teach because of them (Slay et al., 2008; Chigona et al., 2010).

2.3.3 The Benefits Dependency Network

A moment's thought will make clear that the benefits of information systems investments in each of the four segments of the Applications Portfolio (the 'Boston Box' for information systems) will be very different. The first stage simply looks for *an understanding* of the opportunity; in the second for *strategic advantage*; in the third for *revenue (or value) generation*; in the fourth for simple *efficiency* to minimise costs. These are very different scenarios and all aspects of management are affected: funding, risk management, project management, quality management and business change management. A failure to understand these differences leads to the very real risk of an 'unsuccessful migration' (see Figure 11) which represents a lost investment opportunity (Ward & Peppard, 2002, p.311).

Research has shown that most organisations are loath to understand and manage (or incapable of understanding and managing) the benefits of information technology and information systems investments (Ward et al., 1996). Work in Europe, much of which was located within the UK National Health Service, has refined and tested the idea of a 'benefits dependency network' – yet another framework that significantly assists an understanding of the linkages in information technology and information systems management:

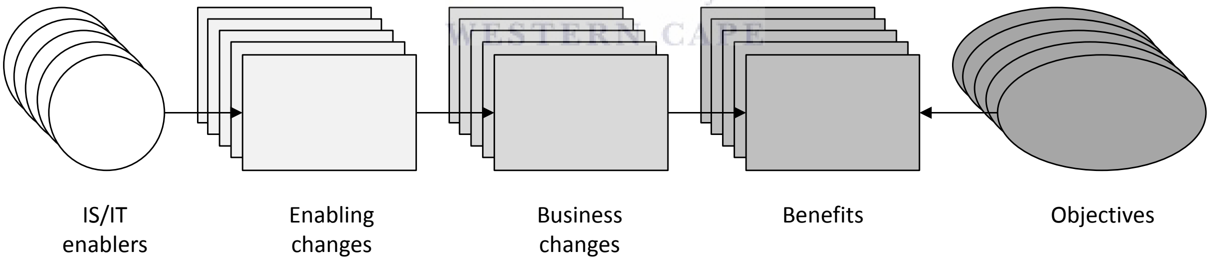


Figure 12 The Benefits Dependency Network

(based on: Ward & Daniel, 2005, p.134)

A detailed discussion of this framework is beyond the scope of the present literature review, but the way in which the management domain is divided into five parts resonates strongly with the other frameworks summarised in Table 1. What is clear is that a failure to understand the different kinds of benefit, the different ways that they are derived from systems and business changes, and the different ways that they serve the strategic objectives of the organisation, all conspire to deny any useful outcome at all from information technology and information systems investments.

This study is concerned with education, and no evidence has been found that there is any specific and explicit appreciation of the different benefits of information technology. Rather, there is concern about how pedagogy might be affected (Loveless, 2003) or how teachers educational beliefs might be challenged (Hermans et al., 2008). Contemporary work is much more concerned with actual or perceived differences in the teachers working in education, and in their local environment

(Chigona et al., 2011; Fanni et al., 2010; Bytheway et al., 2010) with only scant attention to outcomes for learners and for employers. Hence, the question as to what are the different kinds of benefits in education, in schools, and colleges and universities, for older and younger teachers and learners, and in different subjects, remains essentially unanswered.

2.3.4 The value chain

The Value Chain (Figure 13, Figure 14) is another management tool that is easily learned, easily remembered, and extremely helpful in reminding organisations where the value of their efforts comes from and where the costs sit. Originally promoted by Michael Porter and recurring in his published work (Porter, 1985; Porter & Millar, 1985; Porter, 2003) the value chain is used to represent a standard 'manufacturing' business at a very abstract level: cost drivers at the top and value generators at the bottom. It could crudely be related to an input-process-output model, but it should not really be seen as such because it does not purport to show the actual movement of goods, services and funds, rather value and cost. There are examples in the literature, for example the book by Ward and Peppard (2002, p.244 et sec):

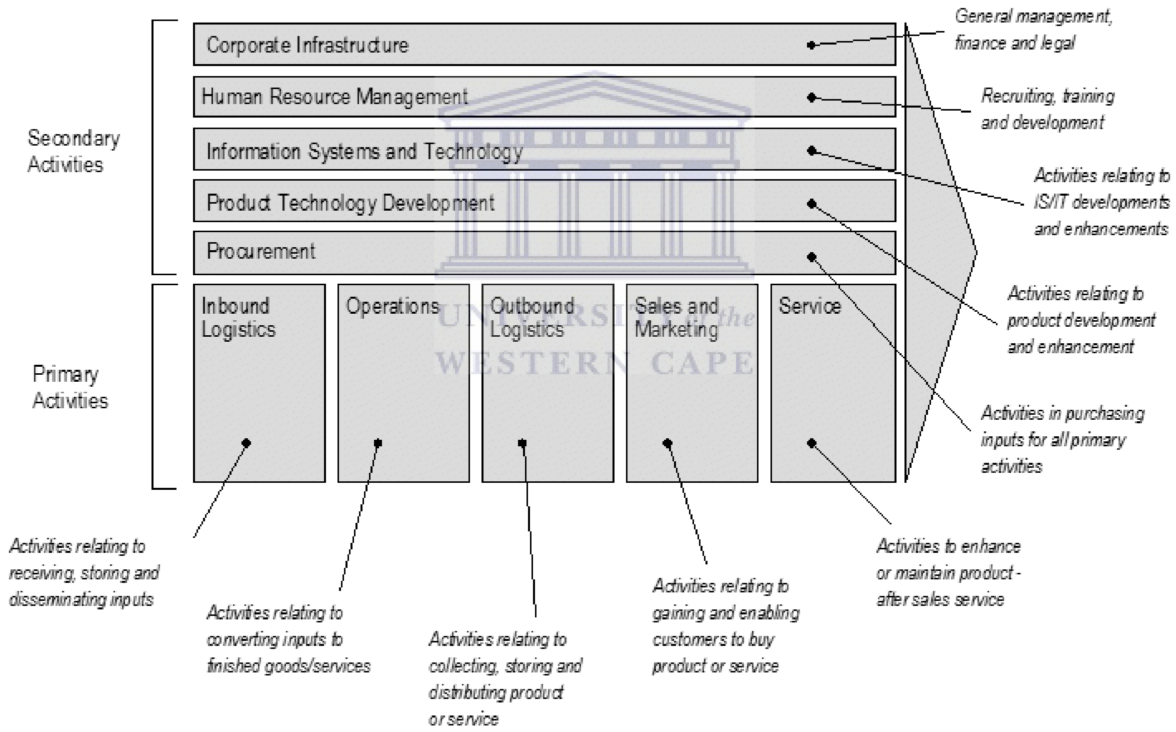


Figure 13 The Value Chain

Source: adapted from Porter (1985)

This is a well-established and well-known model that does not need extensive explanation here. Its key features are that in the lower part the Value Chain identifies the five stages in creating value: acquiring inputs, assembling product, dispatch to a place where it can be sold, selling it, and then servicing the customer following sale. In the upper part it presents the supportive or secondary activities that enable and facilitate the primary activities below; in different presentations of the Value Chain there are different details, but in this representation one of the supporting activities is 'Information systems and technology'. Often, there is reference to governance and to financial management. Applying this model to any regular business allows rational discussion of what parts of the value generation (and facilitation) are working well, and those that are not; the potential to invest in systems that will improve overall business performance can be identified, categorised, and investment decisions taken. Multiple value chains can be constructed, representing multiple organisations all working together in the same industry, and these are usually referred to as 'industry value chains' (Ward & Peppard, 2002, p.245).

It is interesting to apply this model to a business that is a software house, and that takes it closer to the realm of information technology and systems management in education. Bespoke software development does not happen without a specification (and possibly a contract). Hence, the first stage in adding value in the software business is to develop a specification that properly represents the requirement. An old idea, perhaps one of the oldest. Then production is concerned with resourcing, developing and testing, implementation and maintenance:

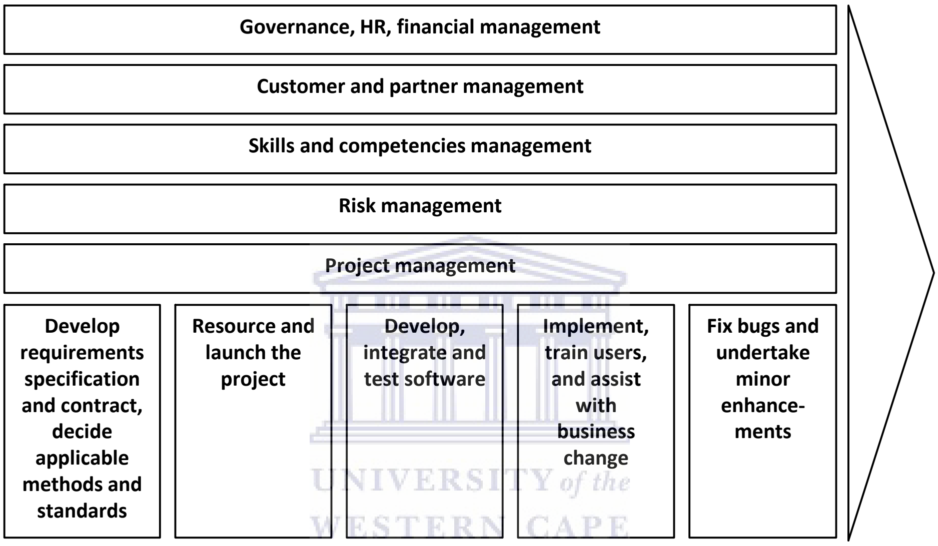


Figure 14 Illustrative value chain for a software house

(Source: Author)

At the same time that this model masks most of the complexities of developing software, it does successfully organise the requisite activity into manageable portions, and reminds us that there is not just a beginning and an end, but a core set of activities that are needed to make sure that the business produces value and keeps running successfully. The value chain was one of the original inspirations for the IMBOK (Edwards et al., 1995).

2.3.5 User satisfaction

In the early days of information systems research, the idea of 'user satisfaction' was commonly used to indicate the extent to which information systems succeeded in bringing benefits. One study produced a comprehensive list of 'attributes' of information systems, and the services that come with them, as seen by the users (Figure 15). This study also adopted the Repertory Grid approach, and successfully extended the attributes that had previously been reported (Whyte & Bytheway, 1996):

Attributes from this study	Attributes from other studies Zeithaml *et al.* (1990)	Bailey and Pearson (1983)	Miller and Doyle (1987)	Ives *et al.* (1983)
Accuracy		✓	✓	✓
Business alignment		✓	✓	✓
Competence	✓	✓	✓	✓
Complexity			✓	
Control		✓	✓	✓
Direction				
Documentation		✓		✓
Effectiveness		✓		✓
Friendliness				
Front office				
Integration		✓		✓
Marketing				
Necessity				
Reliability	✓	✓	✓	✓
Reporting		✓	✓	✓
Responsiveness	✓	✓	✓	✓
Specification				
Training		✓	✓	✓
Understanding	✓			
Upkeep		✓	✓	✓
User involvement		✓	✓	✓

Figure 15 Ways in which users make judgement about information systems and services

(Whyte & Bytheway, 1996, p.90)

This study extends that work, in that it seeks to relate the things that are important to users, and others, as they are exposed in the specific kinds of events that they experience, in their work with information systems, in higher education, whether as users, developers or managers.

2.3.6 Summary

There is no reason why these models (and others like them) should not be applied to *education*. In history they have been used at UWC (Department of Information Systems, UWC, 2000) but there is little evidence that these kinds of models have been widely applied in recent research into education.

2.4 Education Management issues

2.4.1 Introduction

The literature concerning information technology and information systems in the education domain had already been examined minutely in a separate project that for a period of time ran parallel to this one (SAICTED, 2013; Bytheway et al., 2014). A structured search of the education literature, with a bias towards work published in South Africa, established a 'long' bibliography of more than 700 papers. This was developed using the search terms 'Management', 'Information Technology' and 'Education' (and related words, and synonyms). This search found papers addressing societal change in education, how information technology is being managed in education, and how it might be better managed.

Following a first review, 522 of these papers were judged to be relevant to the present context, based on the extent to which their content related to the three key terms: management, education and technology, and also according to their method of working and provenance. Then, the papers were ranked according to the way in which they combined their treatment of management, education and technology, and the top 160 were read in detail and evaluated. This bibliography has contributed to the present study. It was found that in recent research the level of attention to the management of information and communications technology in education was very low, confirming the potential of the present study to make a real contribution. Most of the literature concerning education was taken from academic journals reporting education research, especially those based in South Africa.

But first, should it be necessary, it is important to state the importance of education in any nation (emphasis is added):

> *'Economists identify three factors that lead to growth based on increased human capacity: capital deepening (the ability of the workforce to use equipment that is more productive than earlier versions), higher quality labor (a more knowledgeable workforce that is able to add value to economic output), and technological innovation—the ability of the workforce to create, distribute, share and use of new knowledge.*
>
> *These three productivity factors serve as the basis for three complementary, somewhat overlapping approaches that connect education policy with economic development*
>
> - ***increase the technological uptake of students, citizens, and the workforce*** *by incorporating technology skills in the curriculum—or the technology literacy approach.*
> - *increase the ability of students, citizens, and the workforce to use knowledge to add value to society and the economy by applying it to solve complex, real-world problems—or the knowledge deepening approach.*
> - *increase the ability of students, citizens, and the workforce to innovate, produce new knowledge, and benefit from this new knowledge—or the knowledge creation approach.'*
>
> *(UNESCO, 2008, p.9)*

The role of technology in moving education forward, and thereby contributing to the economy of a whole country, is thereby stated emphatically and with authority. It gives the foundations for measures of investment success and it reminds us that the underlying requirement is that education must be managed properly.

2.4.2 Education management – managing a chain of activity

As in many spheres of human endeavour, it is evident that IT has the potential to provide an effective and equitable solution to the needs of organisations at different levels and in different ways. Education is no exception, except that it is not always clear *where the management of education actually sits:* is it with the national or regional education authorities; is it in the Senate, or in the Council, or in the lecture hall?

In practice, the decisions as to what will be taught, and how, sit firmly within a lecture hall behind a closed door. But the lecture hall is only one component of the chain of activity. A tentative and very abstract 'industry value chain' for South African higher education (see above) might include:

- The execution of research of all kinds.
- Managing repositories hosting the multifarious outputs of research.
- Converting research into educational resources.
- Storing and promoting educational resources and material.
- Managing channels for the delivery of material to all who need it.
- Managing the processes of educational delivery.
- Recording the results of educational endeavour.

Some experts have seen the opportunity at this level of 'supply chain management':

'… no teaching strategy can fully replace classroom teaching, but restricting the teaching process only to the delivery of content from textbooks may not be entirely sufficient in today's competitive scenario. The textbook knowledge needs to be supplemented with ideas from research and industry trends as well as enriched through practice and 'knowledge beyond the book.' (Bhusry & Ranjan, 2012, p.315)

The very close links between research and education can be seen as 'knowledge management'. In thinking about the trends, issues, challenges and opportunities of information and knowledge management teaching (and research) in South Africa, Ochalla states:

'Knowledge management should be seen to be an extension of information management, or information resource management, in space and time.' (Ocholla, 2011, p.14)

Answers to the questions of what makes up education, what comprises the chain of value delivering new knowledge to learners, and how information technology and information systems might help this process, will emerge from this work.

2.4.3 Management capability

It is recognised that not all those involved with teaching, at the coal face (so to speak) will have the background to deal with advanced concepts and ideas:

'Most of today's black teachers and school leaders began their teaching careers under the apartheid regime where they were required to practise in racially prescribed settings (Mattson & Harley, 2002: 285). Also, while many white minorities were able to choose to live in particular communities, black, Indian and 'coloured' South Africans were required to live and work in areas prescribed by the Government under the Native Land Act of 1913 ' (Moloi, 2007, p.463)

In a review paper Moloi provides a very interesting insight into education management generally in South Africa. Her paper relates management to the context of South African schools, in terms of leadership, organisation standards and the management of teaching and learning processes. She provides little on the impact of ICTs, nor on how they might be absorbed into the management 'to-do' list and brought into the curriculum and the pedagogy. However, it was interesting that she highlights the DoE's view that management is a different job from that of teaching, requiring different skills:

'The Department of Education's starting point is that teaching and the management of a school are fundamentally different jobs requiring different skills.' (Moloi, 2007, p.471)

Perhaps that is a good starting point. She concludes:

'The main research needs identified in the review are:

- *Decision-making processes in schools, including the extent and nature of teacher participation and 'distributed leadership'*
- *The extent and nature of 'instructional' leadership in schools*
- *The management of budgeting, fee-setting, and real resources*
- *Human resource management, especially redeployment, and teacher morale and reliability*
- *School choice, 'transformation' and the management of learner admissions*
- *Managing relationships with parents'*

(Moloi, 2007, p.472)

This is a good platform from which to discuss and debate the opportunities for information technology to make a real contribution in higher education: what is the quality of the information upon which decisions are made, and how might that information be improved with good systems? How difficult is it to manage budgets and finances, and how might user-friendly book keeping systems assist? And the same for admissions? How might SMS technologies be used to improve communications with applicants and with registered students?

These are rich potential benefits, but they all need some analysis and prioritisation according to the nature of need and the benefits that might be sought by educational stakeholders.

2.4.4 Management style

Bush has a more complex view of education management, in schools, in the sense of leadership and leadership style:

> *'The western and African models collectively suggest that concepts of school leadership are complex and diverse. They provide clear normative frameworks by which leadership can be understood but relatively weak empirical support for these constructs. They are also artificial distinctions, or 'ideal types', in that most successful leaders are likely to embody most or all of these approaches in their work' (Bush, 2007, p.403)*

In support, Bush provides a typology for management, as shown in Table 2:

Table 2 Bush's Management Typology
(Bush, 2007, p.403)

'Management' model	'Leadership' model
Formal	Managerial
Collegial	Participative
Political	Transformational
Subjective	Interpersonal
Ambiguous	Transactional
Cultural	Post-modern
	Contingency
	Moral
	Instructional

Again, this typology provides a useful starting point for any analysis that is concerned with how managers manage, and the extent to which they are either 'managers', or 'leaders'.

Moving from simplistic models of management to ideas of leadership, one is reminded that in education many of the issues are actual social or societal in nature. Saskia Sassen has written in depth about the social aspects of technology in education:

> *'[M]any sociologists see technology as the impetus for the most fundamental social trends and transformations. To this I would add a tendency to understand or conceptualize these technologies in terms of technical properties and to construct the relation to the sociological world as one of applications and impacts. The challenge for sociology is not so much to deny the weight of technology, but rather to develop analytic categories that allow us to capture the complex imbrications of technology and society.' (Sassen, 2002, p.365)*

This dependency on sociology is partly because educators have to have the competency and capability to work with information technology and systems due to the pressure that is coming as much from society at large as from educational management (Bytheway et al., 2012). UNESCO has published guidelines for teacher competencies (UNESCO, 2008) that set out a high-level framework but fail to get to grips with the details, for good reasons of course: there are many variations on need and opportunity, depending on the context that teachers are working in – one size cannot fit all. Culture is a recurring feature of research in this area (Demetriadis et al., 2003; Czerniewicz & Brown, 2009; Dehinbo & Alexander, 2011). Culture is far beyond the natural interests of most experts working in the technical standards committees and it is difficult to see how culture might be made a feature of standardisation efforts, but it is clear that it is a feature of technology implementation in South Africa.

2.4.5 Management experience in higher education in the Western Cape

Management alone is not always enough, leadership might be needed despite all efforts to be local and '*lekker*'[7], as was established at the University of the Western Cape. In a detailed analysis from Stoltenkamp & Kasuto (2009) it is shown that:

> *'The resistance to eLearning adoption by UWC academics was further characterised by their resistance to the Open Source home-grown eLearning System (KEWL). From first-hand experience in driving eLearning at the inception of EDSU in 2005, the authors of this paper recognised the negating perceptions of UWC staff towards Open Source Software in general and hence the KEWL system in particular which was viewed as an 'experimental, second-grade system' that had not been quality assured' (Stoltenkamp & Kasuto, 2009, p.43)*

There seems to have been some coercion there (coercion is not in Bush's typology – perhaps more work is needed there?) and a decision to 'back off' and allow academics to make their own choices led to better results:

> *'A reflection on the adoption of eLearning by academics at [university] clearly indicates that the non-coercive approach has resulted in the voluntary buy-in and in some cases championing of eLearning by academics.' (Stoltenkamp & Kasuto, 2009, p.49)*

At one institution a continuous awareness campaign pulled participants towards the mission, to:

> *'advance and protect the independence of the academic enterprise and design curricular and research programmes appropriate to its Southern African context, [and to] further global perspectives among its staff and students, thereby strengthening intellectual life and contributing to South Africa's reintegration in the world community …', and so on (Stoltenkamp & Kasuto, 2009, p.52).*

With these experiences behind them, they conclude that a 'one-size-fits-all' strategy will not work, confirming the problem of differences noted earlier and confirming the need for management to pay attention to all the details, all the differences, and to think strategically.

2.5 Summary and synthesis

This review has discussed work on technical standards, the drift towards concepts of good practice, examples of modern management thinking and some aspects of technology in education today. Unfortunately, there is still much evidence of technological determinism, which confounds efforts to step back and see the bigger picture from a strategic standpoint. In the literature right back to the mainframe era in the 1970s references can be found to technology-based opportunities, when 'Computer Based Instruction' first emerged, for example in the form of PLATO (Denenberg, 1978); the availability of the personal computer in the 1980s made a huge difference to the opportunities for teachers and learners (Rowe & others, 1993) and soon everything was connected to everyone (it seemed) by the world wide web (Andersen, 2007; Berners-Lee, 2010). The history of evolving technology is well recorded and well understood but its *management* is not so well understood, especially in education.

But it is not all bad news. As educators come to grips with the opportunities and overcome problems with curriculation and pedagogy, there are some shining lights. In New Zealand, there is a detailed analysis of how Bloom's taxonomy (a foundation stone in traditional education thinking)

[7] *'lekker'* is the common Afrikaans for 'good', or 'excellent'

can be used to organise thoughts and actions with technology (Churches, 2009) and a review of international management experience delivers some happy stories from pre-primary right through to tertiary and adult education (Bytheway, 2013a).

It is clear that:

- **Good practice**: There has been a long term trend from simple consideration of technical standards to the development and validation of 'good management practice'. Early expectations to understand and meet customer and market expectations largely failed, but the idea of good practice has helped to deliver real benefits to real users of information technology. Good practice guidelines are needed in higher education in South Africa.
- **Differences**: From all the good practice guidelines, there are important ideas about capability and maturity that reveal the stages by which an organisation learns to control and deliver benefits from its technology investments; this is just one example of a range of differences that must be recognised in any future work on standards and good practice. Differences exist between institutions and probably between faculties and subject areas; these differences need to be recognised.
- **Complexity**: There are conflicts between the evident complexity of the technology that education is dealing with, and the simplicity that is needed by managers (even capable ones) in thinking about and dealing with their routine work and deciding on courses of action. Research might be driven to the kind of reductionist thinking that is evident in the management models, or it might have to take a much more circumspect approach in order to accommodate the subtleties that lie therein.
- **Dependencies and enablements**: Reducing the problem to its very basics, the frameworks remind us that the linkages between low level (technical) issues and high-level (societal) issues comprise 'dependencies' and 'enablements', whereby one thing depends on another before it can happen, and the other enables something to happen. This is how to bridge the gap between technical and organisational issues, isolate and locate ideas about standard practice and good practice, and begin to deal with the complexities.
- **Management discipline**: In many of the sources that have been read there are references to the adoption of project management, quality management and other techniques that are in routine use generally, perhaps only sometimes in education. Any evidence of a need for these management disciplines will be interesting to consider further.

Chapter 3 Research design

This chapter reflects briefly on the common approaches to research and explains that this is essentially an interpretive ethnographic study with three streams of analysis: qualitative content analysis leading to themes, a repertory grid (RepGrid) analysis of systems-related events, and a desk study that examines selected standards and good practice guides.

3.1 Introduction

This research set out to understand how good ISE practice can improve the deployment and use of information technology-based systems in South African higher education, and to identify relevant standards that are available, applicable, and useful in achieving that good practice. It was therefore necessary to find an approach to the research that would:

- elicit data about education processes,
- identify information systems in use in those processes,
- ascertain the qualities that characterise them,
- identify and examine available ISE standards and good practice, and
- assess their applicability and utility in South African higher education.

3.2 Choosing an approach to the research design

There are many opinions about research design. The positioning of one's ideas and the justification of a choice of a research design could be based on any one of hundreds of expert opinions, frameworks, and vocabularies.

In Chapter 1 there is brief reference to Burrell and Morgan's useful and oft-cited framework that allows the positioning of research work in two senses: the *nature of the research* and the *nature of the change* evident in the phenomenon; here the approach to the research design is examined in more detail, focusing on the choice of method and philosophy.

3.2.1 A South African view

In South Africa, Johan Mouton provides one overview framework that provides a starting point (Mouton, 2001). He argues that there are three levels at which to think about a phenomenon (Figure 16):

1. There is the 'real world' where we see objects in real life. This he refers to as 'World 1'. Figure 2 (the 'Research Model', in Chapter 1) has already presented an initial view of the 'real world' that has been adopted for this study.
2. There is a 'Methodological world' where we conceive and articulate our research design. This he refers to as 'World 2'. The method chosen here will be shown to be qualitative, with frequency and repertory grid analysis.
3. There is a world of 'Meta-science' where is the fundamental or philosophical basis of our work. This he refers to as 'World 3'; this study will be shown to be an interpretive study, moving to 'radical humanist' in the terms used by Burrell and Morgan.

The way that different approaches to research can be seen at each of these three levels is summarised in three groups concerning 'realism' (positivism), 'phenomenology' (interpretivism) and 'critical theory'. In each of these philosophies, sometimes called 'paradigms', the way that the research is organised and the role of the researcher, at the three different levels, is different.

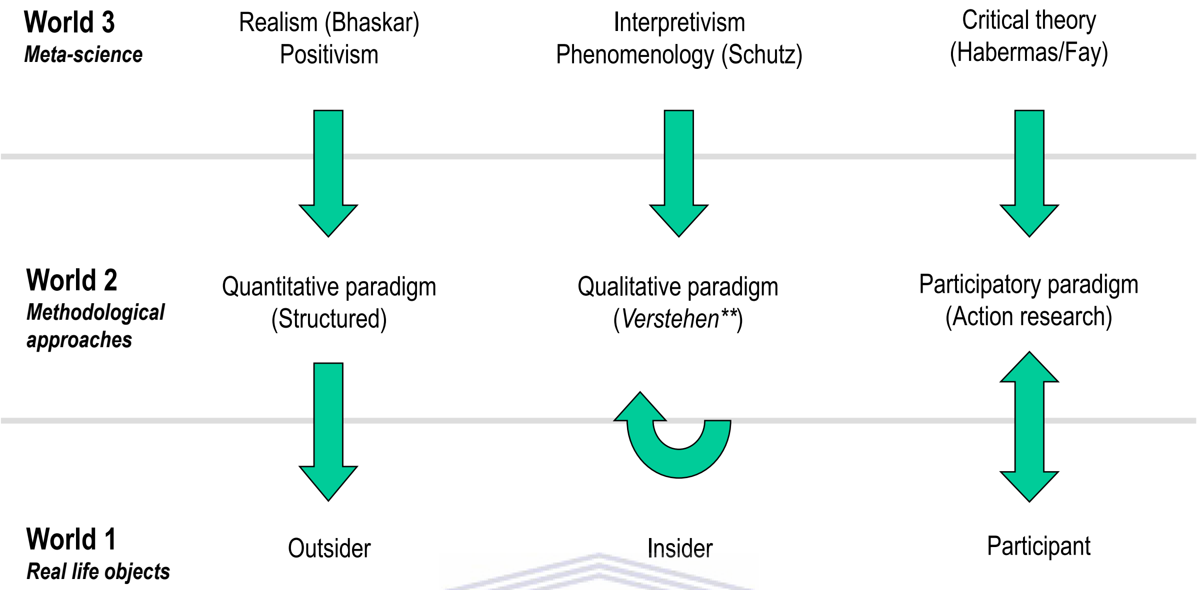


Figure 16 Three philosophical approaches to research mapped to Mouton's three 'Worlds'

(Source: Author, based on Mouton, 2001, p.137 et sec)

**** 'Verstehen' is a German word, approximating to 'understanding' in English**

These options can be seen in other work. Michael Myers' work is widely cited and it sets standards for research methods (Klein & Myers, 1999; Baskerville & Myers, 2002; Baskerville & Myers, 2009; Myers & Klein, 2011). Based on these widely-taught ideas about research, one can summarise the decision as to which approach is appropriate in the following way:

- Positivist research demands that there are known variables that can be measured and analysed, in order to prove or disprove hypotheses about a phenomenon. This is appropriate where cause, effect and interdependency between these known, measurable variables need to be understood. For example, when researching the use of cell phones has impacted on people's productivity at work it is obvious to ask questions such as: 'how much time did you spend on your cell phone last week?', 'how much work did you do last week?'. Because of its reliance on hypotheses, positivist research is generally 'deductive' (testing a theory) rather than 'inductive' (generating a theory).
- Interpretive research allows the investigation of a phenomenon where the variables are not known, and where quantitative data is less helpful to the understanding of the phenomenon than qualitative data – where it is more important to know *what* people think about rather than how hard they think, or how many times they have meetings. In order to understand why people buy cell phones, one must have a conversation: 'can you give me three reasons why you decided to buy a cell phone?', 'what are the features of your cell phone that you like, and that you do not like?'. Because of its reliance on research questions, interpretive research is generally 'inductive' (generating a theory) rather than 'deductive' (testing a theory).
- Critical research is appropriate where participative research is intended to achieve actual change. Here it is better to learn by observation, by direct involvement in the phenomenon,

and by analysis of an accumulated history: 'at a meeting of town councillors, half of them were observed to take phone calls during the meeting and all of them were observed to receive short text messages – the consequence was that there was no agreement, the agenda was not completed, and another meeting had to be scheduled – we have devised rules about the use of cell phones and in the next phase of the study the unnecessary use of cell phones in meetings will be banned, and the consequences will be noted'.

3.2.2 A rarer, more radical view

A fourth way of thinking needs to be acknowledged. Some 30 years ago Richard Daft published an interesting paper that rebuts the presumed need for a *formalised* decision about research, when looking at how people and organisations work (as this research does). He argues that research needs to be *crafted*; he focuses particularly on the potential problems with formalised survey-based research:

> *'What troubles me is that many of us seem never to have discovered or acknowledged the craft aspects of scholarship. Formal techniques and methods dominate in most manuscripts and journal articles that I read. The authors act as if there is only a single approach, which includes measurement precision, perfect prediction, dispassionate analysis, and many variables. Authors often eschew real organizations, storytelling and common sense ... A great scholar such as Kurt Lewin used apprenticeship to pass the research craft to his students (Marrow, 1969). By showing students how to design studies on the basis of anticipated surprise, beauty, firsthand experience, emotion, and storytelling, we can be role models for the kinds of things that go into significant research. (Daft, 1983, p.545)*

Whilst this can be seen as an argument for interpretive research as much as an argument for research 'craft', the appeal to step away from presumptive rules and prescribed methods is very inviting. Perhaps something is lost in the 30 years that have passed since Daft wrote this? Given the increase in the number of people learning about and doing research in this time, perhaps it was inevitable that structure and technics would dominate, in order to render research 'teachable' to ever larger classes of postgraduate students? However, what Daft was arguing still finds traction today: the idea of 'pragmatism' as a way of unravelling the problems and dangers of mixed methods research is a topical issue today:

> *'Fortunately, a pragmatic approach [to research] not only supports the kinds of research methods that we advocate but also provides a basis for reorienting the field of social science research methodology in the directions that we favor. The great strength of this pragmatic approach to social science research methodology is its emphasis on the connection between epistemological concerns about the nature of the knowledge that we produce and technical concerns about the methods that we use to generate that knowledge. This moves beyond technical questions about mixing or combining methods and puts us in a position to argue for a properly integrated methodology for the social sciences.' (Morgan 2007:74)*

These ideas of flexibility, a focus on escaping the constraints of technical concerns about research, and an acknowledgement that research is actually about the *integration* of knowledge, all suits a project like the present one, where there might be some theories that can be invoked, but where the study is apparently so different from previous research that it is necessary to maintain an openness that will permit new theories to emerge.

3.2.3 The chosen approach

As noted in Chapter 1, this research was concerned with understanding change in education, resulting from the adoption of information technology and systems. Using Burrell and Morgan's framework it was argued that the study was executed in a period of potentially radical (and sometimes *actually* radical) change in education, itself hampered and constrained by the status quo and by regulation; the study was therefore subjective in that it set out to understand the views of individuals and build a better understanding of how ISE standards might deliver more effective information systems; this rendered the study quite different from the typical functionalist research that is found elsewhere. It also demanded a level of flexibility akin to crafting the research as it proceeded. This might leave a feeling of uncertainty, but that was no reason to prevaricate at the start of the study – the idea of crafting research in a pragmatic way does not prevent a clear intention that the research design set out to be:

- interpretive, seeking to understand an under-researched phenomenon;
- inductive in nature, trying to establish a new framework of thinking;
- constructivist, setting out to craft the output of the work as it progressed;
- ethnographic because it works with the experiences and understandings of individuals;
- cross sectional because it does not set out to track a phenomenon over time;
- semi-structured, because the interviews included both an open and a directed stage of enquiry.

The study essentially progressed in that way, including elements of grounded theory (Charmaz, 2014; A. L. Strauss & Corbin, 1998), qualitative analysis (Schutz, 1952; Schutz, 1959) and repertory grid (Kelly, 1955; Kelly, 1970); also – in the spirit of Daft's arguments (Daft, 1983) – the study adopted a liberal approach to adaptation of the details as the work progressed, in order to make the most of the data that became available. Discovering Kathy Charmaz's work at a critical stage in the project was a special moment. She has a very constructivist view of Grounded Theory that suited the purpose of this study very well, and her wise words eased a range of anxieties about the approach to the work (Charmaz, 2014, p.12 et sec).

The way in which the research evolved within Mouton's framework can be summarised thus:

World 1: the real world	**World 2: Methodological approach**	**World 3: Meta-science**
Academics, administrators and students undertaking their normal work.	Open discussion followed by a structured 'RepGrid' enquiry	Development of a reference model.

3.3 The research

It became clear in the pilot stage that respondents had very little awareness of the existence or applicability of standards. In the course of the work, just three of the respondents referred to specific examples (ISO 9000, COBIT and ITIL) but it will be seen that there is good evidence about the latent need for standards. It was therefore necessary to adapt the enquiry so as to elicit not the standards that they used, or that they knew *could* be used (because there were so few), but rather to identify the *qualities and characteristics* of *significant events* in their work with systems. These qualities and characteristics then provided the input to a search for the standards and good practice that *might* apply, that accommodated the discovered qualities and characteristics.

3.3.1 Research questions

The initial research model (Figure 2, and then Figure 4) was adapted to accommodate 'qualities and characteristics', and to reposition the standards that might or might not reflect those qualities and characteristics. In Mouton's terms (see Figure 16) this is the second level, the extended research model indicating the method to be adopted through the questions that are to be asked:

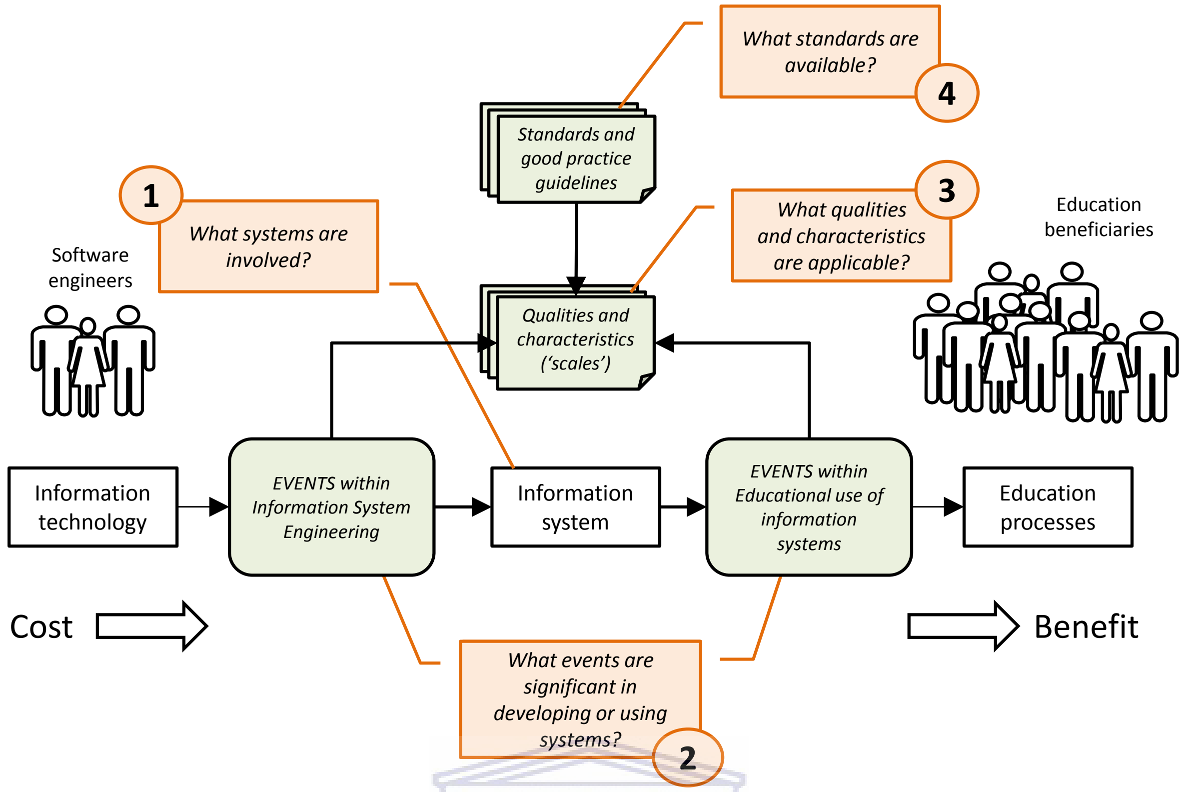


Figure 17 The extended research model (Figure 4) re-visited

Hence, the questions that drove the enquiry at the working level were (see the numbered annotations in Figure 17 above):

1. What ***information systems*** (or artefacts) do respondents work with?
2. In working with those systems (or artefacts), what ***events*** have they experienced that were significant, because they were good, or bad, or for any other reason?
3. For each event, by comparison with two other events (the triadic method), what are its unique qualities or characteristics, or ***scales***, that make it different?
4. What ***standards*** or ***good practice guidelines*** exist that already accommodate those scales, that provide the utility to improve the outcome of events?

With these components of the discovered data in place – about systems, events, scales and standards – it was then possible to assess how ***applicable*** each of the scales was to each of the events, and for those scales that were applicable to be used to establish the ***rating*** of those events on those scales.

In parallel with the interviews that elicited this data there was a desk study to identify representative software, systems and other standards. These were perused for evidence that the qualities and characteristics were recognised and already incorporated in such standards.

3.3.2 Unit of analysis

The research was initially focused on what might be called 'ISE transactions'. An ISE transaction is seen as any event in the work of a respondent where value was given or received. An investigation of 'transaction theory' revealed only 'transaction *cost* theory' (Coase, 1937; Williamson, 1979;

Williamson, 2010) which was interesting, but not quite what was needed because it deals essentially with the balancing of intra- and inter-firm *costs*, not with the other qualities of a transaction.

It was decided to simplify this idea in order to aid understanding on the part of respondents, and the principal unit of analysis for this study is the ***event***. Events are analysed according to their qualities and characteristics as represented by ***scales*** on which they were ***rated***, and their ***outcomes***. Also recorded was the ***nature*** of the systems that provided context for the events, and the ***roles*** of respondents within their involvement with those systems.

3.3.3 Method of working

Table 3 summarises the chosen method of working for each of the four research questions.

Table 3 A summary of the method of working

Research question	Data collection method'	Data analysis tools and techniques'	Refer to
What information systems (or artefacts) do respondents work with?	Open interview prompted by a discussion of where respondents saw their involvement, what systems they worked with, and in what roles.	Conversations were recorded, transcribed, and then open-coded line-by-line. Themes were developed using memos.	5.3 *et sec*
In working with those systems (or artefacts), what events were significant?	Structured conversation directed to identify and record significant events that respondents considered were particularly good, or bad, or some other characteristic.	Event details were entered into macro-driven Excel worksheets. Details of respondent role and event outcome were added to the records.	5.4 *et sec*
What are the unique qualities or characteristics of events, and how might they be measured using 'scales'?	Using the triadic method of elicitation, identification and development of scales that, in the view of respondents, characterised events.	Excel worksheets drove the triadic process and recorded applicabilities and ratings. Repertory grid analysis tested the resulting data for principal components and for correlations between scales.	5.5 *et sect*
What standards or good practice guidelines exist that accommodate those scales?	Desk study and telephone interview with the South African national ISE standardisation representative on the international committee.	Internet searching of ISO standardisation committee web sites, and bibliographic searching of academic publications.	Ch 6

3.3.4 Selection of respondents

Respondents were approached on a snowballing basis, starting with specialists who had attended an earlier two-day workshop on managing information technology in higher education (Bytheway & Bladergroen, 2013). The objective was to approach representatives from certain stakeholder groups (and seek their comments as to who else might contribute) as follows:

- Senior managers
- Champions
- Operational managers (academic and administrative)
- Project managers (in-sourced and out-sourced)
- Users (students and staff)
- Technical specialists (analysts, designers and programmers)

In this way each of the four tertiary institutions in the Western Cape was approached and all contributed to the study. In addition, there were two engagements (as benchmarks for comparative data): one with the chief executive of a small, local software house and the second with a senior manager from a private but well-established hotel school. There were also telephone interviews with team managers working on the national 'Research Information Management System' (RIMS) project and with the South African representative on the international committee for software and systems engineering standards. Details of all respondents involved in the study are provided in Appendix 2, 'Respondent details'.

In summary, the number of respondents according to each type was as follows:

Table 4 Respondent types

Respondent type	Occurrences
Admin	4
Manager	11
Project Manager	2
Researcher	4
Student	2
Technical	13
Academic	2
Total:	**38**

Each interview was preceded by an explanation about the research, and the chain of activity that transforms 'raw technology' into 'information systems' for 'users' (see the interview guidelines in Appendix 3). They were asked to position themselves on that chain of activity as a means to clarify their circumstances and their work responsibilities. Generally, and unsurprisingly, technical people positioned themselves at the technical end, users at the user end, and managers claimed an involvement over all or some large part of the scale. The interview then progressed to an open discussion about the respondents' experiences (the qualitative data) and a structured enquiry about the way that they viewed significant events (the RepGrid data).

3.4 Summary

In summary, the interviews were organised in two parts, the first being a discussion of the experiences of respondents that identified events, and the second a triadic sorting and ranking of those events (revealing their characteristics, as seen by respondents).

The qualitative data, the full text of the interviews, was transcribed and subjected to content analysis. It was coded using *a posteriori* categories (identified and accumulated during the analysis of the gathered data). The specifics of the coding of interview content was guided by qualitative methods originated by Schutz (1959) and subsequently refined by authors such as Anselm Strauss and Juliet Corbin (1998) and Kathy Charmaz (2014). The coding was subjected to frequency and content analysis. As will be seen, the detailed low-level coding was gathered into hierarchies to further understand the data. An analysis of co-occurring pairs of categories highlighted patterns in the data. Thematic developments followed, using memos, in order to aggregate the results and develop themes. This qualitative analysis is reported in Chapter 4.

The structured data was subjected to statistical analysis, revealing frequencies, using the Repertory Grid (RepGrid) approach attributed to Kelly (1955; 1970). Repertory Grid analysis is based on Kelly's Personal Construct Theory and helps to eliminate researcher bias in the collection of data. As will be seen, the detailed low-level ordinal data was gathered into hierarchies to allow the development of cardinal scales for applicability, rating and event outcome, by aggregation and averaging. Inferential statistics based on the RepGrid data revealed some aspects of correlations and graphical analysis revealed the significance of the results; consolidation of the scales, weighted by the aggregated applicability, revealed the nature of the standards that are needed. This analysis is reported in Chapter 5.

Finally, data about available standards was gathered by means of a desk study, searching for indicative examples of standards and good practice guidelines. Two conversations were held with the South African national representative on the ISO-IEC/JTC1/SC7 standardisation committee, responsible for software and systems engineering standards.

Figure 18 below summarises the flow of work through the project.

