A MODEL FOR SUSTAINABLE OPERATIONAL EXCELLENCE THROUGH KNOWLEDGE MANAGEMENT PRACTICES AND CONTINUOUS IMPROVEMENT PRINCIPLES

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Abstract

Integrating Knowledge Management maturity with associated Continuous Improvement efforts in order to remain competitive, is absent in most Operational Excellence initiatives. Furthermore, the intertwined relationship of Continuous Improvement and work development becomes a crucial focus area for organisations that wish to establish a continuously evolving management system consisting of core values, methodologies and tools with the aim of creating more satisfied customers with less resources. The old industrial paradigm that focused on labour, capital, materials, and energy viewed technology and knowledge as external influences on production. This framework is now being challenged and a new trend is emerging. This trend seeks to transform the old industrial system to that of a knowledge-based which one can lead to innovation and hence economic advantage. Continuous Improvement as a concept has roots in many other fields, including social-technical system design, human relations progress and the discussion surrounding 'lean manufacturing'. This study will focus on Continuous Improvement as a noun, referring to on the outcome of the process of a stream of emergent innovations.

The primary objective of the study is to create a model that will present an organisation with a three-layer knowledge reference process grid, which will align and depict the surrounding business knowledge functions, knowledge-enabling processes and knowledge-manipulating processes aiming for enabling Operational Excellence. This study promotes the theory that the cognitive domain layer, functional domain layer and resources layer of an organisation can be increasingly stimulated by focusing effort through Continuous Improvement routines towards the associated inter-organisational knowledge processes sustaining Operational Excellence. The proposed model is structured to review, compare, evaluate and integrate existing Knowledge Management practices of

an organisation within the context of clear definitions for important concepts of Knowledge Management. Additionally the model provides an assessment instrument for evaluating the organisation's Knowledge Management maturity level. The study concerns itself with two concepts towards business value creation which will lead to increased Operational Excellence. Firstly, the maturity of Knowledge Management processes, and secondly the level of the organisation wide process of focused and continuous incremental improvement namely, Continuous Improvement.

A case study with PriceWaterhouseCoopers was concluded and an on-line Internet survey was used with a stratified sample from knowledge workers to test the factors from both a Knowledge Management and Continuous Improvement perspective. These factors were verified by means of a hypotheses network, describing in a structured and descriptive way, the importance of Knowledge Management and Continuous Improvement collectively on sustainable Operational Excellence as an integral development of Operational Excellence. With respect to Knowledge Management practices, the hypothesis network proposed at least three domains, which of knowledge generation, knowledge mobilisation and knowledge application as important input to the proposed process grid of knowledge development and associated layer elements. From a Continuous Improvement principles perspective it is apparent that elements from Continuous Improvement routines and Continuous Improvement characteristics are associated with the organisation Continuous Improvement ability. These findings are also a result of the deliberate design of processes, tools, structures and environments with the intent to increase, renew, share or improve the use of knowledge represented in any of the three elements for structural, human and social of intellectual capital.

The proposed model combines the framework of the Boyd cycle as it is conceptualized as self-assessment activities, for it becomes possible to use them as basis of a self-assessment with sense making navigational properties across

the proposed knowledge process grid for the model. The model will facilitate the concept of a three-layer knowledge reference process grid, which represents the main components of the knowledge processes within the cognitive domain layer, functional layer and resources layer of an organisation. The proposed model will deliver a single value that co-exists with the Knowledge Management maturity level and Continuous Improvement readiness index rating attained. Logical relationships to dynamic, evolving and flexible enabling Knowledge Management practices for each layer of the proposed three-layer knowledge reference process grid will be integrated as output of the proposed model.

The research has limitations as Knowledge Management practices were measured using a subjective norm scale. It is suggested that a more comprehensive measure of Knowledge Management maturity processes may be needed to represent this construct. The complexity of the proposed model and the number of associated variables included in the results need further confirmation using possible multiple samples and additional measures of Knowledge Management maturity and Continuous Improvement readiness elements. The benefit of the proposed model as a practical Operational Excellence tool is to overcome the perceived gap of implementing Knowledge Management practices and Continuous Improvement principles collectively to deliver and sustain Operational Excellence.

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"You are worthy, our LORD and God, to receive glory and honour and power,
for you created all things,
and by your will they were created and have their being."
(Revelation 4:11).

List of Abbreviations

CI	Continuous Improvement
COQ	Cost Of Quality
IC	Information Communication
ICT	Information Communication and Technology
KM	Knowledge Management
KMS	Knowledge Management System
KMSS	Knowledge Management Support System
OE	Operational Excellence
OODA	Observation, Orientation, Decisions, & Action
POC	Price Of Conformance
PONC	Price Of Non-Conformance
QM	Quality Management
TQM	Total Quality Management

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Chapter 1 – Seminal of study

1. Introduction

This chapter introduces the research problem and includes the reason for interest in the research issue. The research assumptions as well as research scope and focus are presented. Further, this chapter introduces the research map or cycle which resulted in this thesis; it outlines a notion of Knowledge Management and Continuous Improvement paradigms for today's business environments, and then outlines the research approach and contributions. This chapter also includes the purpose created from that background, the chosen delimitations and the organisation of the thesis with respect to the research paradigm such as the hypothesis of research and research techniques.

1.1 Background

While today's businesses endeavour to drive growth in the face of growing competition, they are finding that the key to keeping and acquiring customers is Operational Excellence. Customers expect high-quality service and flexibility, online access to timely information about availability and delivery, and the ability to draw on value-added services such as customer information management and call-centre support. More than ever before companies today are under constant pressure to boost profits, reduce costs and increase revenues. At the same time, competitive pressures require organisations to react faster to solve business issues and meet customer needs. Treacy and Wiersema (1995) in *The discipline of market leaders,* suggested that organisations excel in one of the following three disciplines namely Operational Excellence, product leadership and customer intimacy, and that they are competitive – but not necessarily excellent – in the other two.

In addition to the above today's complex and turbulent environments require a Continuous Improvement approach in products and processes. Continuous Improvement has many attractions (Bessant, Caffyn, Gilbert, Harding & Webb, 1994: 18), one of the most important being a potentially low cost approach. Therefore the design and redesign of business processes, should factor in an understanding of where and how knowledge plays a role in the performance of the process. In turn this is accomplished by identifying the knowledge needed to make the decisions or take the actions that make up the process, within the ambient of product or service improvement. Improvement emanates from a deep and broad understanding of current processes and practices, their patterns and implications. Therefore Continuous Improvement could be defined as a company-wide way of work consisting of focused and continuous incremental innovations (Larson, 2003: 191). Developing this kind of understanding requires *knowledge transfer* about business processes and practices between individuals occupying various organisational roles and located in different work units.

Knowledge transfer is a dyadic exchange in which a recipient learns and applies knowledge transmitted from a source (Ko, Kirsch & King, 2005: 62; Argote & Ingram, 2000: 154). There are significant relationships between Knowledge Management and decision-making, productivity, innovation, reinvention and Operational Excellence. The concept of coding and transmitting knowledge in organisations is not new: training and employee development programs, organisational policies, routines, procedures, reports and manuals have served this function for years. Process improvement of any kind – including that of Operational Excellence initiatives - is not simply a matter of individuals embracing incremental changes. Rather, armed with new knowledge, individuals in various roles and units fundamentally rethink work patterns and relationships, developing new cognitive frameworks and schemas and embed these new structures into their work practices (Spencer, 1994: 448; Ravichandran & Rai, 2000: 392).

Many researchers have made substantial contributions to the field of Knowledge Management since the 1990s. Researchers focused on topics like: what is Knowledge Management (Wiig, 1999: 159; Davenport & Prusak, 1998: 50); the inevitability and necessity of Knowledge Management for a firm's survival in the knowledge era (Bontis, Dragonetti, Jacobsen & Roos, 1999: 63); the research for better Knowledge Management strategies and tools facilitating Knowledge Management (Tiwana, 2000: 33) and measurement of intangible assets and their impact as echoed by Sveiby (1997: 12) and Edvinsson and Malone (1997: 190, 192).