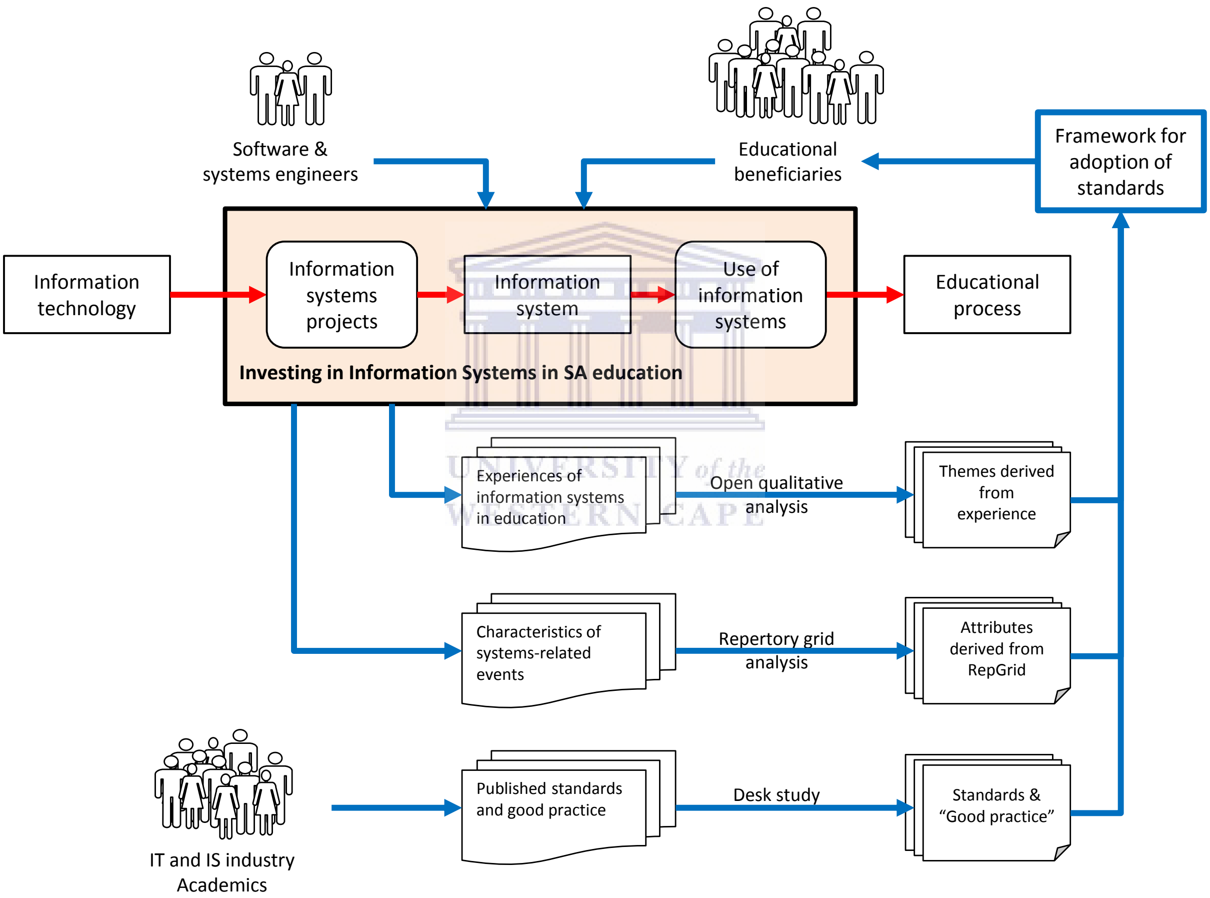


Figure 18 The project workflow

Chapter 4 ISE in higher education – the 'landscape'

This chapter deals with the first of three analyses: the narrative content of discussions with 38 respondents. The sections that follow explain the method of working and present a quantitative analysis of the categories (codes) that were found in the narratives. Selected text from the narratives is provided by way of illustration. The chapter then examines the areas of particular interest of the different types of respondent, and finally undertakes a brief analysis of co-occurring pairs of categories so as to reveal areas of particular importance that are carried forward.

4.1 Introduction

This chapter analyses the first part of the interviews, which in every case was a loosely structured discussion about the work of the respondent and their views of the systems with which they were involved (highlighted in Figure 19):

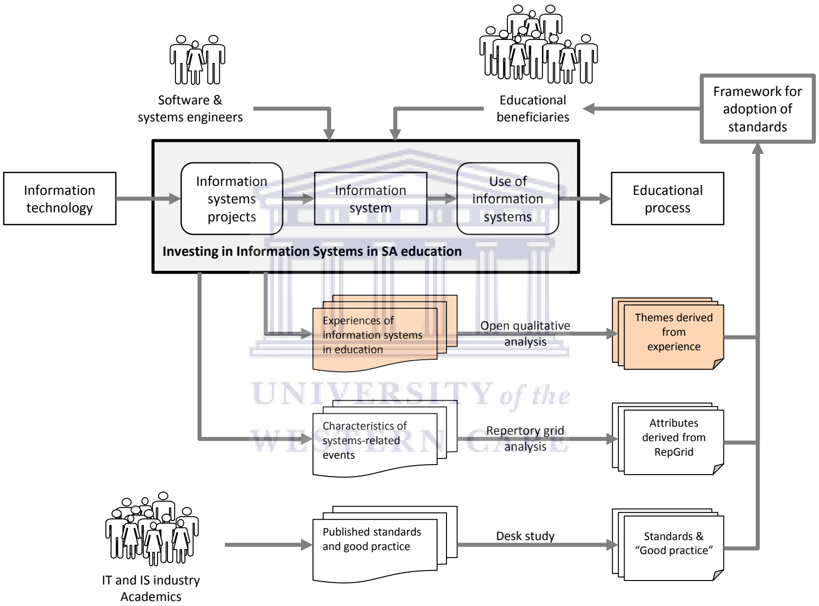


Figure 19 The project workflow: Stage one (systems in use in education)

The objective of this open discussion was to identify the roles that they fulfilled, hear about the systems that they developed or used (according to their role or roles), and to gather background information that could be organised into a 'landscape' description of what it is like to work with information technology and information systems in higher education.

This analysis was developed using the *individual perspectives* of the respondents. It was found that some respondents had multiple roles: for example as managers *and* technical specialists *and* champions, but at different stages of the same or different projects. In other cases respondents had developed their own systems for their own use, taking on all necessary roles for a single purpose.

There was no attempt to combine this data according to the organisations where they worked, nor the projects and systems with which they worked (which were also sometimes common to respondents). The objective at this stage is solely to accumulate the *personal* viewpoints of these individuals working in different roles, independently of their affiliation and the projects on which they worked. Nor was there any attempt to force a discussion of different kinds of system: the systems that were discussed (and analysed) were simply those that they found significant, or interesting. As will be seen (see Appendix 7), the result was somewhat eclectic.

4.2 Résumé of the method of working

Except in four cases, these discussions took place between the researcher and individual respondents, one at a time. Two cases were team meetings with technical specialists and were undertaken as group interviews where there was a shared discussion; the other exceptions were telephone interviews, with RIMS project managers in Gauteng and with the South African national representative on the international software and systems standardisation committee.

The telephone interviews were not recorded but detailed notes were taken and shared with the respondents for their comments. All the face-to-face discussions were recorded (with permission), transcribed by the researcher personally, and loaded into a database driven software suite that facilitated the analysis of the data. This was done in the manner already explained, informed by authorities such as Schutz, Strauss, Corbin and Charmaz (Schutz, 1952; Schutz, 1959; A. L. Strauss & Corbin, 1998; Charmaz, 2014), but with some adaptation. Whilst adopting the principles espoused by these authorities, this analysis was nevertheless undertaken using the 'crafting' approach to research articulated by Richard Daft (Daft, 1983), and with a focus on the constructivist ideas articulated by Kathy Charmaz (2014).

The examination of the data progressed in this way:

- Breaking down the transcribed text into 'chunks', where each chunk represented a single component of the discussion – for example a question and an answer, or a question and a longer answer that was itself divided into parts that were freestanding expressions of a series of opinions or experiences.
- Open coding of those chunks, using an accumulating list of categories that emerged from a line-by-line reading of the chunks in the general way of open coding. Later, the list of categories was lightly edited in order to bring together identical or very similar categories, and to eliminate categories that were clearly 'outliers' that had seemed important in the first reading but proved to be exceptional and extraneous.
- Thematic review and analysis of the coded chunks, developing the themes to be found therein as 'memos', according to the significance and intensity of the content under review.
- Re-structuring of the categories into a hierarchy, based on the thematic analysis; high-level groups were divided down into intermediate groups as appropriate, accommodating the categories that were actually used in the coding at the lowest level.

This was a subjective process that required judgements to be made about the relevance of categories, their similarities, and the common characteristics that would justify their inclusion at a certain point in the hierarchy.

4.2.1 The qualitative data

The interview transcripts were loaded to a data management and analysis package[8] which then facilitated the coding process. In the transcripts there is a total of 94,455 spoken words, of which 36,995 are instances of ‘substantive’ words (that is, excluding common words such as ‘the’ and ‘it’). Appendix 4 provides a diagnostic report from the analysis package giving some useful statistics.

The organisation of the collected qualitative data in the database was as shown here (Figure 20):

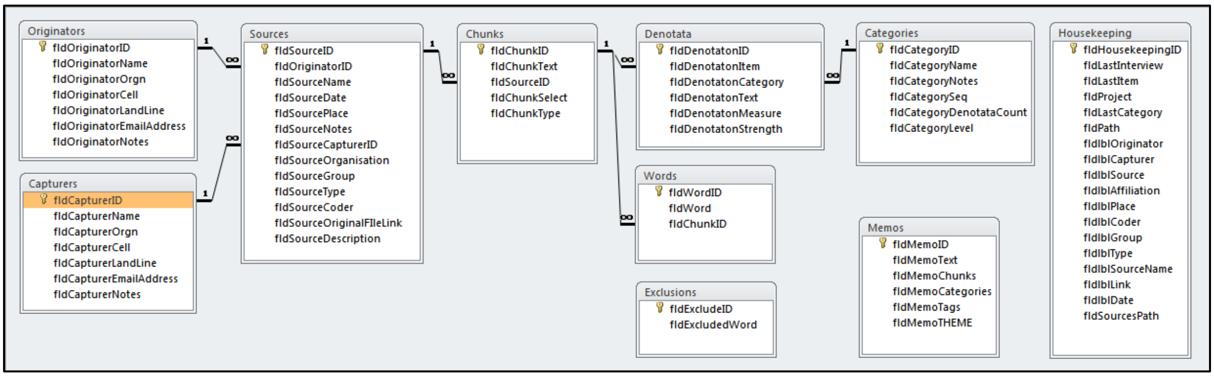


Figure 20 The organisation of the qualitative data in the database

4.2.2 Volume of data

As explained already, the study was undertaken principally in the interpretive paradigm, and the first set of findings is based on the verbal evidence elicited from the participating stakeholders. *A posteriori* open coding was undertaken, and this led to 113 codes (‘categories’ in the analysis package) and 3,423 applications of those categories to the transcribed text. The categories were organised into different hierarchical structures in order to investigate the results in different ways.

The following statistics summarise the volume of available primary data and the extent of the analysis, based on the diagnostic facilities in the analysis software suite. There were:

- 31 interviews including 38 individual respondents
- 36,995 instances of 6,034 substantive words
- 1193 substantive words per source, on average
- 699 chunks (52 words per chunk, on average)
- 3,423 codings (4 codings per chunk, on average)
- 113 categories (30 codings per category, on average)
- 377 invocations of significant codings in the thematic analysis

At this early stage the objective was to deliver an organised, hierarchical view of the landscape, based on the emergent themes and the detail within them. The full thematic analysis is provided in Appendix 5; in view of the volume of detail involved it was decided not to burden the main body of the thesis with this data, but there are paragraph cross-references where they are appropriate.

[8] This suite had been previously developed by the researcher and had already been deployed in a range of earlier research projects; it is assessed in previously published reports (Bytheway, 2013b). Appendix 4 has a diagnostic report from the software that records the volume of data collected and of the coding that was done.

4.2.3 The analysis

The analysis that follows is organised into three sections.

- The first looks at the overall shape and size of the primary data that was elicited, the development of the themes and the frequency of codes within them.
- The second looks at selected areas that are examined in more detail according to the roles of the respondents.
- The third digs deeper by looking for co-occurring pairs of codes.
- Finally, there is a summary of what is learnt from this qualitative analysis.

4.3 The shape and size of the qualitative data

The frequency of the initial line-by-line coding was as shown in Figure 21. This very early result is notable principally for the highest frequency codes, which include:

- Outcome (204)
- Challenge (133)
- Human capability (117)
- Context (116)
- Need (109)
- Functionality (100)
- Method (85) and
- Technical availability (84)

and so on. Whilst a more insightful interpretation of the data than this is needed, there are already signs of a focus on outcomes and challenges. Much of what was said was really a commentary about the context within which people were working, but what they needed and the functionality that provided it were very clearly expressed. No discussion about systems would be complete without reference to the methods worked with, and the availability of the technical resources upon which information systems run.

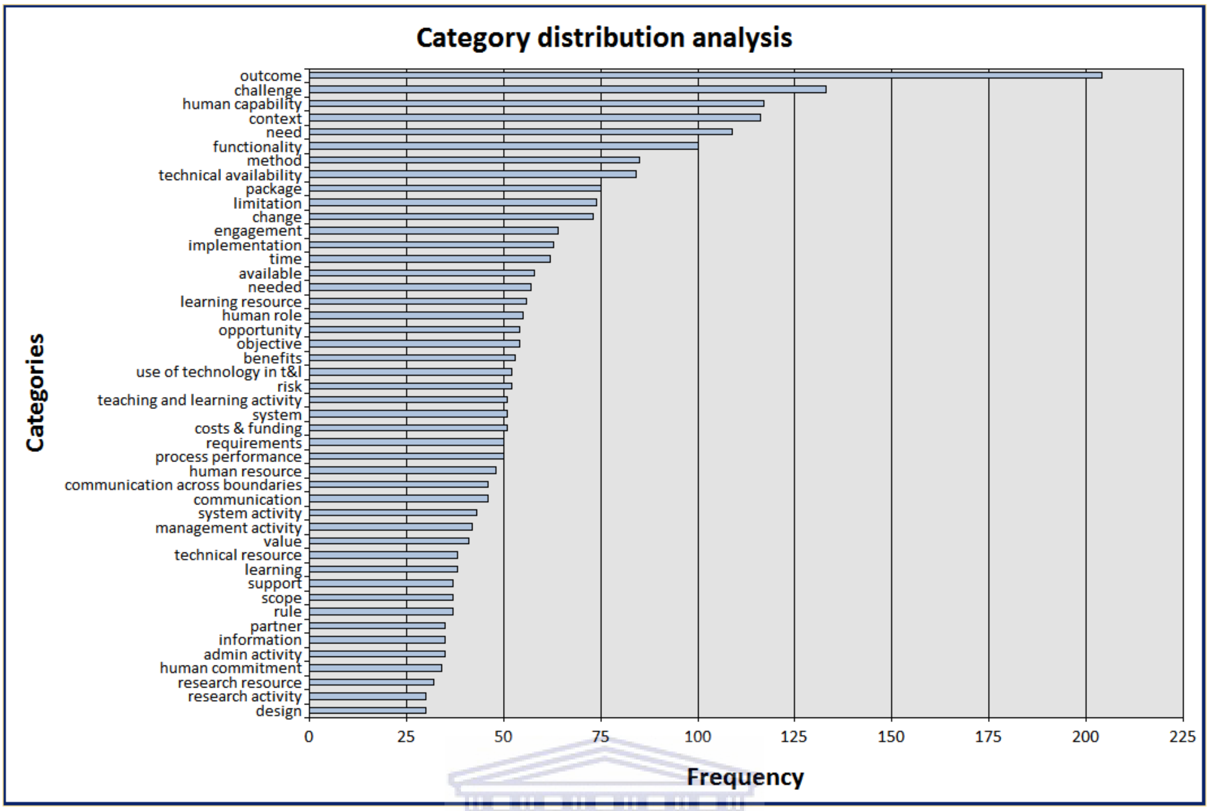


Figure 21 The initial line-by-line coding: frequencies

4.3.1 The thematic analysis

Insight comes from a careful re-reading of the transcripts and an aggregation of the detailed coding into themes that organise higher level ideas about what is important and what people wanted to talk about. From this comes an understanding of what needs to be managed and where problems and opportunities might be found.

This was done by the development of 'memos' that were accumulated during the second reading of the transcripts. The topics that emerged, embodied in the memos derived from the detailed review of the chunked and coded discussions, are gathered (in Appendix 5) into four thematic areas:

- Processes: The activities that people undertake that consume resources, require human capacity and capability, and deliver outputs and – ultimately – outcomes.
- Products: The resources, inputs and outputs that are inherent in the processes of higher education, including technical and administrative resources of different kinds, the data and information that is needed, and in some perspectives even the people who are involved (as human resources).
- Boundaries: The junctions at which information systems exchange their information products are the points at which performance can be monitored and assessed; standards can be used that inform decisions about problems and opportunities, and ensure satisfactory quality in what is delivered.
- Management: in this context, management is seen more at the level of governance than operational control. This includes the analysis of institutional circumstances, the formulation and implementation of strategy, including the likely costs and benefits of information

technology and information systems investments, and the management of consequential changes to teaching, learning and research practices.

It is commonly understood that education ***processes*** need appropriate inputs in order to deliver the required outputs – educational resources and management information are the lifeblood of academic, administrative and management activity in higher education and for the present purpose they will be referred to as education ***product***. This study has brought additional focus to the ***boundaries*** at which educational products are exchanged, and the ***management*** activities that decide about the use of information technology and information systems in higher education.

The detail that substantiates this result is provided in Appendix 5. Within the four thematic areas, the 14 memos identified (and the components of the memos, coded from M1 through to M153 in the appendix) included:

Management

- Planning and strategy (M1-M12)
- Identifying the benefits (and costs) (M17-M24)
- Changing teaching and learning (M25-M33)
- Changing research (M34-M35)
- Change and migration management (M36-M46)

Processes

- Engagement between stakeholders (M47-M56)
- Method of working (M57-M65)
- System management (M66-M76)
- Information management (M77-M79)

Products

- Functionality and capability (M80-M91)
- Having the right resources (M92-M111)

Boundaries

- Scope (of a project and its system) (M112-M119)
- Boundaries with the outside world (M120-M133)
- Need for standards (M134-M152)
- Final word (M153)

Each incremental addition to a theme (as shown in the appendix) includes a reference to the chunk wherein the idea was found and the category that was used to capture the idea. Short textual comments were added to the memos to develop the narrative.

With this organisation of the detailed coding at hand, in the four high-level groups, the frequencies of coding within each was calculated to give an overview of the collected data and an indication of balance. This was done by collecting the original categories into the four high-level themes in a tree structure, with the following result (Figure 22):

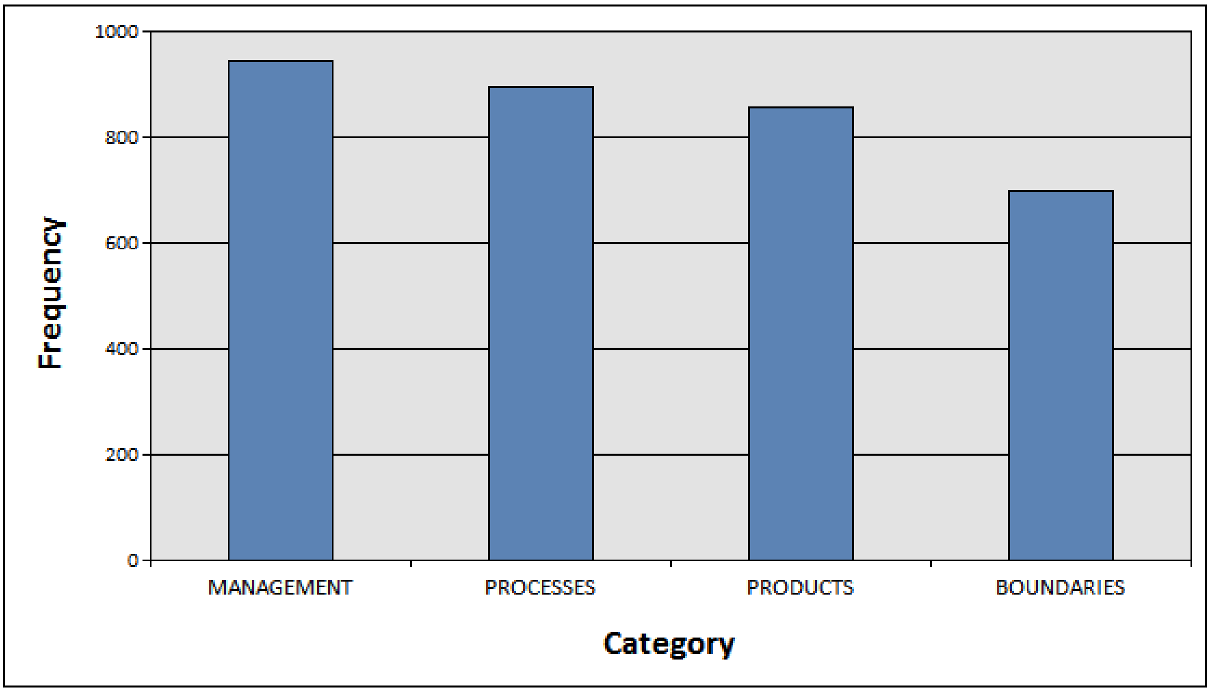


Figure 22 The coding frequencies within the four high-level themes

4.3.2 Management

Management issues (943 instances) were predominant, much concerned with the formulation and implementation of strategy, and often started with 'vision'. One director of e-learning had a strong, clear, vision of what she wanted to create in her institution, grounded in what she believed all stakeholders, students especially, expected and needed:

> *'The vision I have is that all lecturers, all support centres, no matter who they are - whether the library, or even campus control, will have an online presence. When you click on our website, you will see that there is a link to e-learning as well … When students come here, they are already living in a space where they think 'I will have an online pseudonym'. So my vision is still that these things are ubiquitous and I do think we took a good approach, we did not make it mandatory … The vision I have is that it's everybody's business - I think that we are living that out.' [RES 05 - HEI E-Learning director, University B, 2014/08/07]*

This is an extraordinarily clear articulation of ambitions that are immediately comprehensible to all involved and all of their tactical moves seemed to originate from within it. Strategy is the means whereby targets are set and design business processes that will fulfil them. Within the management group of codes there are two principal sub-areas: the *formulation* of strategy (390 instances), and the *implementation* of strategy (183 instances). This bias to formulation rather than implementation of strategies hints strongly at the human propensity to *think* about things more often than to actually *do* things.

The formulation of strategy can be seen as enjoyable by those who seek distraction – endless meetings, copious documentation, and frequently a plethora of PowerPoint presentations. Implementation of strategy is different and can be a nightmare of incapacity, incompetence, missed schedules and unexpected consequences.

Take the RIMS project – an important and substantial national investment in research management. The HEI CIO was asked what he thought about the progress of RIMS implementation and its likely contribution to research:

> *'I think if you look at the stage in terms of hype, and vision, I think hopefully we are there, going up, as opposed to going deeper down, and so hopefully we are there, and there is a next wave coming in … ' [RES 02 - HEI CIO & Programme manager, University A, 2013/12/04]*

Hype and vision are easy, but making a major multi-institutional system like this work may take more than a 'wave' or two. Two years later, this system is still in its early stages and mainline researchers across the country have still not heard much about it. The respondent had no immediate answer as to how this system was going to facilitate those researchers actually working at the front line who would be the originators of the information needed; their principal concerns are not preparing returns for the national funding agency, rather they are concerned to seek funding, find the requisite resources, do the research and get it published.

The dynamics of strategy are often ignored and here it is about the timing and interaction of different aspects of academic life. At one level, there is the 'academic year':

> *'In general one can say that the university information systems need to become more flexible. The old year-driven curriculum, that's changing. Things [are] extending over the academic year. We are rigid in the academic year. First of January to the end of December, everything should happen in that time ... ' [RES 34-38 - Technical Team B, University A, 2015/10/01]*

In University A there were clear pressures to accommodate activities *not* related to the academic year as the nature of higher education is changing, and the constraints of certain administrative procedures tied to the start and end of the year were holding things back. That was an institutional problem.

At another level, it becomes personal:

> *'Before we come up with a proposal [for a new system or project] we have to have our research done. Yes, it is quite a big thing. I was fiddling around with the idea at home, and I wondered – 'what if she says no?' We do so much that benefits the university, we need to hear it now!! [Laughter]' [RES 27-30 - Technical Team A, University B, 2015/08/18]*

Would a good personal or team track record encourage senior management to approve a new project? Certainly that should be an important contributing factor. Is the good work of young technical people always appreciated? That would need further investigation.

Management issues were never far from the surface and they came in all forms and in all sizes. In another institution, the vision of how things might be managed came in at a lower level, but just as strongly:

> *'In this case, it's probably the overall planning, future planning - Is it about "on plan" or "off plan"? It's about strategy; it's a lack of strategy. A lack of prioritisation. They are not doing the documentation, application portfolio [and] lifecycle management, applications don't die and the burden mounts ... It's all about portfolio management!' [RES 34-38 - Technical Team B, University A, 2015/10/01]*

This is an interesting example of insight into the management of information technology and systems investments, using a portfolio approach, seen at the level of a system designer and programmer working on systems in a mixed environment. According to some experts (Ward & Peppard, 2002) the applications portfolio idea is central to the successful management of information technology and information systems and this group seemed to be on the brink of accepting and adopting the idea.

4.3.3 Process thinking

Process thinking (895 instances) is equally predominant. It can be seen immediately that although respondents knew that the research was concerned with matters of standards and good practice, the tendency was to actually talk about the processes with which they were involved, the strategic context within which they worked, and the things (entities) that they worked with. For example:

> *'Now the question is really about a structured approach to [the] delivery of the use of technology in higher education … to what extent is the methodology approached - is it COBIT or ITIL methodology, or whatever methodology - can that be superimposed onto the lifecycle of development of ICT in higher education?' [RES 02 - HEI CIO, University A, 2013/12/04]*

This Chief Information Officer was quick to focus on the biggest process issue of all: delivering technology in higher education. In order to do that he invokes the idea of professional good practice guidelines and the extent to which they might work successfully in a university, which is, after all, not the same kind of organisation as the businesses and industries that led the development of good practice guidelines like COBIT and ITIL. As will be found later, these guidelines are very process-oriented and rather than laying down tight standards (for procedures, or documents, or system design features) they tend to leave the detail open to some interpretation. But the point that the CIO was making is that it is the *process* that tends to drive people's thinking - it doesn't get much bigger than that for senior technology management. Later it will be seen what other people see as important or significant processes, working in other roles.

Processes can be thought of at a very high level, and the term 'academic project' is often used in South Africa to try and embrace all that is done in universities, in just two words:

> *'I think the big driving force of this whole system is the academic project. If you didn't have a timetable, then you can't have the classes. So that need was so strong that it overcame any barriers. We needed to purchase something, the institution was still dilly-dallying about which program they [might] get, and we said we will buy this one.' [RES 09 - IT Facilitator, University C, 2015/05/15]*

The outcome that was needed here was a working timetable, of course. The process was one of evaluation, budget approval and software acquisition. The sharing comes from the joint responsibility between management, administration and academic staff to generate a workable timetable.

Processes can also be seen at a much lower level. Closer to the detail of what might be wanted in other particular cases, and the extent to which the involved parties understand each other, it gets more challenging. In preparing the periodic statistical returns required by the Department of Higher Education …

> *'… they have to set up the system to show how many first time entry students we have. That is the goal. Monitor the first time entries that enter the university annually. Click on the button, all the student types are reflected there, fifteen of them. I said: 'But that's not what we asked … You are giving [me] all, from undergraduates to postgraduates. I only asked you for one!'. The argument of the registrar is 'you asked for it and you signed'. I said, 'I signed that for the tracking system, I didn't sign for this, this is something else!' [RES 22 - Information manager, University A, 2015/07/09]*

… directing our attention to the need for standards that will assure proper understanding and agreement about systems functionality. There is other evidence that personal beliefs can override the right thing to do, and often work is done on shifting sands at the level of specifying the technical details:

> *'… we were building a new LMS redoing the Windows one with PHP on a Linux platform. The head of department had a religion about free software. That was used on campus, all over, then that was*

phased out in favour of [an open source package], because they wanted to be like [another university]! It was a really interesting learning process both in terms of the development of an LMS and of the mistakes that we made. If I could go back in time there are things that I would do differently. It was not optimised at the database level, and the result for a long time it was very slow, and that was a problem. The other problem was feature creep. It was an LMS that was also capable of being a this thing, and a this thing, and a this thing.' [RES 27-30 - Technical Team A, University B, 2015/08/18]

This indication of different kinds of problem provides evidence about understanding properly the things that we are working with: people, technologies, systems features, and managerial problems. Strategy is the means to unravel these complexities, it is argued.

Within the process coding group, processes and activities associated with systems (446) were predominant. The codes associated with academic (119), administrative (35) and management (43) processes were significantly lower.

4.3.4 Product thinking

Products (857 instances) are a little trickier to deal with and the way that this idea is handled here will be important. Early in the project, in the pilot stage, there were some good examples. A head of department was asked about the introduction of a new marks administration system:

'Yeh, they did tell us we have got to use it, and add these plans or schedules or whatever you want to call them on the system - the marks allocation system - and then what people would do to overcome the marks allocation system you would have your own marks system on your Excel, but to prevent yourself from entering the marks here, entering it again on [the new marks allocation system] you would just enter the final mark. But we would like to know every month how the student is doing - that type of thing - but we have got so many small examination systems that you don't feel like entering all of that into this very laborious system. It's much easier to enter it as a combined mark.' [RES 00 - Pilot 1 respondent, University B, 2014/02/11]

Consider for just a moment the rich variety of things that are evident in this example: plans, schedules, the system, people, the personal marking system, Excel, the 'final' mark, the date ('every month'), student, examination system, even 'feelings'. Feelings are indeed important in the successful management and adoption of key new operational systems like this one, so why should feelings not be an entity? Having reliable information about people's feelings is important to effective management. Telling people they 'have to use it' is not the way to win support.

In this example there is evidence of a startling variety of things that might have to be properly understood in the course of management (or in the course of research): the idea of 'products' (for the present purpose) as *all those things that represent the 'stuff' of higher education, about which we need information*.

There was a wide range of different things within the product group within which all things that were resources were included. Resources directly related to systems (205) and resources within the human realm predominated (199). Viewing a person's role as a resource, there is evidence of people playing different roles, with good outcomes:

'I've played many roles, it depends on the budget! I've played programme manager, project manager, and data migration manager. Those are the key roles I play, depending on what I have been brought in for. However experience of being programme and project manager on other projects often assists to diagnose issues and point things in the right direction.' [RES 31 - Business consultant as PG student, Independent, 2015/08/29]

And so it is found that it is useful to know who exactly is working with (or for) us and what they are capable of. Sometimes they are not capable. A mature first year student had difficulty communicating with teaching staff, based on the need to learn to use the free resource that is Dropbox:

'I would like one system and to know that all my lecturers are using it, and I know that they are not all using it. I have a [lecturer] that uses Dropbox, and I am not comfortable with Dropbox because I have hardly used it. I now have to get [my husband] to download DropBox stuff for me, and I don't feel comfortable about that, not at all.' [RES 06 - Mature first year student (health), University B, 2014/09/01]

Here is a product, Dropbox, that has caused some problems even for a mature student with something of an IT background. The younger students have a different problem: a surfeit of technology. When asked how many students have 'smart phones':

'Virtually every single one of them. Everyone has a cell phone and virtually everyone has either a tablet or a laptop. People that are on student financial aid, they were given laptops. They needed one for physics so they were all given laptops. So every student has access to their email account.' [RES 10 - First year student (science), University D, 2015/05/16]

This student went on to explain how each of her devices (she had four) fulfilled different needs. Having four devices brings one face-to-face with the issue of technical standards. Apple have developed a closed environment (IOS) that is difficult to incorporate into a Microsoft Windows environment:

'… they had a problem with the system, the hardware. If it's an Apple and it doesn't speak to whatever you have, an operating system sometimes gets in the way … so there's still some problems.' [RES 00 - Pilot 1 respondent, University B, 2014/02/11]

A manager responsible for technology reflected on this particular issue, and it drove him to admit that this is where standards really have to play a part.

'From a user perspective, in terms of buying laptops, desktops, and so on, tablets, what do you buy? Windows? Androids? Apple? iPads? Having to support those, getting the balance between getting value and longevity ... from a hardware perspective, that is where the issue of standards become very important in terms of telling users what will work and what will not work, but also giving them some choice.' [RES 26 - Technology manager, University C, 2015/08/11]

4.3.5 Boundary thinking

Boundaries (697 instances) are where the action becomes visible, as product from one process passes to another, or passes to the external world beyond the institution. Where the technical world meets the world of academic activity there is the 'user interface', which can be a real hot spot of excitement or disappointment. A long-serving head of an academic department reflects on the functionality of modern email systems (this extract starts with the questions asked by the researcher):

'- But hasn't email evolved? Was there a moment when the improved functionality of email hit you? When something wonderful happened?

It was incremental. For example today, to copy and paste colour images is taken for granted as normal but that was certainly not possible in the 1990s. Email forums were made possible and you could for example negotiate with a foreigner to set the same essay and the same reading list for example.' [RES 19 - Academic Head of Department, University B, 2015/07/08]

To require that an email system shall be able to handle attachments, and to agree the size and nature of the attachments that are permitted, is still an issue 25 years later. It is an example of a needed operational standard where bandwidth is limited and where abuse and security issues might be prevalent. This head of department has a history of international co-operation which both brought out the need to exchange images and document files, and the possibility to use email to set common rubrics (for essays) and reading lists; organisational policies for bandwidth utilisation and email management are an example of what might be called a 'soft' standard.

There is evidence of 'hard' standards as well. The same head of department remembered when the IT department were promoting the use of the 'latest and greatest' features of information technology, but were unable to provide it to their users – an example of a clear need for a 'hard' standard concerning standard configurations for academic users:

> *'The key point was that [the IT director] would be teaching and encouraging academics to use "X", when the equipment in their office did not have "X". It meant that his workshops to 'upgrade' staff were wasted, because you could not use the information you were taught because the equipment did not arrive.' [RES 19 - Academic Head of Department, University B, 2015/07/08]*

A 'help desk' manager was actually *heavily* involved in technical issues: sourcing and managing specialist equipment for post graduate research students. He was working with much more technical matters, PC and CPU chip performance, benchmarking, and all the details that underpin the advanced research work that is concerned with modern evolving information technology:

> *'… it's all theoretical based on manufacturers' specifications, like Intel, ASUS, they give you specifications and give you benchmarking results, so when you get the computer, you have it physically in your hands, now you run your own benchmarking and you match it to the theoretical [figures] that they gave you. The research part is I think the larger part. I always think of the iceberg theory: the iceberg is a big triangle but you see only the tip of the iceberg but the biggest part is underneath, that's the research component! So in your research the iceberg applies there as well' [RES 21 - Help desk manager, University D, 2015/07/09]*

Sometimes standards, especially those concerning performance, are a matter of timing:

> *'If the chain of decision is not quick enough you lose … technology changes quite quickly, Moores law, but we don't change, so I've found that with technology it might be dated and so the responsiveness and agility of infrastructure nowadays - in the olden times infrastructure [was not] agile - but [now] it's changing so much and the demand for big data, like if we are going to do a simulation of the universe or of a galaxy - a complete simulation - you need big high performance computing. So it's that responsiveness as to how quickly and [whether you get] to be the first to do a simulation …' [RES 04 - HEI Technology manager, University B, 2013/11/19]*

Yes, academics are indeed setting out to simulate the universe, but let us pass over the implications of that possibility here, and attend to the four areas from the thematic analysis in turn, in a little more detail.

4.3.6 The awareness of standards and good practice

The general understanding and level of interest in standards and good practice was somewhat elusive. This means that the search for evidence must stand back a little, and look for instances where *performance* came through as an issue, or where *problems* indicate a need to look for standards as a means of resolution. This means that many of the allusions to performance and problems could be coded as issues of *functionality* (99), as seen in the chart below (Figure 23).

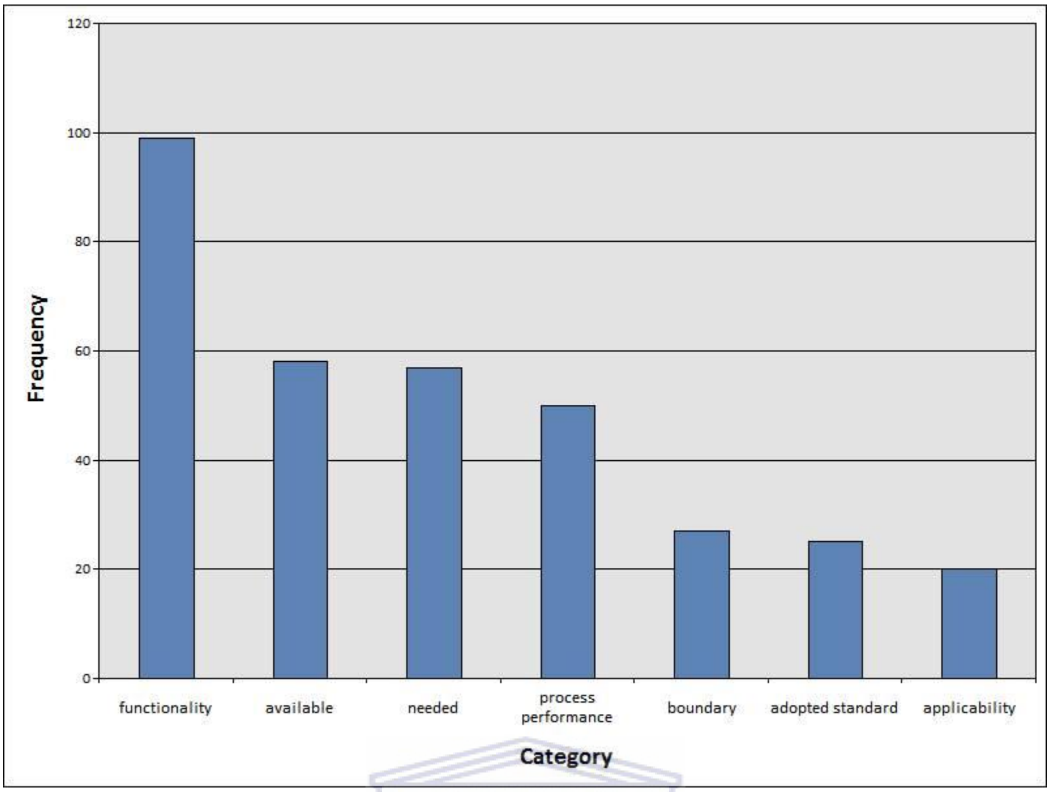


Figure 23 The awareness and need for standards

Functional performance was the predominant feature of the narratives that included or implied standards, and this can be seen at a simple human level as well as at a technical level. A young research administrator was still learning features of the Microsoft Office suite, and was looking to her manager (and her manager's manager) for some acknowledgement of her progress:

> *'For the statistics, when we want to know how many people go, and then how many publications, they say it's excellent because it is a summary. They don't have to go to the [full] report ... I also do mail merge. Once my spreadsheet is accurate I am able to do 100 letters. Within two seconds you have all your letters [done].' [RES 14 - Research administrator, University C, 2015/05/04]*

It seems this is excellent only because it is saving the managers' time, not because our young administrator was seen to have done well.

At a higher level of professional work, the library at one university came in for special praise from a postgraduate student who was searching for obscure sources for his doctoral study:

> *'I think the university service was excellent, because I could request it in two ways: through the web [or] online. I could put my details in, and the title, and the year and author and all that, and they would come back and email me and tell me I could come collect at the university or I could have an electronic copy of it, or I could go to the research assistant (more one-on-one) and he would dig and delve deeper into many other areas where normal service wouldn't be able to find it. Remember there was some tricky stuff there.' [RES 31 - Business consultant as PG student, Independent, 2015/08/29]*

Another postgraduate student, working to develop an application in the Android environment, had decided not to use XML (a data description standard) because of problems with the space it needs:

> *'Previous cases, particularly when it came to content creation, things like what data structure or what data interchange format authoring tools use, so there was an overwhelming majority of them leaning towards XML, because of namespace management, a case of moving from one system to another and pick a name space, change the name space, name space support. But we didn't want something that is*

really bloated and XML is bloated. So we also looked other interchange formats. Most people are looking now at JSON and Java - Java Script Object Notation. It's less bloated, it's an Oracle thing.' [RES 16 - Masters student, University D, 2015/05/22]

JSON is a newer standard that has captured the interest of many contemporary system designers and developers but inevitably there are schools of thought that incline in different directions. Making the wrong choice could jeopardise the usefulness of the resulting application, if the wider context and the extant standards that are in use are not understood.

Having said all that, it was found (from a detailed analysis of all the results) that the general awareness of standards and good practice was low, other than amongst one or two managers, one research programme director and the research students who were actually writing code and struggling with the compatibility of web software development systems.

4.3.7 Re-organisation of the original line-by-line codes

With the thematic analysis done, another way of seeing the data is through the hierarchy of categories organised according to those themes, as shown in Figure 24. This figure provides an overview of the 'working' category hierarchy that emerged at this stage of the analysis. It is organised into four sections: one for each of the emergent themes.

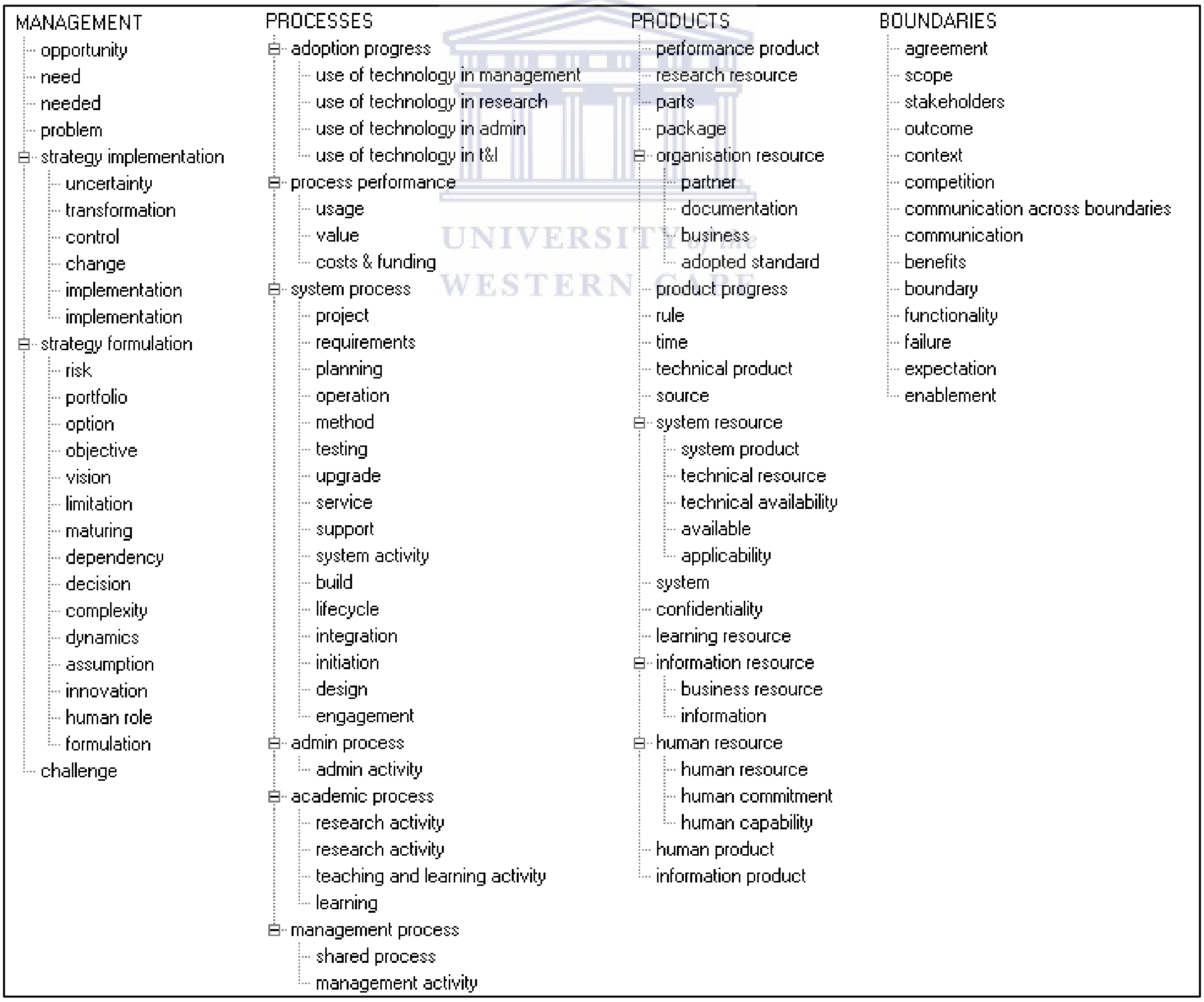


Figure 24 A working version of the full category hierarchy

Clearly, as well as being the most frequently referenced by respondents (see the details in Figure 24) the PROCESS leg of the tree is rich in detail, at different levels. At the first level, there is a group of categories concerned with the adoption of technology in the different realms; there is copious evidence of technical processes concerning the systems that have to be specified, built, testing and implemented – a familiar idea to anyone who has been involved in these things; the traditional separation of academic, administrative and management processes is there – that is how many people in tertiary education typically divide up what is done.

4.3.8 Summary of shape and size

Reflecting on this overall hierarchy of categories, even though it is only a working and subjective analysis, makes clearer the shape and size of things. It is just one way of digging into the detail so as to reveal possibly significant issues. It must be remembered that this hierarchy was developed subjectively, according to the way that the ideas emerged during the conversations, but that is the intended constructivist approach that was adopted and this is reconciled with the more structured analysis that follows at a later stage (see Table 18 in Chapter 7, on page 138).

Note: There is one area of uncertainty still. The discussion and illustration of *boundary* issues has a strong resonance with the idea of *service*, because it is at a boundary that service is delivered and performance (for example in terms of timing, product quality, reliability and empathy) can be measured. As the thesis proceeds the four high-level thematic areas will be referred to as:

> **process**, **product**, **management** and **boundary (service)**,
> or just:
> **process**, **product**, **management** and **service**.

4.4 Who spoke about what, and to what extent

In the sections that now follow, there is a more detailed analysis according to who talked about what, in selected areas that represent some of the focal issues within the study:

- **Outcomes** of one kind were the most frequently occurring codes. This is an important focus for the respondents.
- **Strategy** is needed if outcomes are to be delivered. Strategic issues were evident at the level of strategy *formulation* but not so much at the level of strategy *implementation*.
- **Technical processes** were also widely discussed and were a focus for respondents.
- **Standards** are, at the end of the day, what this study is all about.

The respondent roles that were captured include: *technical specialist*, *student*, *researcher*, *project manager*, *manager*, *business* (partner), *academic* or *other*. The charts that follow display the differences using different colours.