The issue of integrating a specific Knowledge Management maturity with the associated Continuous Improvement effort as deemed necessary to remain competitive, is absent in most Operational Excellence initiatives. Furthermore the intertwined relationship of Continuous Improvement and work development becomes a crucial focus area for organisations that wish to establish a continuously evolving management system consisting of core values, methodologies and tools with the aim of creating more satisfied customers with less resource. Previous works of Axelson (2000) and Bengston and Ljungstrom (1998) emphasize the importance of the relationship between Continuous Improvement and work development. Bengston and Ljungstrom argue that this relationship promotes motivation that spans an enterprise and correlated performance across multiple dimensions of people, technology and processes.

From the above it could be concluded that Knowledge Management has been proven to be effective and well implemented within organisations. A formal approach to evaluate Knowledge Management maturity and the enabling development of Continuous Improvement routines, towards effective and efficient Operational Excellence, is something that has not been explored. Therefore, this study will explore the interdependency between Knowledge Management and Continuous Improvement and will suggest that this result in Operational Excellence. This will be the central theme of the study.

1.2 Objectives and scope of study

Based on the problems and the advantages described above, this thesis will explore two concepts which create business value creation and will result in increased Operational Excellence. Firstly, the maturity of Knowledge Management processes, and secondly the level of the organisation wide process of focused and continuous incremental improvement, namely, Continuous Improvement. This study will therefore investigate the degree to which the Knowledge Management maturity as well as the Continuous Improvement of an organisation contribute to Operational Excellence.

To gain insight into the critical influencing factors of Knowledge Management and Continuous Improvement on Operational Excellence, a conceptual model will be developed which is shaped by theoretical constructs impacting on the model. Three major concerns from building the research model emanated. Firstly, the author did not want to propose a model that defines all the variables or processes that affect Operational Excellence. Secondly, the author wanted to focus on shared knowledge as the leading expression of Knowledge Management. Thirdly, Knowledge Management and Continuous Improvement have been perceived to both affect Operational Excellence. The proposed research model's key construct areas, functional linkages with explanation of knowledge variables and analysis proportions will be discussed in Chapter 6.

The model contains three constructs to be mapped and modelled and serves the basis for the redesign of Knowledge Management practices and Continuous Improvement principles. The methodology behind the model proposes supporting tools and procedures for extensive mapping and modelling, partly standard mapping and modelling tools as well as elements developed specially for the methodology. The methodology furthermore defines a set of analytical methods and tools, as well as design guidelines.

The first construct of the research model, namely the *Knowledge Management maturity assessment* represents the level of knowledge in relevant knowledge development segments, with emphasis on the current state of knowledge towards the desirable level of knowledge. The second view of the research model will be used to investigate the *Continuous Improvement ability* of an organisation, and will consist of variables around how things are done and how well they are done in an organisation. The third view of the research model, namely the *Knowledge reference process grid* is where relevant linkages between knowledge processes with the cognitive domain layer, functional layer as well as the resources layer relevant to an organisation will be measured and presented.

1.3 Motivation for study

This study will investigate the degree to which the Knowledge Management process maturity, coupled with the Continuous Improvement ability of an organisation, contributes to Operational Excellence. Output of this research is the development of the research model. Boyd's OODA loop, which stands for Observe, Orient, Decide and Act is a notion applied to the combat operations process and frequently at strategic level in both the military and business-related operations. In the OODA loop the outside information, unfolding circumstances and unfolding environmental interaction are "Observed." These are then fed forward and previous experience, new information, genetic heritage, cultural tradition and analysis and synthesis led to an "Orientation" which also feeds backwards to Observation. In most cases this creates an implicit guidance and control to a person's Action. Although sometimes a Decision is made, in which case it feeds forward into action and feeds back to Orientation. In every case, Action feeds back to Observation (Fadok, Boyd, & Warden, 1995: 43). It is this concept of the OODA loop as a cognition model, that will be integrated as framework for the assessment procedure of Knowledge Management maturity

and Continuous Improvement readiness of an organisation, where a response itself evokes behaviour once a situation of self-assessment presents itself as will be explained in the following paragraph.

When the Boyd cycles are conceptualized as maturity assessment cycles or activities, then it becomes possible to use them as basis for a maturity assessment model. However, unlike typical business initiatives that attempt to codify actions – "if this happens then do that" – the Boyd OODA-loop provides a decision framework within the maturity assessment of the proposed model. Saunder (2000: 235) argues that the OODA loop in a business context is such that if you can perform this sequence faster than your competitor in making yourself more attractive to your customer - you will achieve a competitive advantage. For this approach the OODA-loop will provide a decision model that allows participants to both identify answers, and then measure the effectiveness of their response – rather than just providing an answer for the decision made (Thompson, 1995: 152). The constructs of the OODA-loop cycles can be correlated to provide a current-state of both the Knowledge Management maturity assessment activities as well as the Continuous Improvement ability results of an organisation. Chapter 4 of the study will portray the properties and assessment capabilities of the proposed model, with discussions leading up to the mapping of unified processes towards the creation of Operational Excellence.

1.4 Purpose of study

The purpose of this research is an attempt to improve organisational Operational Excellence through a systemic model which integrates Knowledge Management practices and Continuous Improvement principles. To achieve Operational Excellence, a model is proposed – that is supported by Knowledge Management and Continuous Improvement independent variables and the perceived effect it will have towards Operational Excellence improvement. These independent

variables become the matrix whereby the next steps towards Operational Excellence will be indicated and measured.

The purpose of this study is thus twofold: firstly, to investigate the relationship between an organisation's Knowledge Management maturity rating and the organisation's Continuous Improvement ability value concept. These concepts are explained in section 4.3. Secondly, to apply the Knowledge Management rating that coincides with the organisation's Continuous Improvement ability value, to present the positioning of the organisation on a grid of processes that will be used to achieve Operational Excellence.

1.4.1 Primary research objectives

The primary objective of this research is to create a model that will present an organisation with a three-layer knowledge reference process grid, which will align and depict the surrounding business knowledge functions, knowledge-enabling processes and knowledge-manipulating processes aiming for enabling Operational Excellence. The model will facilitate the concept of a three-layer knowledge reference process grid, which represents the main components of the knowledge processes within the cognitive domain layer, functional layer and resources layer of an organisation. The proposed model will deliver an indicator that co-exists with the Knowledge Management maturity level and Continuous Improvement ability rating attained; this indicator will be used to plot the positioning amongst the knowledge process grid. This knowledge process grid holds logical relationships to dynamic, evolving and flexible enabling Knowledge Management practices for each layer of the proposed three-layer knowledge reference process grid.

1.4.2 Secondary research objectives

Secondary objectives include:

- To generate an analysis instrument, which allows for a holistic assessment of the Knowledge Management activities of an organisation, which covers all relevant key areas of Knowledge Management and that derives suitable steps for development, which is based on the current status of Knowledge Management.
- To develop a Knowledge Management instrument that will identify the maturity levels of Knowledge Management, where the maturity levels should be seen as relatively robust states of an organisation, which are based on in-place activities and processes practiced over time.

1.5 Clarification of concepts

In the following section, the meaning of certain important concepts and terms to be used in this study will be clarified. Following this, the relevance of the concepts to this study and research problems will also be linked and contextualized.

1.5.1 Knowledge Management

Knowledge is neither data nor information, though it is related to both, and the differences between these terms are often a matter of degree as stated by Davenport and Prusak (1998:101). Knowledge is increasingly recognised by modern organisations as their most important source of competitive advantage. However, the key to obtaining long-term competitive advantages is not to be found in the administration of existing knowledge, but in the ability to constantly

generate new knowledge and to move on to new products and services (Bach, 1999: 364). This generation of new knowledge is a challenge to most organisations, referred to by the following citation “in an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge” (Nonaka, 1991: 103). Present society is often referred to as knowledge society, as categorised by Bell (1973) and Drucker (1993).

Nonaka and Takeuchi (1995) argue that effective organisational knowledge creation best occurs through the spiral process where knowledge is converted from tacit to explicit in a continuous and dynamic cycle. It is when tacit knowledge and explicit knowledge interact that the possibility of innovation may occur. Knowledge creation is facilitated by deliberately managing the cycle. Organisational knowledge creation begins with socialization, where individuals share experience and mental models. It develops into externalization when individuals use metaphors or analogies to articulate hidden tacit knowledge that is otherwise difficult to communicate. It moves into the combination phase for knowledge to be articulated, shared and expounded. Finally, individuals learn by doing and internalizing the new knowledge. The spiral begins again as the experience-based operational knowledge learned in the first cycle provides a larger knowledge base for continuous innovation and growth. It is this model that demonstrates how knowledge is achieved. This cyclical assessment procedure of the model is reminiscent of the command and control for the Observe, Orient, Decide, and Act (OODA) loop of late Col. John R. Boyd (1927-1997), in which information and then knowledge are transformed into action (Cowan, 2002). In section 2.6 of the following chapter the features of a Knowledge Management system will be discussed and explained in light of the proposed model.

1.5.2 Continuous Improvement

Probably the best known early pioneer on Continuous Improvement was W. Edwards Deming. Deming revolutionised the field of quality with his new, fresh

theories on how to use quality management as a tool to generate profit instead of seeing it as an expense, which used to be the common view. Deming was also among the first to recognise the utility of ongoing, incremental change. One of Deming's fourteen points is to "…improve continuously and forever the system of production" (Deming, 1986: 27). Deming (1986) also emphasizes that everyone in the organisation should understand the interactions between people, components, sub processes, methods, machines, materials, and the process in which they function. The quality process must be integrated in the whole organisation and include the commitment of everyone involved, in order to function. These ideas are not unfamiliar to the learning organisation, the proposed model as final product for this study will utilise these core abilities, measured during Continuous Improvement mapping studies through the presence or absence of selected behaviours. The observed behaviours during assessment will further be used to map associated Knowledge Management maturity practices. Although as Kirton (1980: 216) points out, that some preferred behavioural styles towards Continuous Improvement may not always lean towards radical expression of such innovative behaviour. More recent discussion around this topic, captured by Imai (1997: 109) has been strongly influenced by experience in Japan of what is often termed ‘kaizen’ and which has generally been translated in Western parlance as ‘Continuous Improvement’. Continuous Improvement is used and deployed both as a verb – the process whereby continuous stream of innovation emerge – and also as a noun, referring to the outcome of that process.

Underlying the principle of Continuous Improvement is a belief that all individuals can make a contribution to problem-solving innovation within the organisation. But most organisations still hold the belief, originating in the scientific management approaches developed at the turn of the century, which sees a split into ‘thinkers’ and ‘doers’, illustrated by Bessant and Francis (2000: 34). In a review of Continuous Improvement literature, De Lange-Ros (1999: 221) makes it clear that the field of Continuous Improvement is very much oriented towards

applied research, where the main question is what organisations should do, rather that what they actually do – therefore the need to constantly measure Continuous Improvement maturity of an organisation arises. Continuous Improvement is defined by Bessant *et al.* (1994: 23), as "a company wide process of focused and continuous incremental innovation". The level of Continuous Improvement maturity can be measured using a Continuous Improvement maturity ability index value; this ability index value has been developed by Bessant and Caffyn (1997) for researchers to make a detailed assessment of a company's status in the development of an effective Continuous Improvement process. Learning in the sense it is used here is defined further by Dodgson (1993: 375), as a "purposive quest to retain and improve competitiveness, productivity and innovativeness in uncertain technological and market circumstances".

1.6 Thesis overview

Figure 1.1 portrays the sequence of themes that shaped the construct of the study, with main threads listed for each chapter of the thesis. From a general overview of perspectives and approaches and methods commonly encountered in addressing Knowledge Management maturity and Continuous Improvement capabilities, the discussion then focuses on a Knowledge Management reference model with associated levels, namely the cognitive domain layer, functional layer and Knowledge Management resources layer as a hybrid model in achieving Operational Excellence. This is then followed with a definition and identification of knowledge development elements and Continuous Improvement capabilities at different levels of development; a mapping of the identified elements for each layer is then defined and tabled. The study concludes with the analysis of the results and presentation follows in the final chapter. By such time the investigation hypotheses will have been tested and fully or partially supported, by the significant – or insignificant – of the relevant paths.

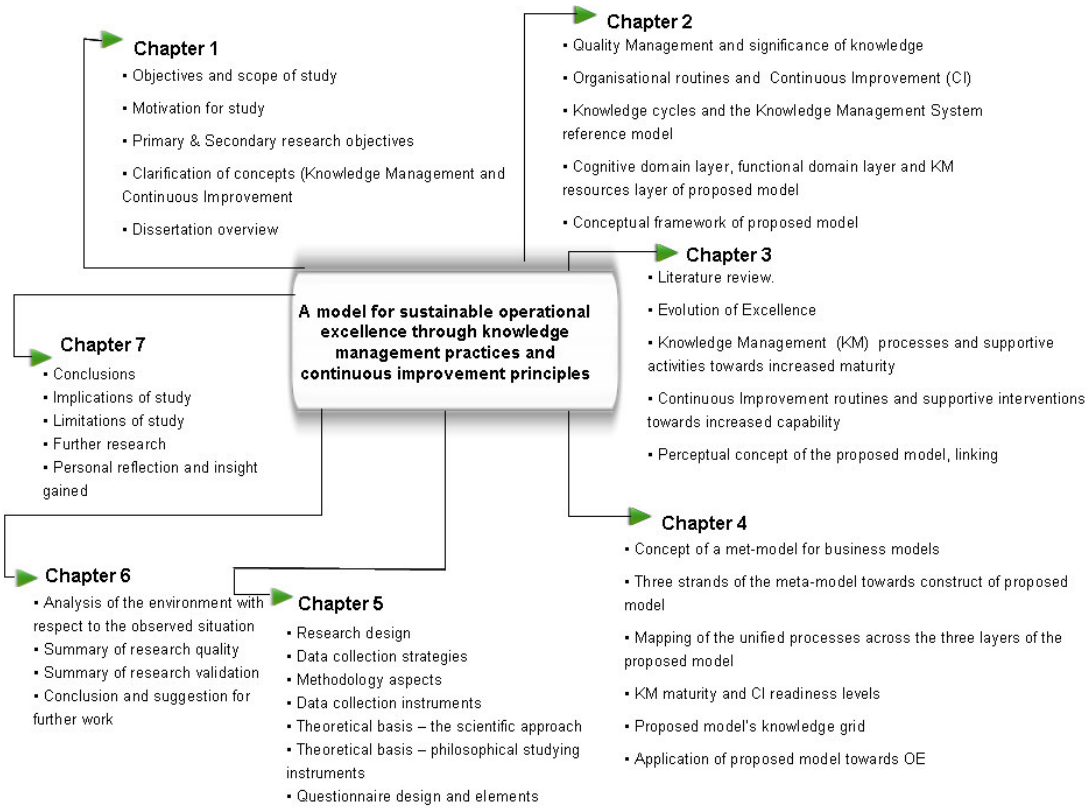


Figure 1.1 Study overview and themes for each chapter
Self-constructed

The author will apply regression-based techniques that permit the testing of casual models using cross-sectional data and normalised path coefficients (betas) in order to determine the strength and direction of casual paths or relations. The application of Cronbach's *alphas* and the analysis of variance will be conducted in order to further secure the validity of the hypotheses. The author also presents the conclusions together with a reference to the research's limitations and some recommendations for future research.

Chapter 2 – Theoretical aspects of study

This chapter introduces theoretical aspects of the knowledge based economy and highlights the importance of the organisational knowledge creating process. The process of knowledge distribution to Operational Excellence is detailed; this leads the research investigating Knowledge Management practices and Continuous Improvement principles which will be used to direct the investigation into Knowledge Management elements and Continuous Improvement capabilities. After establishment of the theoretical background, this chapter also indicates the conceptual framework towards the proposed research model.

2.1 Introduction

Present society is often referred to as the knowledge society and defined as a society of mobility and combined all the social functions of the old communities, whether performed well or poorly (Drucker, 2003: 238). This categorisation is however, a crude one, as it does not advise on the relative relevance of knowledge for knowledge workers. At the individual level, knowledge creation may be sufficient to shape a knowledge development cycle. Since the organisation is not equated with individual knowledge in the organisation, as a result the last two phases of the knowledge creation cycle (namely knowledge distribution and knowledge revision) become crucial for converting knowledge to organisational knowledge as contained in studies by Bhatt (2000: 26). The present society and the intrinsic economics of the development world, have for some years found themselves in a transitional phase, with the inflection shifting in the sense that knowledge is steadily gaining weight as a production factor. The development towards a knowledge economy is manifesting not only in the growing service sector, but also in such 'traditional' sector such as the agriculture and manufacturing industry. South African and international businesses now find

themselves in a global environment that is characterised by a number of trends, which increasingly shape strategic thinking. The reality of the knowledge economy is also reaching the micro-markets within South Africa, due to the shift of markets over the past decade. The old industrial paradigm that focused on labour, capital, materials, and energy viewed technology and knowledge as external influences on production (Organisation for Economic Co-Operation and Development, 1996: 11). This model is now being challenged and a new trend is emerging. This trend seeks to transform the old industrial system to that of a knowledge-based one (Kochan, Cutcher-Gershenfeld & Orlikowski, 2002: 5) which can lead to innovation and hence economic advantage. This knowledge-based economy seeks to mobilise human capital as the major building block of the economy, over and above that of resource wealth or geographic location. More specifically, knowledge-based economies, "… are directly based on the production, distribution and use of knowledge and information" (OECD, 1996: 7). Knowledge and innovation play a rapidly increasing role in the way contemporary South African businesses operate and as such the ability for economies to reinvent themselves has become extremely important.