The variation in the proportion of occurrences according to respondent type is quite complex, and it is affected by the number of respondents in each category (the figures are not adjusted to percentages, nor are they weighted in any way).

4.4.1 Outcomes – what people want

Figure 25 below shows the breakdown of the data coded in the *boundary* group, where the predominant category is *outcome*. This is of course *directly associated* with the process that delivered it, and it might be critically important to a process that is enabled by it. Outcome is of primary interest to all roles, except, surprisingly, to managers, who seem to be more interested in *context*. Business partners are seen to be little interested in benefits, perhaps they have their own priorities and they seem (reasonably) to raise issues of *communications* across boundaries. Equally, as one would expect, project managers are focused on outcomes. Functionality and outcome are both of intense interest to students.

However, as already noted, these figures do not account for the variation in the number of people responding in each role and so this interpretation must be tentative.

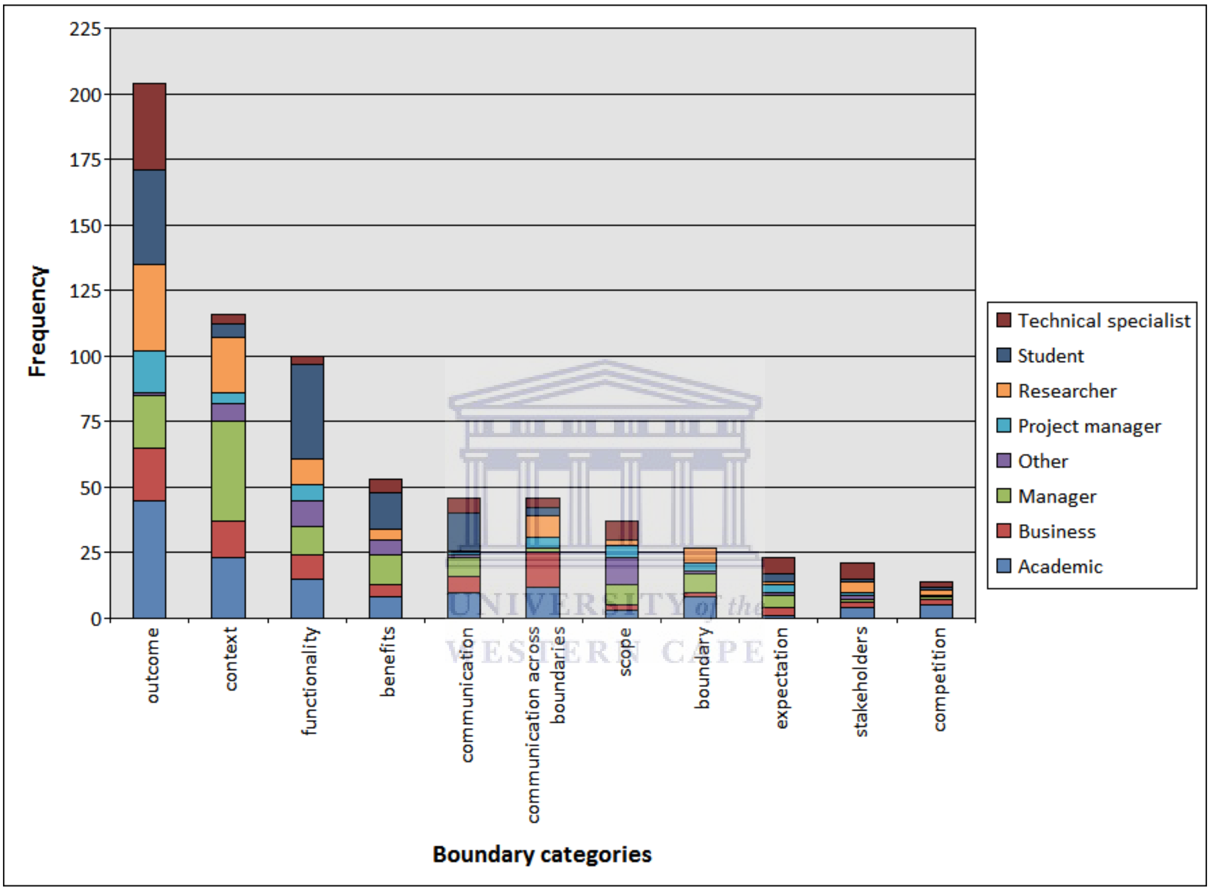


Figure 25 Analysis of boundary coding by respondent

Any consideration of outcomes has to consider what targets are set, what objectives there are, and how stakeholder expectations are to be met. That is a matter of strategy.

4.4.2 Formulating strategy – lining up targets and objectives

The references to management issues were frequently concerned with the formulation of strategy, and it is clear that either the formulation of strategy is more easily talked about than its implementation, or it takes a higher importance in the view of respondents. In management research this is an old issue, and the data here confirms what many who are involved in strategic management already know: delivering statements of intent is easier than delivering the actual or implied promise (Figure 26).

Managers talked about *objectives*, *risks*, and the role of *humans* in strategic planning. Academics, researchers and students were concerned about *limitations*, suggesting a degree of suppressed demand on their side. Managers and technical specialists were concerned about *complexity*.

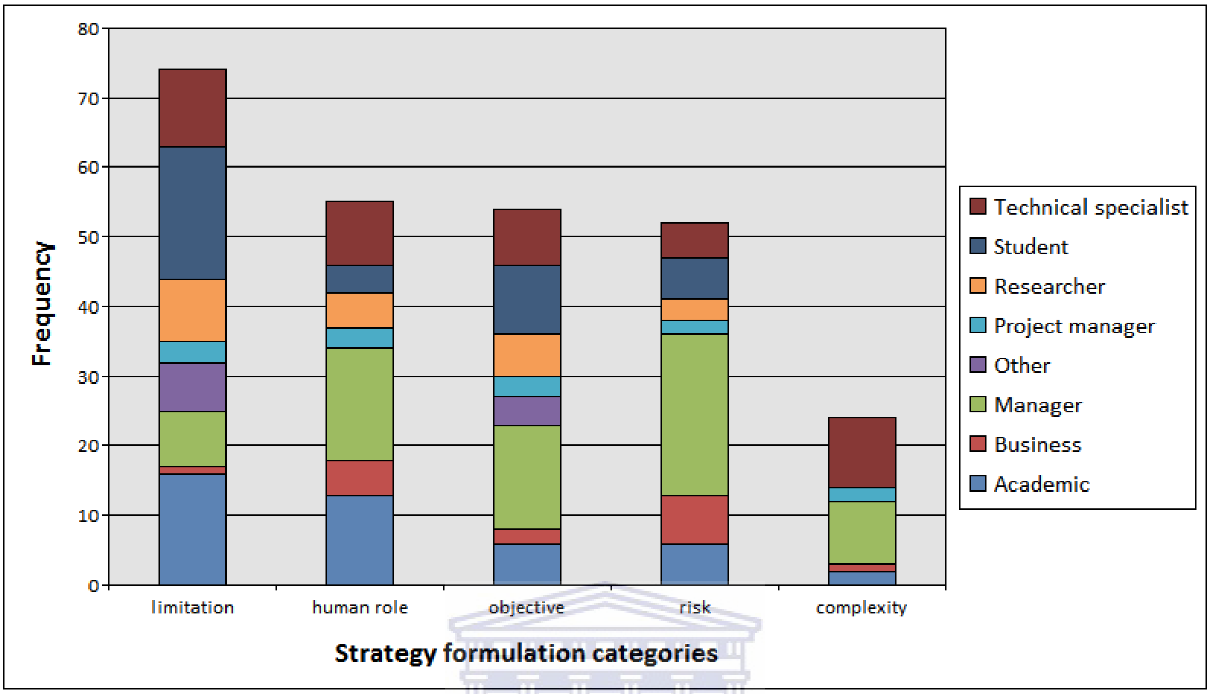


Figure 26 Analysis of strategy formulation categories by respondent

At the time of this study there were initiatives to develop strategies, but the intense interest found here, across most role players, suggests that this is not just a formality or a management fancy, there is a serious level of interest in setting goals and targets, and the interminable 'visions' and 'missions' really do need to provide hooks onto which good strategic ideas can be hung, evaluated, and adopted. Only in this way can sense be made of all the implementation and technical work that has to be done.

4.4.3 Technical processes – getting the systems in place

Figure 27 below shows the breakdown of technical sub-processes according to the frequency of reference and the type of respondent. It displays a number of interesting results.

There was quite intense interest among managers and others about the *methods* adopted to work with systems; managers are also interested in *engagement* (with other role players), *requirements analysis* and the *integration* of systems. Business partners are interested in *engagement* and in *methods of working*. Technical specialists are also interested in *requirements analysis* as well as with the *building* of systems (which is, after all, their main role).

The apparent interest among students in *building systems* is attributable to the fact that two of them were heavily involved in exactly that, for their masters projects. The interface between users and technical development teams occurs here as *engagement*, *requirements*, *implementation* and *support*. This points to the importance of the technical-user interface. The core technical activities of *initiating*, *designing*, *building*, *testing*, *upgrading* and *operating* are all present in reasonable proportion.

The category *system activity* refers to cases where respondents talked about their use of a system.

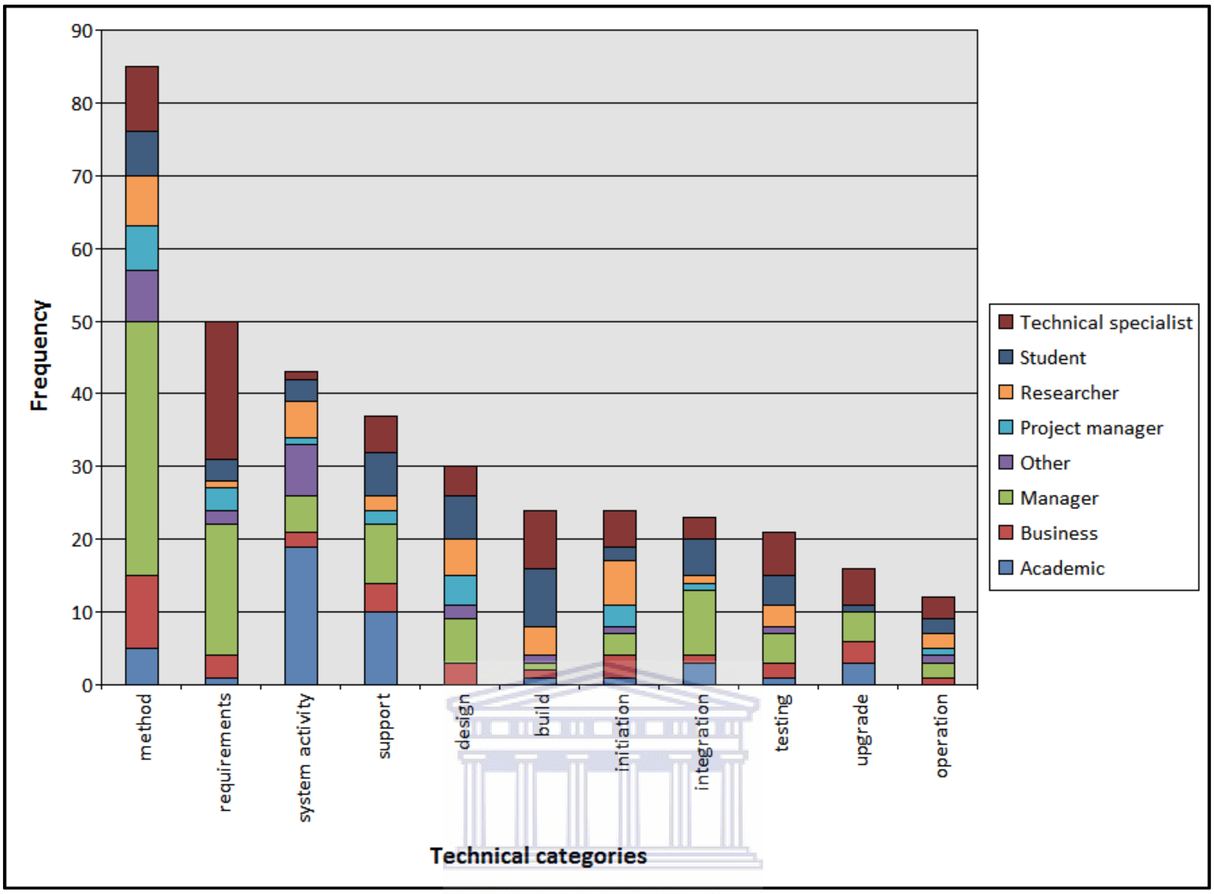


Figure 27 Analysis of technical activity by respondent

The success of technical work might depend on the extent to which there are standards that guide and ensure that everything fits together.

4.4.4 Standards – the route to efficiency and effectiveness

This is the weakest area, in the sense that it has the least occurrences. In developing and applying the codes within this set, given the sparse interest and the importance of the topic to the research, codes were devised that were closely associated with the idea of standards but not necessarily explicitly. For example

- *Functionality* raised a number of occurrences.
- *Availability*, *need* and *process* performance are clearly evident.
- Specific references that implied *boundary*, *adoption* and *applicability* were few.

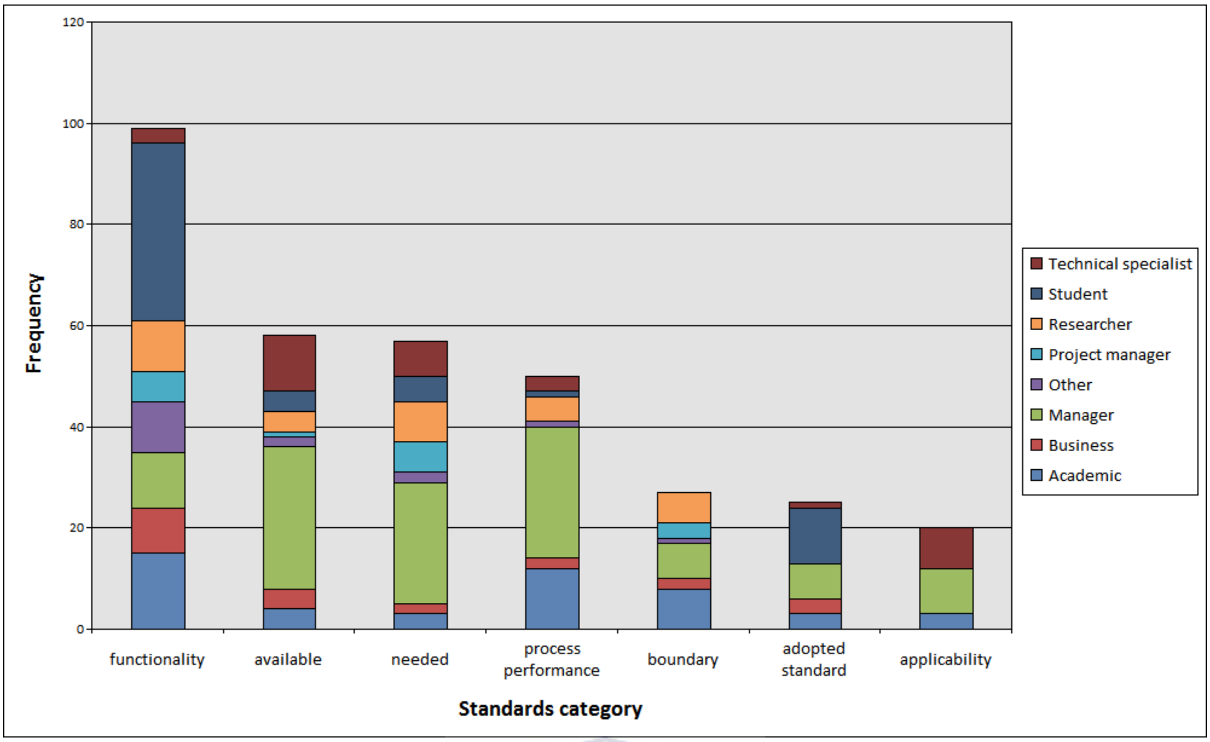


Figure 28 Analysis of standards by respondent

This distribution reveals some distinct tendencies (Figure 28). Students have a very strong interest in *functionality*, and managers contribute most of the references to *availability*, *need* and *performance*. Academics focus on *functionality* and *performance*. Researchers and academics are most evident in the comments on *boundaries*, along with managers, which is interesting. Are boundaries not such an issue to the other role players?

4.4.5 Summary of role analysis

Investigating who said what about anything adds to the understanding of people's experiences and where their concerns lie, but there are no revelatory findings yet, other than the surprising lack of awareness of the *implementation* of strategy, only evidence that respondents have inputs to the *formulation* of strategy.

The selection of respondents is representative but the populations within each group are low. For example, of the four students included, two are masters students intently focused on developing mobile apps for their projects – hardly representative of the general student body. Nevertheless, some patterns are appearing and there is evidence that can be triangulated with the later analysis of the more structured data.

4.5 Digging deeper

There is one more step to be taken before moving into analysis of the structured data from this study – it is possible to analyse the frequency of occurrence of *pairs of categories* in the same chunk. Categories that co-occur frequently would suggest an association of some kind between them.

4.5.1 Analysis of co-occurring pairs

The total set of data was analysed again, as a whole, *for the categories that tend to occur frequently in pairs*. In a simple example, frequent occurrence of 'size' with 'cost', for example, would give the (unsurprising) result that the *cost* of things depends on their *size*.

So the question arises: what are the most frequently occurring pairs of categories in this data?

Having over 100 categories, a huge number of pairs are possible, of course. It is necessary set a threshold so as to look only at those pairs that occur most frequently. For the present purpose, a threshold of 12 or more times is set - an arbitrary threshold, but it gives a manageable result that can be worked with, as shown in Figure 29. 38 pairs are found to occur more than 12 times or more.

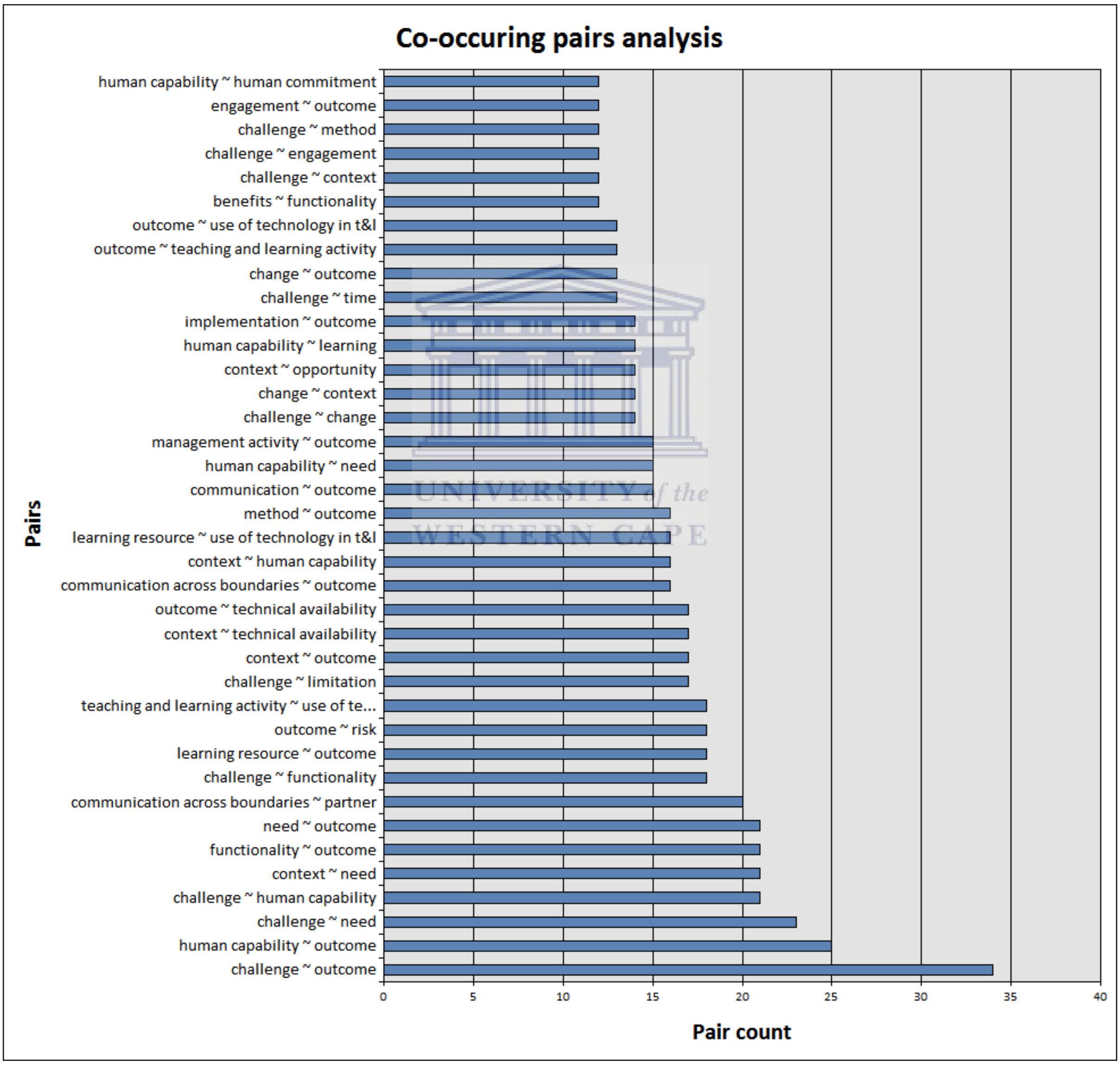


Figure 29 An analysis of co-occurring pairs

Now it can be seen that *challenge* and *outcome* occur together 34 times; other pairs reduce in frequency from 25 down to our chosen threshold of 12. It can also be seen that the category *outcome* occurs in very many of the pairs (after all, it was the most frequently occurring single category) providing additional focus. *Outcome*, in all its occurrences with other categories, needs to be examined. The 16 pairs (from those above) that include *outcome* are shown in the following chart.

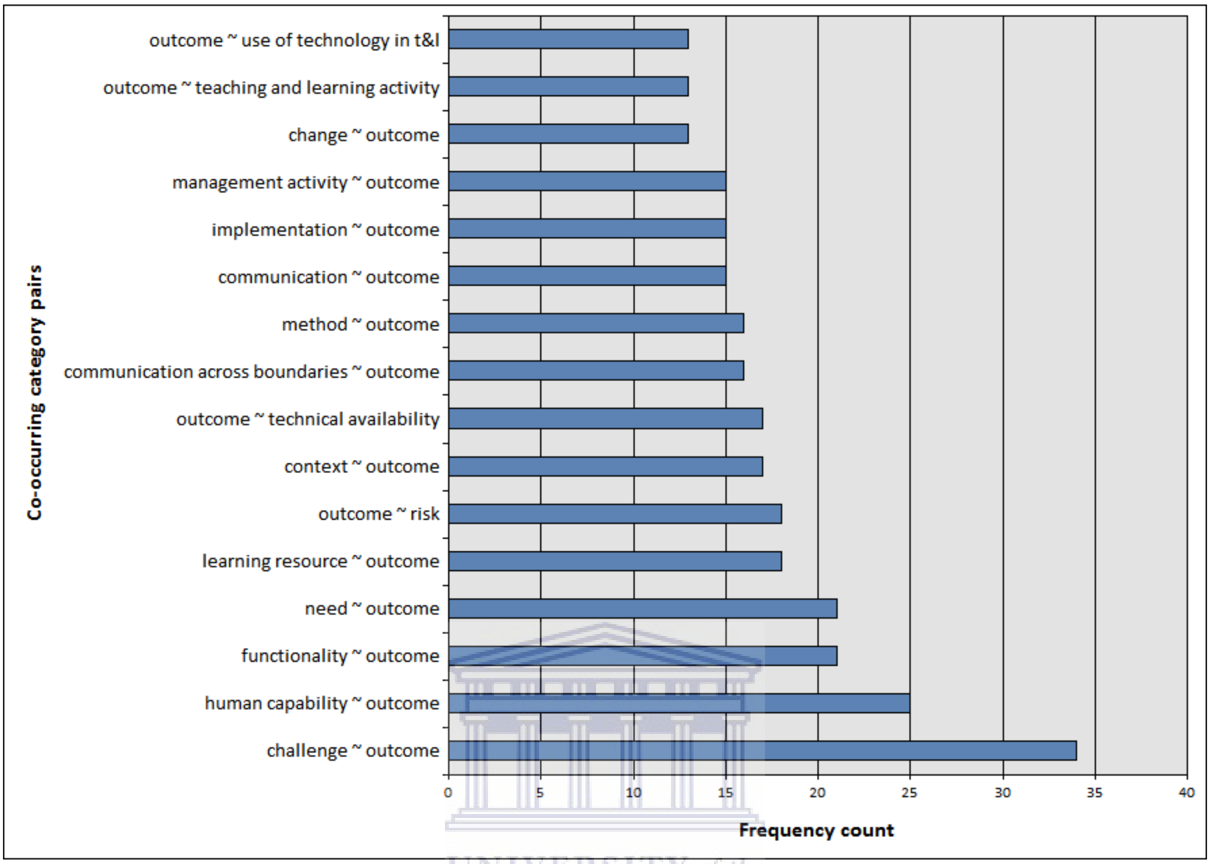


Figure 30 Co-occurring pairs involving 'outcome'

This might all be anticipated, of course, but it provides real evidence and a useful focus for the analysis. There is now considerable justification to investigate the interplay between processes, the quality of the products exchanged, and the outcomes.

4.5.2 Some examples of challenging outcomes

First, let's look at the challenges of financing an effective 'remote data collection system' for research students' laboratory experiments:

> *'It becomes much easier because they have this box, and basically the student can sit in his office behind his computer where the data is logged, and he doesn't need to go to the actual system and see and write down. So to get it to the level where everything is automated and automatically collected, it's not so easy. It puts a lot of strain on the budget first of all, the simpler a system, the less cost, and simpler means typically you have to write it yourself. You have to note and write down the temperatures and pressures.' [RES 07 - Director Research Projects, University B, 2014/10/24]*

It seems like a small thing (why should students not run up and down stairs to the lab?) but when one considers that there were almost 30 students in this case, and the laboratory context presented health and safety issues, it all starts to make sense.

Cost was a recurring feature of the discussions. Here a commercial software house that was working with a university tells of a project where the sales person cheated on the implementation team, by reducing the estimates below a viable level:

'I suppose another event in that specific project was definitely the fact that - and this wasn't a good experience - where I had done the project plan, I done the costing, the hours - and it came to "Y". The person that sent out the quote had put "Y minus something" on the quote, which I wasn't aware of. So, as the project came to an end I was getting hell because "blah blah blah blah" and I'm saying "well, blah blah blah blah" and eventually it's like "show me the quote" and like "this is not what I thought it was going to be" and it came down to having to go to the client and "Will you pay this?" and [they said] "Not my problem!" Which is fine, but that wasn't my role at the time, to determine profits or losses, it was just that whole experience of making sure that you get your figures right!' [RES 08 - Outsource partner CEO, Software and systems services business, 2014/11/21]

Not a happy situation – everyone loses in some way or another. The relationship between a supplier (of services) and a client (purchasing those services) is at risk when the client does not do what was agreed they should do and that must be done:

'If you deliver something every two weeks, you sort of expect that it will be tested! But the first thing on their side wasn't particularly good. Like most of the projects, we got to the end, user testing still wasn't being done properly, and then production was moved out from one month … we actually had like two and a half months to finish that project, which was crazy! So we did our best, but then their testing was a bit lacking ... I think that was a bit of a negative experience in the sense that we were like chasing their dates and yet on their side there were technical problems, things weren't happening properly - from my perspective - maybe from their perspective they would say "Well, we did this!". I don't know!' [RES 08 - Outsource partner CEO, Software and systems services business, 2014/11/21]

The extent to which the 'user' side is unwilling or incapable to pull their weight is interesting, and there is evidence that administrative management can delude themselves about new ideas and the foundations of what could become a new strategic opportunity:

'There was a time in 2000 when the University decided to continue with the [big] system which was concluded in 2012, but they [now] talk about Business Intelligence, but I think that not one of them understands what Business Intelligence is all about. Because when I asked them to explain to me what is Business Intelligence they all looked at me, and they couldn't answer.' [RES 22 - Information manager, University A, 2015/07/09]

Problems with management recur, when there is evidence of selective treatment and a failure to understand the consequences of bad decisions:

'One of the things [is] conflict of interest. So when it comes to procurement, it's what better suits the people with the signing powers that will happen faster. For example, when I started here I had 20 computers in the lab and 500 students that I was working with, so you can imagine what my timetable looked like. For about three years I was just trying to get more computers into a venue. One of the other courses was being developed, and when the person that was responsible for those courses decided that they needed more computers it happened overnight. And I am still stuck with my 20 computers. Prior to that, if I needed computers I go to the rector of the institution would say "I need some computers", and he would say let's work it into the budget for next year, and at the beginning of the year I would have my computers.' [RES 09 - IT Facilitator, University C, 2015/05/15]

These difficulties are echoed in the administration, when communications fail to make it easy to do the right 'thing', notwithstanding just doing things 'right':

'Whether it's a communication thing I don't know, but one finds oneself thinking you're doing the right thing and filling in the right form, but then a few weeks later it comes back with a note saying you used the wrong form, or you didn't sign this block, or you used the wrong code, or you should have taken something from this list. That's been a headache for a lot of us. Not always knowing what you need to fill in and where.' [RES 09 - IT Facilitator, University C, 2015/05/15]

This respondent was able to carry on with a number of stories of challenges that arose from weak management, and led to adverse consequences. Echoes of these kinds of problems can be seen in other lines in the data, in Figure 30.

A professional project manager, hired to run a strategic outreach project, had a very poor opinion of the IT services offered in her new university context:

> *'Very negative - every now and then they send out a communication [about mailbox full problems]. For some reason everything I deleted, everything that was in my trash was still there, so when I opened up my [email client] it was 110% full which means that no mail can come in or out, but I had to spend the time again to go through all of those [messages] to decide what I should delete. It was an impact on productivity and frustration.' [RES 12 - Project manager, University B, 2015/05/04]*

What becomes clear is that it is the boundaries between different processes that need to be managed; an outcome is the result of one process, that will enable (or disable?) the next, and that happens at a process boundary. The project manager was positively disabled by the poor service provided by the email system. Boundaries are the places that need procedural or data exchange standards and performance measurement: these are the places where the performance of an institution as a whole can actually be measured. Whether internal boundaries or external boundaries, this is an idea that needs to be more carefully examined.

4.5.3 Introducing the concept of 'service'

A review of the examples provided above finds that there is one unifying idea that is strongly evident in all of them: the idea of *service*:

- the director of research projects is driven by the need to provide a good automated system to service the data collection needs of his post graduate students;
- in her role as a project manager, the CEO of the outsourcing partner had serious problems at the interface between sales and project management - the one side should always service the other responsibly;
- in the same role, she expected the client to promptly test the developed system - another service function, albeit in a reverse sense but still in the best interests of the client;
- the information manager was troubled by a lack of understanding of what 'business intelligence really is, but perhaps he should have provided them the service (as an expert information manager) that would have informed them about what it actually is, rather than revelling in their lack of understanding;
- the IT facilitator needed a far more rational and comprehending service from management, who were seemingly motivated to apply the wrong priorities so as to compromise the quality of student learning;
- he also needed a much more effective service from the administration function, so as to avoid wasting time by filling in an old and out-of-date requisition form;
- the project manager was appalled at the poor quality of the university email system which fell far short of the level of service she expected, and that she was used to elsewhere.

One last example makes the point that this is not just about institutions, or departments within an institution, it is a national issue. In reflecting on his experiences with 'central government' systems provided to tertiary education in South Africa, the institutional research director saw deep problems of resourcing that led to a failure to service the national need for support in its expansion of research:

> *'This debate fought itself over 20 years. [Our IT director] saying now we can write it ourselves, the NRF saying well we are going to use our own developers because they are cheap and we can't afford [expert help], then we end up with 'no, they're gone and they're now working in the United States and we've forgotten what they actually did'. The actual recording of what the systems were, and how they were*

written, and how they might be fixed, was appalling, across all of South Africa, deeply unprofessional. If we had auditors it would not have passed any audit.' [RES 18 - Research director, University B, 2015/07/02]

This example exercises issues of management, resourcing, contracting and capability – all of which can be located easily as problems that can be seen in a service management context.

4.6 Summary

This chapter has reviewed what was termed the 'landscape' of information technology and information systems in higher education. It does not provide any revelation in terms of understanding, although it points to problems of strategic management. It also provides insight into the perceptions of some of the main role players, and it has delivered four themes from the thematic analysis that comprise an appropriate framework for a more detailed analysis: **process**, **product**, **boundary** and **management** (with supporting detail). Process, product and boundary are clearly closely intertwined and interdependent; management stands somewhat separate, as a means to control and optimise those things: what is done with systems and technology, by the manipulation of processes, products and boundaries.

- There is an over-riding level of **concern about outcomes** and their association with need, challenges, capability, and context.
- **Fourteen themes** emerged from the line-by-line coding that are able to be accommodated in **four high-level groups**:
  - Management
  - Process
  - Product
  - Boundary
- Within ***management***, the *formulation of strategy* is more often discussed than its implementation.
- Within ***process***, things are seen at different levels and *activities relating to systems* were predominant.
- Within **product**, there is a wide variety of things that comprise the inputs and outputs of processes, not all of them technical.
- ***Boundaries*** are where things become very visible so that they can be measured and managed.
- There is a generally *low level of awareness and appreciation of standards* and good practice, other than simple ideas of the need for systems, and their availability and functionality.
- The ***different respondent groups*** - technical specialist, student, researcher, project manager, manager, business (partner), academic and other - had *variable levels of concern* about some of the principle areas of general interest. Hence, *differences become important* to anticipate and understand.
- The idea of **service management** emerges from an examination of the strong dependencies between 'outcome' and 'process', as an appropriate discipline to apply at the boundaries between processes, where outcomes and performance levels become visible.

Chapter 5 ISE in higher education – the 'inside story'

This chapter now works through the detail of the structured data – principally the events that respondents identified, the scales of assessment that were developed by means of triadic analysis, and then the relationships between the two according to the applicability of those scales to events, and the rating of events on those scale where they were found to be applicable. Simple Repertory Grid analysis is used to establish the significance and correlation between the scales. The scale ratings are compared with the outcome of events. The analysis is then taken forward as a framework with which to assess the availability, applicability and utility of standards.

5.1 Introduction

The focus of this chapter is on the means to measure performance in ways that address the perceived needs of respondents.

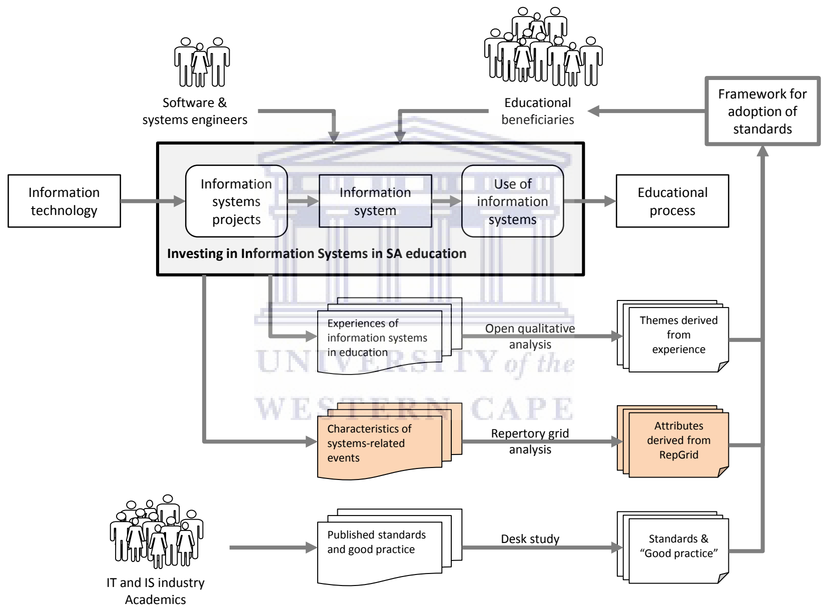


Figure 31 The project workflow: Stage two (qualities and characteristics of events)

If chosen standards or guidelines are to be effective, then it is necessary to know what criteria or characteristics they would apply to make judgements about events. But first, from all the thousands of events that are involved with systems it is necessary to identify those that are significant. This chapter therefore takes a more detailed look at the ***events*** identified by respondents, and the ***scales*** that emerged that characterise those events as successful, or in other ways. The ***applicability*** of those scales to events is then summarised and the ***ratings*** are reviewed that respondents allocated to events using those scales. Repertory grid analysis identifies the 30 scales that are most significant in relation to event success, and allows the development of a set of nine 'success groups' that accommodate those 30 scales in an orderly manner.

5.2 Résumé of the method of working

As before, most discussions took place between the researcher and respondents individually, but with teams in the case of the two groups of technical specialists, where there was a shared discussion. The telephone interview with the RIMS team did not include the collection of any structured data, and one or two respondents were either unable or unwilling to undertake this exercise (see Appendix 6 for details).

Respondents that did undertake the structured data collection stage worked through the identification of events, scales, applicabilities and ratings using pre-prepared Excel worksheets, in this way:

- Respondents identified situations involving systems, that are here termed 'cases' so as to avoid the exclusion of 'non-system' but 'technology-related' events[9].
- Respondents were invited to nominate events that they considered significant in their involvement with those cases, whether as developers on the technical side, as users on the other side, as managers, or in other roles. A minimum of eight and a maximum of 16 events were sought.
- Then, using the triadic method, up to 16 scales were derived by comparison of the events, in triplets (one against two). The object set for respondents was to nominate a characteristic that was applicable to one event, but *not* to the other two, or the converse. These characteristics were then named by respondents as scales, with appropriate terms to indicate the extreme left and right hand ends of the scales. A minimum of eight and a maximum of 16 instances were sought. Some respondents were not able to deliver as many events and scales as others.
- Because a scale was derived from only one out of three events, each respondent was then asked to test *all* their events for applicability to *all* the events in the set, on a scale of 1 to 5, where '1' was *slightly* applicable and '5' was *highly* applicable. Respondents were invited to skip instances where there was no applicability[10]; they were not asked at any stage to assess events from other respondents (that would have required a complete second round of data collection).
- For those scales with an applicability of 3 or more, respondents were then asked to rate the event somewhere between the left and right hand ends of the scale, again on a scale of 1 to 5 where '1' indicated the extreme left (generally the 'good' end, where the scale indicated good or bad) and '5' the extreme right (generally the 'bad' end); again, they rated using only their own scales.

This issue of 'applicability' is arguable, because if scales are to be used to *rate* an event it can be argued that scales with no applicability (to an event) would be rated at the mid-point on the bi-polar scales (for example, neither 'good' nor 'bad' in a simple case), or they could be omitted (although missing values might create problems in the statistical analysis). Nevertheless, because respondents were faced with the possibility of a matrix of up to 16 events and 16 scales (256 combinations), it was decided as a good tactical move to require *all* combinations to be assessed for applicability, but

[9] For example, the help desk manager (RES 21) spoke at some length about the *infrastructure* that was needed to support postgraduate research projects investigating the radio spectrum, where the data proved to be not usable for technical reasons – this was not about a system, it was about a technology.

[10] Later in the analysis, missing entries were eliminated by modifying the SQL queries appropriately.

then (when that stage was complete) to invite respondents to rate only those with an applicability of 3 or more. This provided them with some relief at the critical point where they were more than one hour into the interview, and seemingly being asked to 'do the same thing twice' (although it was not the same thing, of course).

All respondents who started the structured data collection completed it, although, as already noted, there were some cases where it was not possible because of the role that they had fulfilled, or respondents were simply unwilling. Consider the case of one member of Technical Team 'A':

> *'You are telling me that you have having difficulty with the ratings - tell me why?*
>
> *I can't remember what my state of mind was clearly enough, when doing each of those tasks, to be able to give an accurate feeling about it. Secondly there are many aspects that do not quantify by a simple number. In some respects it was one thing, and in other respects it was another. If you average the two together you get something that is neither case. Like the old story about an old man with his head in an oven and his feet in iced water and on average feels fine. It's much more complicated and much more subjective - any attempt to reduce things to numbers is inherently inaccurate.' [RES 30 - Technical Team A, University B, 2015/08/18]*

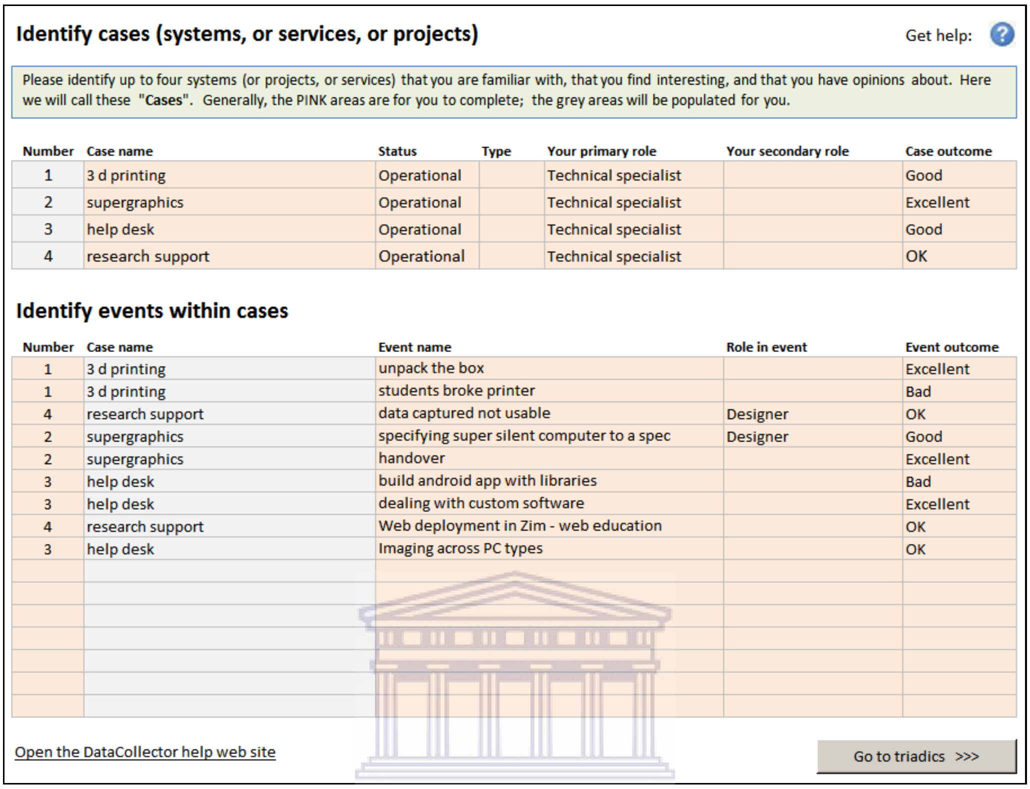
Compare this with the reaction of one of his colleagues, who was able to stand back and comment very positively on the interview experience as seen in the worksheets that he had completed:

> *'I feel when I did the last page, and so had a look at my previous answers, it actually brings out a lot of things that I initially thought were unimportant, so if you match these two up, the previous questions and align to the last one, they actually speak to one another, they actually bring out the things that I find most important. The things that I need to work on especially. Definitely. But only when I filled in the last page. I thought OMG, it's all coming out now!' [RES 27 - Technical Team A, University B, 2015/08/18]*

This is a reminder that although this was a *structured* data collection exercise, there are always the soft edges where personal feelings, and the respondents' reactions to the process, affect the answers that are actually given.

5.2.1 Identifying cases (systems)

The illustrative data provided here (Figure 32) is taken from RES 21, the 'Help desk manager':



Identify cases (systems, or services, or projects) Get help:

Please identify up to four systems (or projects, or services) that you are familiar with, that you find interesting, and that you have opinions about. Here we will call these **"Cases"**. Generally, the PINK areas are for you to complete; the grey areas will be populated for you.

Number	Case name	Status	Type	Your primary role	Your secondary role	Case outcome
1	3 d printing	Operational		Technical specialist		Good
2	supergraphics	Operational		Technical specialist		Excellent
3	help desk	Operational		Technical specialist		Good
4	research support	Operational		Technical specialist		OK

Identify events within cases

Number	Case name	Event name	Role in event	Event outcome
1	3 d printing	unpack the box		Excellent
1	3 d printing	students broke printer		Bad
4	research support	data captured not usable	Designer	OK
2	supergraphics	specifying super silent computer to a spec	Designer	Good
2	supergraphics	handover		Excellent
3	help desk	build android app with libraries		Bad
3	help desk	dealing with custom software		Excellent
4	research support	Web deployment in Zim - web education		OK
3	help desk	Imaging across PC types		OK

Open the DataCollector help web site

Go to triadics >>>

Figure 32 Collecting data about events

Respondents entered the data themselves, although the researcher was present in all cases to assist, and to deal with any problems.

5.2.2 Identifying scales

When events were complete, the process moved on to scales (Figure 33):

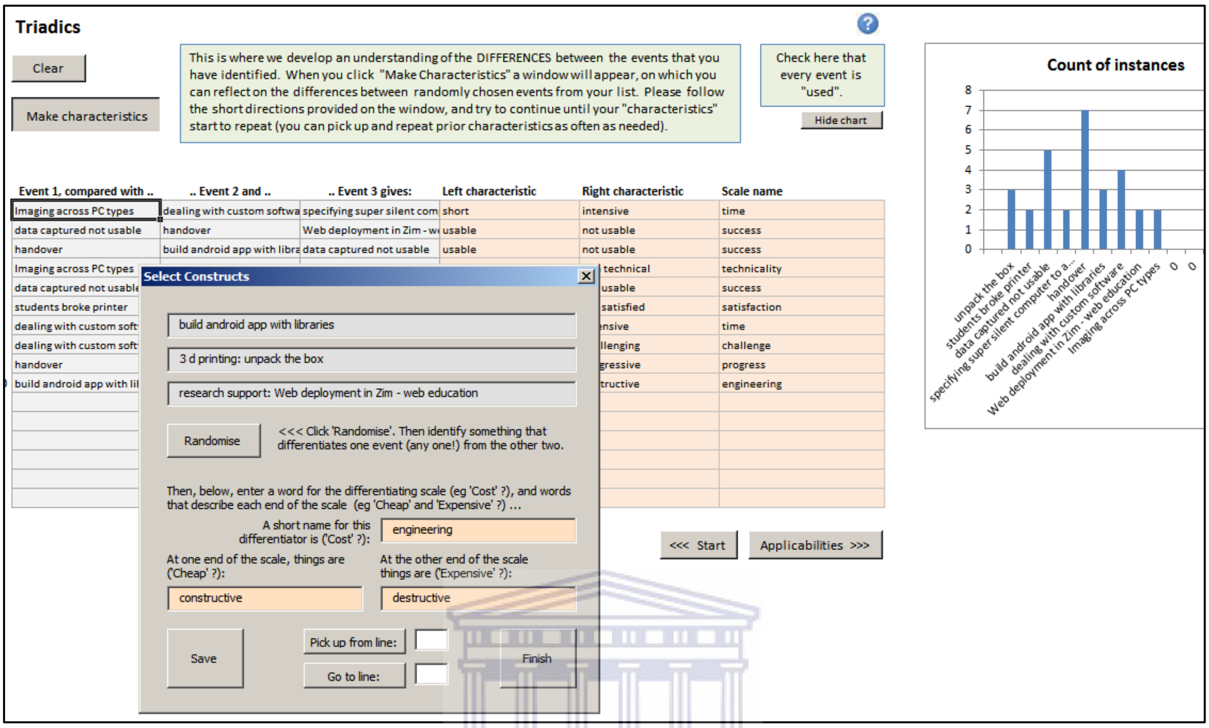


Figure 33 Developing scales using the triadic method

The way in which scales were identified is important, because it was done with the triadic method associated with Repertory Grid analysis, assisted by the use of macros in a spreadsheet. Excel workbooks were programmed to randomly select three events at a time, so that respondents could identify the scales by a short name and by an indication of the scale at the ‘good’ and ‘bad’ ends (if the notion of good and bad actually applied, which was not always the case). Figure 33 shows an example, as it appeared at one stage in developing scales with the help desk manager (RES 21). It can be seen that the number of instances of each event was monitored (in the chart at the right) to make sure that all events were included and to keep an eye on the overall balance. In cases where there were many events (up to 16) it was deemed sufficient that each event was included at least once.

5.2.3 Identifying applicability and ratings

Further worksheets provided for the assessment of applicability of scales to events (on a scale of 1 to 5) and for the entry of ratings (also on a scale of 1 to 5). In order to generate ratings *only where there was applicability*, this was allowed where the applicability was above 2 (i.e. 3, 4 or 5). This provided some relief to respondents, and happily all who started the data collection completed it. This generated two matrices of ordinal data that were then ‘flattened’ and combined into a single serial flat file for transfer to the Microsoft Access database for further analysis.

Figure 34 and Figure 35 below show first the final matrix of ratings for RES 21 (the applicabilities matrix that preceded it was very similar), and then a portion of the flattened data that was transferred into the database for analysis. The pink cells are the ones where the applicability was 3 or greater:

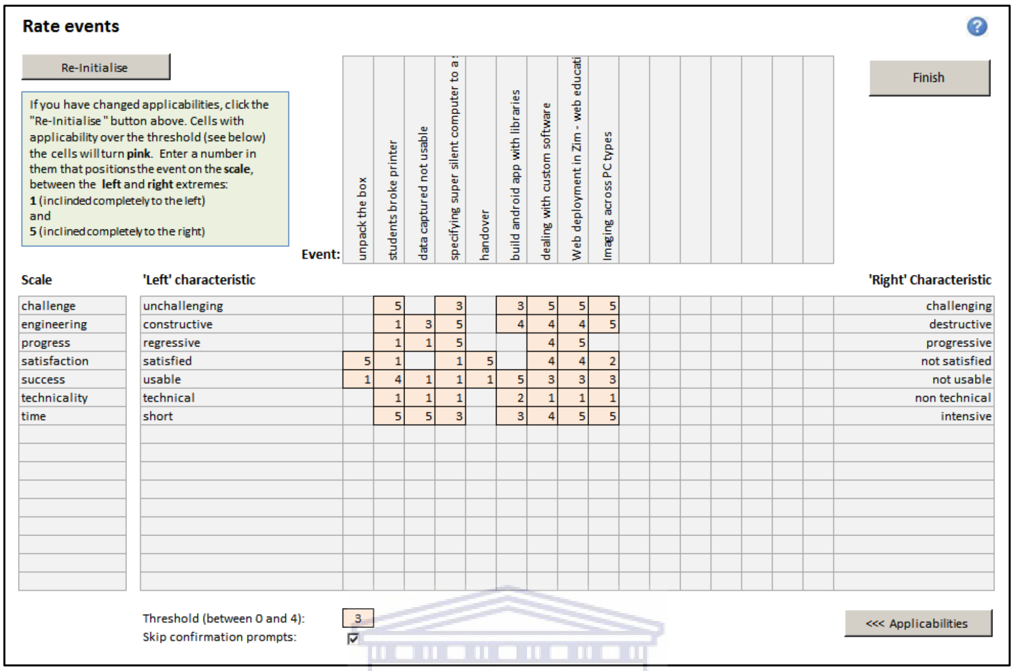


Figure 34 Rating events on the scales

A 16x16 matrix would generate 256 applicabilities and a proportionate number of ratings, of course, and so the flat files generated a considerable volume of data for further analysis:

	A	B	C	D	E	F	G	H
1	Col	Row	Applicability	Rating	Event	Scale	Left	Right
2	1	1	0	0	unpack the box	challenge	unchallenging	challenging
3	2	1	5	5	students broke printer	challenge	unchallenging	challenging
4	3	1	2	0	data captured not usable	challenge	unchallenging	challenging
5	4	1	5	3	specifying super silent computer to a spec	challenge	unchallenging	challenging
6	5	1	1	0	handover	challenge	unchallenging	challenging
7	6	1	5	3	build android app with libraries	challenge	unchallenging	challenging
8	7	1	3	5	dealing with custom software	challenge	unchallenging	challenging
9	8	1	3	5	Web deployment in Zim - web education	challenge	unchallenging	challenging
10	9	1	5	5	Imaging across PC types	challenge	unchallenging	challenging
11	1	2	0	0	unpack the box	engineering	constructive	destructive
12	2	2	5	1	students broke printer	engineering	constructive	destructive
13	3	2	3	3	data captured not usable	engineering	constructive	destructive
14	4	2	5	5	specifying super silent computer to a spec	engineering	constructive	destructive
15	5	2	0	0	handover	engineering	constructive	destructive
16	6	2	3	4	build android app with libraries	engineering	constructive	destructive
17	7	2	4	4	dealing with custom software	engineering	constructive	destructive
18	8	2	5	4	Web deployment in Zim - web education	engineering	constructive	destructive
19	9	2	5	5	Imaging across PC types	engineering	constructive	destructive
20	1	3	0	0	unpack the box	progress	regressive	progressive
21	2	3	5	1	students broke printer	progress	regressive	progressive

Figure 35 A portion of the flat file ready for transfer to Microsoft Access

In the database (implemented using Microsoft Access) the data becomes amenable to analysis by SQL queries and Pivot Chart analysis, as will be demonstrated.

5.2.4 The structured data

Data about events, scales (qualities and characteristics), applicabilities and ratings were collected in Microsoft Excel, and then ported into the database for Repertory Grid analysis. The data collection delivered 312 events from 30 responses, leading to 228 scales, 2,242 applicabilities and 1,132 ratings. This structured data in Excel was loaded to the Access data management and analysis package, developed for this study (see Figure 36).

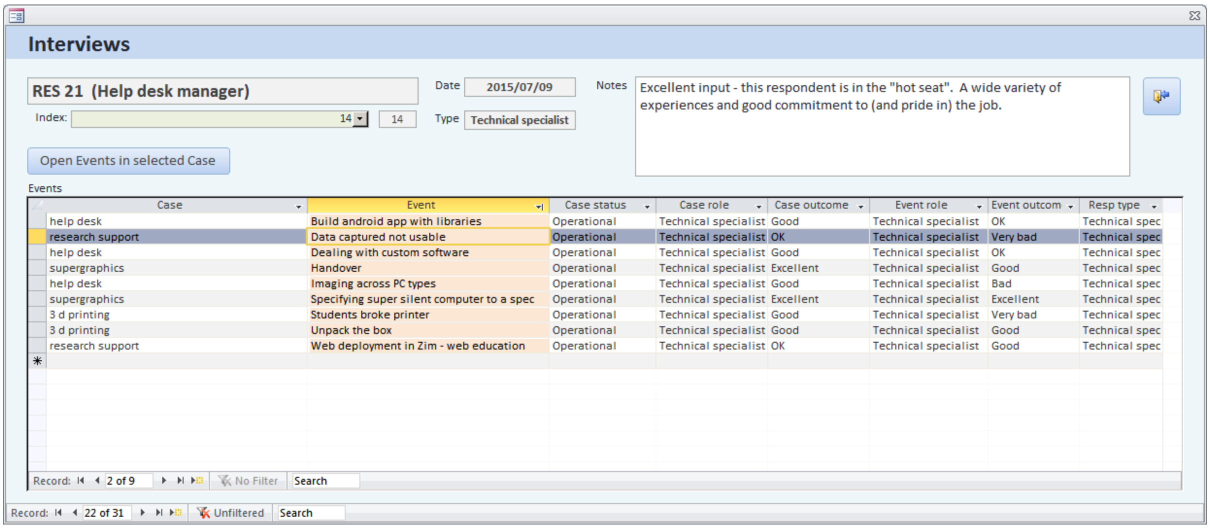


Figure 36 The data in Access, seen at the level of the 'Interview'

5.2.5 A note on the Repertory Grid

This study was concerned with the nature and characteristics of events (ISE transactions), as seen by role players working within a chain of activity that delivers educational value from information technology investments. It was necessary to design a data collection process that elicited the perceptions of those role players without bias from the researcher. As explained elsewhere, the collection of data was principally based on the Repertory Grid method grounded in Kelly's theories of personal constructs (Kelly, 1955; 1970). Although this is an old idea, the use of the Repertory Grid in information systems related research has been discussed in great detail in a more recent paper, in which it is explained that the method supports both quantitative and qualitative research, and also idiographic and nomothetic research (Tan & Hunter, 2002). This flexibility makes it an extremely useful approach when a degree of pragmatism is needed. Tan and Hunter note that …

> *'The RepGrid technique, for IS, entails a set of procedures for uncovering the personal constructs individuals use to structure and interpret events relating to the development, implementation, use, and management of IT in organizations. The meaning individuals ascribe to an event is anchored in its antecedents and consequents.' (Tan & Hunter, 2002, p.2)*

In his original work, Kelly argued that people make sense of their experiences using personal 'constructs' emerging from their experiences, which can be 'linked' to 'elements' of their cognition about what makes up their world. In this kind of research, constructs are generally taken to be 'bi-polar' in that they have two extremes, so that an element can be 'rated' by positioning it on that scale. For example, in a study of personal experiences, the *quality* (the construct) of an *experience* (the element) could be seen as good, or bad, or at some point in between (the rating, associated with, or actually comprising, the link). Essentially, a link is a construct that is related to an element by means of conversation, or by other means.

Consider the following examples (Figure 37) which are illustrative – they are *not* drawn from the collected data:

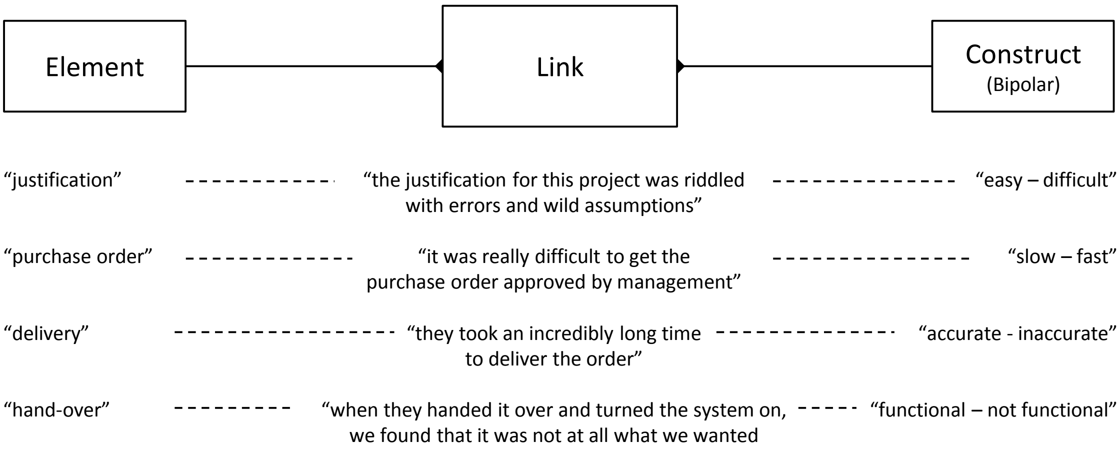


Figure 37 The components of Personal Constructs, with examples

In this research:

- Kelly's 'elements' are the events that respondents reported.
- Kelly's 'constructs' are the scales that were derived from the discovered qualities and characteristics.
- Kelly's 'links' are the instances where bi-polar scales were considered to apply to an event, and were used to rate the events.

5.2.6 The structuring of the RepGrid data

For the purposes of the interviews and for the ease of respondents it was decided to refer to ISE transactions simply as '***events***'. Respondents were asked to think about and nominate events they had been involved with, where there was an exchange of cost or value, or any other consequence that was significant for them. They were then asked to develop ideas about the qualities and characteristics of those events that would distinguish them from the others (the triadic method used by Kelly) and to rate them accordingly, using those qualities and characteristics on what (in the interviews) were simply called '***scales***'.

Thus – conceptually – there are ***qualities and characteristics*** that may or may not be accommodated in available ***standards and good practice guidelines***; these may then define ***scales*** that can be used to assess ***events***, leading to ***ratings***, that may or may not correlate with the ***outcome*** of the events (as reported by respondents).

These inter-dependencies can be summarised in the following data model. It uses the general principles of entity-relationship modelling, so that the final resulting model is fully normalised, and the notation makes the cardinality of the relationships clear. Relationships all have labels and directional indicators, to give full meaning to the model.

As indicated by the annotations in Figure 38 below:

1. **Available** standards and guidelines can be tabulated and examined for their content.
2. **Applicability** of those standards can be assessed according to their acknowledgement of the qualities and characteristics that are important to respondents.

3. **Utility** of those standards can be assessed by examining the relationships between the ratings (derived by application of the qualities and characteristics) and the outcome of the events.

Ultimately, the only one of these three key issues that really matters (being entirely dependent on the first two) is the third: *Are the available standards useful*? This is a subjective issue that depends entirely upon the perceptions of the different role players that served as respondents to the study.

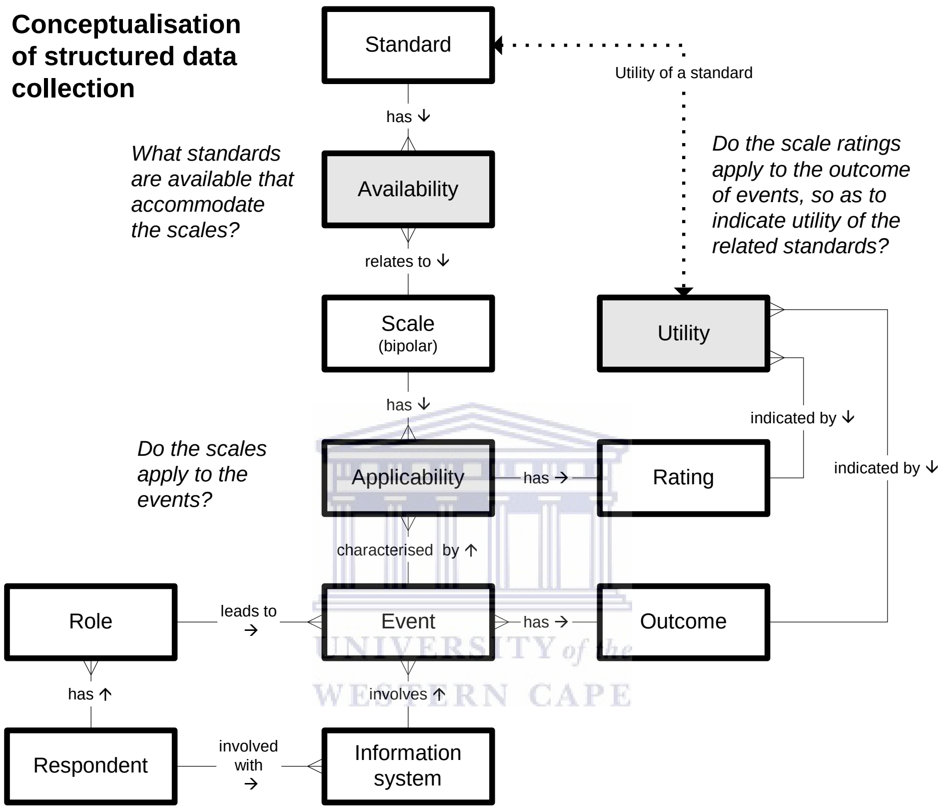


Figure 38 The structuring of collected data

The organisation of the collected structured data in the database (Figure 39) reflected this model (with some small changes):

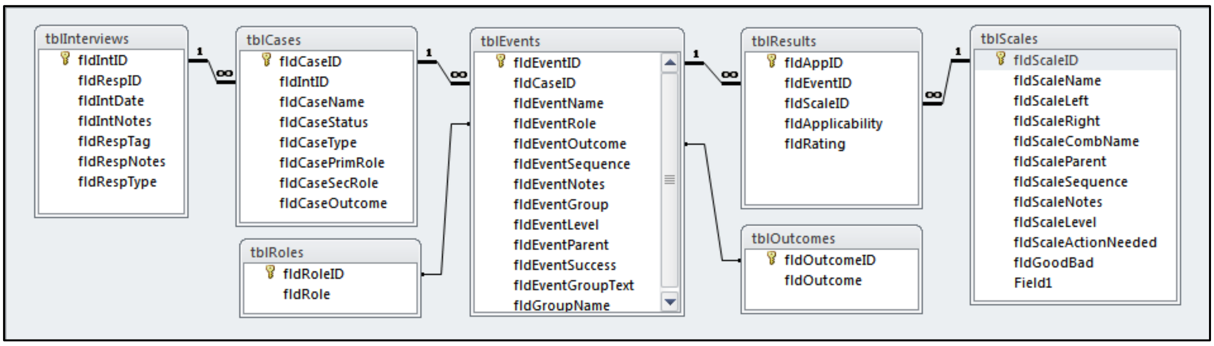


Figure 39 The organisation of the structured RepGrid data in the database

The RepGrid data was analysed using the OpenRepGrid library that is available within the RStudio statistical analysis package[11], which produced – for each respondent – the actual grid, a principal component analysis and a Pearson Correlation Analysis. The output from the RepGrid analysis can be found in Appendix 10.

5.2.7 The analysis

The analysis that follows is organised into three sections that correspond to the first three research questions:

- **What kinds of systems are being developed and used?** The first section looks at the variety and nature of the systems that were discussed, whether in development or in use.
- **What events are significant in developing and using systems?** The second section looks at the events that were deemed significant to respondents due to in their involvement with systems as developers, as users, or in some other role, and organises those events in different ways to investigate frequencies.
- **What are the qualities and characteristics of those events?** In a similar way, the third section looks at the scales that emerged from the triadic analysis and organises them in different ways to investigate frequencies; it then goes on to investigate the evidence of success and to report on the Repertory Grid analysis.

5.3 Analysis of systems in development or in use

This section addresses Research Question 1:

What kinds of systems are being developed and used?

More than 80 'cases' of information systems were found in the discussions with respondents. It was interesting that despite the discussion being directed to *information systems*, what respondents actually chose to talk about often concerned *situations* relating to information systems they were involved with, and so the term 'cases' was adopted so as not to exclude what was, to them, important evidence to put forward. There is a tabulation of cases in Appendix 7.

5.3.1 The variety of cases

Respondents chose to talk about different situations that related to their involvement with information systems. There was talk of administrative processes, core operational systems, data and information services, infrastructure, technical experiences, methods of working, innovation and a range of strategic initiatives.

Administrative processes were sometimes not at all directly connected to information systems as such. For researchers, dealing with the acquisition and assignment of resources was important, as was the negotiation of employment contracts. Financial reporting systems for researchers are very short on the right facilities that they require – institutional accounting systems do not have the facilities required by researchers and do not provide timeous data when it is needed. In one case, a research project director had committed considerable personal time and effort to the development of a system that did successfully provide what was needed. Elsewhere, a research administrator

[11] The version used was RStudio (Version 0.98.1103) with the OpenRepGrid Library (Version 0.1.9).

took special pride in the spreadsheet system that she had developed, on her own, in the interests of efficiency in dealing with research project management. On the other hand, a technical specialist responsible for the acquisition of special hardware for computer science research had no particular difficulties in invoking standard institutional procedures for purchasing. For a technical team thinking about the development of a new system, a key activity was visiting a teaching and learning facility in order to find out what was actually needed in teaching nursing (this was clearly preferable to making assumptions about what *might* be needed, which is often the approach of IT specialists).

Core operational systems were more or less as expected: student application processing, student information systems, timetabling, learning management, student assessment and marks administration all featured strongly. Services provided in-house such as printing services, email, and library facilities led to a range of stories of wonderful success and abject frustration. Institutional web sites were mentioned, but did not predominate despite the critical significance of these interfaces with the outside world, and their role as an information portal for those working with or within an institution. There was, of course, evidence of major efforts to develop and upgrade these core systems. One institution is investing in short courses as a 'third-stream income' opportunity and this was presenting challenges because of integration problems with the existing core systems. Such work is strategic. It is clear that the adoption and implementation of learning management systems is at different stages in the different institutions but still presents some strategic management challenges in terms of realising all of the expected benefits for the different stakeholders. Students clearly value learning management support (indeed, they very soon take these things for granted, it was found) but academic staff have different levels of willingness to change the way that they teach so as to release these potential benefits to all students.

Data and information services take on ever greater importance in higher education. Google searching, Google Drive and Google Scholar featured prominently among academic and administrative staff. YouTube is taken for granted as a legitimate source of supplementary learning resources by students and by some staff. Open bibliography management services like Mendeley are widely adopted and used, despite some institutions' efforts to develop their own or to recommend others. Help desk services are seen as important. There has been much talk about 'service management' as an alternative to 'IT management' and there is no doubt that the accessibility of so much technology gives management less and less opportunity to control what is chosen, which may be a good and not a bad thing. But it 'levels the playing field' and makes it more difficult for an institution to excel and differentiate itself solely through the quality of its information systems and services. There was at least one (possibly apocryphal) story of a research unit in one institution that had completely divorced itself from the standard institutional services and had committed to using Google Drive and Google Docs as its complete operating environment. This research unit was never found and so it did not contribute to this study.

Infrastructure and technical stories revolved around Internet, network engineering, database design, maintenance, upgrading and documentation; also web development tools such as Android studio, Eclipse, Textpad, Java, Net Bean, and LaTeX. It is clear that the new tools for web- and cloud-based systems development are still immature, they change quickly, and as much effort is needed to keep them working well as is needed to actually write and test the systems. In the more traditional domain of legacy systems, the options to buy bespoke, develop in-house or buy off-the-shelf continue to present challenges to executive management. The time needed to change these core systems is extended and is generally much longer than the time that it takes to build web applications, despite the difficulties with web development tools. Managing the information technology investment at this level continues to be a challenge.

The invitation to talk about systems prompted some discussion about methods of working. COBIT[12] and ITIL[13] were of particular interest to one or two respondents in senior technology management positions, and more specific schemes such as HEAT[14] and Software Process Improvement[15] were referred to in the detail of the conversations. Only ITIL and COBIT seem to have had serious attention (in the four involved institutions) as a possible means to improve performance, but discussions are continuing and adoption initiatives are on the horizon.

More vibrant were the discussions around innovation and strategic initiatives. A very wide range of forward-looking situations were discussed, possibly because respondents' interests were stronger in looking forward to new things than in looking back to the past. For example: the effort to 'professionalise' teaching and learning (in its use of information technology) was strong in one case, and closely associated with a significant investment in a new learning management system; the community-developed system for a growing range of higher education administration – Kuali[16] – is known locally and it is of considerable interest to some respondents; at another level there was interest in the 'clicker' idea that improves teaching interaction in the lecture hall, and SMS technologies are creeping into many corners of the higher education world in order to keep people informed. 'Business Intelligence' is not only of burning interest in business, the idea was found to be a current issue within all institutions. At the level of actual education, one senior lecturer had single-handedly conceived, argued for, and implemented a radical new post graduate programme to help bachelor-level graduates who had been unemployed for more than a year, teaching them systems design and programming skills and organising employment opportunities. Outreach is important to all institutions, as they need to be seen contributing to the national transformation agenda. 'Apps' are being developed to provide connectivity to communities in rural locations. On the research side, there was considerable activity to develop special systems for laboratory telemetry, graphics and audio research, and of course there is the national investment in RIMS (although that was virtually unknown to research leaders, only to certain administrative management). At a more technical level, systems development and code management tools such as GitHub are changing the way that software is developed, and shared.

5.3.2 The good and bad cases

As the discussions proceeded a record was taken of whether things were going well, case by case, in order to ascertain where any identifiable areas of success and difficulty could be found.

The areas of difficulty included institutional infrastructure, financial reporting, application processing, and hardware purchasing – also the problems in acquiring specialist equipment and

[12] http://www.isaca.org/Cobit/pages/default.aspx
[13] https://www.axelos.com/best-practice-solutions/itil
[14] https://heatsoftware.com/platform/hybrid-service-management/it-service-management/
[15] http://www.iso.org/iso/home/store/catalogue_ics/catalogue_detail_ics.htm?csnumber=54175
[16] https://www.kuali.org/

software for research. In one case there was particular anger at the poor level of email services offered to professional educators and researchers; also at an institutional failure to recognise that a good email system is about more than just messages, it provides a repository for work and a record of progress over long periods of time. Certain projects seemed to be facing special difficulties, perhaps for specific reasons, as in the case of a simple booking system for student services.

The areas of success were far more numerous and included effective personal use of 'Office' suite software, and of publically available services such as WhatsApp, Google Drive and GitHub as well as core institutional systems such as timetabling, library services, learning management and learning innovation. Where research works well it delivers a high level of satisfaction that is associated with success, but it seems that for some there is more satisfaction in successfully *addressing problems* than in simply succeeding. This is why some of the web development tools were seen as problematic and unreliable: they can waste a lot of time, but when they work the results can be spectacular. Of course, success in one perspective might be failure in another: in the case of one new marks administration system that the project manager reported as a great success (because it forced the imposition of the academic rules) the same was reported as a distinct failure by an academic, because it prevented him administering his marks in the way that he wanted. Generally, where they were working well, core systems such as student administration were seen as successful. It is clear from a review of the data that success is associated with executive support and user engagement as well as with availability and reliability. The evidence about RIMS was interesting because there seems to be prevailing optimism – administrators have had good experiences with early implementation and are looking forward to a full range of facilities – and yet the project has been running for several years and has found an awkward mix of requirements within the different kinds of institution nationally.

5.3.3 'Systems' summary

Table 5 summarises the number of different kinds of 'system' that were described by respondents, and the extent of their assessment of their outcome as good or OK on the one side, or bad on the other:

Table 5 A summary of the kinds of 'systems'

Category of system	Number	Good/OK	Bad
Admin	11	8	3
Core operational	21	17	4
Infrastructure	5	4	1
Innovative	17	16	1
Management	2	2	
Method	3	2	1
Service	7	7	0
Strategic	7	5	2
Technical	9	8	1

This survey of 'information systems' was expected to generate a simple list of what traditionally would be seen as systems, but it generated something quite different: a portfolio of what have been called 'situations' here in order to accommodate the variety of cases proffered by respondents. These situations illustrate the reality that respondents consider to be the important issues in working with information technology and information systems. It does not matter if they chose to talk about the delight in making web development tools work properly for the first time – that is what they considered to be important and rewarding. It does not matter if they rant and rave about poor email services and the inadequacies of the people in the IT function – that is what has really affected their personal productivity in trying to accomplish their academic, administrative or management work with information technology and systems.

In terms of standards and good practice, this result cautions us that successful investments in information technology and systems rely on much more than just the qualities of the technical work. What is needed is not just a guide to writing good software program code, or designing a proper system testing plan, it is about something bigger: having sight of what an institution is trying to achieve in all its different realms of activity, and putting in place policies and procedures that will join the technology capability to the educational need, or stimulate new educational opportunities from new technologies.

Further insight can be gained by a more careful inspection of the detail of these experiences with systems and technology. This is now done, at the level of the events that respondents considered significant within their experiences.

5.4 Events analysis

This section addresses Research Question 2:

What events are significant in developing and using systems?

Overall, 211 events were identified in the interviews, each of them standing as an example of what might happen when working with information systems and technology. They are tabulated in full in Appendix 8. Because in the team interviews a single event was characterised and rated more than once, separately by each individual team member, the source data actually provides 274 instances of event assessments.

The words used in naming and describing the events were chosen by respondents and so the events were reviewed in order that associated, similar or identical events could be gathered into groups. Such an aggregation of the detailed data also provides for the calculation of cardinal data (averages and standard deviations, for example) from the detailed ordinal data that is in the source tables. This is done here by means of frequency analysis and by mapping in three different ways:

- By respondent group, or role, in order to see the balance of evidence between the different kinds of people in the population.
- By activity group within functional areas, in order to see the spread of evidence across the different areas of work within an educational institution.
- By IMBOK domain, in order to see the extent of evidence along the chain of activity that delivers not just software and systems, but benefits that serve the strategic intentions of an institution.

5.4.1 Events seen by role

As already noted, respondents worked in different academic, administrative and management areas but the role that they fulfilled at the level of events varied. For example an operational manager might have acted as 'champion' in a special project, or a technical specialist might have been given project management responsibility in relation to a particular project. These roles were recorded for all events, at the time of the interviews.

The number of events that were found from each group of respondents is shown in Figure 40 below.

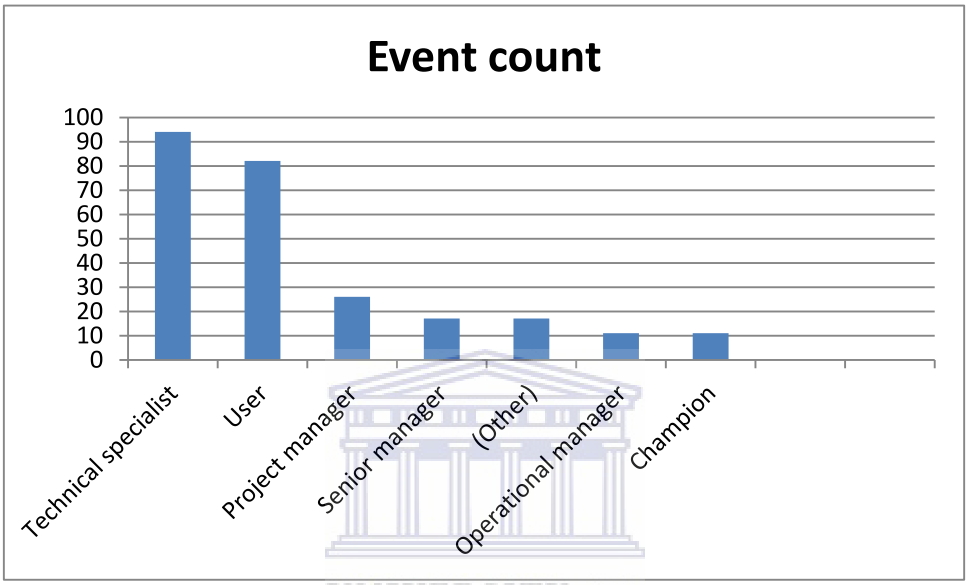


Figure 40 The number of events captured within respondent groups

The focus on 'technical specialists' and 'users' is appropriate, because at the end of the day it is the technical people who undertake the core software development work; it is the students, researchers, teachers and administrators who need to be assisted by means of that software. For an exploratory study like this one, the representation of the other groups was considered to be adequate.

5.4.2 Events seen by functional area

Notwithstanding the respondent group that they were in, respondents were involved in different functional areas. Academics do 'administration'; administrators register as students and do 'learning'; technical specialists get involved in 'management'.

The aggregation of events into groups was undertaken subjectively, but it was guided by the natural separation of university work into four areas, thus:

- Academic (teaching and learning)
- Academic (research)
- Administrative
- Management

  and additionally …

- Systems

At the highest level, in the context of this study, the first four main event groups are indisputable: these are the principal areas within which people work in higher education and many of the events discovered were easily organised into one or other of the first four top-level groups. However, there was a preponderance of events concerning *systems-related* activities (as will be seen shortly) and therefore the fifth top-level group was added.

Figure 41 below shows the frequency of events as summarised at the top level.

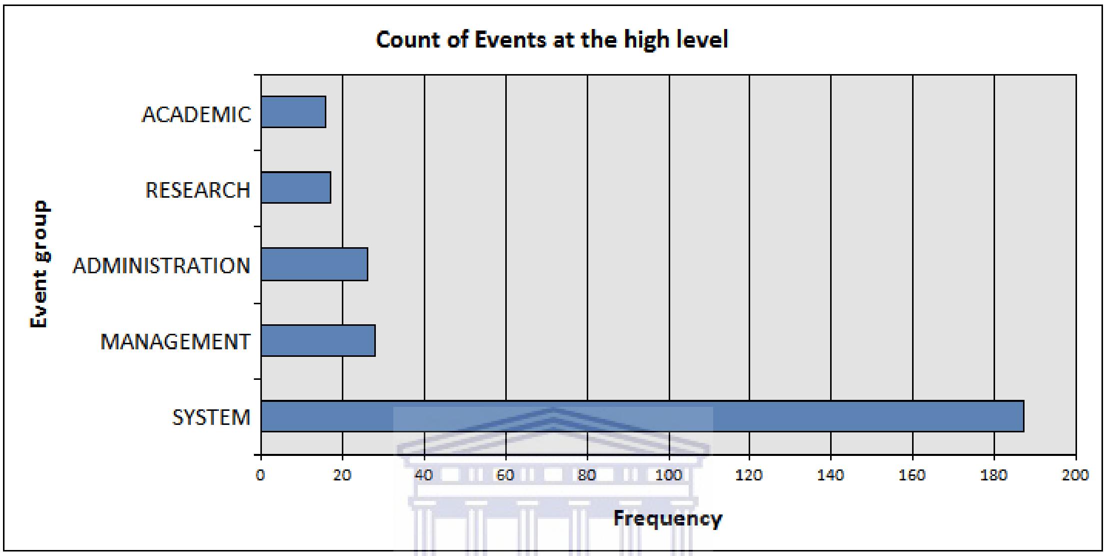


Figure 41 Frequency of events in the high-level event groups

In order to investigate the variety of events in more detail, further review within these five high-level groups derived 35 intermediate-level groups that accommodate the actual events, as given by respondents. These are shown in Figure 42; one intermediate event group of potential interest, SYSTEM BUILD, is expanded to show the original terms used by respondents:

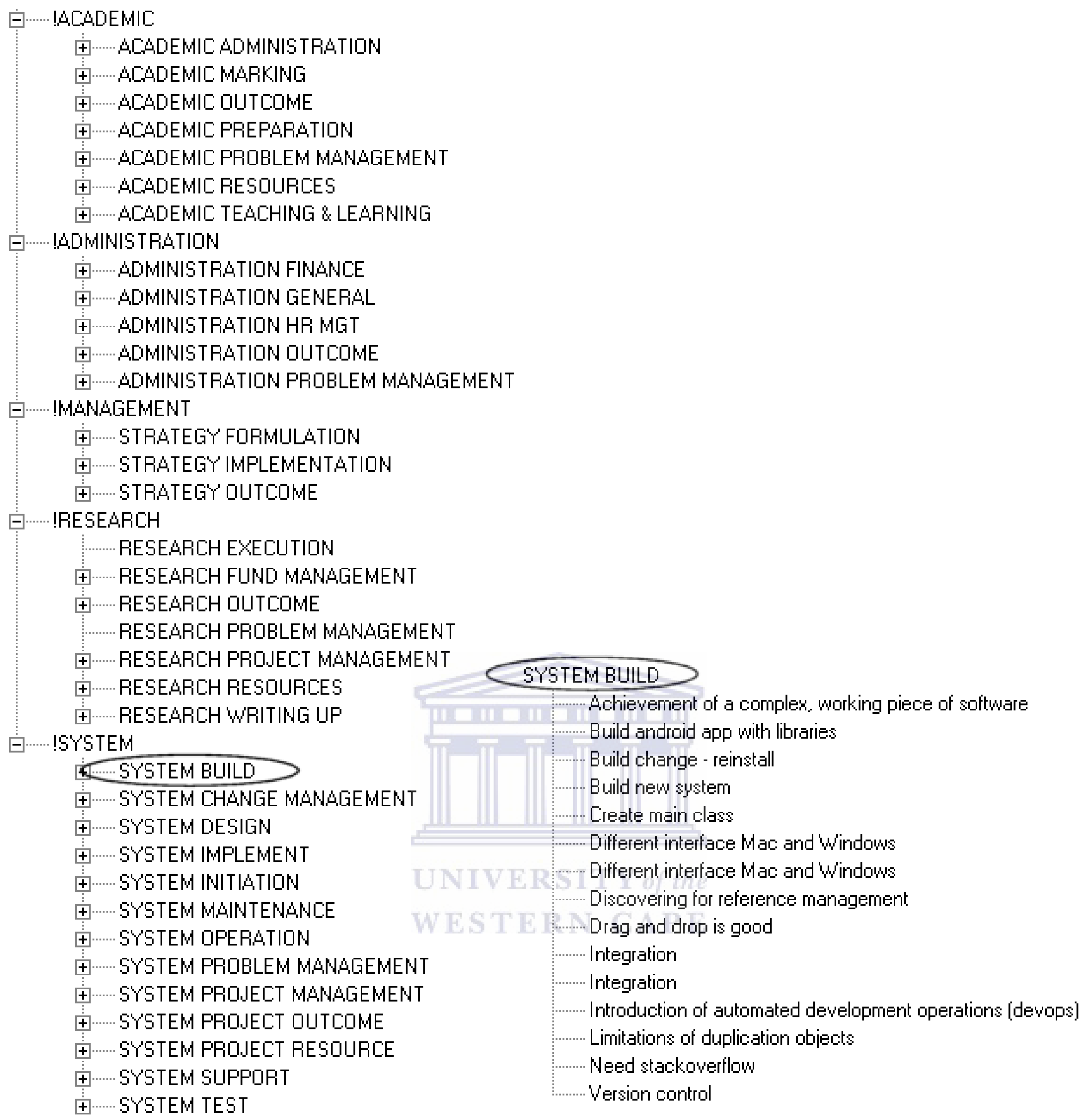


Figure 42 The event groups at two levels, with one expanded to show detail

At the intermediate level, some evidence about the size and shape of people’s work becomes clearer (Figure 43). Within the predominant group, ‘Systems’, there are the following frequencies:

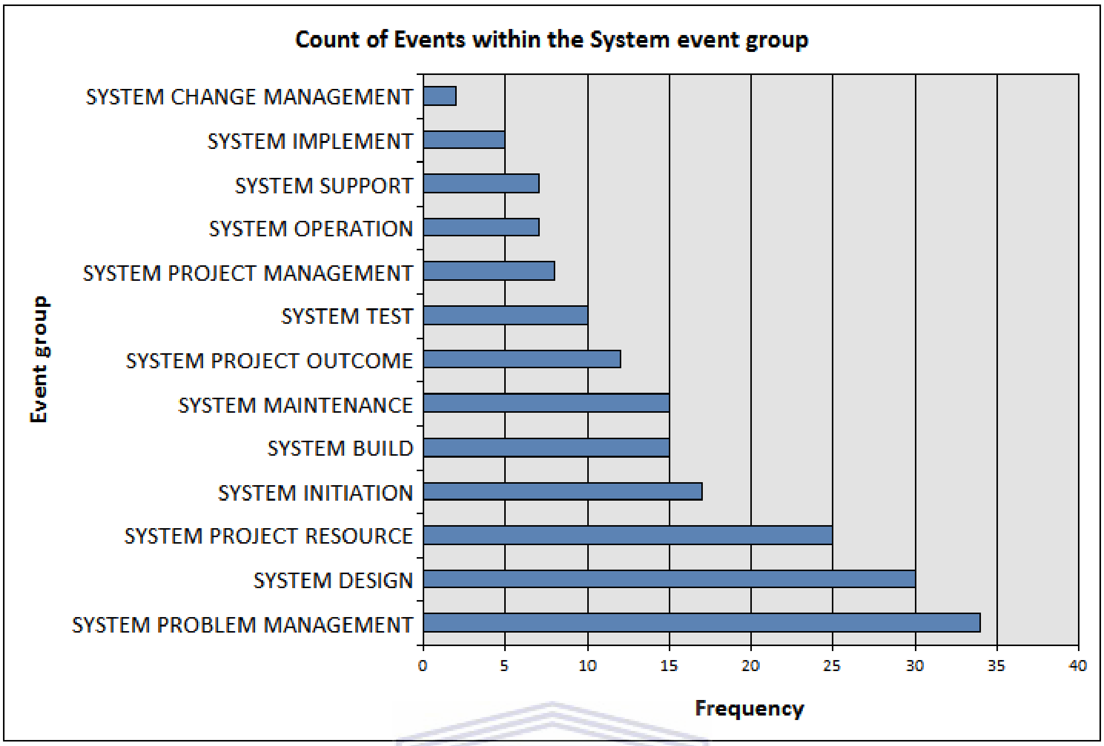


Figure 43 Frequency of events in the 'System' intermediate group

It is interesting that system problem management (25 instances) is the most predominant. No doubt institutional management would wish it otherwise but this gives justification to the study: these problems need to be solved. The core technical activities of designing (18) and building (15) systems are well represented together with resources (13), outcomes (12) and initiation (11). Systems project management (8) and testing (7) complete the work before implementation (5) and operationalisation (7), support (7) and maintenance (3). Considering the difficulties that change management presents, it is surprising that there are only two (2) events that can be classified as concerned with system change management. This might point to a lack of change, or a failure to address it. But – significantly – change is something that pervades much of what has to be done in higher education.

This simple tabulation of the frequencies of events in the 'system' intermediate group shows that there was a certain spread in the collected data, but beyond warning of many systems problems, design and resourcing issues it is not particularly informative and some of the frequency counts are low.

5.4.3 Events seen in the IMBOK domains

There is another way to look at the diversity of the data, and compare it with the intentions of the study, by invoking the Information Management Body of Knowledge framework ("IMBOK", already introduced in Figure 10). The IMBOK identifies five domains of management: information technology, information systems, business processes, business benefits, and business strategy. It also identifies the four transitions between them, making a total of nine domains of interest. To those nine can be added the domain of management activity that is directed at the control of these nine domains. All 211 events were reviewed individually, and attributed to one or other of these ten domains – the result is included in the complete tabulation of events, to be found in Appendix 8.

Below (Figure 44) is an extract from that appendix that includes the words naming the event (as given by the respondent), brief field notes from the researcher, an indication of the IMBOK domain[17] in which the event was placed, and the outcome of the event as perceived by the respondent:

	using systems if there are alternatives.		
Take over for change management	Previous experience in business had been better than the experience within a university.	IS-BP	Good
Terminal window	This is a feature of program coding today - used frequently.	IT	OK
Testing on production	The idea of testing upgrades on a production system (i.e. with live data) is an extremely bad idea.	IT-IS	Very bad
Training module	Training ahead of the introduction of a new national research reporting system.	IS-BP	Good
Trying to assess expenditure	Sometimes the information is there, and assessments can be undertaken.	BP	Excellent
Underlying operational system failed	Another case where inter-system co-operation is	IS	Very bad

Figure 44 Sample events, showing notes, IMBOK classification and outcome

The cross-tabulation of the event data (in Table 6 below) shows the mapping of the event group frequencies to the ten IMBOK domains, according to the functional areas within which they are located (remembering that 'where one is working' – the rows - is not the same as 'how one is contributing to the delivery of information technology investment benefits' – the columns).

Table 6 Mapping events to the IMBOK

	IT	IT-IS	IS	IS-BP	BP	BP-BB	BB	BB-BS	BS	MAN	Totals
Event group											
SYSTEM	22	72	25	39	12	1	2			14	187
ACADEMIC	3		1	1	6		1			4	16
ADMINISTRATION				4	16		1		1	4	26
RESEARCH	1	1	2	1	11					1	17
MANAGEMENT		1		3	3		1	2	7	11	28
Totals	26	74	28	48	48	1	5	2	8	34	274

The IMBOK adds to our understanding because it highlights the events that stand at the interfaces of technology (IT), systems (IS), processes (BP), benefits (BB) and strategy (BS). The transitions from IT to IS (74) and from IS to BP (48) together account for almost half of the total number of events.

The reader will notice that in the table there are now two categories of management – one in the columns and one in the rows. This is because the interpretation of 'management' in the IMBOK concerns management of the technical level; in the event groups, 'management' concerns institutional management activities.

What is more interesting is the correspondence of technical, operational and management activity between the two sets of data. The fact that the frequencies trend from the top left to the bottom right shows some synergy between the two sets of data. This is significant, and makes clear that it is the exchange of value between the information systems project and its 'supply' side and 'demand'

[17] Note that the IMBOK domains refer to 'business' (*business* processes, *business* benefits and *business* strategy); the word 'education' could be substituted (*education* processes, *education* benefits and *education* strategy), but in this thesis the word 'business' is assumed to indicate education, unless stated otherwise.

side that is the major concern of respondents. One might have anticipated this, but to have real evidence at hand helps to direct this enquiry in a useful direction.