This emerging paradigm shift underpins the understanding of maintaining a sustainable competitive advantage, by unlocking latent talents and creativity. These latent talents and creativity can best be directed effectively towards Operational Excellence by means of underpinning Knowledge Management processes and variables that are measurable, monitored and continuous of nature. With the end result underpinning the message of *The discipline of market leaders* (Treacy & Wiersema, 1995) is that no company can succeed today by trying to be all things to all people. It must instead find the unique value that it alone can deliver to a chosen market. This concept is further strengthened by van den Berg, Pol, van Winden and Woets (2005) that, distinctions are made between various types of knowledge and information. The difference between codified knowledge and tacit knowledge is very important. Van den Berg *et al.*

noted that codified knowledge is information that is widely available through ICTs (especially Internet) and other media, and it is accessible to everyone and cooperative to competitive advantage. The authors defined that tacit knowledge is only available to limited numbers of contacts and often has to be passed on face-to-face. It therefore tends to benefit those locations where there is most access and contact – namely largest cities and larger organisations (Lever, 2002: 861). Lambooy (2002: 299) discerns three levels of complexity: data (unstructured facts); information (structure & facts) and knowledge (the competence of individuals to judge and evaluate, to use data and information and to reformulate and solve problems). Important to this study is the basic dissimilarity that should be drawn between knowledge and information, as cited by the studies of Dosi (1996) and Foray (2003). This basic dissimilarity predicts that a better understanding of knowledge transfer can be achieved by distinguishing organisational similarity from dissimilarity, training from fertilization and autonomous from interactive practice. This is particularly helpful to discuss what the role and value of technology is in supporting knowledge transfer in organisations effectively.

However, as mentioned above, knowledge – in whatever field – empowers its possessors with the capacity for intellectual or physical action. Information, on the other hand, takes the shape of structured and formatted data that remain passive and inert until used by those with the knowledge needed to interpret and process them. The full meaning of this distinction becomes clear when one looks into the conditions governing the reproduction of knowledge and information. While the cost of replicating information amounts to no more than the price of making copies (i.e. next to nothing in recognition to modern technology), reproducing knowledge is a far more expensive process because several cognitive capabilities are not easy to articulate explicitly or to transfer to others.

From the introduction above, compelling benefits for organisations can be derived from making decisions that build a knowledge sharing culture.

Furthermore, a strong alignment to knowledge and knowledge sharing surrounds these associated benefits, and a number of suggestions correspond to the anticipated findings of this research:

- ability to attract, train, develop and retain new employees, bringing them to higher levels of competency considerably earlier in their careers;
- capacity to improve design-to-market skills by combining experts, their expertise and available resources;
- stronger technological and innovative competencies;
- experience in the identification and implementation of complex projects and application of the best engineering and design practices to clients;
- skills to better disseminate best practices (Den Hertog & Huizenga, 2001).

Building on this knowledge sharing culture is the concept of Kolb's model of learning styles, which is grounded in a more elaborate theory of experiential learning, describes an individual's preferred method for assimilating information, principally as an integral part of an active learning cycle. Kolb's experiential learning model assumes that individuals exhibit a preference for certain learning behaviours and these preferences can be grouped into distinct styles. For instance Kolb (1981: 230) operationalised his learning theory by formulating two dimensions, namely perceiving and processing. Concrete experience (CE) and abstract conceptualisation (AC) at the opposite ends of the continua of the perception dimension represent feeling and thinking, respectively.

According to Kolb (1981: 232), the learning cycle involves four processes that must be present for learning to occur:

- Activist - Active Experimentation which includes simulations, case studies and homework. Typical training approach includes problem solving, small group discussions, peer feedback and homework are all helpful.
- Reflector - Reflective Observation may include logs, journals and brainstorming. Training approach: lectures are helpful providing expert interpretation judgment of performance is usually by external criteria.
- Theorist - Abstract Conceptualization by means of lecture, papers and analogies. Training approach: case studies, theory readings and thinking alone helps; almost everything else, including talking with experts, is not helpful.
- Pragmatist - Concrete Experience by means of work in laboratories, field work and observations. Training approach: peer feedback is helpful; activities should apply skills usually self-directed autonomous learner.

The above-mentioned theories could best be utilised in an environment that is conducive to further learning methods that are focused on achieving quality work delivery which contributes to Quality Management.

2.2 Quality Management

Kolb (1981: 290-291) learning styles complement the two core elements of shared knowledge namely that of understanding and appreciation among groups and their managers for the technologies, and processes that affect their mutual performance and quality of work – this can be linked to the paradigm shift as explained in section 2.1 under quality management towards a knowledge-based economy.,

The term quality has started from purely product quality to cover an extensive and multiplicity of business processes. Quality Management has been recognised as a comprehensive management paradigm for efficacy of both organisational performance and competitiveness. Kanji (1990: 4) regarded Quality Management as “the second industrial revolution.” Empirical research

indicates that QM practices involve an organisation's performance and competitiveness (Das, Handfield & Ghosh, 2000: 649-690; Kaynak, 2003: 405-435). Previous work and attempts by organisations included formal inspections, customer services and motivation programs directed at satisfying their customers. This has led to the decentralised organisation and work methods and was later labelled as Total Quality Management (TQM). In the same manner that quality has distinct meanings to different people it is hard to find any two companies that describe and fulfil their way of working with TQM in the same manner. What is more, TQM also depends on the size of the company, its field of business, physical location, technological foresight and human resources (Powell, 1995: 30).

Notwithstanding the above-mentioned differences between quality, some general themes and components are prominent for this research:

2.2.1 Total Quality Management (TQM) can best be described as a philosophy pertaining to management concepts and practices that have evolved in the world of business from Dr Edwards Deming's theories in the early 1980s, on how to increase productivity and quality in organisations. Encompassing the principles of quality control, quality assurance, and quality improvement. TQM is a quality-centred, customer-focused, team-driven, senior management-led process that enables service or product providers to assess their services and products in order to improve customer satisfaction, increase efficiency and continuously improve productivity concurrently with any development that may emerge in terms of customer needs (Arcaro, 1995; Beich, 1994).

2.2.2 Zero defects quality programs often see the importance of doing things right and eliminating the possibility of making mistakes the first time. Crosby (1979) defines this quality as conformance to requirements. Crosby elaborates to the extent that quality must be defined in measurable

and clearly stated terms to help the organisation take action based on tangible targets, rather than on instinct experience or opinions. To Crosby, quality is either present or not present. There is no such thing as differing levels of quality. Management must measure quality by continually tracking the cost of doing things wrong. Crosby refers to this as the price of non-conformance. To aid managers in tracking the cost of doing things wrong, he developed the following formula: Cost of Quality (COQ) = Price of Conformance (POC) + Price of Non-conformance (PONC). The POC refers to the cost of getting things done right the first time. PONC provides management with information regarding the wasted cost and a visible indication of progress as the organisation improves.

2.2.3 The current adaptation of the American Continuous Improvement cultivated is out of the Japanese quality movement as it originated in the late 1960s and evolved through the 1980s. It was brought to the notice of Westerners in the early and mid-1980s by Western observations of the corporate practices of leading Japanese companies, as well as authors such as Masaaki Imai (Imai, 1997). It combined ideas, developed earlier by leading Western authors like Shewhart, Deming, and Juran. It can be argued that the concept and tools of Continuous Improvement have seen slight evolution since the 1980s. To be sure, Six Sigma made a big impact in the 1990s, but the contribution of Six Sigma has not been in the tools it uses or revolutionary thinking, but rather in its marketing of the innermost thoughts of Continuous Improvement and its integration of these thoughts with business incentives and objectives (McGuire, 2002: 604). Six Sigma, like traditional Continuous Improvement, is dedicated towards the reduction of errors.