This mapping reveals one other issue that is more troublesome – despite the high level of concern about the formulation of strategy revealed previously (see section 4.4.2) there is very little in the events data showing *linkage* between basic operations and strategy: BP-BB (1), BB (5) and BB-BS (2) in Table 6. Even strategy itself – BS (8) – is not well represented at the level of the reported systems events. The benefits of systems in business processes are not easily seen in narratives such as those in this study. In these circumstances, strategic success from information technology and information systems will be extremely difficult to achieve.

5.4.4 Events Summary

This review of the discovered events has shown that from the vicarious detail collected from respondents it is possible to aggregate the data in different ways. Within the data there is rich detail about systems work, and some detail about management and other operational activity. Mapping events to the IMBOK, an established model, reveals a lack of awareness of links to strategic issues. It can be concluded that the working 'horizons' of different role players are limited; they seem to see only what they think they need to see. The lack of evidence that the benefits of information systems are seen and understood by respondents is worrying.

5.5 Scales analysis

This section addresses Research Question 3:

What are the qualities and characteristics of those events?

In the same way, it is useful to look at the scales data for its representivity when compared with existing views about performance measurement. A large number of scales (170) emerged from the triadic analysis and were subjected to a similar process of grouping and review. There is a full and annotated tabulation of the scales in Appendix 9. Figure 45 shows a sample, with the scale name and end-descriptors (as chosen by the respondent) and notes from the researcher.

		Hardly a continuous scale, but interesting to recognise the differences.
Decisiveness	Decisive : Indecisive	This is a scale that the respondent attributed to external authorities that took decisions without proper assessment of the consequences, and (more specifically) in the sense that users can be indecisive. Ratings were middling, I am not convinced that
Delivery	Easy : Difficult	Very similar to the idea of the cost of rollout being variable, the ease with which systems and upgrades can be implemented is variable and significant, and leads to additional costs that might be avoidable.
Delivery	Delivered : Not delivered	Not everything that is expected or intended is delivered. Although this scale emerged from the triadic analysis, it was not deployed.
Dependency	Dependant : Independent	In a research management role, the dependency of the project on funding and the rate of expenditure is important. This respondent

Figure 45 A sample of the recorded scale data

In order to progress the analysis it was necessary to organise the scales into groups. This was a progressive process, testing different ideas, and involving two existing frameworks from the literature and the repertory grid analysis:

- The Balanced Score Card, which is a popular management device that extends the measure of organisational performance beyond simple financial measurements, so as to embrace the 'customer', internal efficiencies, and internal learning.
- The Service Management Gap model, which highlights the differences between actual and expected performance, perceptions of performance, and actual performance in a service delivery situation.
- The repertory grid analysis was used to gather the scales that were statistically significant and to gather them into groups that best represented the correlation with event success. As will be shown, this showed a satisfactory alignment with the four high-level themes that came from the landscape analysis.

The sections that follow report on these mappings.

5.5.1 Scales seen within the Balanced Score Card

In this context the Balanced Score Card (BSC - Figure 46) provides one way to organise performance measures:

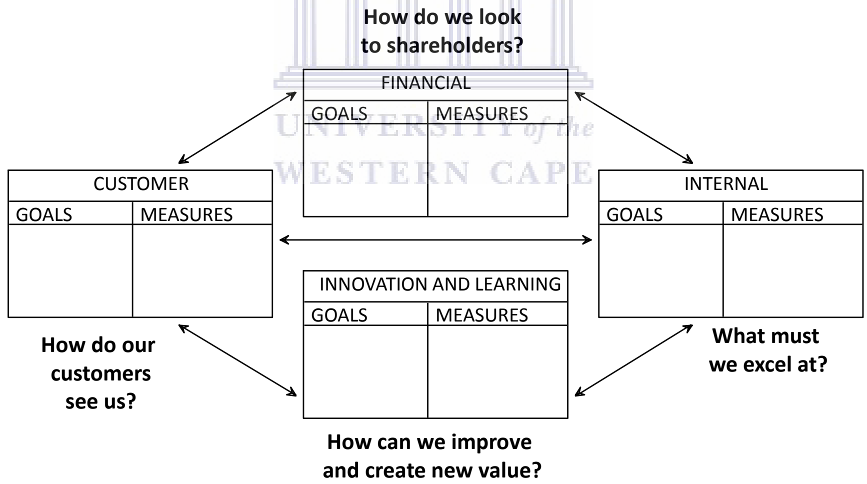


Figure 46 The Balanced Score Card

(Based on: Kaplan & Norton, 1996)

The four areas of measurement from the BSC are adapted and extended thus:

- Change management ('innovation and learning' in the BSC)
- External relations (*'customer' in the BSC*)
- Performance (*'financial'* in the BSC)
- Process management (*'internal' in the BSC*)

Here the BSC can be usefully augmented with two additional areas of measurement relevant to the present work …

- Project (because project management is a critical internal process)

- System (because a successful system is the objective of information systems engineering)

The group frequencies at this high level are provided in the Figure 47, bringing the idea of the process to the fore, yet again. By far the largest number of scales (44) was concerned with the measurement of process characteristics. Otherwise, the measurement of least interest was performance (16); the others fell in a close range (between 26 and 29).

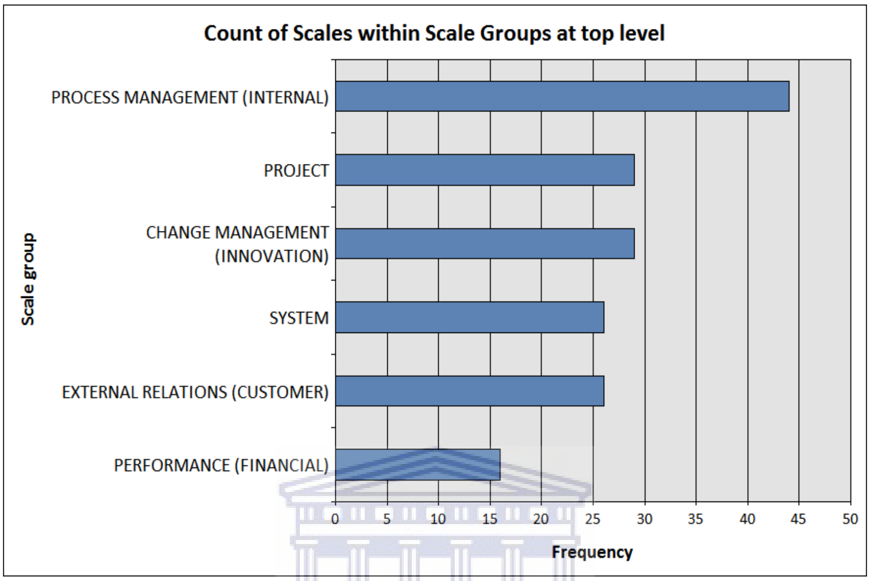


Figure 47 Frequency of scales in the high-level scale groups

In order to investigate the detail within these six high-level groups, 23 intermediate level groups were devised in order to more carefully organise the lowest level scales (as given by respondents). Figure 48 below shows the hierarchy that resulted, and an expansion of the SYSTEM SPECIFICATION scales so as to reveal some of the original detail.

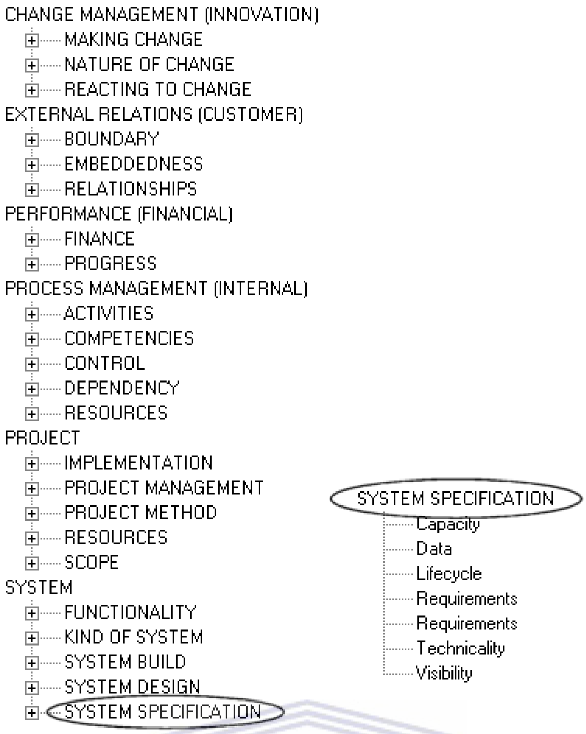


Figure 48 The scale groups at the first and second levels, with some system detail

At the detailed level (Figure 48), there is a variety of characteristics that respondents considered interesting in specifying systems, including the capacity of the system to work, identifying the associated data, the nature of the lifecycle, as well the requirements (twice, from two different respondents).

It is worth drilling down to the detail of the 'Process' group, to see where the interest lies therein.

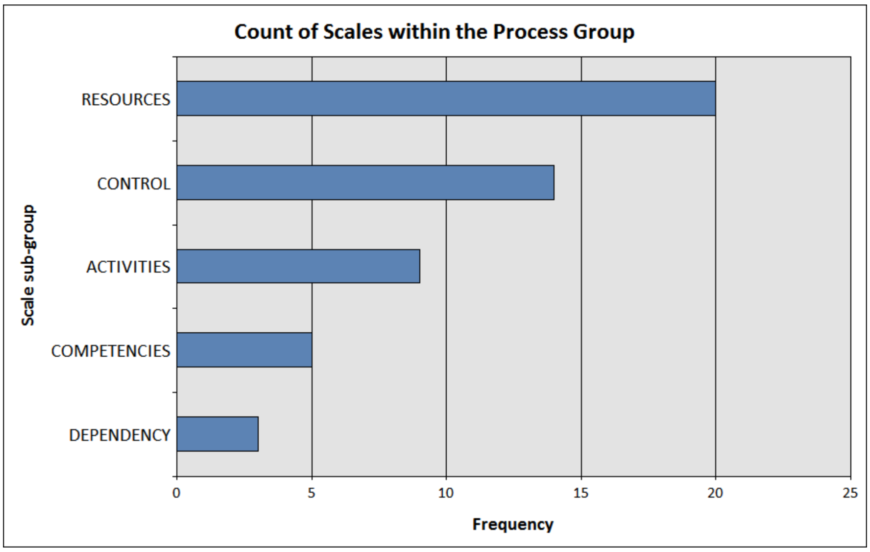


Figure 49 Frequency of scales in the 'Process' intermediate group

It is found (Figure 49) that processes concerning 'Resources' (for example, their acquisition and disposition) predominate (20), which further reinforces the idea that the 'stuff' of information systems engineering is of considerable interest. The other sub-groups cascade down: control (14), activities (9), competencies (5) and dependency (3). Although they scored least, competencies and dependencies are more than passingly interesting; for the author, the moments when these issues arose were particularly meaningful and might yet stand as the abductive moment, when something emerges that proves to be a good hook on which to hang a great deal of the other evidence.

5.5.2 Scales seen within the Service Management 'Gap' model

A second view of the discovered scales can be seen using the Service Management model (Figure 50), which divides the measurement of service quality into several 'layers' between management, service providers, and the people receiving service:

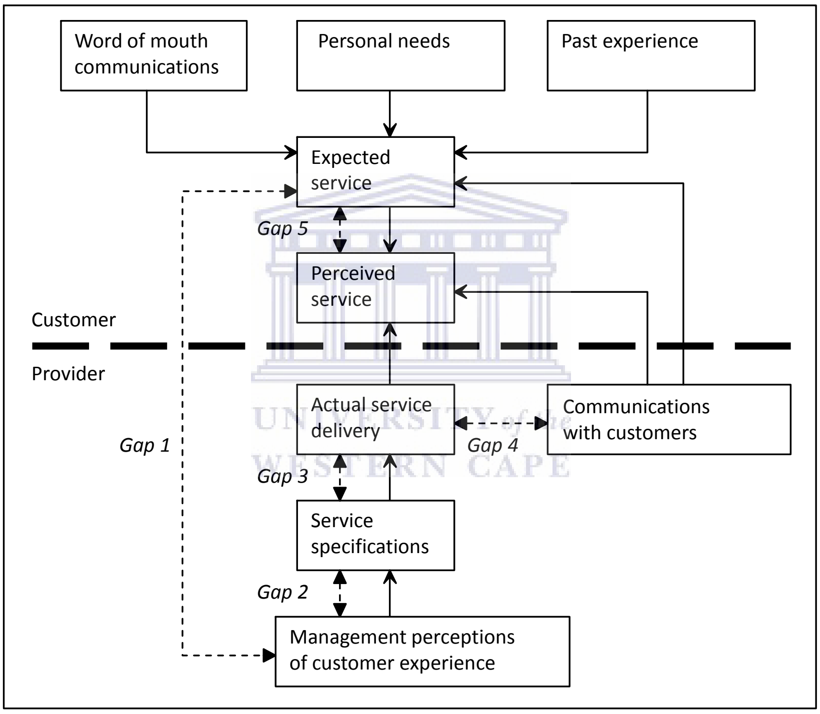


Figure 50 The service management 'gap' model

(Based on: Parasuraman et al., 1985)

The Service Management gap model shows seven areas within which there might be scales as derived in this study:

- Managers' **perceptions** of what needs to be done, and what is being achieved.
- The **specification** of services that are to be delivered.
- The actual **delivery** of services and the service level that is achieved.
- The **perceptions** of service that is delivered (not necessarily the same as actuals).
- The **expectations** of service that is needed by recipients.
- The past experience of recipients, and other **background** considerations.
- The **communications** between role players about all of the above.

These scale groups were formulated and the original source data about scales (177 in number) was re-assigned to see what the balance was, according to the Gap model (Figure 51). All scales were able to be allocated to one or other of the seven groups. The frequencies were:

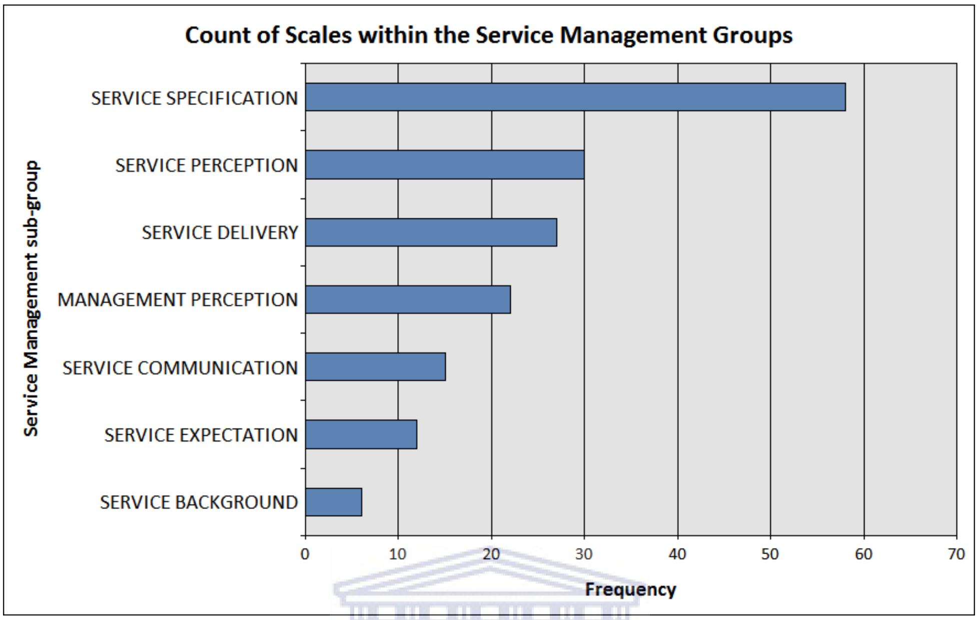


Figure 51 Scales organised into Service Management Groups

This result suggests that the service management paradigm works well in the present context, and that there is a high-level of awareness of *service specification* issues. The scales within that group were then further organised into subsidiary groups (Figure 52) according to:

- The nature of the service (for example, relating to academic or other activities).
- The scope of the service (internal, external, technical or otherwise).
- The lifecycle stages (traditional, agile).
- The timing issues (urgency and criticality).
- Complexity (controllability, security, cardinality).
- The service function (usability, input or output).

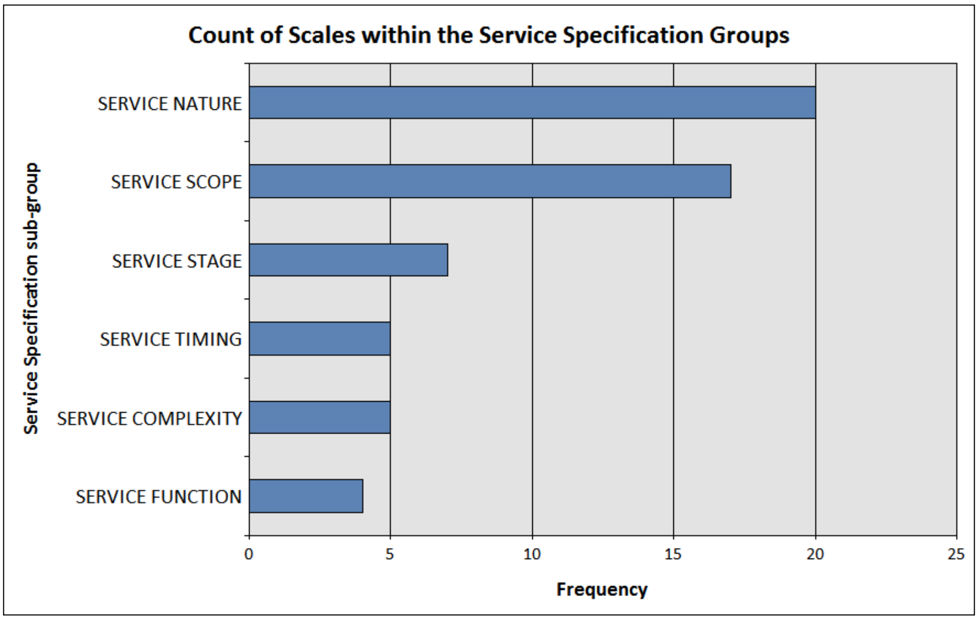


Figure 52 The detail of the Service Specification sub-group of scales

The focus on the nature of services highlights the need to recognise the differences in circumstance, when considering whether standards are needed and how they might be applied; the focus on issues of scope is perhaps to be expected, and brings to mind the matter of the boundaries that have to be defined and managed, and that became the focus of attention in the earlier chapters.

It is clear that the thematic area **Boundary** is associated with the idea of **Service**, because it is at a boundary where performance and service levels can be measured.

5.5.3 Success and Rating

Finally, for the moment, it is possible to map the success that is associated with these scales (at the level of event outcome) with the overall ratings on the discovered scales. A good correlation would indicate that there is the possibility that standards that improve performance *on these scales* will lead to better event outcomes, and therefore better systems outcomes.

However, not all scales were concerned with 'good' and 'bad' ratings – some were concerned with classifying events in different ways, for example as being within or without the boundary of a project, or of the institution. Others were concerned with the nature of work, for example being research or administration.

The scatter graph below (Figure 53) includes all those scales that were specifically concerned with 'good' and 'bad' measures and that had more than two ratings. It indicates visually that there is a positive correlation: high success is quite consistently reported where the ratings are high; low success is reported where the ratings are low.

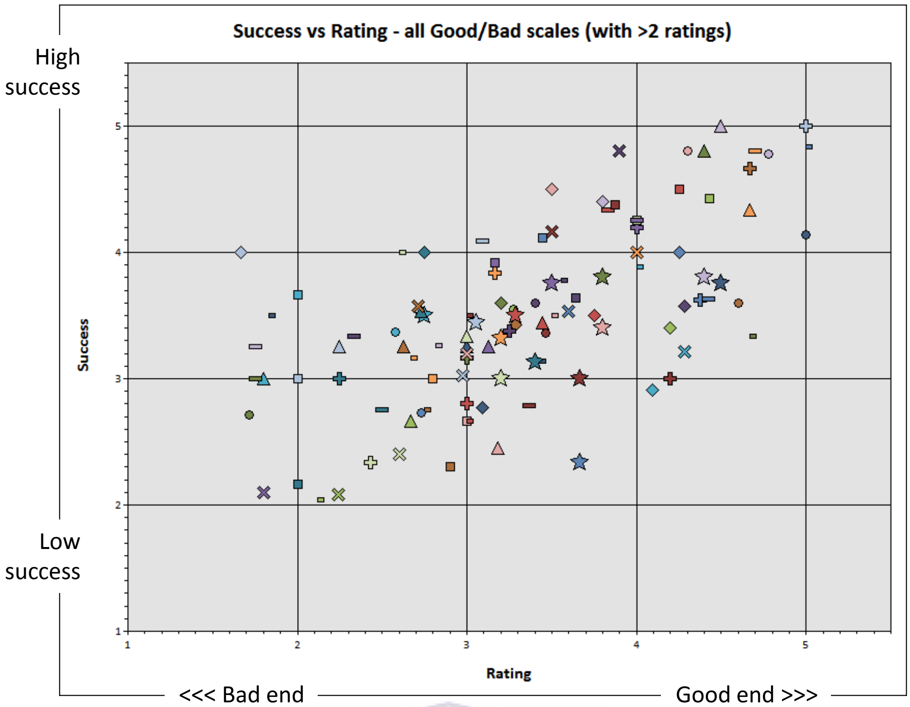


Figure 53 Rating and success for only those scales that indicate 'good' or 'bad'

This is a useful result that shows a clear correlation between success and those ratings that have a sense of 'good' and 'bad'. But there is more potential in the data: there is the possibility to undertake statistical analysis, and this is done in the section following, using Repertory Grid analysis.

5.5.4 Repertory Grid analysis

The repertory grid technique looks at data in a way that relates two perspectives – the *elements* and the *constructs* in Kelly's original terminology – using data that links instances of one to instances of the other (refer to section 5.2.5 for some details). This study is concerned with ***events*** as elements and ***scales*** as constructs, and – as already shown – these can be gathered into intermediate and high-level groups. The two-way mapping takes the form of a matrix and comprises what is known as the 'Repertory Grid'. The Repertory Grid invokes statistical methods to establish patterns of association between the scales, and correlations between them – here there is special interest in the correlation of scale ratings with event success.

As an introduction, Table 7 has been constructed using aggregated data: ***events*** are gathered into the IMBOK groups (the columns) and for this purpose ***scales*** are gathered into the four high-level thematic areas (the rows):

Table 7 An example of repertory grid data

	IMBOK Domain																			
	IT		IT-IS		IS		IS-BP		BP		BP-BB		BB		BB-BS		BS		MAN	
Scale group	Success	Rating	Success	Rating	Success	Rating	Success	Rating	Success	Rating	Success	Rating	Success	Rating	Success	Rating	Success	Rating	Success	Rating
MANAGEMENT			3.41	3.47	2.10	2.50	3.39	2.89	3.92	3.67	5.00	3.00			4.00	2.67	2.50	3.25	3.35	3.61
PROCESS	2.76	2.59	3.22	3.39	2.64	2.73	3.43	3.14	3.97	2.94			4.80	4.00	3.00	2.67	2.43	2.86	3.21	3.15
PRODUCT	2.67	3.39	3.39	3.22	2.87	2.93	3.67	3.48	3.85	3.15			4.50	4.75			5.00	4.50	3.42	2.58
SERVICE	2.83	4.67	3.39	3.65	3.33	3.17	3.80	2.80	3.88	3.94			4.00	5.00	3.50	2.50	4.00	3.00	3.71	4.29
Grand Total	2.73	3.24	3.32	3.42	2.68	2.79	3.52	3.13	3.91	3.30	5.00	3.00	4.60	4.40	3.50	2.63	2.93	3.21	3.33	3.24

This data was loaded into RStudio as raw data in plain text, using a defined template and delimiters (highlighted here in red) thus:

```
ELEMENTS
IT
IT-IS
IS
IS-BP
BP
BP-BB
BB
BB-BS
BS
MAN
END ELEMENTS

CONSTRUCTS
Management (Bad : Good)
Process (Bad : Good)
Product (Bad : Good)
Service (Bad : Good)
Success (Low : High)
END CONSTRUCTS

RATINGS
3.00    3.47    2.50    2.89    3.67    3.00    3.00    2.67    3.25    3.61
2.59    3.39    2.73    3.14    2.94    3.00    4.00    2.67    2.86    3.15
3.39    3.22    2.93    3.48    3.15    3.00    4.75    3.00    4.50    2.58
4.67    3.65    3.17    2.80    3.94    3.00    5.00    2.50    3.00    4.29
2.73    3.32    2.68    3.52    3.91    5.00    4.60    3.50    2.93    3.33
END RATINGS

RANGE
1 5
END RANGE
```


Notes:

- The *rating* data is taken from the main portion of Table 7 (see the *pink* cells).
- Missing values have been substituted using the convention of the mid-point rating: here, as the range is 1 to 5, the mid-point value is 3.00 (they are shown in the above data listing in *blue*).
- To analyse the correlation of success with the rating data, a fifth line is added as a further construct representing *success*, by taking the average success within each of the IMBOK domains in Table 7 (see the *green* cells).

The generated output, when the RStudio package is prompted using appropriate commands, provides the following:

- The **ratings**, in the layout of a repertory grid with the events (elements) in the columns and the constructs (scales) in the rows.

- A **principal component analysis** showing the components that emerged from varimax rotation of the data, and indicating the portion of the data that was accommodated within the analysis as proportionate and cumulative variance.
- A **Pearson correlation analysis** showing the correlation between each pair of scales. Of special interest here is the 'Outcome' scale that was derived from the event outcome, and then added as an additional scale in the data frame (referred to as 'Success' in the example above).

The first block, RATINGS (Figure 54), shows the average ratings that were loaded, organised as a repertory grid, where the values indicate in each case the extent to which the rating is to the LEFT (when the value is low, the 'bad' end) or to the RIGHT (when the value is high, the 'good' end):

```
RATINGS:
                                   BP - 5     6 - BP-BB
                           IS-BP - 4    |     |     7 - BB
                         IS - 3    |    |     |     |     8 - BB-BS
                 IT-IS - 2    |    |    |     |     |     |     9 - BS
               IT - 1    |    |    |    |     |     |     |     |     10 - MAN
                    |    |    |    |    |     |     |     |     |     |
Management (Bad (1)   3.00 3.47 2.50 2.89 3.67 3.00 3.00 2.67 3.25 3.61   (1) Good)
   Process (Bad (2)   2.59 3.39 2.73 3.14 2.94 3.00 4.00 2.67 2.86 3.15   (2) Good)
   Product (Bad (3)   3.39 3.22 2.93 3.48 3.15 3.00 4.75 3.00 4.50 2.58   (3) Good)
   Service (Bad (4)   4.67 3.65 3.17 2.80 3.94 3.00 5.00 2.50 3.00 4.29   (4) Good)
   Success (Low (5)   2.73 3.32 2.68 3.52 3.91 5.00 4.60 3.50 2.93 3.33   (5) High)
```

Figure 54 An example repertory grid

Hence, the rating of information technology (IT) Service is very good (at 4.67), and the rating of information systems management (IS) is rather poor (at 2.50).

Principal component analysis (PCA) gathers scales into groups of scales that are producing similar results: in the same or opposite 'directions', and to a similar extent. Sometimes a component includes two or more scales that are *clearly* of a similar nature but sometimes there is no obvious similarity; however, if the component is statistically significant then it represents a vector that describes the phenomenon and it has to be seen as important - in such a case a phrase might be found that accommodates the component parts, or it can be referred to by its code.

In the analysis undertaken here, values over 0.70 (or under -0.70) have been taken as significant, and are highlighted in red:

```
PRINCIPAL COMPONENT ANALYSIS
                          RC2   RC1   RC3
Management (Bad - Good)  0.88 -0.19  0.13
Process (Bad - Good)     0.36  0.57  0.63
Product (Bad - Good)    -0.03  0.92  0.10
Service (Bad - Good)     0.76  0.44 -0.01
Success (Low - High)     0.01  0.04  0.97

                RC2  RC1  RC3
SS loadings    1.48 1.41 1.36
Proportion Var 0.30 0.28 0.27
Cumulative Var 0.30 0.58 0.85
```

Figure 55 Principal component analysis

From Figure 55 shows that `Management` and `Service` are both significant in the first column (which is the *second* component of the data rotation (RC2) but which accommodates the largest portion of the source data); `Product` is alone in the next column (the first component, RC1), and `Success` is similarly not associated strongly with any of the others and is alone in the third component (RC3). In the second block, it can be seen that (in simple terms) these three components accommodate 85% of the source data. The fact that the other values (not highlighted in red) are low adds some significance to these results.

The result seems to suggest:

- Measures of `Management` and `Service` go together: good management delivers quality service, and where there is quality service then there is likely to be good management.
- Measures of `Product` work largely independently of the other components.
- `Success` (outcome) is also independent.

This suggests that there are cases of poor processes producing poor product, independently of good and bad efforts of the management to define and manage service.

The package also calculates the correlation between the scales, as shown in Figure 56:

```
PEARSON CORRELATION ANALYSIS
                          1      2      3      4      5
Management - Good) 1         0.26 -0.05   0.40   0.11
Process (B - Good) 2                0.50   0.48   0.55
Product (B - Good) 3                       0.26   0.15
Service (B - Good) 4                              0.09
Success (L - High) 5
```


Figure 56 Pearson correlation analysis

However, there are no strong correlations revealed here – that would be indicated by a high or low value in column 5 and only `Process` shows any degree of correlation with `Success`.

The degree of aggregation here, in absorbing 791 ratings into such a simple matrix, is masking the interesting detail that is to be found at the lower level, using the original data, and while this example is useful as an illustration, it provides nothing that can be relied upon without more detailed analysis of the source data.

5.5.5 The detailed results

The repertory grid calculations for each of the responses are provided in Appendix 10. On each page the analysis is shown in a similar way to the example above.

The result is useful because where scales are found to have similar statistical characteristics – because they co-occur in an analysis of principal components or they correlate with success – they can be separated out and reviewed so as to develop a new grouping, unique to this study and specifically informing the way that systems are used in higher education. The review process proceeded to group the results as follows:

- Values in the principal component analysis and correlation analysis that were over 0.70, or under -0.70, were highlighted. As a result, 35 Scales were rejected as not significant, having a value between -0.69 and 0.69; 136 scales were found to be significant at the chosen level.

- In the table of scales in the database, 26 *non-specific* scale groups were created and labelled from 'A' to 'Z', to provide *non-specific* 'containers' for scales that showed together in the derived principal components. This avoided any prejudice that might arise from adopting an existing model, such as the BSC or the Gap model. Naming these non-specific containers would be appropriate only when all the data is so organised, and if coherent patterns were observed.
- As the review progressed, the qualifying scales from each component were added progressively to the non-specific scale groups ('A 'to 'Z'), based solely on their co-occurrence in a component, or on their prior occurrence elsewhere when they had already been 'found'.

By way of example, in the first analysis (RES 03 - the first case in Appendix 10) it is found that `delivery` and `development` are inversely contained within RC1, and `need`, `novelty` and `visibility` co-occur in RC1:

PRINCIPAL COMPONENT ANALYSIS

	RC1	RC3	RC2
Cost (Low - High)	0.12	0.13	**0.96**
Delivery (Easy - Difficult)	**-0.73**	0.00	0.68
Development (Not challenging - Challenging)	**-0.88**	0.31	0.07
Need (High (might do own) - Low)	**0.85**	0.20	0.49
Novelty (Familiar - Novel)	**0.94**	-0.13	-0.07
People (In-house development - External non-development)	-0.15	**0.93**	-0.17
Stage (Design stage - Client operations)	-0.01	**0.80**	0.57
Technology (Older technology - Low - New technology - High)	0.06	-0.68	-0.51
Visibility (Process - Product)	**0.94**	-0.31	0.07
Outcome (Bad - Good)	0.52	-0.82	-0.20

All four contribute to the one vector. This was the first case and so they were all loaded to the first non-specific scale group, 'A'. `People` and `Stage` are evident in component RC3, and they were loaded to the next non-specific scale group, 'B'. `Cost` stands alone, and that was loaded to scale group 'C'. And so on.

As the review progressed, where recurring scales occurred multiple times (such as `Functionality`) they were in each case loaded to the same group as the first occurrence (Group 'C', in the case of `Functionality`, as it happened), together with its companions with in the principal component in which they were found.

5.5.6 Re-organisation of the scale groups

When the process was complete, there were 25 non-specific scale groups that were candidates for naming, so as to become specific. The content of the groups was reviewed, and it was found that two groups were extensively loaded with scales of a similar kind: group 'L' had scales predominantly concerned with *process* issues (55 cases), and Group W had scales predominantly concerned with *product* issues (39 cases). This was a good result. It was thereby found that the repertory grid analysis had revealed two scale groups that closely align with two of the thematic groups from the landscape analysis.

It was decided to pursue the idea that the four main high-level thematic groups from the landscape analysis would accommodate *all* of the success-related scales, and so scales *not* allocated to the groups 'L' (product) and 'W' (process) were assessed as candidates for allocation to two new groups. This proved to be possible, without difficulty, and these two further groups were adopted as *service* (18 cases) and *management* (23 cases).

In this way, the repertory grid analysis found that the statistically significant scales align well with the emerging high-level themes: PROCESS, PRODUCT, SERVICE and MANAGEMENT. Naturally, this process required some subjectivity, but it is important to note that all these scales satisfied the requirement that *they should feature as significant in the principal component analysis*. Further consolidation of these results would be possible, but for this study it is deemed sufficient that the RepGrid analysis has provided statistical support for the four high-level themes. There is a full tabulation of the results in Appendix 10.

5.5.7 The development of 'success groups'

While the Balanced Score Card analysis suggested that most scales are associated with internal process management, and the Service Management Gap model suggested that the larger number of scales is concerned with service specification, these simple mappings took no account of the statistical significance of the scales. The apparently successful mapping to the four high-level themes is convenient but also subjective rather than objective in nature. The Principal Component Analysis, supported by the Correlation Analysis, identifies those scales that either work together in component groups or correlate as pairs.

Of particular interest at this point is to identify and review the scales that correlate strongly with success. The 30 scales that correlated with success at 0.70 or above (using the results of the Pearson Correlation analysis) are tabulated in Table 8. In the case of negative correlations the scale end points have been reversed, so that all can be seen as positive (on the left) and negative (on the right).

Table 8 Scales correlating with successful outcomes

Scale	Good	Bad	Correlation with success
Enablement	Enabling	Disabling	0.95
Functionality	Functional	Dysfunctional	0.92
Platform	Facilitation	Obstruction	0.92
Resource	Adequate	Inadequate	0.88
Facilitation	Succeeds	Fails	0.87
Reach	Outreach	In reach	0.85
Progress	Progressive	Regressive	0.85
Progress	Forwards	Backwards	0.84
Lifecycle	Implementation of Requirements	Determining Requirements	0.84
Boundary	Out of university	In university	0.83
Academic	Successful	Unsuccessful	0.81
Dependency	Independent	Dependant	0.80
Design	Well designed	Poorly designed	0.80
Process	Out of process	In process	0.80
Control	Liberating	Constraining	0.79
People	In house development	External non-development	0.77
Stage	Design stage	Client operations	0.77
Expanding	Working together	Working in silos	0.77

Data	Movement	Storage	0.77
Show stopping	Non Showstopper	Showstopper	0.77
Development	Not challenging	Challenging	0.75
Liberation	Liberating	Constraining	0.75
Engagement	Listening	Not listening	0.74
Visibility	Product	Process	0.73
Technology	New technology ~ high risk	Older technology ~ low risk	0.73
Criticality	Not critical	Critical	0.73
Motivation	High	Low	0.72
Functionality	Functional	Non-functional	0.72
Specificity	One project	All projects	0.71
Time	Short	Intensive	0.71

A fresh approach to the review of these ‘success scales’ progressed as follows, taking the scales in order of the highest scoring first, and working down the list (refer to Table 8):

- Enablement was the top-scoring scale, at 0.95. This was taken as the beginning of a new success group, **scales**, that are associated with ‘outcome’ because *enablement is seen as a desirable outcome of use of an information system*.
- Functionality was the next at 0.92. This relates to a new success group, **product**, because *it is functionality that enhances a product that is a system*.
- Platform was also at 0.92 and has a different connotation. A platform is the means to develop and operate a system, and a third success group was started concerned with **means**, because *resources such as development and operational platforms are the means to deliver the functionality of systems*.
- Resource followed at 0.88. This adds to the idea of **means** because *resources generally are the means whereby work is done*.
- Facilitation scored 0.87 and is an aspect of **outcome**, another success group.
- Reach scored 0.85 and was added to another new group, **boundary**, because the reach of a system is described by its scope, in terms of how extensive are the process and product aspects of a system.
- Progression scored 0.85 and was added to another new group, **transaction**, because *progress is indicated by the accomplishment and completion of a transaction*.

And so on. The three other scales that caused the creation of new success groups were:

- People (0.77) as an indication of **management action**.
- Criticality (0.73) as an indication of **need**.
- Design (0.80) as an indication of **capability**.

The figure that follows shows the result graphically and includes the respondent identifier and the correlation score for each of them.

- Boundary (scope)
  - RES 03 - Visibility (Process : Product) - 0.73
  - RES 07 - Boundary (Internal : External) - 0.83
  - RES 19 - Data (Storage : Movement) - 0.77
  - RES 19 - Reach (Outreach : Inreach) - 0.85
- Capability
  - RES 03 - Development (Not challenging : Challenging) - 0.75
  - RES 03 - Technology (Older technology - Low : New technology - High) - 0.73
  - RES 32 - Design (Well-designed : Poorly-designed) - 0.8
- Management action
  - RES 03 - People (In-house development : External non-development) - 0.77
  - RES 05 - Engagement (Listening : Not listening) - 0.74
  - RES 19 - Control (Liberating : Constraining) - 0.79
- Means
  - RES 13 - Dependency (Independent : Dependant) - 0.8
  - RES 26 - Expanding (Working together : Working in silos) - 0.77
  - RES 32 - Platform (Facilitation : Obstruction) - 0.92
  - RES 32 - Resource (Adequate : Inadequate) - 0.88
- Need
  - RES 07 - Specificity (One project : All projects) - 0.71
  - RES 08 - Motivation (High : Low) - 0.72
  - RES 13 - Criticality (Not critical : Critical) - 0.73
- Outcome
  - RES 06 - Liberation (Liberating : Constraining) - 0.75
  - RES 19 - Enablement (Enabling : Disabling) - 0.95
  - RES 31 - Showstopping (Showstopper : Non Showstopper) - 0.77
  - RES 32 - Academic (Successful : Unsuccessful) - 0.81
  - RES 32 - Facilitation (Succeeds : Fails) - 0.87
- Process
  - RES 03 - Stage (Design stage : Client operations) - 0.77
  - RES 26 - Process (Supports whole lifecycle : Supports only one section of lifecycle) - 0.8
  - RES 27-30 - Lifecycle (Determining Requirements : Implementation of Requirements) - 0.84
- Product
  - RES 10 - Functionality (Functional : Non-functional) - 0.92
  - RES 32 - Functionality (Functional : Dysfunctional) - 0.72
- Transaction
  - RES 12 - Progression (Progressive : Non-progressive) - 0.85
  - RES 21 - Progress (Progressive : Regressive) - 0.84
  - RES 21 - Time (Short : Intensive) - 0.71

Figure 57 The 30 'success scales' organised into 'success groups'

Table 9 provides short notes on the final grouping of the scales that emerged.

Table 9 The 'success groups'

Group	Notes
Boundary (Scope)	The idea of scope ran strongly through the study. It concerns the boundary of an endeavour, or a task, or of the product that is to be produced. Systems can reach far and wide, or they can be localised and contained.
Capability	The capability to do something relates to the familiarity that one has with the technology at hand, the quality of the inputs to a task, and the general (subjective?) feeling that a task is going to be difficult or easy.
Management action	Actions of management that have impact, such as deciding insourcing and outsourcing, applying different levels of control, and engaging properly as management with those undertaking the work.
Means	The means to achieve a task is concerned with the enabling resources such as management approval, the co-operation of colleagues, and having access to the right tools and techniques.

Need	The measurement of need is concerned with the criticality of a system – the extent to which it will contribute to the work of individuals developing or using systems
Outcome	An outcome is not the same as an output – it is something more important that makes a direct contribution to the strategic ambitions of an organisation. Typically, it will be when something changes for the better, perhaps when the functionality of a new system delivers real efficiency and effectiveness benefits.
Process	The collection of activities that takes input, adds value to it, and delivers it (transformed) to another process elsewhere.
Product	The material input and output, to and from processes, that ultimately delivers the systems or services that are required by the institution. Where educational processes are adding knowledge to people, ‘product’ could be interpreted to include ‘uneducated people’ as input, and ‘educated people’ as output.
Transaction	Respondents were advised that the study was seeking to understand the transactions that deliver value, but that for the purpose of the study they would be called events. They are the focus of management performance analysis, based on timing, value delivered, engagement and the need to achieve ‘progress’.

This is an important result: it provides the first sight of a set of scales of measurement, each of which has been found to correlate with success, as seen in the outcome of systems-related events in higher education.

5.5.8 Scales summary

The scales were developed by the triadic method, whereby in the interviews three randomly chosen events were compared to establish a quality or characteristic of one that was not shared by the other two. The results were reviewed in different ways: using the Balanced Score Card, the Service Management Gap model, and repertory grid analysis.

Using the Balanced Score Card, it became clear that most scales are associated with internal process management, then roughly equally with project management (not the same thing as internal process management), change management systems activity and external relations at the boundary. A smaller number of instances were found in the financial performance management group. Hence, it can be deduced that process management is an important aspect of working with systems in higher education.

Mapping the scales to the Service Management Gap model reveals that the larger number of instances is concerned with service specification. Within that group, scales concerned with the nature and scope of the service predominate. The idea of service has a strong resonance with the idea a boundary – service happens across boundaries and that is where performance can be measured.

The repertory grid analysis revealed those scales that correlate with success and allowed the development of ‘success groups’ of scales that fall into six groups.

5.6 Summary

The structured data collection led to details of 211 events and 274 instances of event assessment, using 170 scales. When mapped to the IMBOK framework it became clear that the majority of the events (133 out of 211) were concerned with system activities; academic, research and administrative activity together accounted for only 53 events, and management for 25.

This mapping provided the first signs that there are very few events concerning the delivery of benefits from business processes (only 1), and few concerning the fulfilment of business strategy (2) and general examples of benefits and management events (5 each).

When mapped to the service management gap model, it became clear that scales were predominantly concerned with service specification (58 instances) and then with other service issues on a sliding scale (30 down to 6); specification issues were mostly concerned with defining the nature of the service, and its scope.

A review of success data showed a good correlation between scale measures and success (for those scales that have a good-bad connotation), based on visual inspection of a scatter plot of about 130 results.

The repertory grid analysis identified scales that are significant (according to principal component analysis), and provided additional information about the scales that correlate well with success (according to a Pearson correlation analysis). This permitted a reorganisation of scale groups based on the results of the principal component analysis, and a review of success based on the correlation analysis.

Although the scales were able to be mapped to the Balanced Score Card and to the Service Management Gap model, the most useful result is a mapping based on the repertory grid analysis, supported by statistical component and correlation analysis. This subset of all the discovered scales provides a useful indication of event success, and has the potential to provide useful management information relating to systems-related performance and to where improvement is needed, within process, product, management and service capabilities. It can be concluded that the four high-level themes from the landscape analysis – process, product, management and service (boundary) – are supported and embellished by this analysis of the structured data.

Chapter 6 The availability of standards

This chapter examines just four of the many published standards that are available. They were chosen based on the awareness that was found in the interviews and following a conversation with the South African national representative on the principal software and systems engineering standardisation committee. There is background on the organisation of international standards, and then each standard is discussed individually in terms of its content, the approach that is taken, and the impression that is gained about the potential usefulness. They are then compared in a tabulation of their coverage of the four high-level areas that have emerged from the previous work – management, process, product, and boundary.

6.1 Introduction

At its conception, this study was predicated on the assumption that there are information systems engineering standards available that would be useful within the tertiary environment in South Africa.

This chapter answers Research Question 4:

What standards are available that might usefully improve the outcome of events?

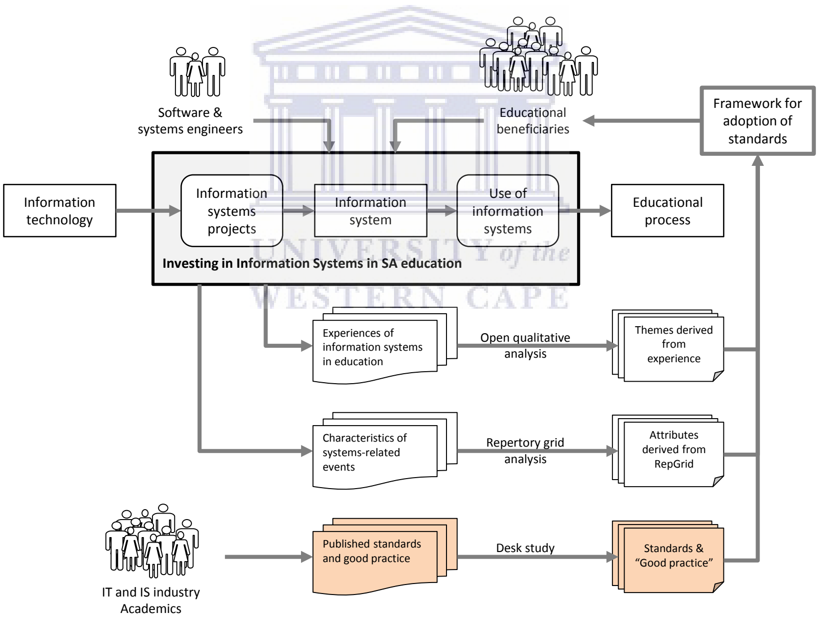


Figure 58 The project workflow: Stage three (the availability of standards)

It has been found that there is a low level of awareness of available standards amongst respondents, with just two or three cases where there was awareness of quality standards (ISO 9000) or IT-related professional guidelines (COBIT and ITIL).

There are different kinds of standards, of course, including (at the national and international level) *de jure* standards and *de facto* standards; the first are *required* to be applied (as in the case of automotive seat belts and domestic electrical equipment); the second tend to *emerge* as markets mature and as socio-economic patterns develop, as in the case of the VHS video recorder and computer communications devices that use USB interfaces. In all cases, there are forces at work that shape the standards in different ways, emanating from manufacturers, consumer groups, regulators and business partners.

Another way of looking at the different kinds of standards, more useful in the present context, is as follows:

- International standards
- National standards
- Industry standards
- Professional association standards
- Organisation standards
- Ad hoc standards
- Project standards
- Individual standards

And so on. Such a list can be augmented endlessly, but it is not necessary that such a list is exhaustive, it has already been established that there are certain international and national standards that might have applicability, and that among those individuals who are managing information technology in South African tertiaries there is some awareness of professional standards such as COBIT and ITIL. This chapter investigates the principal features of standards from ISO-IEC/JTC1/SC7, the international committee for software and systems engineering standards, and then the good practice guidelines from COBIT and ITIL. These choices are informed by the evidence from the respondents, and conversations with the South African national representative on the international committee for software and systems engineering standards.

6.2 ISO-IEC/JTC1/SC7

JTC1 is a joint technical committee that works under the aegis of both ISO (the International Organisation for Standardization) and IEC (the International Electrotechnical Commission), being concerned with standards for engineering generally as well as for software and systems. Within JTC1, sub-committee SC7 deals specifically with software and systems standards. It was founded in 1987. At the time of writing, it declares that it has 160 published standards, 39 participating countries, and 20 countries acting as observers.

As the 'parent' committee, JTC1 has a 'strategic business plan' (ISO-IEC/JTC1/SWG3, 2015) that offers a cautious summary of its present situation, summarising some of the challenges as follows:

- The processes of standardisation at this level are slow
- Gaining international consensus before release is problematic
- JTC1 standards have to be bought, whereas other sources are free
- The costs of participation, especially for travel, are high
- Complexity arising from 'Big Data' and 'The Internet of Things' creates problems at the boundary of their work.

These are considerable challenges in an age when things are expected to happen so quickly, when ideas are shared so widely, and when so much good thinking is available at little or no cost. Of course, JTC1 considers that there are benefits to the adoption of standards.

6.2.1 Benefits of International Standards

JTC1 argues (on its web site[18]) that international standards bring technological, economic and societal benefits, and they break these down by sector:

- **Business**: cost savings, enhanced customer satisfaction, access to new markets, increased market share and environmental benefits.
- **Society**: product conformance, environmental quality.
- **Government**: support for public policy, expert opinion, and opening up of world trade.

These benefits would need some re-interpretation for the world of higher education. Although at this level none of the proclaimed benefits can be seen as *irrelevant* to higher education, none seem to directly address the working needs of higher education.

6.2.2 SC7 Work programme

The organisation of the sub-committee JTC1/SC7 (seen at the level of its advisory and working groups) gives the first insight into the specific work that is undertaken:

Table 10 ISO-IEC/JTC1/SC7 working and advisory groups

ISO/IEC JTC 1/SC 7/SWG 1	JTC1/SC7 Business Planning Group (BPG)
ISO/IEC JTC 1/SC 7/AG 1	**Life Cycle Processes Harmonization** Advisory Group (LCPHAG)
ISO/IEC JTC 1/SC 7/WG 2	System software **documentation**
ISO/IEC JTC 1/SC 7/WG 4	**Tools and environment**
ISO/IEC JTC 1/SC 7/SWG 5	Standards management group
ISO/IEC JTC 1/SC 7/WG 6	**Software Product and System Quality**
ISO/IEC JTC 1/SC 7/WG 7	**Life cycle management**
ISO/IEC JTC 1/SC 7/WG 10	**Process assessment**
ISO/IEC JTC 1/SC 7/WG 19	**Techniques for Specifying IT Systems**
ISO/IEC JTC 1/SC 7/WG 20	Software and systems **bodies of knowledge** and **professionalization**
ISO/IEC JTC 1/SC 7/WG 21	**Information technology asset management**
ISO/IEC JTC 1/SC 7/SWG 22	Vocabulary validation
ISO/IEC JTC 1/SC 7/WG 24	SLC Profile and guidelines for VSE *[software lifecycles for very small enterprises]*
ISO/IEC JTC 1/SC 7/WG 26	**Software testing**
ISO/IEC JTC 1/SC 7/WG 28	A joint working group, ISO/IEC JTC 1/SC 7 with ISO/TC 159/SC 4: Common Industry Formats for Usability Reports
ISO/IEC JTC 1/SC 7/WG 42	**Architecture**

Perusal of these working group titles indicates that both process and product standards are evident – selected working groups have been highlighted with **bold** and warrant some discussion.

The fact that **processes** need harmonising (AG1) indicates that there are problems of co-operative working, or that there are different incompatible views about process management. Then, the difference between life cycle management (WG7) and process assessment (WG10) needs further

[18] http://www.iso.org/iso/home/standards/benefitsofstandards.htm

investigation; the specific work on specification techniques (WG19), testing (WG26) and asset management (WG21) would seem to cover some of the particular ground within software and systems engineering, but by no means all of it.

On the **product** side, documentation has a home (WG2) and 'software product and system quality' (WG6) implies an interesting layered approach where the product might be standardised at the level of the software and also the system. References to 'architecture' (WG42) are always problematic because it is not at all clear what that implies.

The idea of '**bodies of knowledge**' is important, because in a complex domain such as this surely is, a standard or publication is needed that presents an organised view of what could or should be done with 160 standards, that might or might not work together (WG20). In his input to this project, the South African SC7 representative to JTC1/SC7 (RES20) recommended the 'Guide to the Software Engineering Body of Knowledge' (SANS, 2007) – and this does provide a starting point and a useful resource.

6.3 The Guide to the Software Engineering Body of Knowledge (SWEBOK)

This document is not a standard, but a guide to the standards and other sources that are available. It carries the name of Leonard Tripp as 'Project Champion', already referred to at the start of this thesis as a champion of the software and systems engineering standardisation cause (Tripp, 1992; Tripp & Voldner, 1995).

6.3.1 Content

It is a large document, with over 200 pages organised into just 11 sections:

- SOFTWARE REQUIREMENTS
- SOFTWARE DESIGN
- SOFTWARE CONSTRUCTION
- SOFTWARE TESTING
- SOFTWARE MAINTENANCE
- SOFTWARE CONFIGURATION MANAGEMENT
- SOFTWARE ENGINEERING MANAGEMENT
- SOFTWARE ENGINEERING PROCESS
- SOFTWARE ENGINEERING TOOLSAND METHODS
- SOFTWARE QUALITY
- RELATED DISCIPLINES OF SOFTWARE ENGINEERING

This document is focused on software not on systems, and so it will be of limited interest to the wider academic and administrative audience; given the *laissez faire* attitude to software engineering standards that has prevailed (Land, 1997b) it may also not engage technical specialists.

The section on the software engineering process is worth looking at first. It is introduced thus:

> *'The Software Engineering Process knowledge area can be examined on two levels. The first level encompasses the technical and managerial activities within the software life cycle processes that are performed during software acquisition, development, maintenance, and retirement. The second is the meta-level, which is concerned with the definition, implementation, assessment, measurement, management, change, and improvement of the software life cycle processes themselves. The first level is*

covered by the other knowledge areas in the Guide. This knowledge area is concerned with the second.' (SANS, 2007, pp.9–1)

Indeed, it is the management issues as well as the technical issues that are of concern here. Project management, computer science, quality management, systems engineering and management generally are all seen as related disciplines in the SWEBOK.

6.3.2 Approach

The SWEBOK does not define a single process or product which is 'right', rather it attempts to tabulate all the processes within software engineering and the way in which they may vary, and it references a wide range of other sources that might provide the knowledge that is sought.

So, what does it actually tell us?

One would have to refer to the references provided within the SWEBOK for the detail, typically within its text it provides only a few words. Take the section on the management of software projects:

'Project Management

Project management is defined in the 2000 Edition of A Guide to the Project Management Body of Knowledge (PMBOK®Guide) published by the Project Management Institute and adopted as IEEE Std 1490-2003, as "the application of knowledge, skills, tools, and techniques to project activities to meet project requirements."

The Knowledge Areas identified in the PMBOK Guide for project management are

- *Project Integration Management*
- *Project Scope Management*
- *Project Time Management*
- *Project Cost Management*
- *Project Quality Management*
- *Project Human Resource Management*
- *Project Communications Management*
- *Project Risk Management*
- *Project Procurement Management'*

(SANS, 2007, p.12–2)

And that is all. The part concerned with software development ('Software construction' – the third main section listed on the previous page) includes just eight pages, within which the section on coding simply provides a list of nine 'considerations', drawn from ISO/IEC 12207 and other sources:

3.2. Coding

'[Ben00; IEEE12207-95; McC04]

The following considerations apply to the software construction coding activity:

- *Techniques for creating understandable source code, including naming and source code layout*
- *Use of classes, enumerated types, variables, named constants, and other similar entities*
- *Use of control structures*
- *Handling of error conditions—both planned errors and exceptions (input of bad data, for example)*
- *Prevention of code-level security breaches (buffer overruns or array index overflows, for example)*
- *Resource usage via use of exclusion mechanisms and discipline in accessing serially reusable resources(including threads or database locks)*
- *Source code organization (into statements, routines, classes, packages, or other structures)*
- *Code documentation*
- *Code tuning'*

(SANS, 2007, p.4–4)

These two examples are typical of the style of the SWEBOK, and while all the references given are fully supported with details that should enable access to the actual sources, it can be seen that the core of the document is more of a catalogue of annotated references than an explanation of what to do, and how. The reference to ISO/IEC (IEEE) 12207 indicates what assistance might be available at the next level of enquiry.

There is some material additional to the hierarchy of detailed topics, for example:

- The first appendix provides rules for the development of knowledge area descriptions.
- The second appendix provides a history of the evolution of the SWEBOK.
- The third appendix maps the content of the SWEBOK to ISO and IEEE standards, as they were available at the time.
- The final appendix is more interesting, it relates the detail to Blooms Taxonomy, as an aide to educators wishing to use the guide in the design of curriculum content. Bloom gives us six levels of increasing cognitive educational achievement:
  knowledge, *comprehension*, *application*, *analysis*, *synthesis* and *evaluation*.
  The topics given in the SWEBOK are wholly attributed to the first four of Bloom's levels, none are attributed to synthesis and evaluation. This indicates quite strongly the limitations of the guide for a practitioner who simply needs to know how well s/he is doing, and how to improve.

6.3.3 Summary of SWEBOK

For those people with the time and energy, the SWEBOK provides an exhaustive listing of useful sources of standardisation, help, and guidance.

However, it is already more than 10 years since it was published, there are few references to it in the literature, and so it would appear that the extent of actual interest is limited. One paper is of particular interest, however, that takes the SWEBOK and lays out some ideas for the development of an ontology (Abran et al., 2006). It also provides useful background and explains some of the rationale behind its design and development (emphasis added):

> *'The [SWEBOK] editorial team applied the criterion of **generally accepted knowledge**, to be distinguished from **advanced and research knowledge** (on the grounds of **maturity**) and from **specialized knowledge** (on the grounds of generality of application).' (Abran et al., 2006, p.7)*

Maturity and specialisation are both issues that have emerged in this study. There is a variety of capability and maturity across the institutions of higher education, and across the faculties, schools, research institutes and departments within those institutions from which respondents came. There is also a wide range of specialised needs that are evident.

In order to understand more about international standards at this level, it is appropriate to look at just one of the standards that is featured in the SWEBOK, the IEEE standard for software lifecycle processes.

6.4 ISO/IEC 12207:2008: Software life cycle processes

ISO/IEC 12207 is another long standard that originates from the IEEE. The document is well over 100 pages, wherein the work that is done with software and systems is broken down in a hierarchical manner.

6.4.1 Content

At the lowest level it tabulates the tasks that must be done in undertaking (for example): planning, acquisition, project management, risk management and other processes.

It is highly structured, and –

> *'It contains processes, activities, and tasks that are to be applied during the acquisition of a software product or service and during the supply, development, operation, maintenance and disposal of software products.' (ISO-IEC/JTC1/SC7, 2008, p.1)*

At first sight it seems to confuse 'system' and 'software', because the main section (Section 6, page 16 *et sec*) is entitled '*System* Life Cycle Processes', and yet as the above quotation suggests, it is intended to be principally about *software*. There is some clarification:

> *'This International Standard applies to the acquisition of systems and software products and services, to the supply, development, operation, maintenance, and disposal of software products and the software portion of a system, whether performed internally or externally to an organization. Those aspects of system definition needed to provide the context for software products and services are included.'(ISO-IEC/JTC1/SC7, 2008, p.1)*

And later:

> *'This International Standard establishes a strong link between a system and its software. It is based upon the general principles of systems engineering. Software is treated as an integral part of the total system and performs certain functions in that system. This is implemented by extracting the software requirements from the system requirements and design, producing the software, and integrating it into the system.' (ISO-IEC/JTC1/SC7, 2008, p.9)*

Interestingly, the standard includes guidance on the adaptation of its content to particular circumstances, for example to accommodate issues of stability, commercial risks, novelty, size and complexity (ISO-IEC/JTC1/SC7, 2008, p.85). It seems particularly weak in areas other than process management.

6.4.2 Approach

This raises one of the issues when working with international standards of this kind: they are highly structured and fragmented and they tend to focus on only a selective part of the system or software realm. Anyone using them therefore has to invest considerable time trying to establish which ones might apply, and whether their choice will align successfully in a single working context. What is also concerning is that ISO/IEC 12207 is so concerned with process that it fails to provide any effective guidance at all on the *information* that is needed to effectively manage software and systems development, implementation and operation. A 'process model' with only passing reference to the 'data model' that would support it is extremely limited.

A brief perusal of the complete catalogue of SC7 standards (in Appendix 1) will confirm these concerns – and it must be remembered that this catalogue excludes the many standards that are still under development. ISO/IEC 12207 itself cross references no fewer than 35 other standards with which it is related. One begins to understand the outcome of the Land survey (Land, 1997b) that makes it clear that 'users' of these standards tend to use them selectively as input to an internal process of process and product design, but not as a complete guide to be used.

Having said that, the early and late sections of the standard do offer some interesting material, for example Annex B contains a 'process reference model, for assessment purposes'. At the start this annex explains what a process reference model is and how it shall be constructed, referring to

ISO/IEC 15504, a standard for the assessment of information technology processes. On inspection, it proves to be another hierarchy of requirements, at the lowest level specifying outcomes. Consider this portion, that defines the purpose and outcomes of a Supplier Tendering Process:

> *'B.3.2.1 Supplier Tendering Process*
>
> *This process is a lower level-process of the Supply Process.*
>
> *B.3.2.1.1 Purpose*
>
> *The purpose of the Supplier Tendering Process is to establish an interface to respond to acquirer inquiries and requests for proposal, prepare and submit proposals.*
>
> *B.3.2.1.2 Outcomes*
>
> *As a result of successful implementation of the Supplier Tendering Process:*
>
> *a) a communication interface is established and maintained in order to respond to acquirer inquiries and requests for proposal;*
>
> *b) requests for proposal are evaluated according to defined criteria to determine whether or not to submit a proposal;*
>
> *c) the need to undertake preliminary surveys or feasibility studies is determined;*
>
> *d) suitable resources are identified to perform the proposed work; and*
>
> *e) a supplier proposal is prepared and submitted in response to the acquirer request.'*
>
> *(ISO-IEC/JTC1/SC7, 2008, p.93)*

There is no explanation of what might comprise a 'communication interface', nor what effective 'criteria' might be, nor what 'resources' might be appropriate. One imagines that these more specific issues will be the subject of other standards.

ISO/IEC 12207 has attracted some interest and there are two papers that are of interest: Singh (1996) provides a very readable introduction, and Polo (1999) shows how the standard has been used to develop a method for software maintenance. However, both these papers are old, probably stimulated to some extent by the original publication of the standard. Despite that, there are ideas that could be adopted and incorporated into an institutional standard for the processes of software acquisition, development, implementation and use. The University of Kansas is one example where ISO/IEC 12207 has been adopted as the basis of the "*minimum required phases and considerations for developing and/or implementing new software and systems at the University of Kansas*"[19].

6.4.3 Summary of ISO/IEC 12207

Like other standards from the same source, ISO/IEC 12207 is 'scoped', but this quickly leads to questions about what other standards might be needed. Busy people will probably need more useful and usable sources with which to work. Such people have developed more accessible and usable guidelines, such as COBIT and ITIL.

6.5 COBIT

COBIT ('Control Objectives for Information and related Technology') has evolved over almost two decades and has a very international background. In fact, there are 12 names from South Africa included amongst the many from all over the world who have contributed to the development of the fifth, current, version. It also references the King Code of Governance for South Africa (Institute of Directors in Southern Africa, 2009) together with many other international sources.

[19] http://policy.ku.edu/IT/systems-development-life-cycle-standard

As well as internet sources (identified in footnotes) the principal source for this review of COBIT's content and approach is a 90 page document available from the ISACA web site[20] that is replete with figures, diagrams and textual explanation (ISACA, 2012).

6.5.1 Content

The COBIT document starts with a strong assertion that organisations need information and that value from information management is a key driving force. There are five principles upon which it is based:

- Meeting stakeholder needs
- Covering the enterprise end-to-end
- Applying a single, integrated framework
- Enabling a holistic approach
- Separating governance from management

The holistic approach is appealing, and the separation of management (making sure that things are running to plan) and governance (making the plan, according to internal and external factors) is made clear. In the detail of the guidelines there is separation of the 'enterprise' and 'IT' issues. The customisation of COBIT to suit the requirements of individual organisations is encouraged.

6.5.2 Approach

The contrast with the IEEE and ISO-IEC approaches is immediately apparent.

Meeting stakeholder needs takes things from the top down, and ensures that what is done in an organisation is justified by the needs of those who are dependent on that organisation, or on whom the organisation is dependent. Reference is made to the Balanced Score Card, which is used to organise the commentary on setting organisational goals at the enterprise and IT-related levels.

Covering the enterprise end-to-end ensures that all activity, IT and other, is dealt with in an integrated way and the 'silo-effect' is obviated. The availability and management of information is seen as a key enabler of end-to-end integration of organisational activity.

Applying a single, integrated framework implies that diverse standards are all expected to work in harmony (or that differences will be resolved) and the document does have cross references to a range of other standards, as indicated in Figure 59 below. However, as has been found in this study, mapping one sphere of activity to another is a complex process, that has to be undertaken at a defined level. The claim that '*COBIT 5 integrates all of this knowledge*' (ISACA, 2012, p.25)is rather suspect and would need to be tested.

[20] http://www.isaca.org

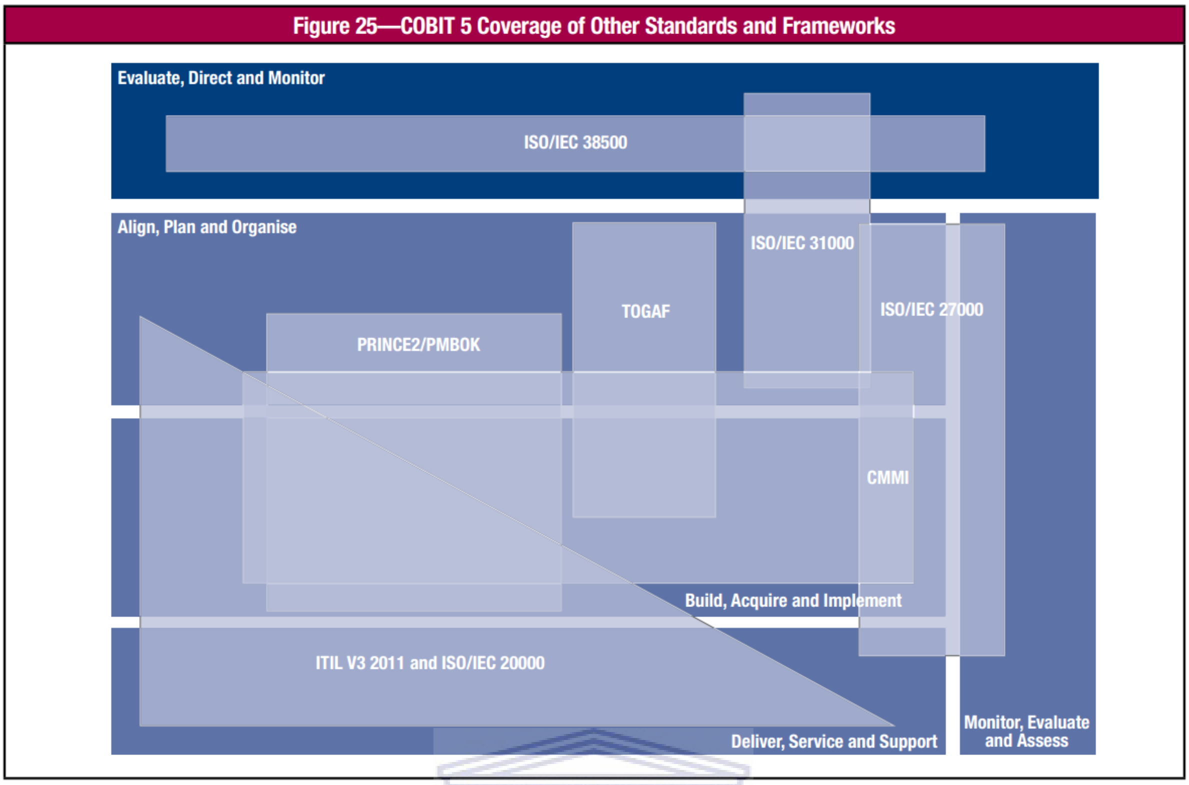


Figure 59 COBIT aligns with other standards

(Adapted from ISACA, 2012, p.61)

Enabling a holistic approach is at the heart of the COBIT way of thinking. Invoking principles, policies and frameworks that guide the management of processes, organisational structures, culture, infrastructure and skills and competencies – and *information* – is what is needed, it is argued. The idea of interconnection of enablers is highlighted; talking of security as an example:

> *'The need for information security requires a number of policies and procedures to be created and put in place. These policies, in turn, require a number of security-related practices to be implemented. However, if the enterprise's and personnel's culture and ethics are not appropriate, information security processes and procedures will not be effective.' (ISACA, 2012, p.28)*

Separating governance from management

The separation of governance and management is a present issue in South Africa, and the King guidelines have received wide recognition if not universal application. COBIT provides useful detail in a number of areas, for example when discussing the governance and management issues relating to *information*:

> *'The [COBIT] process model describes inputs to and outputs from the different process practices to other processes, including information exchanged between governance and management processes. Information used for evaluating, directing and monitoring enterprise IT is exchanged between governance and management as described in the process model inputs and outputs.'*

COBIT places emphasis on setting out the enterprise and IT goals, and maps them to the Balanced Score Card. Table 11 is based on the detail within the COBIT documentation.

Table 11 Mapping of COBIT goals to Balanced Score Card perspectives

(Adapted from ISACA, 2012, p.19)

BSC perspective	**Enterprise goals**	**IT goals**
Financial	Stakeholder value of business investments	Alignment of IT and business strategy
	Portfolio of competitive products and services	IT compliance and support for business compliance with external laws and regulations
	Managed business risk (safeguarding of assets)	Commitment of executive management for making IT-related decisions
	Compliance with external laws and regulations	Managed IT-related business risk
	Financial transparency	Realised benefits from IT-enabled investments and services portfolio
		Transparency of IT costs, benefits and risk
Customer	Customer-oriented service culture	Delivery of IT services in line with business requirements
	Business service continuity and availability	Adequate use of applications, information and technology solutions
	Agile responses to a changing business environment	
	Information-based strategic decision making	
	Optimisation of service delivery costs	
Internal	Optimisation of business process functionality	IT agility
	Optimisation of business process costs	Security of information, processing infrastructure and applications
	Managed business change programmes	Optimisation of IT assets, resources and capabilities
	Operational and staff productivity	Enablement and support of business processes by integrating applications and technology into business processes
	Compliance with internal policies	Delivery of programmes delivering benefits, on time, on budget, and meeting requirements and quality standards
		Availability of reliable and useful information for decision making
		IT compliance with internal policies
Learning and Growth	Skilled and motivated people	Competent and motivated business and IT personnel
	Product and business innovation culture	Knowledge, expertise and initiatives for business innovation

COBIT has a process 'reference model' that gives an elegant overall structure to the work that has to be done (ISACA, 2012, p.74):

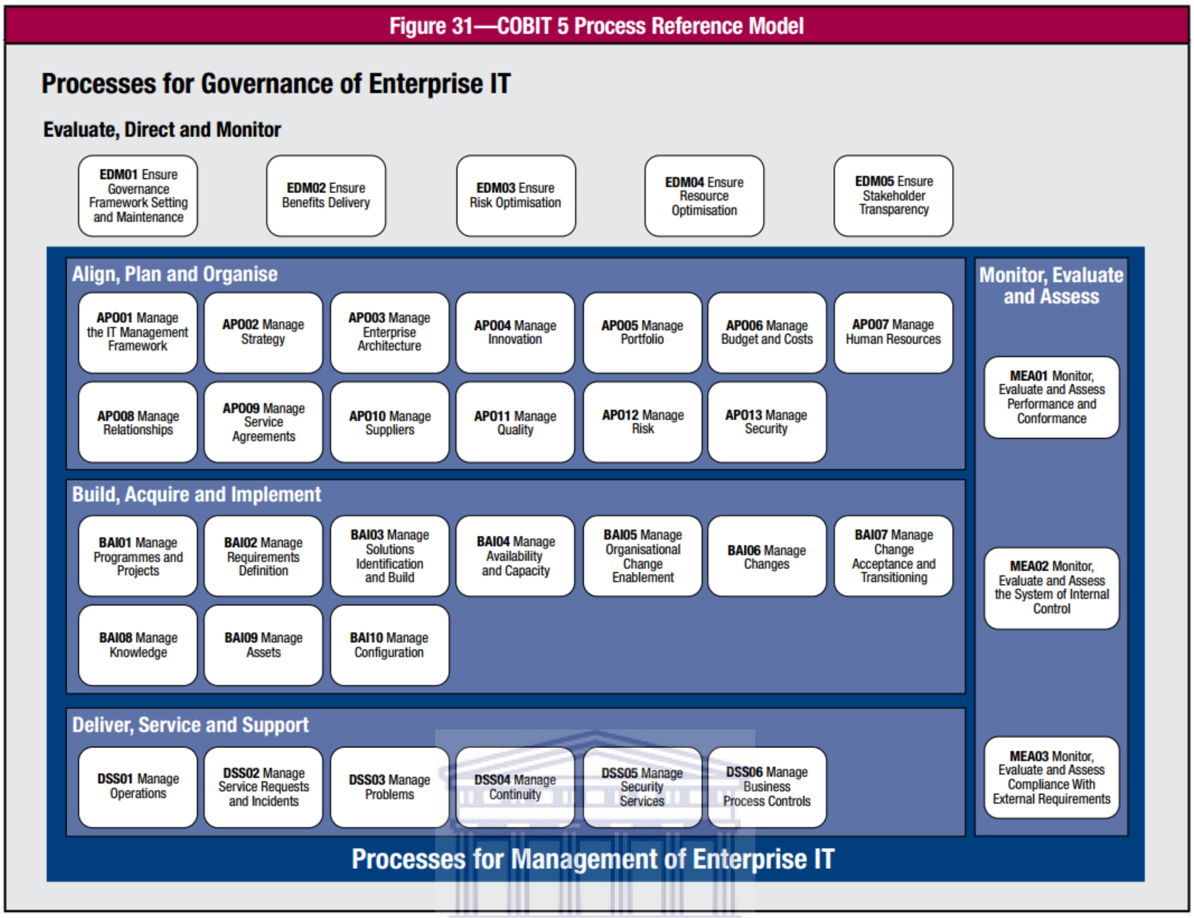


Figure 60 The process 'reference model' from COBIT 5

In the extended COBIT documentation there is detail for all of these processes, of course.

6.5.3 Summary of COBIT

COBIT takes the issues of managing information technology and systems from the top down, and presents a multi-dimensional view of what must be done, based upon its own arrangement of already-established ideas, such as the Balanced Score Card and other ideas within strategic management practice. It is quite a complex view that does not sit quite so easily as the simple process hierarchy in the ISO standards, and it is therefore hardly memorable – it would need study and practice to become an effective approach in a higher education institution. However, there is copious implementation advice and there is already an awareness of it amongst some of the respondents within this study. It needs to be taken seriously. The lack of academic research into the COBIT methods has been noted by De Haes, Van Grembergen and Debreceny (2013), its adaption for implementation in the public sector has been examined by Al Omari, Barnes and Pitman (2012), finding that a complete implementation would be beyond the capability of the typical public sector organisation (in Australia) but that there are twelve control objectives that are of most potential interest.

6.6 ITIL

ITIL (the 'IT Infrastructure Library') originates from an investment by the UK government more than 30 years ago, aimed at understanding ways to manage information technology based services more effectively. It was originally drafted by consultants and throughout its life it has had a commercial aspect to it, although ownership still rests with the UK Cabinet Office. It has found wide support but it is not frequently referenced in the academic literature. It has already been noted that there seems to be an active ITIL community continuing to promote and extend the initiative (see section 2.2.4.1).

There are many books to be acquired for a full set of documentation on ITIL – the Axelos web site lists 36, priced between £2.99 and £299 each[21]. As well as Internet sources, the principal source for this review of ITIL is a book, chosen principally because it was a single volume and it was rated in the online catalogues (Farenden, 2012).

6.6.1 Content

ITIL is based on a single idea: the service management lifecycle. It describes processes, as do COBIT and the JTC1/SC7 standards, and extends the process idea to the organisational *functions* that are found within it, and the *roles* that people fulfil within those functions. But the idea of a service is at the heart of it:

> *'… a service is a means of delivering value to customers by facilitating outcomes that customers want to achieve without [them having] the ownership of specific costs and risks.' (Farenden, 2012, Chapter 2)*

Such services can be seen as internal, shared or external – the idea of boundaries that must be managed thereby emerges quite quickly, and becomes central to the idea.

As published, the ITIL comprises several volumes with a variegated history – there are different authors, and the history of the whole work is complex because of its origins, and the number of individual authors who have been involved.

6.6.2 Approach

At first sight ITIL uses a waterfall-like model to organise the service management lifecyle:

> *'Strategy*
> > *[prepare a] business case*
>
> *Design*
> > *[document] requirements*
> > *[develop a] design*
>
> *Transition*
> > *Build [a system]*
> > *Test [the system]*
> > *implement [the system]*
>
> *Operation*
> > *deliver and support [the operational system]*
>
> *Improvement*
> > *Improve [for ongoing benefits]'*
>
> *(Adapted from Farenden, 2012, Figure 3.2)*

It progresses to define processes and accompanying details. Experts have found that there has been fragmentation in the definition of processes and functions (for example) over the years (Skeptic,

[21] https://www.axelos.com/best-practice-solutions/itil

2007). It is widely seen as a 'bottom up' approach to management although the promotional material starts with the topic of Service Management Strategy. ITIL might therefore justify further evaluation, especially as it is so focused on the service paradigm.

6.6.3 Summary of ITIL

ITIL clearly informs many aspects of *service* management, a topic that has already been determined to be one of the principal four domains of particular interest in this study. However, it does not offer any especially novel or insightful ideas – it is voluminous, and quite highly structured, and it has been found to work from the 'bottom up' which does not really assist in a study that is trying to work from the top down.

In Australia there are reports of 'phenomenal practitioner interest' in ITIL but it is also noted that little research has been published that informs about its implementation and benefits (Cater-Steel & Tan, 2005); a broad ranging review of standards and methods undertaken in the United Arab Emirates finds that ITIL benefits from a degree of cross-fertilisation from six or seven other approaches that they identify (Soomro & Hesson, 2012). It seems to be only part of what might be needed.

6.7 Other standards and guidelines

There are of course a wide range of other standards that could have been reviewed, but a short review of such standards as ISO/IEC 20000[22] (developed from a quality management standpoint), PMBOK[23] (the Project Management Body of Knowledge), CMM[24] (the Capability Maturity Model), the Microsoft Operating Framework (that has been compared to ITIL) and TOGAF[25] (The Open Group Architecture Framework - an interpretation and guide to Enterprise Architecture) did not bring forth any ideas that warranted attention here. The PMBOK (Project Management Body of Knowledge)[26] is another related and very well established source of information that is useful in software and systems engineering. The voluminous nature of these published standards is already clear, the principals of quality management are already clear, maturity has been found to be a useful feature of the standards that have been reviewed in detail, and the idea of architecture development as presented in TOGAF shares some of the ideas already discussed in section 2.2.4: 'Selected frameworks and methods of working'. However, TOGAF is committed to *open standards* and holds the promise of being more widely applicable with other standards striving to be open.

It was concluded that the four standards reviewed conveyed an adequate understanding of the kind of assistance that standards of those kinds – of which there are many – might offer.

[22] http://www.iso.org/iso/catalogue_detail?csnumber=51986
[23] http://www.pmi.org/PMBOK-Guide-and-Standards.aspx
[24] http://www.sei.cmu.edu/reports/93tr024.pdf
[25] http://www.opengroup.org/subjectareas/enterprise/togaf
[26] http://www.pmi.org/PMBOK-Guide-and-Standards.aspx

6.8 Summary of standards availability

There are too many standards in two senses: the nationally sponsored standards from ISO, IEC and IEEE are numerous, and the good practice guidelines such as COBIT and ITIL (and others) are very extensive in their scope and their treatment of the subject.

SWEBOK is a catalogue of standards and guides that is already about 10 years old and may require extensive updating and revision to meet the situation and needs of today. The three standards that have been reviewed in some detail represent three quite different styles of standardisation.

ISO/IEC 12207 is typical of much thinking in the United States, where reductionist approaches to process analysis have been more common than the deeper entity-relationship modelling approach that is more ontological in its result. Although it has had international representation it demonstrates what might be seen as the predominant way of thinking within the IEEE – process oriented reductionism. It faces possible problems with maintenance, because of its age and the shifting nature of software and systems development.

COBIT takes a quite different approach based on a rich, top-down view of an organisation, its stakeholders, their needs, and the actions that will enable satisfactory delivery. It is interesting that COBIT came originally from the audit and accounting profession, so that a broader view is taken of organisational performance. COBIT is also very international.

ITIL has perhaps the longest history and sections of the community seem to think that this has led to some fragmentation and differences between the different 'versions'. The focus on service management has merit, but the adoption of this standard has already presented one of the respondents with resourcing problems that shifted his attention to COBIT.

In Appendix 13 there are tables that summarise the relevance of the reviewed standards to the four domains of need developed in the landscape analysis: *management*, *process*, *product*, and *service*. Table 12 follows below, and provides the essential details.

Table 12 A summary of three standards

Three standards summarised	**ISO/IEC 12207 'Systems and software engineering — Software life cycle processes'**	**COBIT: 'Control Objectives for Information and related Technology')**	**ITIL: 'IT Infrastructure Library'**
APPROACH	*Structured treatment with a strong focus on process, little on product, and few actual guidelines. Good detail to pick from at the bottom level.* ***Hierarchical.***	*A multi-faceted view with rich detail and good explanations, solidly grounded in the needs of stakeholders and the things that enable success.* ***Adaptable, top-down.***	*Different versions exist, generally a mature approach based on service management, a cycle of service strategy, design, transition, operation and maintenance.* ***Bottom up.***
PROCESS	An encyclopaedic overview of lifecycle activities, at the system and software levels. Little on methods and 'how-to' details. Provides copious detail about activities – useful as a first source?	Organised as 'Align, plan and organise', 'build acquire and implement' and 'deliver service and support' - good detail to have at hand. Governance and management are separated and there is a strong emphasis on stakeholder needs, ensures things are done for good reasons and with good outcomes.	Organised around the 'service lifecycle' – important but limiting. Focused on the management of the relationship with 'users' at the contact point between the business and the IT function.
PRODUCT	Does not accommodate the interaction between process, and data, and the context within which systems have to work. The one and a half pages dealing with 'tailoring' of the standard fall short of what is needed.	Helpful in dealing with the complex details. The optimisation of business functionality is one of the high level considerations in COBIT. Enablement and usability are high on the priorities. Makes benefits a portfolio management issue and refers to the maturity model idea.	One respondent considers the implementation of ITIL creates difficulty with 'virtual' roles. Is service management sufficient to deal with product quality? Recognises that there is a need to adapt to need. Also refers to the maturity model idea.
SERVICE	There is no explicit treatment of the external boundaries with suppliers and customers where service management might be applied, other than a passing treatment of the need to achieve agreements with suppliers, and to support customers.	COBIT provides very strong and appropriate advice for dealing with stakeholder needs, hence service is in there. Specific idea of 'service level agreements' is not dealt with at the overview level.	In dealing with service ITIL does well, focusing on business relationships and demand management. The issue of service management is dealt with in great detail, including the development and deployment of service level agreements.
MANAGEMENT	The word 'strategy' is used frequently, but generally to refer to the planning choices at the working level. There is no reference to strategy as a main topic for the attention of management. There are detailed tabulations of activities that need management.	Focus is on strategic issues such as stakeholder management. An organisation that knows what it wants to do would benefit greatly from taking COBIT as a 'plug-in' to its strategy formulation and implementation processes. The multiple dimensions adopted ensure a fulsome plan.	Focus on stakeholders, the importance of their needs, and the way that this feeds into planning and implementation. However, the general treatment of strategy seems dependent on which version of ITIL is used. Copious references to the need for planning, monitoring and control.

Chapter 7 Discussion: the applicability and utility of standards

This chapter reviews and summarises the findings based on the four research questions, and draws conclusions about the standards that are applicable, and the extent to which they might be useful.

7.1 Introduction

It is now appropriate to review the questions that were posed by this research and the findings of the previous chapters that addressed them. There are four research questions:

1. What kinds of systems are being developed and used?
2. What events are significant in developing and using systems?
3. What are the qualities and characteristics of those events?
4. What standards are available that might usefully improve the outcome of events?

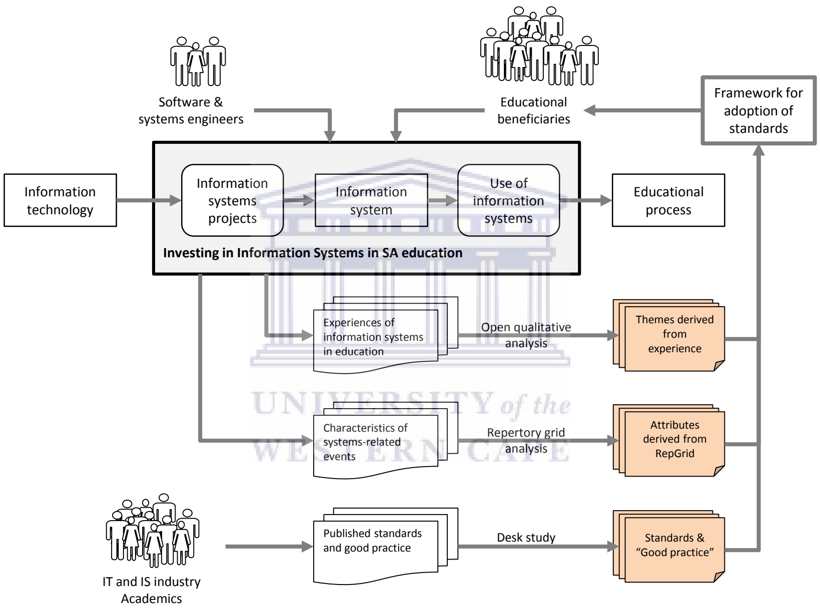


Figure 61 Project workflow: Stage four (review results against research questions)

7.2 What kinds of systems are being developed and used?

The survey of systems (Section 5.3) generated more than a list of systems – it generated a mix of what had to be called 'situations'. Some were institutional processes, some were projects concerned with innovative technology, some were aspects of administration, and some were indeed systems. This indicates a variety of situations that need to be managed, in ways that obviate or alleviate problems and improve performance. Because the analysis has worked with respondents' personal viewpoints and has not sought to compare institutions and assess the qualities of specific systems, it has generated a rather complex mixture of circumstances that needs to be understood and managed.

On the one hand there are the core operational systems that keep these large institutions working – for example in terms of teaching and learning, student administration, research, and finance. But on the other hand there are the local (even *personal*) systems that fill in the gaps, provide the satisfaction of being 'in control', and sometimes comprise the seeds of bigger ideas. From the start, in the landscape analysis, it was clear that all respondents were anxious to talk about outcomes and ideas about innovation and strategic advancement recurred. The instinct to keep moving forwards is very strong, although the problems that are created in so doing were also evident.

There are two candidate variables that emerge when considering the systems (or situations) that were recorded, and that might help to resolve some of the differences: first there is the idea of *scope* (another concept that was recurrent in the analysis of the data), and second there is the idea of *present and future value* (evidenced by the frequent direct or implied references to strategy).

7.2.1 The scope of systems

The scope of a system is defined by its boundaries, and it has been found that both process and product are relevant in determining boundaries, and that boundaries are important as the point at which service performance can be measured. A system serves a process (or it should so do) and at the boundaries of the process the products that it produces are seen. These products will generally comprise the input to another process. For example, student applications are received and processed – partly by 'the system' but also by administrative and academic staff in manual activities; both the human and automated components of the system contribute to the overall process. In simple terms, this process then produces lists of applicants that are 'accepted' and those that are not, and this list goes on to other processes that allocate and register students to programmes, and to residences, and so on. In the collected data, the quality of student administration is variable (as seen by the two first-year students). Their involvement can be seen as an accumulation of events, such as getting a student card, going to residence for the first time and gaining entry with the card, and so on:

> *'The first thing that pops into my mind is I got my student card with my friend, at about 7 o'clock in the morning, they said it would be active in two to three hours. So we patiently waited, and then we went to the library and we let ourselves into the library and the light flashed green and it made us feel like we are students! We had access to the library!' [RES 10 - First year student (science), University D, 2015/05/16]*

However, the scope of other systems might be quite different. For the research administrator, the relatively simple spreadsheet that she had developed allowed her to distribute large numbers of emails about the status of research projects and funding applications by means of an email merge, almost literally at one click of the mouse.

> *'[I use Excel] for the statistics, when we want to know how many people go, and then how many publications, so [the managers] say it's excellent because it is a summary. They don't have to go to the [full] report. What I do is I consolidate everything for that. That's good. I also do mailmerge. Once my spreadsheet is accurate I am able to do 100 letters. Within two seconds you have all your letters [done].' [RES 14 - Research administrator, University C, 2015/05/04]*

She was able to provide management with summary exception reports that saved them time and rendered the process of administering research much more efficient – all out of her own initiative and with considerable personal satisfaction to add to the efficiency. Going in the other direction, the RIMS system is national, it embraces all tertiary institutions in the country, and it is intended to contribute to the efficient management of all research:

> *'There are many stakeholders, many of whom (that are most visibly associated with the project) are rather distant, and concerned with national needs and policies. Engagement with institutional stakeholders, especially researchers, seems very weak. It is not clear what future opportunities are*

enabled by the project; rather it is concerned to level the opportunities for all HEIs, of all backgrounds, and bring them forward to a common level. Having said that, it is clear that this will not be easy, it will take a special effort in terms of project management, and this feels like a "bottom up" (ie technology-push) project rather than a "top down" (ie researcher and management pull) project.'
[RES 01 - National Software Project - Notes of a tele-meeting, National Government, 2012/09/20]

It can be concluded that there are considerable differences in the scope of the systems that are important to respondents.

7.2.2 Present and future systems

From the moment when 'outcome' was revealed as the predominant category in the open coding, to the moment when strategic thinking was revealed in the organisation of that coding, it has been clear that respondents are driven to a significant extent by ambitions and visions of a better future.

So it's not necessarily about the design and or the maintenance of this system, but rather how it's used now, how we foresee its use in the future. [RES 17 - Information manager, University A, 2015/06/30]

The fact that 'challenge' was the second most frequent category might be seen as a negative, associated with problems, but it was also very frequently paired with 'outcome', suggesting that the wish to deliver something useful is the main challenge for many respondents. This raises the question of institutional strategy. Without a strategy of some kind, and change agents who will promote it, there will be no framework with which to judge the importance and merits of different investments:

'I think at least in one institution you can always refer back to [just] one strategy, and [it is good that] there is a single change agent which can bring that closer together ... but even within an institution you are talking standards and talking within faculties … we sat this morning with the computer user area manager where one again becomes acutely aware of the different interests within an institution.' [RES 02 - HEI CIO & Programme manager, University A, 2013/12/04]

This insight from a CIO reminds us that strategies might have to be devised for faculties, rather than for institutions. Or, institutional strategies must recognise the variation in needs and priorities between the natural and social sciences, and other areas of academic endeavour, such as research. It is clear from this study that research is a distinct and clear opportunity in all institutions but the provision of a supporting information management environment for research is not easy. RIMS has found real differences between institutions, and there will be real differences between faculties and other academic units:

'What I have found is that if you take the student application process, all six faculties do it differently - how do you standardise that electronically? This makes significant challenges for us. It depends on certain compliance requirements. Another example is, if you look at paying somebody salary it's got the involvement of HR, finance and payroll. And what I have realised when we started this upgrade project is that get people in the same room and you find that finance have got their little bit, payroll have got theirs, but the whole process has never been done. The focus on business analysis becomes quite strong.' [RES 26 - Technology manager, University C, 2015/08/11]

This raises the question: should student application procedures be standardised at all? Applicants for health studies might be expected to qualify in quite different ways from applicants for business studies, or for languages. Whilst the study has not explored the specific strategic issues in different disciplines, it has established that the differences are there and that they need strategic solutions. The focus on process, evident in the above evidence from the technology manager, is entirely appropriate because systems must not be developed for departments, they must be developed with recognition of the overall process that is at hand however many departments are involved. It follows that moving to a strategic future will make additional change management demands on those working and studying at a progressive institution, but the evidence suggests that moving forwards will generally be welcome despite the challenges. For some, strategy planning and implementation is a lot to do with the management of the data:

> *'You have to sit outside, and look at the whole world. Take research, it's so easy to create vast volumes of data now, that data needs to be retained and shared. That raises questions of data quality … and yet we are so parochial! No, you can't have it, that's 'my' data! We never remember how long it takes to change fundamental things. The question is, you see, is it not part of the cultural vision and change in this institution, as an institution? [Do we] really understand where the institution wants to go? I went through four rectors and five registrars, you understand, and strategic planning, from low student enrollment to high student enrollment … the big situation is: nobody really understands. I'll be quite honest with you, nobody understands data, and how to interpret data ... [I have] an opportunity at the end of the year to speak to the Deans at a two day workshop. So I'm busy preparing the data for them, to give them the shock of their lives. I have to give it to them, the current reality.' [RES 22 - Information manager, University A, 2015/07/09]*

This seasoned information manager had a particularly clear vision of the challenges involved in dealing with data, as distinct from dealing with process. It can be concluded that managing the data and information will be a feature of moving to a new future.