The three themes, namely 2.2.1, 2.2.2 and 2.2.3 play a central role in enabling Continuous Improvement. Joined together with Knowledge Management they will result in achieving Operational Excellence. This is supported by the view of

Bessant *et al.* (1994), as Continuous Improvement does not need specialised knowledge and hence any learning style such as Kolb's learning styles, would be appropriate with the spreading of learning being current and forthcoming to excellence. Aristotle (born 384, Stagira — died 322 BC, Chalcis) conceived excellence as "…an art won by training and habituation. We do not act rightly because we have virtue or excellence, but we rather have those because we have acted rightly. We are what we repeatedly do." Excellence, then, is not an act but a habit. (Encyclopaedia Britannica, 2007).

While Quality Management and its underlying assumptions about organisations may be different from other management theory (Grant, Shani, & Krishnan, 1994: 25), research on Quality Management can be an important source for generating theories in the field of management. The proposed model encompasses the elements of successful alliances of both Knowledge Management and Continuous Improvement that are built on principles of Quality Management.

2.3 Significances of knowledge

Because knowledge's immense and growing influence on all parts of the market and the commercial organisations within it, Knowledge Management has become the primary focus of management sciences (Nonaka & Takeuchi, 1995). As contrasted to other managed resources such as assets, capital and people, knowledge is characterised by perpetual regeneration: the more often knowledge is used, the more knowledge is produced. Knowledge cannot be simply stated as being information; rather it is more than information in itself. Information can be transformed into knowledge when someone understands, interprets or applies the information to a specific task or work function (Lee & Yang, 2000: 783). Knowledge can be grouped into two diverse types, tacit - and explicit knowledge. Tacit knowledge is knowledge that cannot be explained fully and only after long processes of apprenticeship will the knowledge be learned (Lee & Yang, 2000: 784). Explicit knowledge, or codified as it is commonly labelled, is knowledge that

can be easily communicated; thus can be easily transferred between organisations and individuals. Once knowledge becomes codified, it is possible to store and transfer it as information (Johnson & Lundvali, 2001: 4). An essential difference is that codified knowledge can be found, shared and transferred through a variety of mediums such as publications and patents, as this is achieved largely due to information technology. On the contrary tacit knowledge is found, shared, and transferred through the movement of people and the knowledge they carry with them. In the knowledge based economy, tacit knowledge is equally as important as formal, codified knowledge. As a result; both these knowledge types are recognised as crucial resources in the creation of the knowledge based economy.

Towards the last decades of the 20th century, a group of eminent business experts (Drucker, 1985, 1990, 1991; Sveiby, 1997; Nonaka & Takeuchi, 1995; Nonaka, 1991, 1994) among others have supported the notion that fruition is based on the administration of knowledge. This administration encapsulated the growth and expansion of human and organisational potential and on the creation of an environment that leads towards innovation, creativity and uniqueness. The theory of knowledge as a resource is something that has caused great confusion in some academic circles, namely that of economics. Clarke (2001: 189) defined that the reason for this is that knowledge is distinct from any other resource since it appreciates over time unlike other resources: “Unlike physical goods that are consumed as they are used, providing decreasing returns over time, knowledge provides increasing returns as it is used. The more it is used, the more valuable it becomes, creating a self reinforcing cycle”. A large and capable knowledge base does not automatically lead to economic success. The application of this knowledge can lead to innovation therefore increasing productivity and product differentiation, which equates to a competitive advantage (Simmie, 2004: 1107). Knowledge as a means to a resource also has the capability to mature, as knowledge become richer through business process execution and the

recognition of Continuous Improvement behaviours, towards unlocking Operational Excellence activities.

2.4 Organisational routines and Continuous Improvement

According to Grant (1996: 380) there are fundamentally two distinct categories of mechanisms that can be used to incorporate knowledge in an organisation: directions and organisational routines. Mechanisms are classified as “directions” and are explicit rules and instructions, such as standard operating procedures or plans. In contrast, organisational routines are those mechanisms that allow for incorporating knowledge without explicitly communicating it: “… the essence of an organisational routine is that individuals develop sequential patterns of interaction which permit the integration of their specialized knowledge without the need for communicating that knowledge” (Grant, 1996: 379). Surgical teams and project teams use routines to transfer knowledge when individuals hold a general consideration of roles and interactions where they bring their own expertise to bear on the task, and work closely together towards their objective.

Essential improvement is gained by means of incorporating knowledge to organisational routines as mentioned above, which by itself require a sense of Continuous Improvement framework, where Continuous Improvement adopts an approach to improving performance which assumes more and smaller incremental improvement steps. Slack, Chambers and Johnston (2001: 4) argue that Continuous Improvement is not concerned with promoting small improvements *per se.* Continuous Improvement focuses on the achievement of incremental innovation through many small improvements on existing systems (Bessant *et al.*, 1994: 18). Continuous Improvement does see small improvements, however, as having one significant advantage over large ones – they can be followed relatively painlessly but other small improvements are also known as Kaizen, a Japanese word with the definition conceived by Imai (1997: 46) as an improvement in personal life, home life, social life and work life. When

applied to the work place, Kaizen means ongoing improvement involving everyone – managers and workers alike. In Continuous Improvement it is not the rate of improvement which is important; it is the momentum of improvement. It does not matter if successive improvements are small; what does matter is that at every instant in time, some kind of improvement has actually taken place. The ability to improve on a continuous basis is not something which always comes naturally to managers and staff. There are specific abilities, behaviours and actions which need to be continuously developed if Continuous Improvement is to be sustained over a longer term. On the other hand, organisational routines are a more implicit means of transferring knowledge, which emphasizes the movement of knowledge "without language" (Nonaka, 1994: 19), which is relevant to the Continuous Improvement routes. These routes manifest within the different knowledge cycles, and will be discussed later in this research. The actual practice of managing knowledge is complex, and can require the services of an expert. Some companies even have a full-time knowledge manager.

2.5 Knowledge cycle

Although many have written about the knowledge cycle (Marquardt, 1996: 35; Holsapple & Joshi, 1997: 104; Van der Speck & Spijkervet, 1997: 31), the knowledge cycle used in this research paper contains three elements: the creation, transfer, and utilisation of knowledge. The following sections will apply the knowledge cycle in a manner which will provide opportunities to see the synergy among different functions and approaches within the field in order to identify opportunities for Operational Excellence. The knowledge cycle is an interlinked series of functions. Knowledge creation involves the research, adaptation, generation and discovery of knowledge. Knowledge transfer is the distribution, dissemination and diffusion of knowledge, while knowledge utilization is the application of knowledge to problems, systems and situations. The knowledge cycle has both feedback and feed forward aspects. Knowledge is fed

forward as needs and gaps in existing knowledge are identified, while feedback occurs every time knowledge is applied and new knowledge is created. Although data, information and knowledge are usually thought of as part of a hierarchy, with data on the bottom and knowledge on the top, this model fails to capture the dynamic relationship between the three terms.

The knowledge cycle suggests this dynamic: new data create new information, which can lead to new knowledge; this then stimulates the need for new data and so forth. The knowledge cycle will require a system that will support and direct knowledge purposefully towards the Continuous Improvement routes as described earlier. This system can take the shape of a Knowledge Management support system with the construct aimed at the enterprise's cognitive domains, functional layer and the resources layer of which all are composed of variable elements. The main aim of such a Knowledge Management support system is to provide the basis for the identification of the processes enabling knowledge as a commodity of knowledge creation and re-creation (Von Krogh, Ichijo & Nonaka, 2000: 8).

2.6 Features of a Knowledge Management system

Alavi and Leidner (2001: 114) define a Knowledge Management system (KMS) as "IT (Information Technology)-based systems developed to support and enhance the organisational processes of knowledge creation, storage/retrieval, transfer, and application." They observed that not all Knowledge Management initiatives will implement an IT solution, but they support IT as an enabler of Knowledge Management. Maier (2002) expanded on the IT concept for the KMS by calling it an ICT (Information and Communication Technology) system that supported the functions of knowledge creation, construction, identification, capturing, acquisition, selection, valuation, organisation, linking, structuring, formalisation, visualisation, distribution, retention, maintenance, refinement,

evolution, accessing, search, and application. The idea of a KMS is to enable employees to have access to the organisation's knowledge of facts, sources of information and solutions.