7.2.3 The portfolio management idea

The idea of a portfolio approach to managing systems in the future is latent in the evidence. Clearly, one or two respondents were fully aware of the potential of the portfolio approach, as already noted. Here is the evidence from Technical Team B again, now in more detail:

> *'In this case, it's probably the overall planning, future planning … is it about "on plan" or "off plan"? It's about strategy, it's a lack of strategy. A lack of prioritisation. They are not doing the documentation. Application portfolio, lifecycle management, applications don't die and the burden mounts. It actually speaks to portfolio management. It's all about portfolio management! It's like maintain the system, or rewrite it. We should look at the way that we manage - at what point is it better to rewrite? There are all sorts of portfolio management issues. Do these things speak to a lack of portfolio management? In this case it's not the lack of, it's the different kinds of system within the portfolio.' [RES 34-38 - Technical Team B, University A, 2015/10/01]*

This idea would not go away, in that conversation. The importance of managing data and information well as a useful outcome of proper portfolio management came through strongly, later in the same conversation:

> *'We have a massive database full of information … we lack proper management of the software portfolio: what's running, what its lifecycle is. We get mature: we get new, adolescent, legacy, retired, senile! [Laughter].' RES 34-38 - Technical Team B, University A, 2015/10/01]*

The idea of appropriate outcomes is strongly linked to strategic management, of course. The other technical team sensed the problem but were not familiar with the portfolio management idea. In talking about the difference between technical outcomes at the project level and institutional outcomes, one member of the team said that:

> *'You would think that once a system is operational then there would be an outcome [for the institution]. Forget about us. So would the outcome be specific to us as developers, would that be fine? Are we getting somewhere with the application development, as opposed begin stuck in a rut getting nowhere? We don't know what they want.' [RES 27-30 - Technical Team A, University B, 2015/08/18]*

If there is an idea for portfolio management that will work for higher education, it seems to be urgently needed.

There is one other issue that is latent in the evidence: the idea of maturity.

7.2.4 Institutional maturity to manage systems

This sense that time passes and systems get 'old' in some sense is important. In explaining about systems in organisations, for decades many institutions have chosen to use 'the Systems Development Lifecycle' as the principal vehicle for teaching and learning. But there is a different and more important cycle, concerned with the emergence and decline of *new systems ideas*. The idea of the portfolio has a hint of present and future importance in information systems ideas, and it was found that the maturity of systems thinking and the maturity of an organisation to successfully adopt and implement systems is crucial. In explaining what he had found in COBIT, this CIO explained:

> *'COBIT has got 34 control objects for IT. The new 35th one is about adding value. The others are more risk oriented, which says that that is a list of 34 things and you can say, you can tick them off that you have done them. One of the items could be: Have you got a good help desk? A support centre? Or have you got a financial plan? Have you got a strategic plan? You cannot do this unless you have a strategic plan! You use these 34 to determine the maturity of the whole process ... we are [talking about] the availability and utility of ISE standards, and COBIT in engineering is a standard.' [RES 02 - HEI CIO, University A, 2013/12/04]*

The RIMS project has found varying capability and maturity in the different higher education institutions in South Africa:

> *'This [RIMS] was a brilliant idea, but it is an example of how not to approach implementation. The project is working across competing HEIs that all want to use research to augment their reputations - how is it possible to get a common platform when there are such different capabilities, strategies and maturities within the HEIs?' [RES 01 - Pilot 2, National Government, 2012/09/20]*

This brings the focus once more to managing change. Institutions will have to change to some degree if RIMS is to deliver its full potential at the national level.

This need to accept change goes right down the line. At a more practical level, one research director admitted that getting people to use the new financial management suite that he had developed took time and effort:

> *'Do all five directorates use the financial management software? Yes, this is now generally accepted as the way to do it. And it was quite a struggle initially: new software, nobody likes new software.' [RES 07 - Director Research Projects, University B, 2014/10/24]*

It is found that maturity, at the level of institutional and personal capability to manage change, is another factor that affects the choice of standards for developing and using information systems. Institutions and individuals that have no culture or willingness for change will often find it difficult, and – if they do not – they will probably find a way to make it difficult.

7.2.5 Systems summary

Successful projects to deliver new information technology and systems rely on a wide range of variables that are more than the technical ones. It is not sufficient to tell people what they must do to develop new systems, they must be assisted to know how they can work that out for themselves, according to their circumstances.

Standards and guidelines for systems must embrace issues of strategy, scope, importance, and maturity. This must be done not only at the level of the institution, but at all levels where the combination of these things distils down to an identifiable and coherent mix of strategic intention, systems scope, priority and capability.

7.3 What events are significant in developing and using systems?

The analysis of events (in Section 5.4) has shown that the vicarious detail collected from respondents can be aggregated and mapped to the IMBOK framework, an established model. This is useful because it reveals the balance of interest in all the main stages in creating value, from the acquisition of raw technology infrastructure right through to the fulfilment of institutional strategy. But it was found that there is an imbalance: the links between the *benefits* of information systems and the *strategic needs* of institutions are weak, in that there were very few events that populated the territory between 'business processes' and 'business strategy' (only 8 out of 215). Further, despite the implied interest in strategy that emerged from the landscape analysis, there were only 5 events that actually represented strategic management activity.

In order to investigate this further, it was decided to look at the detail, for all role players and for each role individually. There are three measures derived from the analysis:

- The number of times an event occurred.
- The success of the event as indicated by its outcome on a five point scale of 1 to 5.
- The rating of the event using the discovered scales, again on a five point scale of 1 to 5.

7.3.1 Presentation of summary measurement data

By grouping the events into the domains of the IMBOK, and by grouping the scales into the high and intermediate groups that emerged from the repertory grid analysis[27], it is possible to see these three measures across the breadth of activities (the IMBOK) using a range of scales (from the RepGrid).

Appendix 12 has the result of this analysis in detail, in seven charts that present the data thus:

All respondents

	IMBOK Domain														
	IT			IT-IS			IS			IS-BP			BP		
Scale group	Count	Rating	Success	Count	Rating	Success	Count	Rating	Success	Count	Rating	Success	Count	Rating	Success
MANAGEMENT CHALLENGE (Doable : Not doable)				20	3.82	3.27	9	2.50	2.25	14	2.70	3.40	7	3.86	4.29
MANAGEMENT CONTEXT (One thing : Another thing)				3	4.33	5.00				4	5.00	4.50			
MANAGEMENT SCOPE (In scope : Out of scope)							1	5.00	5.00	3	4.00	3.50	1	4.00	3.00
MANAGEMENT SIGNIFICANCE (High : Low)				7	3.00	3.29	7	1.80	1.20	11	3.33	3.33	2	4.50	4.00
MANAGING CHANGE (Managed : Not managed)				3	1.67	2.33				2	3.00	4.00	4	2.67	3.33
PROCESS CHALLENGE (Low : High)	8	2.25	2.75	16	3.25	3.42	8	2.67	1.83	6	2.33	3.50	6	3.17	4.17
PROCESS CONTEXT (Good : Bad)				13	3.43	3.14	1	4.00	3.00	8	3.86	3.43	4	4.00	4.33
PROCESS CONTROL (In control : Out of control)	5	1.00	1.50				2	3.00	2.50	2	1.00	2.00	1	5.00	4.00
PROCESS METHOD (Traditional : Novel)				23	2.89	3.47	1	1.00	2.00	12	3.40	3.10	4	1.75	4.25
PROCESS NATURE (One thing : Another thing)	5	3.20	3.00	2	3.50	2.00	1	3.00	1.00	8	3.50	3.50	5	2.67	3.67
PROCESS PROGRESS (Forwards : Backwards)	5	3.20	3.20	16	3.57	2.93	3	2.67	1.67	4	2.75	3.50	5	2.00	3.25
PROCESS RESULT (Good : Bad)	5	2.80	2.80	12	3.60	3.70	3	2.67	1.67	15	2.79	3.07	8	2.83	4.17
PROCESS SCOPE (More controlled : Less controlled)	1	1.00	2.00	3	4.33	3.67	7	2.00	4.40	20	3.36	3.64	14	2.64	3.64
PROCESS TIMING (Short term : Long term)	3	1.00	1.50	1	4.00	1.00	3	3.67	3.33	2	3.00	3.50	11	3.14	4.29
PRODUCT BENEFITS (High : Low)	16	3.45	2.64	5	2.40	3.40	8	3.17	3.50	16	3.20	3.40	13	3.63	4.00
PRODUCT FUNCTIONALITY (High : Low)	7	3.80	3.20	1	5.00	3.00	7	2.67	3.50	4	3.50	3.25	8	3.17	3.33
PRODUCT NATURE (One thing : Another thing)	5	4.40	2.60	10	3.20	3.10	4	3.50	2.50	12	3.45	3.82	9	2.67	4.00
PRODUCT QUALITY (Good : Poor)	8	3.43	2.86	13	3.36	3.45	7	3.20	2.60	5	3.75	4.00	4	4.00	4.75
SERVICE NATURE (One thing : Another thing)	2	4.50	3.50	25	3.47	3.32	5	2.80	3.00	4	2.25	4.50	11	4.00	3.89
SERVICE OUTCOME (Effective : Not effective)										3	2.67	3.33	3	4.33	4.00
SERVICE QUALITY (High : Low)	4	4.75	2.50	5	4.50	3.75	1	5.00	5.00	4	3.67	3.33	5	3.80	3.80
Grand Total	74	3.23	2.74	178	3.37	3.32	78	2.80	2.70	159	3.19	3.47	125	3.26	3.94

	BP-BB			BB			BB-BS			BS			MAN			Grand Total		
Scale group	Count	Rating	Success	Count	Rating	Success	Count	Rating	Success	Count	Rating	Success	Count	Rating	Success	Count	Rating	Success
MANAGEMENT CHALLENGE (Doable : Not doable)	1	3.00	5.00				2	2.00	3.50	2	3.00	2.50	16	3.69	3.31	71	3.28	3.30
MANAGEMENT CONTEXT (One thing : Another thing)										1	2.00	1.00	3	4.50	4.50	11	4.25	4.25
MANAGEMENT SCOPE (In scope : Out of scope)													5	4.00	2.80	10	4.11	3.22
MANAGEMENT SIGNIFICANCE (High : Low)							1	4.00	5.00	1	5.00	4.00	13	3.70	3.90	42	3.29	3.29
MANAGING CHANGE (Managed : Not managed)													2	2.50	3.00	11	2.40	3.10
PROCESS CHALLENGE (Low : High)				1	5.00	4.00	1	2.00	2.00	2	2.50	1.50	5	1.80	2.80	53	2.70	3.04
PROCESS CONTEXT (Good : Bad)				2	4.50	5.00							6	3.50	4.00	34	3.73	3.69
PROCESS CONTROL (In control : Out of control)																10	2.33	2.33
PROCESS METHOD (Traditional : Novel)										4	3.50	2.50	7	3.29	3.57	51	2.98	3.36
PROCESS NATURE (One thing : Another thing)							1	4.00	2.00				10	4.30	3.40	32	3.63	3.17
PROCESS PROGRESS (Forwards : Backwards)										1	5.00	5.00	8	1.88	3.13	42	2.90	3.05
PROCESS RESULT (Good : Bad)										2	2.00	2.00	12	3.00	3.09	57	2.96	3.18
PROCESS SCOPE (More controlled : Less controlled)				4	3.67	5.00	1	2.00	5.00	1	3.00	4.00	10	3.25	3.50	61	3.02	3.79
PROCESS TIMING (Short term : Long term)																20	3.00	3.40
PRODUCT BENEFITS (High : Low)				4	4.67	4.67							14	2.75	3.42	76	3.22	3.42
PRODUCT FUNCTIONALITY (High : Low)				3	4.50	4.50							1	5.00	4.00	31	3.48	3.44
PRODUCT NATURE (One thing : Another thing)													13	2.20	3.70	53	3.13	3.41
PRODUCT QUALITY (Good : Poor)				2	4.50	4.00				2	4.50	5.00	1	1.00	0.00	42	3.53	3.44
SERVICE NATURE (One thing : Another thing)				1	5.00	4.00	1	2.00	2.00				3	4.00	2.00	52	3.47	3.44
SERVICE OUTCOME (Effective : Not effective)																6	3.50	3.67
SERVICE QUALITY (High : Low)							1	3.00	5.00	1	3.00	4.00	5	4.40	4.40	26	4.17	3.75
Grand Total	1	3.00	5.00	17	4.43	4.57	8	2.63	3.50	17	3.29	2.94	134	3.22	3.42	791	3.23	3.37

Figure 57 All roles

The reader is referred to Appendix 12 for the full (and readable) detail. Here, the data will be presented in summary form and with no special formatting, so that the significance of events can be seen through the *count* of instances within the IMBOK domains, at the *highest level* of scale groups according to the landscape analysis.

The figures that now follow show the above data at that summary level, thus:

[27] The 'success groups' of scales are dealt with shortly – at this stage the analysis is working with the thematic areas from the landscape analysis.

Table 13 Events in IMBOK domains, by high-level scale group, all respondent roles

fldEventRole: All

Scale group	IT Count	IT-IS Count	IS Count	IS-BP Count	BP Count	BP-BB Count	BB Count	BB-BS Count	BS Count	MAN Count	Grand Total Count
MANAGEMENT		33	17	34	14	1		3	4	39	145
PROCESS	32	86	29	77	58		7	3	10	58	360
PRODUCT	36	29	26	37	34		9		2	29	202
SERVICE	6	30	6	11	19		1	2	1	8	84
Grand Total	74	178	78	159	125	1	17	8	17	134	791

The detailed charts in Appendix 12 provide all three measures: the count, the average rating and the average success, with colour coding to indicate the results visually.

What Table 13 shows is the preponderance of events that were concerned with information systems projects (IT-IS), implementation (IS-BP) and management (MAN). Events within business processes – essentially the core work of the institution in teaching and learning, administration or research – accounted for a similarly high number of events. The lack of evidence in delivering business benefits (BP-BB, only 1 instance), and delivering business strategy (BB-BS, only 8 instances) reveals that there is inadequate attention, across all four institutions, and across all roles, to the linking of operational activity to strategic requirements.

7.3.2 An analysis of significance according to role

Consider the same analysis, but only for the senior managers who participated (Table 14):

Table 14 Events in IMBOK domains, by high-level scale group, Senior Managers only

fldEventRole: Senior manager

Scale group	IT Count	IT-IS Count	IS Count	IS-BP Count	BP Count	BP-BB Count	BB Count	BB-BS Count	BS Count	MAN Count	Grand Total Count
MANAGEMENT		9	3	1	3			1	2	13	32
PROCESS		20	3	3	6			2	7	18	59
PRODUCT		3									3
SERVICE		2		2	5			1		1	11
Grand Total		34	6	6	14			4	9	32	105

There is no involvement with IT, and – worryingly – no involvement at all with the delivery or management of business benefits. The awareness of strategic issues seems to be minimal, but there is involvement in the projects that deliver systems (IT-IS, 34 instances) and management of course (MAN, 32 instances).

The tables (Table 15, Table 16, Table 17) that follow provide the equivalent data for operational managers (who, apart from management activity are principally concerned with business processes) and project managers (who have a wider interest, but focused on the implementation issues) (IS-BP, 74 instances):

Table 15 Events in IMBOK domains, by high-level scale group, Operational Managers only

fldEventRole: Operational manager

	IMBOK Domain										
	IT	IT-IS	IS	IS-BP	BP	BP-BB	BB	BB-BS	BS	MAN	Grand Total
Scale group	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count
MANAGEMENT					5				2	8	15
PROCESS					3				1	6	10
PRODUCT					2					6	8
SERVICE					2				1	3	6
Grand Total					12				4	23	39

Table 16 Events in IMBOK domains, by high-level scale group, Project Managers only

fldEventRole: Project manager

	IMBOK Domain										
	IT	IT-IS	IS	IS-BP	BP	BP-BB	BB	BB-BS	BS	MAN	Grand Total
Scale group	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count	Count
MANAGEMENT		6	3	26	2					8	45
PROCESS	1	8		30	3					20	62
PRODUCT		3		12	1					13	29
SERVICE		3		6	4					2	15
Grand Total	1	20	3	74	10					43	151

This disparity between the involvements of the different roles is perhaps to be expected, but it suggests a situation where individuals are quite tightly focused, but all roles taken together still reveal a lack of attention to the realisation of strategic benefits.

7.3.3 The perceptions of event success

Finally, in this brief review of the data available in Appendix 12, the matter of significance can be informed by the spread of perceived 'success', as indicated by the respondents' assessment of event outcomes:

Table 17 Success of events in IMBOK domains, by high-level scale group, All roles

fldEventRole: All

Scale group	IT	IT-IS	IS	IS-BP	BP	BP-BB	BB	BB-BS	BS	MAN	Grand Total
	Success	Success	Success	Success	Success	Success	Success	Success	Success	Success	Success
MANAGEMENT		3.41	2.10	3.39	3.92	5.00		4.00	2.50	3.35	3.31
PROCESS	2.76	3.22	2.64	3.43	3.97		4.80	3.00	2.43	3.21	3.28
PRODUCT	2.67	3.39	2.87	3.67	3.85		4.50		5.00	3.42	3.41
SERVICE	2.83	3.39	3.33	3.80	3.88		4.00	3.50	4.00	3.71	3.56
Grand Total	2.73	3.32	2.68	3.52	3.91	5.00	4.60	3.50	2.93	3.33	3.36

A success of 3.00 would represent the mid-point, between excellent and very poor. Hence it is found that:

- The information systems domain is the least successful, particularly in terms of the way that information systems are managed.
- Information technology is hardly more successful, and there are no instances of events which could be considered to be the management of information technology.
- The success of business process management and business benefits is illusory, because there were very low numbers of instances. However there were several examples of strategic management (BS, 17 instances shown in Table 13 above), which at an average of 2.93 is on the wrong side of what is needed.
- This leaves management, business processes, systems projects and system implementation as the most successful kinds of events.

7.3.4 Events summary

It can be concluded that according to the perceptions of these respondents, the management of information technology and operational information systems are underperforming relative to other event areas, and that business benefits and business strategy are essentially unmanaged.

7.4 What are the qualities and characteristics of those events?

The scales that were developed by the triadic method have been reviewed in three different ways: by mapping to the Balanced Score Card, the Service Management Gap model, and according to the results of the Repertory Grid analysis, leading to the ‘success groups’. The third review is the most important here, because it is based on this analysis and it attends to those qualities and characteristics (scales) that correlated with event success. However, it is necessary to reconcile that result with the earlier result from the landscape analysis.

The landscape analysis delivered an arrangement of high-level themes based on *management*, *process*, *product*, and *service* (boundary) domains. The arrangement of success groups from the repertory grid analysis does not precisely match this, partly because it is based on selected data that embraces the idea of event success. Table 18 below comments on the success groups relative to the high-level themes from the landscape study, and illustrates the commentary from the transcripts.

Table 18 Success scale groups compared with the high-level themes

Success group	**Comments relative to the high-level themes**	**Illustrations from the transcripts**
Boundary (scope)	The qualitative data brought out the idea of 'scope', which became 'boundary' and then, in the later analysis, it became 'service'.	*That is university, and university only, the scope here is much broader. [RES 06 - Mature first year student (health), University B, 2014/09/01]*
Capability	Capability is also an attribute of a person, an organisational function, or an institutional process. A process has capability that is invoked by a transaction that exchanges product between the producing process and the receiving process. Therefore, 'capability' is also closely associated with the established idea of 'process'.	*I don't think SMS was deployed very widely. It's new but the interest is an African interest ... we are also now planning to plug that offline tool into Moodle which will be awesome because that also needs an offline capability. [RES 08 - Outsource partner CEO, Software and systems services business, 2014/11/21]*
Management action	Here is the intersection of two ideas: the 'management' that came from the landscape analysis, and the scales that comprise a set of 'management indicators'. Management actions will affect matters of boundary (scope) and the way in which things are done (transaction)	*You know you don't just shut a platform down, you manage your users. You know how they complained [about the old system], some do not want to move over now! How crazy! [RES 05 - HEI E-Learning director, University B, 2014/08/07]*
Means	Means are the enabling features of a transaction: approval, access to the tools and techniques – all of which are conventionally within the control of management or (as seen in the evidence) are acquired by role players from their own resources. Therefore, 'means' is closely associated with the idea of 'transaction' and the idea of 'management'.	*[The LMS is] a means whereby lecturers can communicate with everybody that is doing Chemistry at my level so, all the slides, all the lecture notes are put on there - it's there on the machine, they communicate past papers and … just valuable information. If you don't check [the LMS] you're out of the loop, completely. [RES 06 - Mature first year student (health), University B, 2014/09/01]*
Need	Need is an attribute of a person, an organisational function, or an institutional process. A process has needs, or it fulfils needs. Therefore, 'need' is closely associated with the established idea of 'process'. When working as a programmer, one needs peace and quiet to be able to do a good job.	*When we started developing as a team none of us knew IT standards, luckily [we learned] not to do that, do that ... obviously working from home as well! That's the life of a coder! The only thing that sucks is when you get a call and somebody needs help with Excel! [laughter] [RES 27-30 - Technical Team A, University B, 2015/08/18]*
Outcome	Outcome is separate from output: output is what comes out of a process, but an outcome is what is seen by those outside. It delivers to strategic objectives, and therefore 'outcome' is closely associated with the ideas of 'management' and 'transaction'.	*The software did not work very well and it took several iterations to get sorted out ... She knew what she wanted to do educationally with the outcomes, but when it came to the underlying technology … that was an experience. [RES 21 - Help desk manager, University D, 2015/07/09]*
Scope	Scope is concerned with the extent of the processes and products that make up a system. Therefore, 'scope' is closely associated with the ideas of 'process' and 'product'.	*They can't solve the problem because what they require is not within the scope of what we can provide. [RES 21 - Help desk manager, University D, 2015/07/09]*
Transaction	A transaction is seen here as the execution of an exchange of product between processes. It has characteristics such as time criticality, engagement, forward or backward progression, and so on. In this research, events reported by respondents can be seen as transactions, or as parts of, or steps within, transactions.	*The requirement discussion between the client and ourselves ... was a good meeting, everybody agreed what should be done, which was awesome … as long as you have that strong guy then you can feel confident that it's gonna happen [RES 08 - Outsource partner CEO, Software and systems services business, 2014/11/21]*

It can be concluded that the four high-level themes – process, product, management and service – provide a reliable and convenient separation of ideas concerning the management of information systems in higher education, and they can be used to organise one view of the qualities and characteristics of information systems events. However, when statistical significance is taken into account, a different arrangement of ideas emerges. Nevertheless, it is found that this new arrangement of ideas is not incompatible with the high-level themes, and it may be that they actually add some flesh around the bones of that first, rather simple, idea of just four themes.

7.5 What standards are available that might usefully improve the outcome of events?

7.5.1 Reviewing the need for standards

In order to pull together the results that have emerged from the analysis so far, and to ground the discussion in the reality that is being studied, it is appropriate to develop illustrative analyses from the cases that are at hand to assess the potential for useful standardisation of the nine success groups:

1. The boundaries and scope.
2. The required capabilities.
3. The actions that managers take.
4. The means of executing transactions.
5. The needs of an institution.
6. The outcomes that are achieved.
7. The processes that add value.
8. The products that are produced by processes.
9. The transactions that exchange products between processes.

Clearly, the range and variety of the cases that are at hand is wide (only some of them are 'systems'), but one way to deal with this is to review the source data, and select instances where respondents indicated (through the initial line-by-line coding) that there were *challenges* associated with their work, where it involved *systems*. This was done, and 14 such cases are now reviewed in Appendix 14. The review focuses on the nine areas of interest (above), and shows how standards covering those nine areas that would assist, based on the details of the 14 cases – each of which came from the qualitative transcript data, and had been coded as a *challenge* involving a *system*.

In moving forward to a review of standardisation needs and opportunities the nine success groups will now be referred to as the 'standardisation domains'.

The question now arises: are there any standards that address these domains?

7.5.2 The available standards

The need for standards can be seen at two levels. When considering process and product at the operational level, the evidence shows that there is a wide range of formalised software and systems engineering standards to choose from that may deal with the specific processes and products of software and systems engineering. However, when considering the higher-level – the need to align technology and institutional strategies –a need for a different kind of guidance is required. This is deemed important in view of the significant gap that was found (in section 5.4.3) between the operational and strategic levels of working, and the clear ambition to develop strategic intentions that is found in the qualitative landscape analysis (in section 4.3.2). These two different levels will be referred to here as 'Engineering' and 'Strategic management'. In Table 19 they are reviewed against each of the standardisation domains.

Table 19 A review of standards by standardisation domain

Standardisation domain	Engineering	Strategic management
Boundary	See 'Scope' below	
Capability	The SWEBOK has copious references to the Capability Maturity Model (CMM), which is an acknowledged and well established framework whereby an organisation's ability to manage its affairs can be assessed on a scale that extends from 'not managed' to 'self-optimising'. **The Software Engineering Institute manages the CMM, which the SWEBO features in its sections on software maintenance, software configuration management, software engineering process, and software quality.**	The capability of an organisation to undertake its own strategy analysis, formulation and implementation is important. It is found that respondents have quite strong views about strategic needs, but there is very little evidence that strategic management processes in institutions are actually delivering a result. **Frameworks for strategic management are available, for example within COBIT. ITIL and COBIT both deal with capability and maturity.**
Management action	'Business process engineering', or 'Business process re-engineering', has been a feature of progressive management for decades, but it has a spotty history as an idea that might apply engineering principles to management. Management in tertiary institutions is fluid, and there are strongly felt attitudes towards academic freedom. **'Engineering' new management practices is unlikely to work in tertiaries.**	Management actions are evident in the data collected here, in the landscape analysis, but they are revealed by the detailed analysis of the structured data to be disconnected from the actual work that involves systems. **Guidelines that ensure management actions deliver to strategic requirements are needed; for example, COBIT focuses on 'enablers' and has that potential.** COBIT is not a dogmatic approach to strategic management and provides the opportunity to adapt to local needs.
Means	The SWEBOK has copious references to standards and guidelines that deal with resources, which are of course the means whereby work is done. For example, resource allocation, human resource, training resources, system testing resources, and maintenance resources (to name but a few). The software resource is generally managed by means of 'configuration management'. **SC7 has a standard that deals with configuration management: ISO/IEC TR 18018.**	The value chain (see Figure 13 on page 37) is a generic model that separates out the primary value adding activities in an organisation and the ancillary or enabling activities that are the means of production, rather than the material of production. The value chain was developed by Michael Porter at Harvard University, and is widely described and evaluated in the management and research literature since its original publication. **Porter (1985) provides a detailed introduction and explanation of the value chain.**
Need	The SWEBOK has more than 800 references in its text to 'requirements'. In its second section it deals specifically with software requirements analysis and points to IEEE (ISO/IEC) 12207 as the key standard. **SC7 has a standard that deals with requirements: ISO/IEC 12207.**	The benefits dependency network (see Figure 12, on page 36) provides an elegant way of analysing what is needed at each stage in adding value to 'raw' technology so as to deliver real strategic benefits to an organisation. It specifically draws out how the outcome of a transaction at one level contributes to the next. This chain parallels the domains of the

Standardisation domain	Engineering	Strategic management
Outcome	The SWEBOK has a complete section dealing with software quality, but it is already out of date. Recently there has been a series of standards released in the ISO/IEC 25000 series, under the management of SC7. **SC7 has a series of standards that deal with software quality: ISO/IEC 25000.**	IMBOK. By revealing the flow of benefit from the original point of cost (the technology), and by revealing the points at which value transformation takes place, this analytical device addresses need, outcome, scope and transaction, at a high level, and it thereby brings a focus to the means whereby benefits might be delivered. The benefits dependency network was developed at the Cranfield School of Management within a wider study of benefits management, and is the subject of a published book. **John Ward and Elizabeth Daniel (2005) provide a detailed introduction and explanation of the Benefits Dependency Network.**
Scope	The SWEBOK deals with project management as a related discipline, and refers to scope as something that is dealt with in the PMBOK. Review of standards within SC7 reveals that scope is seen more as an issue in scoping *standards* than standardising how scope might be defined; however, 12207 deals with scope in several senses relevant to software and systems engineering. **PMBOK deals with scope at the project level.** **SC7 has a standard that deals with scope at the detailed level: ISO/IEC 12207**	
Transaction	The idea of the transaction is related to, but not the same thing as a process. It is more evident in discussing service management, where each instance of a service can be seen as a transaction. ITIL has extensive detail on request fulfilment, event management, incident management and problem management. **ITIL has extensive content that will assist in dealing with transactions.**	Managerially, the transaction is the point at which data can be gathered and used to assess organisational performance. It is associated strongly with service management, and the Service Management Model (see Figure 50, on page 100) is an early overview of how services can be better managed[28]. **Parasuraman, Zeithaml and Berry (1985) provide a first introduction to the service management gap model.**
Process	The management and standardisation of processes is commonly dealt with, especially since the emergence of business process engineering thinking. However, at the working level, the 12207 standard for life cycle processes is clearly the most frequently cited source for detail in the realm of software and systems engineering. **SC7 has a standard that deals with process design at the detailed level: ISO/IEC 12207**	A strategic, managerial approach to process and product management requires recognition of two factors: the scope of a system (local or global) and future significance of systems (see section 7.2.1 on page 130, *et sec*). The migration of the strategic significance of a system idea from innovation, through the realisation of strategic benefits, to the achievement of worthwhile benefits is exactly parallel to the product lifecycle that is represented in the Boston Box (see Figure 11, page 35). This

[28] This model has been evaluated and adapted in research at UWC, in an investigation of library services to students.

Standardisation domain	Engineering	Strategic management
Product	The quality of software products has been a topic for attention for a long time, and the history of SC7 standards for software product quality reveals eras when different approaches were taken. The wide scale adoption of ISO 9000 stimulated work on adaption of that standard to the realm of software and systems engineering. **SC7 has a range of standards that set out to deal with software quality, most recently ISO/IEC TS 30103 (Framework for Product Quality)**	model has been adapted and widely promoted as a strategic approach to process and product management, in the context of information systems management. It recurred in the conversations with respondents, but it was not yet implemented as a strategic management device. **Bytheway (2015, p.55) provides an introduction and explanation of this portfolio approach to systems management.**

It is found that there are standards and guidelines available, but they come from diverse sources. No doubt if time were devoted to a much wider search of the hundreds of sources that are available, the choice would become yet more difficult.

What is now evident is that at the engineering level the *variety* of standards needs and the variety of standards from which to choose presents a challenge to those who would wish to adopt them and benefit from them. There is no guarantee that any combination of standards will work satisfactorily, and even the SWEBOK, which proved to be a valuable source, provides no assistance in bringing together combinations of standards that have been tested to the point that they work together.

At the level of strategic management the choice (based on those sources that became known through this study) is more limited, but some of the options (for example COBIT and ITIL) include a large volume of detail to be dealt with. On both sides, it becomes a question of making choices, and informing those choices in a way that makes sure that there is coverage, and that there is compatibility.

For this reason it was decided that this study develop a Reference Model from the outcome of the research effort so far, that will provide a higher-level view (a 'meta-standard'?) showing how the nine standardisation domains might be seen in a single ontology, so as to provide foundations for more effective adoption, implementation and development of standards. The objective still is to understand how education performance might be improved by means of more effective systems, that are themselves used more effectively.

Chapter 8 Development of a candidate Reference Model

This chapter moves things forwards by stepping back, reflecting on what has transpired earlier, and deriving a candidate Reference Model. It does this by introducing a new concept at the boundaries of processes, where products are exchanged: the service transaction – broadly equivalent to the events that respondents described and that are featured in the next chapter and by formalising the idea of the transaction described at the start. The Reference Model provides a vehicle with which to answer questions such as: What are the processes of higher education, and how do they engage with each other? How does a product migrate from one process to another, and how is that migration controlled at the boundaries between the processes? How do management actions arise from outcomes, and to what are they applied? Where does the idea of dependency and enablement fit in? The development of the Reference Model is illustrated with examples from the interview transcripts.

8.1 Introduction

In a situation where different role players with different viewpoints have to work together, it is necessary to establish a vocabulary and syntax in order to communicate reliably. A reference model is a device that is intended to do that, and it is generally developed as an abstract ontology or framework, depending on the rigour with which it is developed.

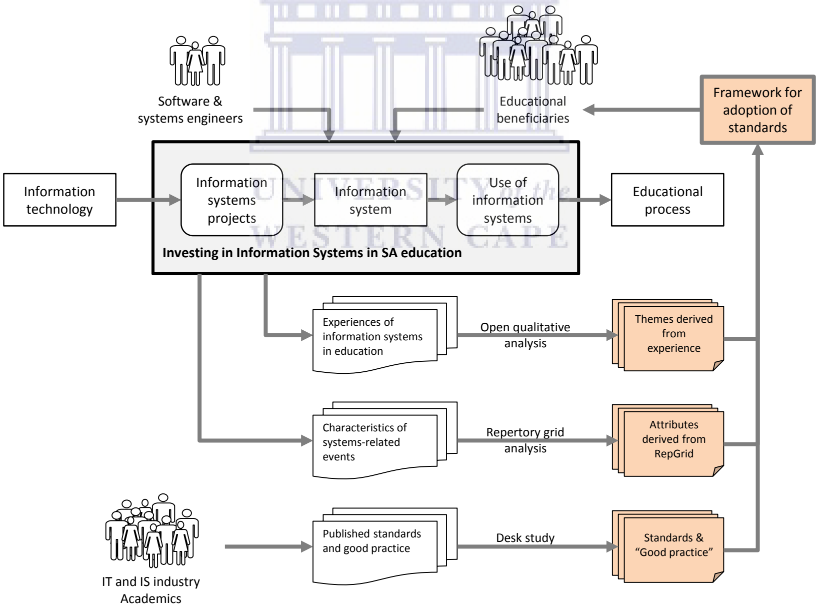


Figure 62 The project workflow: Stage five (developing the framework)

Developing an ontology is more rigorous and establishes the 'relationships' between the 'things' (or 'entities') that are taken to represent the reality of a domain. Here, that rigour will be adopted.

A reference model is useful as a basis for developing standards that are compatible so that they work well together and provide control over the work that is done within a shared domain. With an agreed vocabulary, the consistency of standards and their ability to 'co-work' without difficulty should be assured. A reference model stands above the standards that are developed within its scope and can be seen as a meta-model providing a common vocabulary and semantics that can be shared. Such a model would normally be developed by groups of people, possibly from different backgrounds but sharing an interest in a single endeavour of some kind. An example is the OASIS Reference model for open standards[29]. There are many others, and one of the first was the Open Systems Interconnect reference model, sometimes known as the 'seven layer model'[30].

The Reference Model presented here was developed by a process of reflection and review, based on the empirical evidence gathered by this study. It is then used in a review of representative standards that are available for information systems engineering. In order to ground the model in the present study, this chapter uses selected text from the interviews as illustration of the argument and justification for the detail of the model. The reader is reminded that the bulk of the qualitative analysis is available in Appendix 5; reference is made to that analysis here, where appropriate.

8.2 The Reference Model

This section develops the Reference Model based on the standardisation domains (the 'success groups') and reflects on the data and analysis that has been undertaken in this study. The development picks up the principle separation of ideas that has emerged in the standardisation domains and captures the interaction between them by means of reflecting on the possible associations, and by reference to the evidence.

At the beginning we have the idea that a transaction is the result of *need* (or dependency) and *capability* (or enablement), sitting at the boundary between two processes. In its realisation, a transaction requires the *means* (resources) to accomplish it, and it delivers an *outcome* (benefits) to the organisation; management *actions* arise from differences between the expected and actual outcome, and so checking and adjusting the means will occur as might be necessary. In this way, the relationships between the standardisation domains are exposed.

The paragraphs that follow develop the model and explain the introduction of these components in some detail, stage by stage, and illustrate the steps taken with material from the original transcripts. After the initial presentation of the idea, the model is developed and embellished using the basic rules of entity-relationship modelling, so as to give it the status of an ontology. First, however, it is necessary to examine what has previously been referred to as the 'boundary' and introduce the idea of 'service transactions'.

8.2.1 Transactions at the 'boundary'

The idea of the transaction was under examination at a very early stage in the study (see section 3.3.2, page 49) and provides a hook on which to hang ideas about the boundaries within which work is undertaken. A significant step forward was when the idea of ***service*** emerged, so as to recognise the importance of good practice guides such as the IT Infrastructure Library ("ITIL" - discussed further in section 6.6, page 124) that have proved very interesting to practitioners because of the focus on service management, and so as to accommodate the rather varied detail that was initially categorised as boundary issues. It is chosen here to refer not to *transactions*, but to ***service transactions***. Thus, the principal initial ideas that are at hand are as follows:

- Processes produce product as output

[29] Details can be seen at https://www.oasis-open.org/committees/soa-rm/faq.php

[30] Wikipedia probably gives the best overview of the Open Systems Interconnect model: https://en.wikipedia.org/wiki/OSI_model

- Processes receive products as input
- A service transaction is the exchange of products between processes
- Management controls the exchange of products between processes

This set of ideas gives the first view of what will become the core of the Reference Model: a product is produced by one process and delivered to another, and the exchange of products is initiated by a service transaction that is subject to management control:

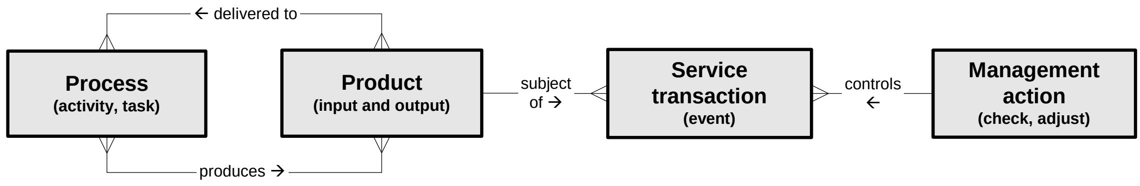


Figure 63 The first sight of the Reference Model

Note that this is not a 'flow' diagram. The relationships (the lines with 'crows' feet') do not represent the *flow* of material, they only indicate that there is a *relationship* between the entities, as indicated by the small arrows adjacent to the relationship identifiers – these show the direction in which the model is to be read, and the crows' foot denotes multiplicity. Hence:

- 'Many processes produce many products' (conversely: 'A product may be produced by many processes')
- 'Many products are delivered to many processes' (conversely: 'A product may be received by many processes')
- 'A product is the subject of many service transactions' (conversely: 'A service transaction deals with only one product')
- 'Management controls many service transactions' (conversely: 'A service transaction is the result of only one management action')

The cardinality of relationships is important in understanding the phenomenon properly. Where there is a one-to-many relationship it makes clear that the one thing can produce, receive, absorb or control many instances of the other; where there is a many-to-many relationship it must be resolved in some way, and it is found that there are two such ways at this stage: the relationships between processes and products. These can be resolved by representing the producing and receiving processes separately, so that an instance of a produced product comes from one and only one process (Process 1), and an instance of a delivered product is provided to one and only one process (Process 2), as shown in Figure 64:

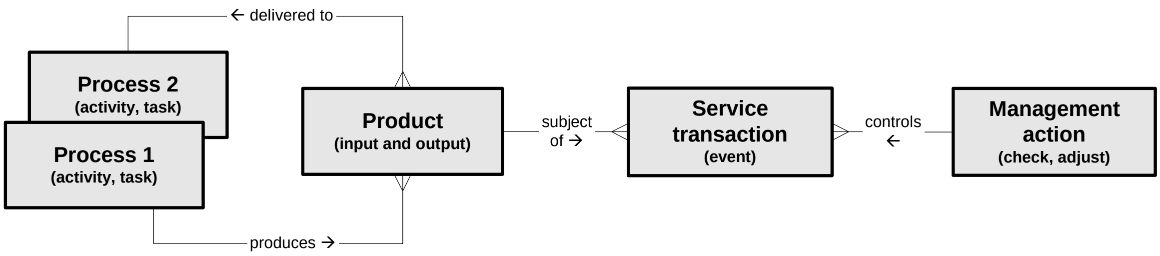


Figure 64 The heart of the Reference Model

Shortly, these multiplicities will be resolved in another more generalised way, but first, some illustrations from the qualitative data in the transcripts illustrate how these ideas occur in practice.

Typically, a service transaction might be initiated for the supply of equipment from vendors, in which case this would be a transaction in the commercial sense. The IT facilitator [RES 09] had clear memories of his early experiences with technology acquisition, which are just as applicable today:

> *'[Did you have] endless arguments about Microsoft or not Microsoft, and things like that?*
>
> *No, no, again we had old computers that didn't have hard drives in, 286's or something like that, and then we wanted to move over to Windows 3.11 so we just said "well what do we do?" and you speak to the vendor and they make some recommendations and you just decide on the way forwards. So you work within your constraints of your available resources and things like that.' [RES 09 - IT Facilitator, University C, 2015/05/15]*

This is a good illustration that invokes the idea of need (for PCs) and opportunity (the vendor's stock), and also the means to make a decision (the recommendations). However, management is not involved.

It would seem that little changes over the years:

> *'I actually bought a new laptop recently. I would expect, I would like, to be able to go somewhere like with my cell phone: "This is my requirement, I want a 15.6 inch display, so much RAM, and this is what I do, what can you recommend?" … there are three vendors but each vendor has a different model. The one supplies Dell, the one Lenovo and the other one Acer ... on a price basis Acer always wins!' [RES 26 - Technology manager, University C, 2015/08/11]*

There is a hint here that management is a factor sometimes, because it is expected that things will be acquired on a 'best price' basis. However, it is not always that simple. At any level, the idea of two processes exchanging something that one needs and the other can produce introduces the idea of a 'product' that is acquired, but the word 'product' is strongly connoted with the idea of material things. It is clear that in the following extract that processes that transact ideas, agreements, and other non-material things are of concern, but they are all included as 'products' in this context. Consider the situation where the need is for a more complex, abstract thing, 'understanding':

> *'[I am thinking about] the 'requirement' discussion between the client and ourselves. There was more than one client. It was a good meeting, everybody agreed what should be done, which was awesome, one of the parties was a lot more - how shall we say it - "driving" the discussion than the other? So you could get a clear sense of the urgency for the one versus the other, which was interesting because even though people collaborate on a project and they say "we want this" or "we think we want this" there will always be one party that wants, [and] as long as you have that strong guy then you can feel confident that it's gonna happen!' [RES 08 - Outsource partner CEO, Software and systems services business, 2014/11/21]*

This outsource partner had extensive experience of working with academic institutions and had many stories about the problems of finding consensus and getting agreements. In terms of service transactions, the outcome here is the agreement – but of course the processes are rather more complicated that simply placing an order for goods. This actual event was just a moment in the negotiation of a contract, a 'transaction' of a higher order that incorporates a range of subsidiary or constituent transactions, such as gaining agreements and deciding specifications. These details, taken all together, comprise the transaction that is the achievement of the contract. Thus, the idea of a *hierarchy* of processes emerges.

Some respondents talked about the 'top down' and 'bottom up' approaches to management which parallels the idea of a hierarchy of things to do:

> *'… it is clear that this will not be easy, it will take a special effort in terms of project management, and this feels like a "bottom up" (ie technology-push) project rather than a "top down" (ie researcher and management pull) project.' [RES 01 - National Software Project - Notes of a tele-meeting, National Government, 2012/09/20]*

When contemplating a service transaction, it is clear that one needs to know at what level it sits in the wider scheme of things – note that the icons for 'Process' include (parenthetically) the lower ideas of 'activity' and 'task'. This problem of levels will be assisted by a clearer understanding of what it is that is needed in any case, and how the provision of a product actually contributes to a need.