Any KMS can be viewed from two different and complementary perspectives, namely (1) knowledge, and (2) process.

From the first perspective, organisational knowledge is characterised by:

- Being a combination of two distinct forms of knowledge: explicit and tacit. Each form of these knowledge forms work separately than the other cannot (Cook & Brown, 1999: 386), and one knowledge form cannot be completely converted to the other.

- The existence of several types of tacit knowledge, to name a few (Blackler, 1995: 1021):

    i) Knowledge (know that), which is dependent on conceptual skills and cognitive abilities. It is noted that this type of tacit knowledge can be explicated with relative ease.
    ii) Embodied knowledge (know how), which is action oriented and is acquired by doing and is rooted in a specific context. Furthermore it is noted that this type of knowledge is difficult to explicate.
    iii) Embedded knowledge which resides in the relationships between organisational constituents such as technologies, roles, formal procedures and emergent routines.
    iv) Encultured knowledge, which is the shared understanding that is socially constructed and re-constructed.

- The variety and diversity of the bearers of organisational knowledge, namely individuals, groups or communities and enterprises. Six forms of knowledge are observed: individual/explicit by means of concepts,

individual/tacit by means of skills, group/explicit in the form of stories and metaphors, group/tacit namely group genres (Cook & Brown, 1999: 391), enterprise/explicit namely patterns and best practices and enterprise/tacit by means of unwritten rules (Yates & Orlikowski, 1992: 543).

- Being context-sensitive in contrast to information. The effective mobilisation of knowledge depends on the context and the experience of the recipient. Moreover, using knowledge depends on the situation and people involved rather than on absolute truth of hard facts. Therefore, for the effective reuse of externalised knowledge, it has to be re-created anew (von Krogh *et al.,* 2000: 37; Conklin, 1996).

- The difficulty of determining *a priori* what knowledge will be requested, who will request it, who will supply it and when and how the knowledge will be used.

From the second perspective, the knowledge (K-) processes are characterised by:

i) Social interaction-intensiveness: Organisational K-processes involved social interactions and direct communication and contact among individuals. Therefore, they are fundamentally social processes that occur most efficiently through direct interactions among members of communities of practice (Von Krogh *et al*., 2000: 40).

ii) Since knowledge requirements are difficult to determine fully the associated processes have to be dynamic, evolving and flexible.

iii) The dual nature of K-processes: successful deployment of KMS is vitally affected by cultural and organisational issues (Alavi & Leidner, 1999: 25; Von Krogh *et al.,* 2000: 44). Consequently every K-manipulating process, a process that deals with knowledge should be associated with one or more K-enabling process (von Krogh *et al.,*

2000: 50), which produces both cultural and organisational enabling conditions for it.

In order to accommodate the prominent features of knowledge and knowledge processes while incorporating the knowledge cycle, a typical knowledge reference model has to include at least three categories of elements (McDavid, 1999: 17). The two categories discussed above will form part of the anticipated proposed model. The proposed model will produce a knowledge process grid which will guide the user, alongside the correct bundle of comprehended knowledge objectives and associated organisational improvement routines to facilitate effective Operational Excellence, within the three categories or layers of a typical knowledge reference model. Abou-Zeid's (2002) knowledge reference model and its principal findings were selected for this study. This model combines knowledge and its manipulating processes and captures the social aspects by including the involved actors and their roles. These will form an integral part of the proposed model. Abou-Zeid's model and framework was selected from various other knowledge management models, as his model incorporates a business-aware approach to Knowledge Management support system development. The following three objectives pertaining to Abou-Zeid's model were key considerations in selecting Abou-Zeid's (2002: 490) approach as underpinning framework in the design of the proposed model:

- The identification of the knowledge processes, this is achieved by first introducing the concept of knowledge things – which characterises organisational knowledge. This characterisation includes, beside the attributes of the relevant knowledge, the possible states in which this knowledge can exist. The knowledge manipulating processes are then defined as the processes that change the current states of the relevant knowledge into the desired ones. Once the knowledge manipulating processes are identified, their organisational enabling conditions together with the processes leading to them can be easily identified.

- Modelling the dynamics of the knowledge processes in general and knowledge manipulating processes in particular, is achieved by introducing the knowledge manipulating situation as a conceptual construct for structuring the functional aspects of a knowledge management support system. While this construct combines knowledge and its manipulating processes, it also captures the social aspects of them by including the involved actors and their roles.

- The classification of knowledge manipulating situations into different types, each with different modes, provides the basis for developing blueprints of ICT-based knowledge management support system. As the nature of the support varies from one type to another and from one mode to another.

The above objectives of Abou-Zeid (2002: 489) model provides the basis for developing the proposed model as a hybrid, descriptive and perspective in applying Knowledge Management and Continuous Improvement jointly in achieving Operational Excellence. The following section will explain the three layers, which will be used in the construct of the proposed model.

2.7 Three-layer knowledge reference model approach

Following on the above-mentioned importance of the three categories or layers of a knowledge reference model, the central theme of this research is based on the assessment of Knowledge Management maturity level and the Continuous Improvement ability value, across the three categories which are described as follows (Abou-Zeid's, 2002: 487).

The first layer: *the organisation's cognitive domains.* This domain is defined as the set of all relevant things, together with the set of possible relationships between them, towards which thought or action is directed or is communicated by the members of the organisation, this might include business (B-) things. A B-thing is the organisation's cognitive domain and may be a concrete or an abstract entity and it may be primitive or composite. There also is a distinction between the organisation's internal cognitive domain and external cognitive domain. Typically the external cognitive domain involves itself with B-things with which an organisation can interact while conserving its identity. This set includes things such as consumer, supplier, competitors and partners. On the other hand, the set of all things that relates and represents the self-image and self-consciousness of the organisation is referred to the organisation's internal cognitive domain (McDavid, 1999: 17). Each thing in the organisation's cognitive domain, namely each B-thing, is associated with certain knowledge that is needed to deal with it or act upon it. This knowledge is characterised in terms of one or more knowledge thing (K-thing). A K-thing describes the knowledge about the knowledge associated with a B-thing, for example the meta-knowledge. Such a distinction between a B-thing and K-thing is important since the knowledge associated with a B-thing is in constant change and is context-dependent. For example, the knowledge required to manufacture a certain product may change because of the introduction of new technologies or emergence of new marketing demands (Eriksson & Penker, 2002: 29; McDavid, 1999: 17).

The second layer: *functional layer.* While things in the cognitive domains of the organisation (B-things) are relatively stable the associated knowledge and consequently K-things are in a state of continual change. The different states a K-thing can have will also reveal the dynamics of changes in K-things; this will also present the different processes that would cause the transitions of states namely the K-manipulating. (Von Krogh *et al.*, 2000: 55). During its life cycle K-things can exist in different states that correspond with the states of knowledge associated with B-things. The state transition of K-things is caused by performing

one or more K-manipulating processes. For this purpose and background the following are examples, from literature reviews of processes and their modes and sub-processes or activities. These processes tolerate the capability to also affect the K-thing's states and constitute the elements of the K-manipulating process model (Firestone, 1999; Nissen, Kamel & Sengupta, 2000: 236; Probst, Raub & Romhardt, 2000: 164; Zack, 1999: 56), these processes are listed below:

Knowledge identification - this process includes all activities that develop the awareness of the necessity to create new K-things or to keep informed existing ones. It also includes activities that identify the form, convertibility and the owners of the required knowledge. Typical activities in this process include:

- Determining the knowledge gap by comparing knowledge needs with the existing knowledge.
- Identifying the form and convertibility of the required knowledge.
- Identifying the possible internal and external sources of required knowledge.
- Discovering mode where the knowledge is hidden in the data sources of the organisation.

Knowledge generation - this process includes all activities by which new knowledge is generated within the organisation. Several modes of knowledge generation exist, to mention just a few:

- Producing or creation mode where the new knowledge is produced by interacting with the things in the cognitive domains (Cook & Brown, 1999: 390).
- Synthesising mode where the new knowledge is generated either by integrating the newly generated and validated knowledge or by combining the existing knowledge.

- Externalising mode where the convertible tacit knowledge of the members of the organisation is conceptualised, articulated and externalised.

Knowledge elaboration - this process consists of all the knowledge activities intended to refine the newly generated explicit knowledge namely testing, labelling, indexing, abstracting, restructuring and to maintain the existing explicit knowledge.