8.2.2 Input, output, need and capability as features of a service transaction

The introduction of separate 'producing' and 'receiving' processes in the model (see Figure 64) is not advisable, because all processes will actually have both characteristics. In a model such as this one, the boxes represent ***entity types***, not instances of those entities. There is actually only one entity type, the process, and it must be shown with both inputs and outputs. This allows the many-to-many relationships to be dealt with in a different way. The ideas of 'input' and 'output' are very basic, and yet they assist in resolving the relationships between processes and products if they can be regarded as singular: an input or output relates to just one process, and is just one type of product, and is initiated by just one service transaction. In this way, 'input' and 'output' can be used to resolve the multiplicities:

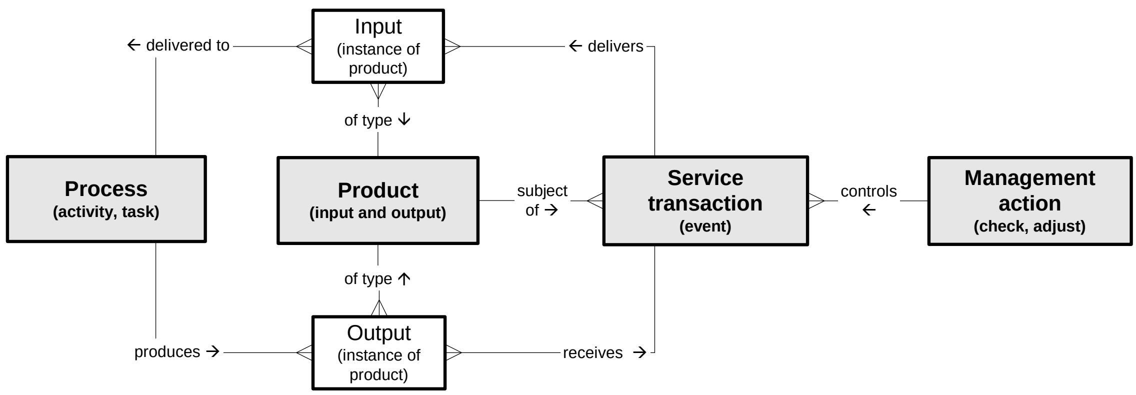


Figure 65 Introducing 'input' and 'output' to the model

An instance of a product as input to, or output from, a process is seen to relate to one and only one process, one and only one product, and one and only one service transaction. Processes, products and service transactions relate to many inputs and outputs, but if it were possible to capture information about every instance of a service transaction, and every input and output, then there would be a very fine level of detailed information available for performance and management purposes[31]. Entities such as these, that resolve many-to-many relationships into a set of one-to-many relationships, are known as associative entities and they are important in achieving a complete understanding of an ontology.

There are other ideas associated with the exchange of products that occur frequently in the transcribed evidence. The idea of 'need' is very evident in the transcripts – it occurs 188 times, putting it among the ten most frequently occurring words. The word 'capability' (28 occurrences or inferences in the transcripts) is another idea: the capability of one process to satisfy the needs of another. Hence, a service transaction fulfils a need, and it exercises a capability. Consider how 'need' and 'capability' can be introduced to the model:

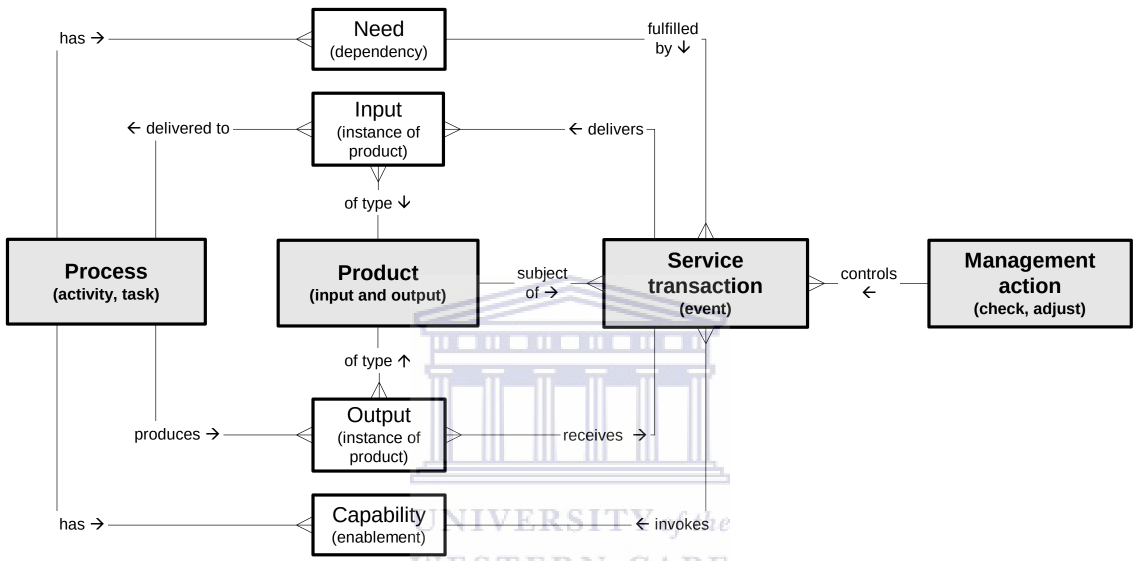


Figure 66 Introducing 'need' and 'capability' to the model

As shown here, a need might be fulfilled by many service transactions, and a process will have many needs. Similarly, a capability will be invoked by many service transactions, many times for the process that has that capability. One might argue that a service transaction would need many capabilities, or it would fulfil many needs, but that would introduce many-to-many relationships. There is the opportunity to define these entities in a way that avoids that:

- 'A service transaction delivers many inputs but it serves only one need, that originates from only one process'
- 'A service transaction receives many outputs but it invokes only one capability, from only one process'

[31] This idea of capturing detailed information at the level of inputs and outputs is at the heart of customer loyalty schemes (Evanschitzky et al., 2012), whereby retailers gather information about every single thing that is bought by a customer; it also becomes the heart of information gathering in the age of the 'Internet of Things' (Xia et al., 2012), where transactional data from telemetry of different kinds is gathered, in large volumes.

If an instance of a service transaction seems to address many needs, or invoke many capabilities, then it is too complex and must be redesigned so as to satisfy the cardinality rules. This is the way that complexity is dealt with.

Consider this example from the discussions with the second technical team:

> *'You could say, it's about the management of scale. It's about operational processes, monitoring. What went wrong? Was it controlled or not controlled? It's a complex system with many parts, and we don't know when or where it's going wrong. Instead of it being systemically controlled it's dependent on single people, the knowledge that people get. There's no system that allows us to monitor and control this environment.' [RES 34-38 - Technical Team B, University A, 2015/10/01]*

The focus here is on incidents and how they might be managed. There are clearly many people who might be able to fix many problems, relating to a system with many parts, and as things are presently running there is no possibility to easily manage the process of problem resolution. What is needed is a process that delivers a problem report (the product), which goes into a process of problem resolution. The allocation of the problem report to a process that might resolve it is the service transaction, but that transaction (the details of which must be recorded, of course) will indicate just *one capability*, from *one resolving process*, addressing *one need*, that emanates from *one other failing process*. Within the resolution, there is still the possibility of *many inputs and outputs* of course. While this sort of discipline might seem onerous, this is how complexity can be managed. The need for information systems that will ease the problems of capturing and processing the data relating to such complexity becomes clear.

8.2.3 Digression: the choice of words

As presented the model includes some alternative wording for these entities. This is based on the terms that emerged from the repertory grid analysis, and from lexical analysis of the transcripts. Words such as 'dependency' (or equivalent words with the same meaning, such as 'depends', 'depending' and 'dependant' – there are 39 such inferences in the transcripts) and 'enablement' (12 inferences) are the words that were used by respondents, and that makes them important. The vocabulary adopted here is not yet stabilised and the choice of exactly which words would work well in higher education is yet to be established.

For example, it is found that the idea of 'enablement' is so prominent that it is not only a key feature of COBIT (which is tightly focused on finding the 'enablers'), in some sectors the word figures in the naming of commercial software packages. In a situation where a head of department wants to enable a member of staff to take a holiday (or sick leave?) one institution has a software package called 'i-Enabler':

> *'The other system that I deal with is called i-Enabler. Staff have a specific number of days of leave a year, different types of leave similar to moves and special leave and whatever and they have to apply so I can allow them to go or not go - so I will be informed by their application. The problem is they don't apply, they just go!' [RES 00 - Pilot 1 respondent, University B, 2014/02/11]*

The need is for information motivating the leave, but in this case it seems the discipline is not yet in place so that people do not actually bother to ask permission – one assumes that there are no consequences in this institution when one does not follow the rules. What might be the outcome of a case like that, when someone takes leave without providing the information that is needed to gain permission? This question about 'outcomes' brings us back to the main discussion, and suggests further additions to the model.

8.2.4 Outcomes, means, and management action

The idea of management and the actions that are taken at that level needs some elaboration. Managers need outcomes – and an outcome is more than just an output. In the context of management, outcomes are expected that provide real benefits that match strategic aims and objectives. At the same time, in order to realise the benefits that may be there, an institution must have the resources or the means to do what is necessary. These ideas are evident in the transcripts, providing further candidates for the model:

- ‘outcomes’ (31 inferences)
- ‘benefits’ (57 inferences)
- ‘means’ (27 inferences, but only some of which are of the noun form) and
- ‘resources’ (27 inferences)

These can be added to the model as flesh around the bones of management actions, in this way:

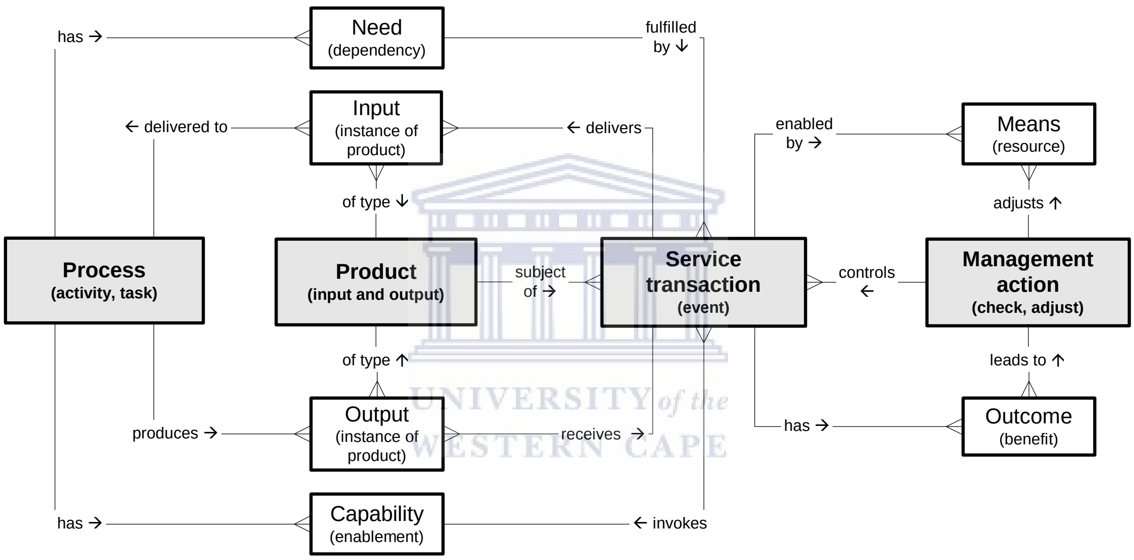


Figure 67 Outcome and means in the generalised Reference Model

These ideas – ‘means’ and ‘outcomes’ – are not the same as the products, inputs and outputs on the other side of the model. They are softer ideas that are, in a sense, at the whim of management thinking. If the Dean of a faculty decides that language policies for certain subjects need to be opened up, then the *need* might be for learning materials and learning support systems that use alternative languages. The strategic intention is to admit more students with specific, previously unrecognised, languages-for-learning and the *outcome* would be a new, diverse and richer community of students learning in new ways; the *means* to achieve this outcome might be the hiring of translators, or requiring existing educators to learn alternative languages, or simply the acquisition of new learning materials that are already available in these alternative languages.

The mature first year student had taken control of her language problem with the help of a fellow student from the east. She needed to be able to translate material written in Chinese, and was introduced to an app for her smart phone that would do it for her:

> *‘This provided me with power that I did not have. Going into Chinese medicine is daunting, from concept, language, culture, and if I had something there, on my cell phone, that gave me instant power*

> *to say "well, I know what that means", "I know what that squiggle means!". For lack of a better word: "power!", it gives me that!' [RES 06 - Mature first year student (health), University B, 2014/09/01]*

The need was translation, the capability came from her smart phone, the means was a friend, and the outcome was considerable happiness. The management of this service transaction – downloading a single app – was entirely within her control. But this was a very simple example, some are more complex.

8.2.5 Benefits of the model

The model brings a structure to the way one can think about academic activity that provides control. It shows that if we need to know what has been consumed in the course of achieving an outcome, then one must track back to the service transactions, and examine all of the instances where resources were consumed as the 'means' of getting the job done. What has been consumed in the fulfilment of a complete process can be tracked with the inputs and outputs, and the related service transactions, and the means that those service transactions absorbed, to give the answer. The sum of all the benefits delivered by a process can be tracked through all of the needs, the service transactions that fulfilled them, and the outcomes of the service transactions. Finally, to undertake a cost benefit analysis, the combination of both these summations as a difference will show the full cost and the full benefit.

Talking about the new learning management system, this student considered:

> *'Well, it's a means as well where lecturers can communicate with not just my faculty but everybody that is doing chemistry at my level. So, all the slides, all the lecture notes are put on there - you don't have to print it out because it's there on the machine, they communicate past papers and … just valuable information.' [RES 06 - Mature first year student (health), University B, 2014/09/01]*

This is a typical example of where the means – the learning management system – allowed a useful outcome – the students were able to be informed about many aspects of their intended learning without queuing at the student book shop, without paying for printing and without having to travel a distance or find out exactly when the shop is open. In this context the learning management system is not seen as a product, its very presence and availability is the means whereby something was possible.

Elsewhere the interdependency between managerial transactions (where decisions are taken) and the operational consequences can be seen:

> *'I was on the tender committee. What normally happens is it becomes a price battle. That's where I think we missed the plot, where we didn't look to build business relationships. For instance I would have said, engage with Samsung and [tell them] that we have the capacity to buy so many laptops, so many tablets, so many cell phones; 'what can you offer? Let's build a relationship together and see how we can engage with each other on that'. In terms of maintaining different laptops from the support perspective, maintaining this maintaining that, it's just horrible. The impact on support is just unbelievable. If you have good products then you don't have to look at that argument of choice.' [RES 26 - Technology manager, University C, 2015/08/11]*

This in turn reveals the undesirable outcomes that can arise when things go wrong, and makes clear the need to check the outcomes and adjust the way that things are done. The collected evidence repeatedly affirmed that nothing stays constant in higher education, and so management processes must constantly check outcomes and adjust operations, in different ways.

This was true in the RIMS project as the new system came closer to its initial implementation:

> *'Institutions are stepping forward to pilot features of the system and helping to adjust it to the SA environment. Modules are configurable in the same way that SAP and Oracle modules can be parameterised and configured - setups are done "up front"; there is no coding or data design involved' [RES 01 - National Software Project - Notes of a tele-meeting, National Government, 2012/09/20]*

Early engagement with users brings new understandings and the need to change design features. The RIMS development platform has features that allow changes without having to write program code, it seems.

Talking about an outreach project, one project manager pointed out that institutional and external factors led to similar constant adjustment of plans and designs (in a project developing a new mobile 'app'):

> *'You have to have a clear understanding of the technology, to make adjustments about what are the implications in terms of the institution, so that you can create [the right conditions] and what are the implications of implementing this novel app, and then in terms of understanding what is happening in the outside space.' [RES 12 - Project manager, University B, 2015/05/04]*

These are issues for management to attend to, and the idea of levelling returns. Understanding the context for higher education is a matter of strategy analysis and strategy formulation – the stuff of the highest levels of management; adjusting the technology to deliver is a matter of operational fine-tuning. The differences between 'governance' and 'management' come to mind – two words that take 'management' and divide it into its separate high and low levels.

COBIT is unique in the way that it talks about governance, and enabling, and different levels of management. The technology manager in one institution had been looking carefully at COBIT and ITIL, and he made clear reference to the differences between the higher and lower levels of management as he reflected on the initial moves in his institution to adopt ITIL:

> *'What happened was, from the institutional perspective, there was no drive from the top saying this is the language we are going to talk when we talk quality or standards. So the ITIL implementation was a bottom up approach, where we in the department felt that this was a good way to go. It was easily translatable and you could show quick benefits in terms of you know, change management, managing risk. Some of the modules are easier to implement than others I think the approach now has changed, there's a significant focus on audit activities in terms of more senior people being appointed to look at audit activities.' [RES 26 - Technology manager, University C, 2015/08/11]*

This is quite a clear view of the differences between governance and management. At the high level, 'no drive' initially but 'more senior people being appointed' later; at the low level, a decision to go for ITIL first, because it was 'bottom-up', and therefore offered quick benefits.

8.2.6 Back to the idea of the boundary

The comments of a project manager in mind, concerning a project intended to introduce ITIL, make clear that much of what has been examined in the course of this study was activity *within* projects that are related to systems and software, but there is also the matter of the operational phase in the life of a system, and the transition from the world of systems development into the world of education, where systems are used.

This is the 'big' boundary, where systems analysts and systems designers battle to understand users and their needs, and where the users battle to understand what the specialists are saying. It is at this boundary that the roles that people are adopting are clearer, because in each service transaction the people involved will have a focus that relates to their role.

At the boundary it is also important to note that it is strategic intention that determines what is good and what is bad, as seen at the level of the outcomes that eventuate. Hence, showing the boundary as the space within which service transactions take place, and where the involvement of people and the recurring idea of 'strategy' can be seen, allows the completion of the Reference Model as follows:

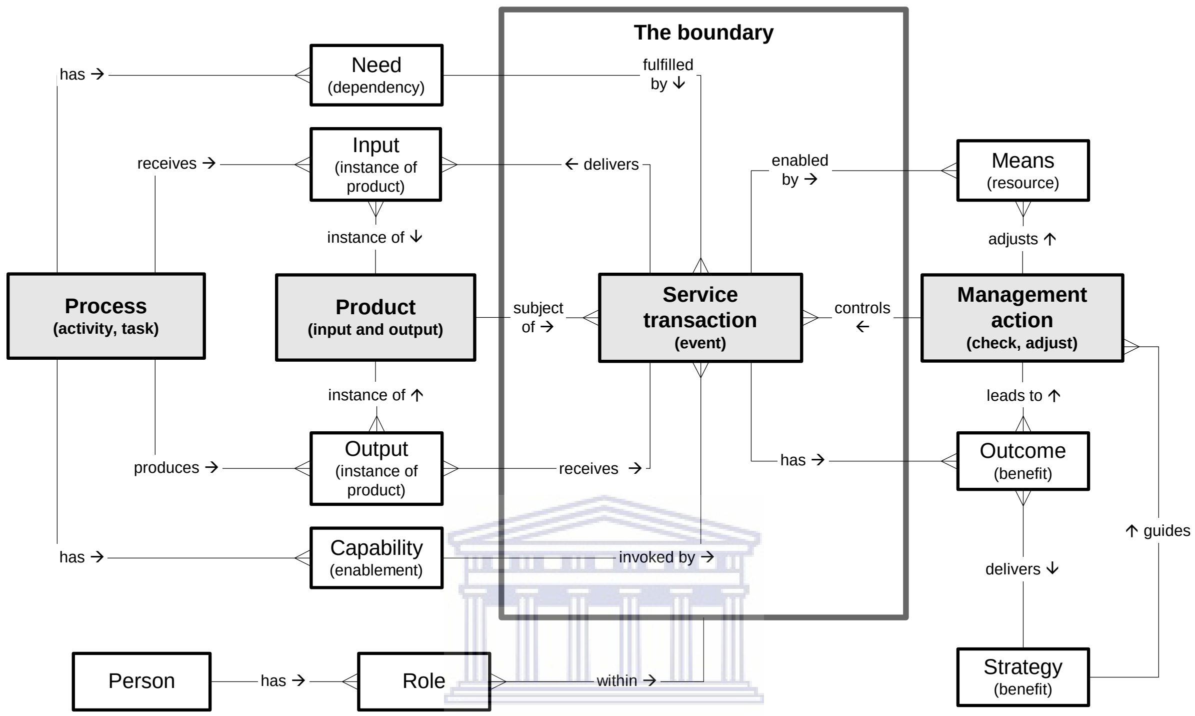


Figure 68 The final form of the Reference Model

8.3 Linking the Reference Model back to the source data

The following table (Table 20) provides some initial comments on the interpretation of the detail of this model and – importantly – it provides references back to the memo items that were accumulated in the thematic analysis, which in turn link back to the transcribed data at the level of chunks and category codes. This is necessary to establish the provenance of the model – without it the model would be simple conjecture.

Table 20 Notes on entities and relationships

Subject		relationship	Object		Notes	Theme memos
one	Process	has	*many*	Needs	Processes have many needs, but every need is attributable to one and only one process.	M50 M51 M56
one	Process	has	*many*	Capabilities	Processes have the capability to do different things, and the same capability may be present in different processes, but here a capability is attributed to one and only one process.	M20 M61 M43 M115

Subject		relationship	Object		Notes	Theme memos
one	Process	produces	*many*	Outputs	Processes produce outputs that serve the needs of other processes. An output is associated with one and only one process.	M23 M45 M48 M56 M125
one	Product	subject of	*many*	Service transactions	The idea of the service transaction provides a single point, in the complexity that exists in any working institution, where deliverables can be identified, attributed to sources and destinations, costed and assessed for value and benefit to the institution. A service transaction is associated with one and only one product.	M23 M48 M50 M76 M123
one	Process	receives	*many*	Inputs	This makes clear that any input is to be associated with one and only one process.	M23 M45 M48 M56 M125
many	Output	is an instance of	*one*	Product	This makes clear that any output is to be associated with one and only one process.	M38 M71 M126
many	Input	is an instance of	*one*	Product	This makes clear that any input is to be associated with one and only one process.	M38 M71 M126
one	Need	is fulfilled by	*many*	Service transactions	This makes clear that any service transaction is to be associated with one and only one need.	M1-M8 M24 M60 M72 M94-M102
one	Capability	invoked by	*many*	Service transactions	This makes clear that any service transaction is to be associated with one and only one capability.	M61 M80 M91 M115
one	Service transaction	has	*many*	Outcomes	This makes clear that any outcome is to be associated with one and only one service transaction.	M43 M74 M142
one	Service transaction	is enabled by	*many*	Means	This makes clear that any instance of 'means' is to be associated with one and only one service transaction.	M1 M5 M20 M43 M50
one	Service transaction	delivers	*many*	Inputs	This makes clear that an input derives from one and only one service transaction	M71 M80 *et sec*
one	Service transaction	receives	*many*	Outputs	This makes clear that an output derives from one and only one service transaction	M71 M80 *et sec*
one	Management action	controls	*many*	Service transactions	Management works by deciding many service transactions, each of which derives from one and only one management action.	M1-M16 M24-M31 M36-M39 *et sec*
many	Outcome(s)	lead(s) to	*one*	Management action	This makes clear that any action is to be associated with one and only one outcome.	M1-M16 M24-M31 M36-M39 *et sec*
many	Means	adjusted by	*one*	Management action	This makes clear that any action is to be associated with one and only one means.	M1-M16 M24-M31 M36-M39 *et sec*

Subject		relationship	Object		Notes	Theme memos
many	Outcomes	deliver	*one*	Strategy	Strategy is seen as singular, but at different levels in an institution there might be many strategies in place. Strategies determine the outcomes that are sought.	M1 M4 M6
one	Strategy	guides	*many*	Management actions	All Management actions must be guided by the strategy that sets appropriate targets and measures.	M12 M20
one	Person	has	*many*	Roles	Adopting the idea of 'roles' gets away from job titles, an unreliable indication of what people actually do. It also helps to separate out what people need from systems, according to their role.	M1 M5 M55 M72
many	Roles	occur within	*one*	Boundary	In this context, it is useful to define a role as that which a person adopts when dealing with a particular boundary (that in turn accommodates service transactions)	M115 M133
one	Boundary	accommodates	*many*	Service transactions	In this context, a boundary is seen as a space rather than a line, wherein service transactions can enable the passing of product from one process to another, ultimately to achieve the outcomes that serve strategic objectives.	M112 *et sec*

8.4 Summary

This chapter has taken the standardisation domains and the unstructured qualitative data, and drawn out a Reference Model that accommodates all of the requisite detail, but at a higher level that sits above the detail. It also sits above the level of the standards that might be considered as potentially helpful in managing information technology and information systems in higher education. The early coding of the data and the development of the themes was subjective, but rich in detail; this 'step back' to the conceptual level, and the combining of the landscape analysis with the repertory grid results, has delivered a model that can be linked back to the original data and is justified by that data, and provides the beginning of a more disciplined approach to the issues.

Chapter 9 Conclusions

This final chapter revisits the objectives of the study and summarises its findings. There is reflection on the limitations of the work, and on what might be done next.

9.1 Objectives of the study

In the first chapter, the aim of the study was stated to be:

> *"… to improve the potential contribution of IT to the needs of South African higher education through better management, based on a better understanding and implementation of standards across the whole chain of activity: from information technology acquisition, through information systems implementation, all the way to the achievement of educational objectives. "*

The standards that are available are better understood, but it is found that they are many and various. The challenge for all concerned with information technology and information systems in higher education is this: to negotiate and agree their educational objectives and work back down the 'chain' of activity in order to determine what is important to standardise and what can be improved by the adoption of good practice.

It is the variety of educational activity and the variety of people in education who are involved that makes standardisation difficult. For example, in disbursing funds for technology acquisition there are huge differences in the benefits of providing new personal computers for administrative staff (who may continue to do the same things in the same way) compared with investing in specialist infrastructure that will support research in a globally competitive way. At the same time, in South Africa, there are academics and students that have the same potential to succeed, but from very different starting points, and the most appropriate approach to systems will vary according to their innate and formative capabilities to use systems effectively.

9.2 Systems, events and scales

The research investigated the kinds of systems that are used, the events that were experienced, and the scales of assessment that respondents considered important in rating events.

In summary:

- The variety of systems is considerable, and a portfolio approach to the management of systems would be appropriate. Such an idea, to manage different kinds of system according to their differences, is latent in the stories that respondents told. It is found that the scope and reach of systems, and their present and future importance, are key characteristics in organising the portfolio. This is an idea that is well founded in the literature and in practice, and while there are no standards there is plenty of good advice, including advice from academics who have written books about information systems management.
  The way that software is best engineered into systems, and the way that those systems are best engineered into educational processes, will vary significantly according to the scope, reach, and future importance of those processes. These variations seem not to be widely understood.
- The events that illustrated the significant experiences of respondents were concentrated on the technical side of the 'value chain' – here seen as the Information Management Body of Knowledge framework (IMBOK). Events fell principally within three areas: the development of

systems, the implementation of systems, and the operation of systems; also, within the management of these things. The desire for useful outcomes is very evident, but if there is to be a useful contribution to South African higher education this desire needs be turned into a plan to deliver real benefits.
Little evidence was found that respondents appreciate, or are involved with, the management and delivery of the benefits of information technology and systems investments.

- The scales that relate to success, as seen in the outcome of events, were gathered into what were first seen as nine 'success groups', but then adopted as nine 'standardisation domains'. These then formed the components of a new model – the 'Reference Model' – that is offered as a framework with which to organise standards and good practice in any situation that needs that kind of assistance.
The Reference Model is not specific to any one situation, and it will therefore assist widely, despite all the variation that is observed in the kinds of system, and the kinds of events associated with them.

9.3 So, where are the standards?

It was noted in Chapter 6 that there are different kinds of standards:

- International standards
- National standards
- Industry standards
- Professional association standards
- Organisation standards
- Open standards
- Ad hoc standards
- Project standards
- Individual standards

The position that has emerged from this study is that there are indeed many standards, and that the real problem is *choosing* which to adopt in a context where there are such variable needs. Stafford Beer would have us meet variety with 'requisite' variety (Beer, 1984) but the complexities are forbidding. The new Reference Model provides a means to organise an approach to good practice, or standard practice, by positioning the need and then working through the nine standardisation domains in order to make appropriate choices.

The international standards are voluminous, often tightly focused, and (according to the limited available information) they are not widely used other than as 'cook books' from which to choose elements that might solve a specific problem. While they have application in military and safety-critical environments, they have little attraction or utility in higher education other than as a source of ideas. The Software Engineering Body of Knowledge was an exhaustive source of primary sources but it is already at risk of being out of date because of its very specific reliance on what is, essentially, a bibliography. The ISO-IEC/JTC1 business plan (ISO-IEC/JTC1/SWG3, 2015) hints at the difficulty of sustaining the effort of standardisation at this level, and it is clear that professional association standards and good practice guides (in which category COBIT and ITIL can be included) have more utility because of their broader scope, the recognition that specific parts may have to be adapted before they are adopted, and because of the focus on *enablement* (COBIT) and *service*

(ITIL). In the experience of those who have used these good practice guides, COBIT is found to be top-down and ITIL is bottom-up, although closer inspection shows that each has the potential to be adopted in either way. Nevertheless, the idea that an institution might choose top-down or bottom-up is useful and helps to start a good conversation about strategies for process improvement.

The understanding gained about the standards that are available, their applicability and their utility leads to one conclusion: there is the potential for the application of standards but they need to be fluid, they need to provide room to manoeuvre and they need to act in a way that works at different levels and between different role players. In mapping available standards to the nine standardisation domains the temptation to reach into the academic literature in order to find coverage was over-riding (see Table 19).

9.4 Key findings

The key findings may be summarised as follows.

9.4.1 From the literature review

- The *potential* for information technology in higher education is self-evident and it is foremost in the minds of many of those people who are involved.
- Research into the *management* of information technology in Higher Education is very limited.
- Published frameworks show that the *linkages* between technical issues and organisational issues involve dependencies and enablements.

9.4.2 From the landscape analysis

- There is a *low level of awareness* and deployment of standards and good-practice guidelines, but in isolated pockets institutions are testing the potential.
- There are issues of *complexity* and *differences*, across different academic domains (such as teaching and learning, research, administration and management) that may require quite different approaches to standardisation.
- The level of interest in *outcomes* is marked and somewhat in contrast to the lack of interest in actually planning, monitoring and assessing the benefits of information technology and information systems investments.
- Within the discussion about experiences with systems, *systems related problems* are the predominant topic.
- Outcome is *very frequently associated* with other issues raised in the conversations, such as challenges and problems with human capability.
- Conversation with respondents reveal recurring themes: *processes*, *strategies*, *boundaries* and *standards*.
  - Within the discussion of *processes*, issues of shared process activity comes through strongly.
  - Within the discussion of *strategies* there is much interest in trying to deal with things strategically, but very little evidence that the implementation of strategies is happening.
  - Within the discussion of *boundaries* the scope and reach of systems and the assessment of performance at boundaries is commonly referenced.

- Within the discussion of *standards*, the main interest seems to be in whether they are needed (or not), whether they are available, and whether they will address problems of functionality in systems.

Based on the frequency analysis of open codes the thematic analysis gathers the evidence into four high level themes that are carried forward: *process*, *product*, *boundary (scope)* and *management*, refined and stabilised by the accumulation of the evidence in memos (as presented in Appendix 5).

9.4.3 From the Repertory Grid analysis:

- Of all the instances where respondents offered a scale of measurement that might be applied to their work, almost half are closely related to *systems events*, as distinct from events in administration and general performance management.
- The scales derived with respondents are of two types: the first is related to notions of 'good' and 'bad' performance and the second is related to non-judgemental factors such as whether something is academic or administrative in nature, or strategic as opposed to operational.
- The 'good-bad' scales correlate well with respondents' perceptions of success.
- Statistical analysis of the RepGrid data leads to nine standardisation domains:
  - The *boundaries* and scope.
  - The *capabilities* that are required.
  - The *management actions* that are taken.
  - The *means* of executing transactions.
  - The *needs* of an institution.
  - The *outcomes* that are achieved.
  - The *processes* that add value.
  - The *products* that are produced by processes.
  - The *transactions* that exchange products between processes.
- A Reference Model incorporating these standardisation domains provides a means to organise standards and good practice ideas independently of the nature or level of the context.

9.4.3.1 From the analysis of selected available standards:

- Standards can be *simplistic*, being based on a single perspective and a tightly organised hierarchy, or they might be *more open and adaptable* by invoking higher level ideas such as 'enablers' as a key construct around which to organise the detail of a standard.
- Equally, standards are more likely to be *tightly bounded* in their scope, meaning that the co-working of different standards is likely to be limited even when they are from the same regime.
- Standards are presented in *very large documents*, or as *multiple documents*, and access may involve a cost. International standards from ISO (acquired in South Africa) are very expensive and access to good practice guides has to be paid for.

9.5 Theoretical contribution

This thesis has tried to avoid a concentration on extant or new theory, being a crafted work that set out to explore an under-researched area that is very important to the future of Higher Education in South Africa, and ultimately to the South African nation at large. The objective was to contribute to *understanding* rather than to deliver a new theory.

Nevertheless, the Reference Model is new and originated from within this project. In the sense that grounded theory methods are intended to deliver a theory, this – the Reference Model – is the outcome. However, it is acknowledged that the rigours of a full grounded methods approach have been avoided and the initial testing of the model, whilst promising, requires more time and effort than was possible within this developmental study.

9.5.1 The Reference Model

The Reference Model has been derived from the qualitative data, the structured conversations and the qualitative and quantitative analysis of people's experiences with systems in higher education. Whilst it was not a main feature of the research questions, it does make a real contribution to any effort to realise the full contribution of IT investment potential in higher education. Testing that Reference Model in a review of fourteen examples (taken from the primary data) has shown that it accommodates the issues and separates out the things that have to be dealt with. The Reference Model shows promise as an accommodating but flexible means to organise guidance to professional people working in Higher Education, by allowing the selection and application of guidelines at different levels, in a way that is amenable to the shared working that respondents were clearly involved with.

9.5.2 Testing the IMBOK – an abductive moment

It was at a very late stage in the project when it was realised that the Reference Model provides the discipline that is needed in moving between the knowledge domains of the IMBOK.

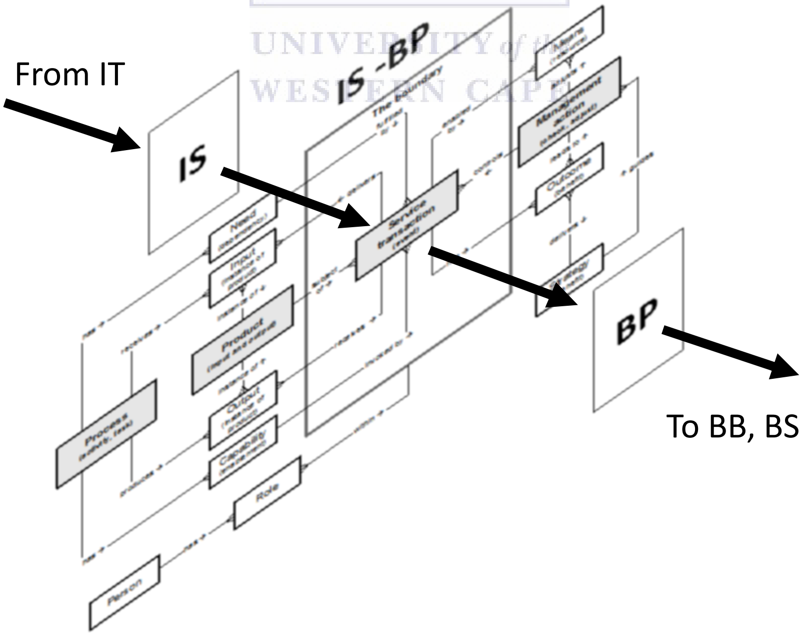


Figure 69 The Reference Model at the IS-BP junction

The IMBOK framework, a major deliverable from a UWC research project in partnership with the Cape Technikon (UWC, 2003) has never been subjected to rigorous research and testing, but it was introduced during the analysis (see Table 6) to examine the spread of data that had been gathered, with a useful outcome. As has been explained, the IMBOK has five 'knowledge' domains, joined by four 'process' domains. The principal risks are to be seen at the junctions, where technology is transformed to system and system to process, process to benefit and benefit to strategy realisation. Figure 69 shows how the Reference Model can be seen to sit in the important, but sometimes very difficult space, wherein information systems are being implemented in business processes. It could equally well be seen between the other junctions: IT-IS, BP-BB and BB-BS.

The IMBOK makes clear the standards that are needed at the four interfaces:

Table 21 Fitting the Reference Model to the IMBOK

IMBOK interface	Boundary issues	How the Reference Model helps
IT-IS	Information technology is often the driver, when it should normally be the needs of the organisation that drive systems development. Decisions about build-or-buy, negotiations with suppliers and establishing technical capability are all typically problematic.	The Reference Model brings a focus to the scope of a systems project, and highlights need and capability. The formulation of contracts with suppliers and partners will be assisted by consideration of all the facets of the Reference Model.
IS-BP	Implementation often demands change, which requires clear management direction. Users must be trained in the use of new systems and there are many ancillary actions that will need to be included in a plan.	The role of Management in setting and overseeing standards is critical, and the work at this stage needs to be clearly related to strategic intentions, as seen in the required outcome of a project at this stage.
BP-BB	From the evidence, defining the downstream benefits at the process level is not well done. In this study, a very low level or awareness and involvement in benefits management was found.	At this level, what were outcomes at the earlier stages become outputs: improved admission procedures mean more students, better teaching and learning leads to better marks, and better facilities and support leads to more successful research outputs.
BB-BS	A strategy should laydown performance targets that will stand as success, if they are met. The benefits that are sought will be expressed in terms of those targets, whether financial, operational or strategic in nature. Different kinds of benefit are not always compatible (reducing investment will impact on time and quality) and it is at this level that institutions must decide whether they are striving to expand (which requires investment) or optimise (which will require reduction of costs).	When considering performance, the service transaction is the focal point where measurements can be taken and performance assessed. The Reference Model puts the service transaction at the centre, and makes clear that detailed performance data will be needed to assure an institution of successful outcomes.

This separation of ideas, applying the Reference Model at each of the IMBOK junctions, makes clearer the kinds of standards that are needed. Having established that the adoption of standards is likely to be a 'cook-book' exercise, it can be concluded that an institution that wishes to adopt standards or good practice can undertake a review in these four domains, and even accumulate and share its experiences in an organised way, by learning what is good to do in each of these four spaces in its own context.

This study therefore represents a further step in the validation of the ideas inherent in the IMBOK, as a 'value chain' of activity that delivers strategic outcomes from information technology acquisitions. At one end (IT and IT-IS) there is the realm of software engineering and computer science; at the other end (BB-BS and BS) there is the realm of strategic management.

9.5.3 Realising Leonard Tripp's vision

The Reference Model stands as a tool with which to link standards to organisational needs in ways that were not previously evident. Leonard Tripp had a vision of standardisation extending from software engineering all the way to the outside world that uses software systems; this study has made a contribution to the realisation of that vision.

9.6 Practical contribution – an example

When it comes to nominating standards for deployment within higher education there are options. It has already been noted that there are different kinds of standards, including national, regional and organisational standards. But do those standards have to tell people what they *must* do? No, in the wider view relatively few standards are mandatory so that they must be fully observed. The examples of automotive seat belts, domestic electrical installations and health and safety at work come to mind. But when it is just a question of guidance, the approach can be different.

This study has deployed the IMBOK and developed a Reference Model that combine to organise the practical steps that can be reviewed as candidates for standardisation. Table 22 below takes an imaginary example, where an institution is considering a major investment in systems to support research. In Table 22, at each of the four IMBOK interfaces there are comments based on the possible need to standardise, in each of the nine standardisation domains (this extends the way of thinking that is evident in Table 21, above):

Table 22 Applying the standardisation domains to the IMBOK interfaces

IMBOK: *DOMAIN:*	**IT-IS**	**IS-BP**	**BP-BB**	**BB-BS**
Boundaries and scope.	An acquired package will always fail to completely meet needs and will require changes to be made.	Research activity will be diverse and dispersed. Find common ground within a manageable scope, ahead of any technical development work.	Intended benefits will be visible at the boundary of research, and that is where they should be negotiated and agreed.	Establish areas of research most appropriate for investment, and identify the outcome that is desired.
Capabilities required.	It is necessary to be able to competently evaluate package features and infrastructure needs must be understood.	Leadership is essential when introducing significant change to the ways that people work. In higher education, a case for 'champions'?	Vision and insight into the local, global and competitive issues attaching to research are needed.	Research has found[32] that organisations that take responsibility for their own strategic analysis are more successful.
Management actions taken.	Procedures to monitor progress, review achievement, manage risk and authorise changes.	Ensure the functionality of new systems in terms agreeable to the user community.	Negotiate, agree and document the expected benefits.	Convene and document strategy formulation meetings.
Means of executing transactions.	Contracts for external personnel, must be clear and identify scope of work, authority and success criteria.	System testing, user reviews and problem reporting.	Incorporate benefits management into routine institutional management processes.	Incorporate strategic management into routine institutional senior management processes.
Needs of an institution.	Infrastructure needs to be evaluated for its ability to support new systems; enhancements might be needed.	Traditionally this is problematic: decide how much change is needed and how much will be tolerated.	Based on the agreed intended benefits.	Based on the agreed strategic analysis.
Outcomes that are achieved.	A capable project team, including project management and client links as well as technical specialists.	Improved business processes serving strategic intentions.	Agreement about commitments to benefit.	Agreement about strategic intentions.
Processes that add value.	This is the traditional software development lifecycle.	Change management is required when new systems are moving an organisation forwards.	Benefits management undertaken at the level of functional and senior management.	Strategy formulation and implementation: external and internal analysis of opportunity and capability.
Products that are produced by processes.	The outputs are specifications, modules and integrated, tested system components.	Working, installed systems delivering benefits.	Documented and agreed statements of intended benefits.	Documented and agreed statements of strategic intention.
Transactions between processes.	Formalised work breakdown structures indicate what is to be done.	Implementation will be by means of formalised change and review processes.	Benefits analysis workshops get people together to discuss ideas and targets.	Off-site strategy planning workshops are often used to achieve agreed strategies.

[32] (Earl, 1993)

This is an example which might, in a real case, highlight issues, bring stakeholders' thinking together and iron out differences in a way that would otherwise be very difficult. At the heart of such a review is the need to identify problem areas in a specific way, and then deploy standards, adopt good practice, or take such other steps as might be necessary or useful.

9.7 Limitations and reflections on methods

This work has all the limitations of interpretive work. However, the patterns that emerge in the data (whether visual, lexical or numerical) are rewarding. The use of cross tabulations and pivot chart tools that render thousands of data points visible, at a stroke (or two), was rewarding, and it was not the purpose of this work to *prove* that better information systems engineering standards would improve institutional performance, nor to *prove* that students are happier using WhatsApp than a formalised learning management system. The purpose was to understand more clearly what kind of discipline could be brought to bear upon our work with systems and how it can be shaped into standards that will be acceptable and effective in use. The first step has been taken along that road.

As noted at several points in this discourse, it was consciously decided to take a crafted approach to the research[33]. The software systems that supported the analysis were also the author's own. The Qualitative Content Analyser[34] has been in use and under constant incremental development for more than four years, since well before this project was launched. The suite of software to manage and manipulate the Repertory Grid data (see Figure 32 and following) was developed 'on the fly' within this project, and provided equally effective control over the data and functionality for its analysis.

So, did issues of standards arise in undertaking this data management and analysis with 'personal productivity software' (basically the Microsoft Office suite, with at one stage just a hint of an early version of Visio)? Certainly they did. Features needed for the tree-view of the hierarchies, for example were disabled one day during the course of the study by a Microsoft 'security update'; it was found that the conventions for data handling operations are not consistent from one component of the Office suite to the next, and undertaking the analysis with anything other than a (*very*) large screen proved tortuous. Nevertheless, the ability to move large tables of data from one medium to another, and to transfer images in different ways, got the job done in a way that would simply not have been possible 15 years ago.

A final comment on method: as the data collection was coming to a conclusion, and as the need to stabilise the approach to data analysis became pressing, the reading of the standard texts on Grounded Theory and general statistical analysis became unavoidable and worrying. Kathy Charmaz[35], speaking for a full hour about her constructivist approach to Grounded Theory, eased these worries. Her easy, relaxed and comprehensive approach to line-by-line coding and everything that follows is a delight. That was the turning point, where caution was (relatively speaking) thrown to the wind. What is now seen here is the result of a truly 'crafted' approach to the work, done in an exploratory way, starting in the interpretivist paradigm (where the perceptions and actions of

[33] The author has seen too many students lose themselves in the minutiae of research methods to want to try and do that better. As an engineer, it is better to engineer engineering approaches to engineering problems, one step at a time.

[34] http://qualanal.wikispaces.com/Welcome

[35] https://www.youtube.com/watch?v=D5AHmHQS6WQ

individuals were gathered and analysed so as to find the key variables) and migrating to the radical humanist paradigm where the means to actually change things is investigated.

9.8 Reflections on further work

The Reference Model is the principal outcome from this work, and it needs to be further tested. At the same time, the study has revealed indicators and measures of success, scope, capability and other things that can now be carried forward into positivist work. There is a great deal of data that has only been partially analysed. Further work can bring the full weight of conventional statistical analysis to bear upon this, and on more carefully gathered data from more carefully chosen research participants.

Between the lines of this thesis there is an unanswered question, that arises from the brief observation that academics value their freedom and will sometimes not willingly do what they really ought to do. One of the distinct and oft-observed differences between IT practitioners and 'the business people' that their systems serve concerns the matter of perfection. It is said that IT people will always strive for the 'perfect' solution, which might be an ambition that comes from their binary world of '0s' and '1s'. Business people routinely seek compromise, but compromise with perfectionists is difficult. This problem of deciding exactly when enough is enough – be it enough functionality, data, program code or just quality – is an issue of 'satisficing' (Winter, 1971; Winter, 2000). As Winter remarks in his later work (Winter, 2000, p.983):

> *'An organizational capability is a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type.'*

This study is all about the institutional capability to deliver information systems that are appropriate, useful and beneficial. Decisions have to be made in order to do that, and standards are a primary vehicle for informing decisions: hence the question of how much is enough. Winter explains satisficing by reference to earlier work by Simon (1987, p.244)

> *'As classically expounded by Simon, satisficing is a theory of choice focused on the process by which alternatives are examined and assessed. As such, it contrasts with optimization theory. Simon has explained that the contrast is between 'looking for the sharpest needle in the haystack' (optimizing) and 'looking for a needle sharp enough to sew with'' (satisficing) (Simon, 1987: 244).*

This sounds like an excellent starting point for another discussion on another day.

9.9 Final word

Higher Education in South Africa needs information systems that are effective enough to make a difference: to the undergraduates who come to learn, to the postgraduates who come to do research, and to the diverse partners that universities work with. If this study has made the smallest contribution to what makes up education, what comprises the chain of value that delivers new knowledge, and how information technology and information systems might help this process, then it will have been worthwhile and its purpose will have been achieved.

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