Knowledge preservation - this process follows the elaboration or generation process, for the careful preservation of knowledge. The preservation process depends on the form of the knowledge. It may include activities such as formalisation, codifying, organising and storing in different media for explicit knowledge. For tacit knowledge the preservation activities also depends on the holder of knowledge. At the individual level the knowledge can be preserved by extending the ownership of the knowledge through mentorship or apprenticeship.

Knowledge mobilisation - this means increasing the visibility of knowledge by sharing it or transferring it from the knowledge provider or owner to another knowledge seeker. Examples of such activities are pushing or pulling, searching or retrieving and professional training.

Knowledge presentation – knowledge and knowledge use is context-dependent, whether this context is related to the individual user or the business process in which it will be used. This process aims to develop the capabilities for presenting explicit knowledge, with sufficient flexibility to render it meaningful and applicable across multiple context of use (Zack, 1999: 51).

Knowledge evaluation – this process includes all the activities that aim at justifying and measuring the business value of the knowledge. Von Krogh *et al.* (2000) have identified three types of knowledge justification. First type, strategic justification, includes justifying the newly generated knowledge against the advancement and survival strategies of the company. The second type, stakeholder's justification, focuses on evaluating the stakeholder's attitudes towards the newly generated knowledge. The last type of emotional justification, concerns the aesthetic value of the newly generated knowledge. With the idea of justification of conceptual knowledge and materialised or operational knowledge where the new knowledge will be used in product, service or process of the organisation.

The third layer: *Knowledge Management resources layer.* Is composed of enabling technologies and tools that support K-manipulating and K-enabling processes of the functional layer at different organisational levels. Technologies have to support the activities of keeping track of various work and experience histories at the individual for the group level. The reason for such is that the prominent features of knowledge as well as K-process, as mentioned above, call for special requirements. Where organisational knowledge is a combination of tacit and explicit knowledge which is always convertible or feasible to be converted into explicit knowledge. Again this supports the research objective, in providing the supported knowledge at a mature level, to the organisation towards Operational Excellence by means of Continuous Improvement routines. Technologies needs to provide for specialised and customised solutions for the different individuals and communities and this is necessary to support the different shapes and actions of the groups (Orlikowski & Yates, 1994: 545). The technologies should also support the related language to content of organisation's knowledge (Schmid & Stanoevska-Slabeva, 1996).

The three layers explored above provide the platform for linking Knowledge Management and Continuous Improvement opportunities towards implied Operational Excellence. These three layers exhibit processes that will lead to the manipulating of knowledge with the outcome of being innovated towards implied Operational Excellence, with associated Knowledge Management and Continuous Improvement elements. The Knowledge Management maturity and Continuous Improvement index value of an organisation will have direct positioning within these layers, for a low -, medium – or high interaction. The anticipated findings and outcome of the self-assessment process of Knowledge Management maturity and Continuous Improvement index value of the proposed model, described in the next section, will provide a single point on a knowledge process grid. This knowledge process grid will be used to pinpoint the improvement areas within the corresponding layer for shaping of the possible associated activities to attaining the next level of Operational Excellence.

2.8 Conceptual framework of the proposed model

Self-assessment (Conti, 2002: 12), and benchmarking (Lema & Price, 1995: 28) are among the most commonly used company evaluation processes. Self-assessment (Conti, 2002: 14; Karapetrovic & Willborn, 2001: 366) differs from traditional management audits in that self-assessment evaluates competitiveness and capability, while traditional management audits evaluate conformance to company rules and procedures. Self-assessment can be conducted using a range of quantitative and qualitative approaches, from metrics and pro-forma methods (Nilsson & Sammuelsson, 2001: 12) to workshops, questionnaires and award simulation (Ritchie & Dale, 2000: 241). The self-assessment process of the proposed model is shaped around the late Col. John R. Boyd's (1927-1997) OODA (Observe, Orient, Decide, Act)-loop, who was an US Air Force fighter pilot of exceptional ability. After his initial combat experience in the Korean War he

devoted a great deal of his life to studying strategy and warfare tactics. Boyd's OODA-loop of activities included:

- Observation: Seeing situation and adversary.
- Orientation: Sizing situation and opportunities.
- Decision: Deciding which combat manoeuvre to take.
- Action: Executing the manoeuvre.

The OODA concept was popularised to business use by Stalk and Hout (1990) and Haeckel and Nolan (1993: 124). The OODA loops of activities were then transformed for the business environment:

- Observation: Seeing change signals.
- Orientation: Interpreting these signals.
- Decision: Formulating an appropriate response.
- Action: Executing the response selected.

If the framework of the Boyd cycles is conceptualized as self-assessment activities, then it becomes possible to use them as basis of a self-assessment model. However, unlike typical business initiatives that attempt to codify actions – "if this happens then do that" (Brunsson, 1982: 32). Pertaining to this research, the OODA-loop will provide a decision model that allows participants to both identify answers and measure the effectiveness of their response – rather than just providing an answer for the decision made.

According to Senge (1992: 10), everybody employs models by which one interprets the world. Our models are our conceptual understanding of the parts important to us. The model serves as a kind of filter, eliminating or straining out extraneous or confusing data, while highlighting meaningful patterns. The

conceptual design of the proposed model does incorporate this finding, with careful articulation of the relationship between the development of the proposed model and the underlying assumptions and context that will govern the meaning, legitimacy and impact of the model on Operational Excellence.

From the above mentioned, Figure 2.1 on the following page portrays the OODA-loop positioning as self-assessment mechanism to measure the capabilities for both the Knowledge Management and Continuous Improvement variables. The proposed model will employ a diagnostic path approach (Conti, 2002: 20), which provides for the identification of systemic causes of performance gaps in the key areas of Knowledge Management maturity and Continuous Improvement ability of an organisation. The proposed hybrid model will allow the user to assess both the Knowledge Management maturity and Continuous Improvement ability of the organisation as indicated in 'Step 1' of Figure 2.1. 'Step 2' of Figure 2.1, indicates the OODA-loop cyclical assessment framework that will gauge the assessment of the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer as a hybrid model in achieving Operational Excellence. Finally 'Step 3' of Figure 2.1, will see the identification of the Knowledge Management practices and Continuous Improvement principles as a descriptive and prescriptive framework for effective Operational Excellence. The areas of the proposed model, overlaps the preceding area in order to create a hybrid and interconnected model.

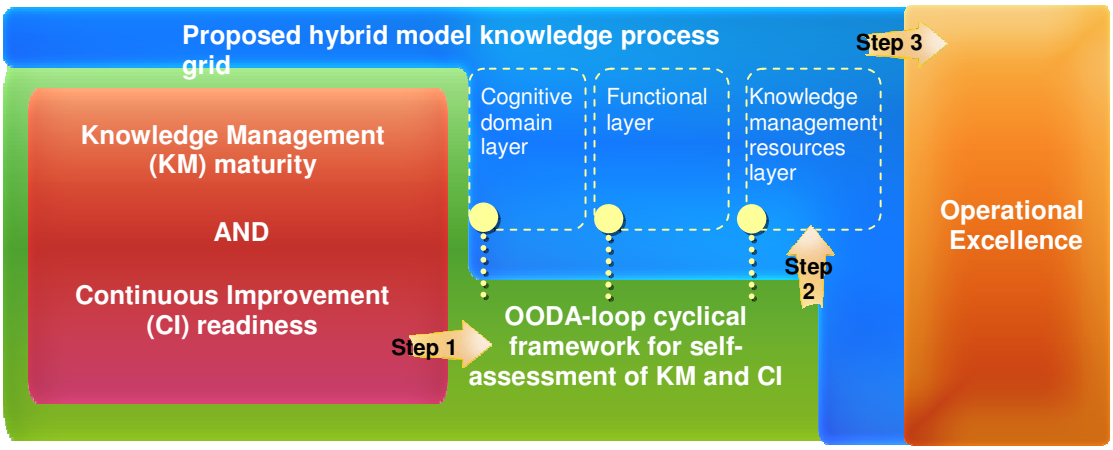


Figure 2.1 Theoretical application of OODA-loop for proposed model self-assessment model
Self-constructed

2.9 Summary

Underpinning the sections discussed in this chapter, the design approach acknowledges the fact that businesses have to constantly adapt themselves to remain aligned with their environment. Furthermore the rapid developments in the fields of technology and knowledge, the external framework within which businesses now operate is changing in an ever-increasing rate (Chaharbaghi, Fendt & Willis, 2003: 373) This in turn requires businesses to change their underlying business models at a faster rate. The purpose of this research therefore also contributes to this reasoning, as it is intended to provide for a new improved model for achieving Operational Excellence.

The following chapter will embrace this literature review and insight gained, towards the construct of a knowledge process grid in relation with the K-manipulating activities and processes. This knowledge process grid is the outcome of the self-assessment process of the proposed model, for which the proposed design provides the basis for developing a hybrid, descriptive and perspective framework in achieving Operational Excellence. The next chapter will also demonstrate the application of the theoretical construct of the proposed

model and will conclude in a high-level overview of the proposed model against the knowledge development cycle.

Chapter 3 – Theoretical construct of proposed model

The theoretical part and construct of this thesis is divided into three parts. Addressing the research approaches were raised in Chapter 1. The first part will attempt to synthesize the evolution of excellence in search of the fundamental application of Knowledge Management as a means to sustainable excellence; it also focuses on a spectrum for Knowledge Management and applications from both the knowledge-centred classification and business perspective classification towards Operational Excellence. The second part focuses on specific elements of Knowledge Management and Continuous Improvement, providing the basis for identifying the processes and procedures for developing the proposed model's knowledge process grid, in particular the linkage of multilateral features from both a Knowledge Management as well as Continuous Improvement perspective towards Operational Excellence. The third part provides a perceptual concept of a general static assessment model, addressing the value creation and requisition of Knowledge Management practices and Continuous Improvement principles towards the introduction of the proposed model's knowledge process grid construction.

3.1 The meta-model for business models

The underlying principle on which the meta-model is based is the simple fact that, in order to comprehend contextual shifts and their impact on reality as it is perceived, a conceptual tool is required that can transcend the specificity emanating from a particular business model. This centrality is derived from the fact that business models are contextual and by being relevant in a particular context, they become descriptive and prescriptive in nature. However, from the case studies presented and conclusions drawn by Chaharbaghi *et al.* (2003), not

only do things that businesses perceive change, but so do the circumstances through which they are perceived. Thus, what is required is a higher level model that, despite contextual shifts, remains unchanged and retains its power of explanation. The proposed model will apply the OODA cyclical loop (as described in Chapter 2), in combination with the meta-model three strands (referred to in the following section) in achieving the crucial significant between 'being' and 'becoming' in order to achieve Operational Excellence. In Platonic terms, 'being' relates to the essential, unchanging qualities that all business models share and 'becoming' refers to the contextualisation of these qualities. By focusing on the abstract, universal 'being' of the proposed model for both the Knowledge Management maturity assessment and Continuous Improvement ability, the similarities and differences that naturally accord once these qualities are contextualised cannot only be explained but also transcended (Chaharbaghi *et al*., 2003: 374).

Thus, unlike business models, which are mainly developed and applied using one of the many possible lenses and are heavily context-dependent for example, being constructed around a certain business perspective to suit a particular context, the meta-model is abstract and is context-independent. These distinctions are important because the level of specificity within business models is problematic because, once the context shifts, the specifics begin to form the basis of the next set of problems facing business (Chaharbaghi *et al*., 2003: 374). Although the proposed model is specifically designed for the assessment of the current Knowledge Management maturity and Continuous Improvement ability of an organisation a meta-model blueprint will be assumed to influence the three strands, encouraging Operational Excellence at each thread of the meta-model. The application of this meta-model concept for the development of the proposed model will be discussed in detail in Chapter 4.

3.1.1 Three strands of the meta-model for business models

Business is one of the most relative, dynamic, amorphous and seemingly complex factors to explore. Behind this seemingly complex concept, however, lies an overlooked simplicity that can only be uncovered by finding the appropriate beginning. However, all beginnings are difficult and it is always the inappropriate beginning that offers the easiest solutions but subsequently presents the greatest difficulties. This is essentially true when exploring the concept of business, as the appropriate beginning has three interrelated strands that are often considered in isolation (Chaharbaghi *et al.*, 2003: 372).

These interrelated strands are the way of thinking, operational system and capacity for value generation. Using each of these strands in isolation will lead to a dead-end. However, the distinction between the way of thinking, operational system and capacity for value generation is of critical importance in exploring and explaining the concept of business. Figure 3.1 illustrates the meta-model diagram, showing the three interrelated strands as the essential qualities shared by all business models.

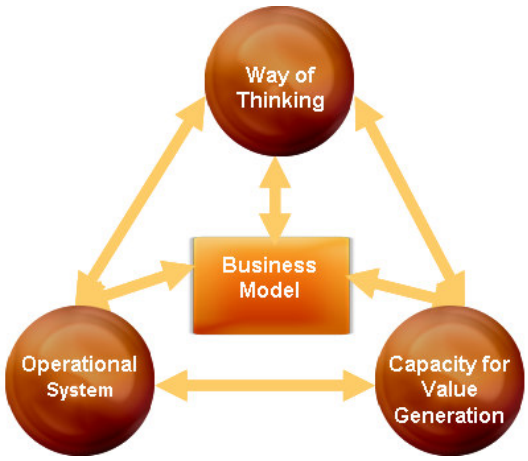


Figure 3.1 Three strands of a meta-model common to all business models
Adopted from Chaharbaghi, Fendt & Willis, 2003: 375

The application of the meta-model for the proposed model will require the following possible interventions, which will be crucial during the application of the proposed model to effectively create Operational Excellence.

Way of thinking: The focus of the proposed model will be on eliminating the dominant paradigm concerning Knowledge Management and Continuous Improvement, and replacing it with Knowledge Management practices and Continuous Improvement routines that can resolve the problems that the current and dominant paradigm concerning Knowledge Management and Continuous Improvement created. Therefore Operational Excellence can be achieved through the Knowledge Management development cycle of activities, and by means of effective identification of Continuous Improvement routines and behaviours in order to attract a critical mass of consumers by means of cost-advantages of products or services.

The operational system strand: The proposed model will require the support of the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer as a hybrid model in achieving Operational Excellence. A prerequisite will be the redesign of some business processes and the introduction of technologies as identified for each Knowledge Management maturity level achieved for the efficacy of the proposed model.

The value generation strand: The sole intent of the proposed model is to apply the appropriate level of Knowledge Management maturity enabling techniques by assessment of the current *status quo* of Knowledge Management maturity and the ability of the organisation to improve towards Operational Excellence. The Continuous Improvement ability of an organisation will be used as guide in identifying the routines and behaviours as established by the various business processes and principles.

A structure of sense making will be introduced at each strand of the meta-model to accomplish the necessary action that will enable the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer as a hybrid model in achieving Operational Excellence. The adoption process of the proposed model does not begin at the introduction of the proposed model, but rather substantially beforehand with the information of initial perceptions and possible symbolic representations of the proposed model, around Knowledge Management practices and Continuous Improvement principles. Therefore the importance of sense making at adoption stage will be vital for the effective uptake of the proposed model within the meta-model strands as described above (Seligman, 2006: 109), and this will be discussed in the next chapter.

3.2 Evolution of Excellence

As the literature review of section 2.2 revealed, Quality Management (QM) has been recognised as a comprehensive management paradigm for efficacy of both organisational performance and competitiveness. It remains the same QM methods which contributed to the evolution of excellence over the last 20 years and which is still current throughout business processes today. Several excellent periods existed, with current trends and critique shaping the current wave of excellence in the business world. *The art of Japanese management* (Pascale & Athos, 1981: 81) is one of many efforts to try and analyse those events in the early 1980s, a period that brought about deep changes in management practice. Two main conclusions came out of the Pascale and Athos's study: the need to take into account human factors besides the economic ones, and the importance of superior values that can form a guiding vision for organisations. A shift in the way excellence was viewed sees the introduction of a new type of excellence in 1988. "Excellent firms don't believe in excellence – only in constant improvements and constant change" (Peters, 1988: 34). Not only does Peters focus on change, but also stresses the other concepts such as "high value add"

which refers to as innovative product and service development. Peters believes that organisations need two main competencies: quality and flexibility and these competencies should be building with highly skilled workers in small units. *The fifth discipline* of Peter Senge (1990) can be seen as the next wave, and further development of Operational Excellence. The concepts of learning and knowledge have been around for a while but Senge's analysis is at the base of a renewed interest for the concept of the "learning organisation". Senge built his study on the concept of "discipline". According to Senge a discipline is a body of practice, based in some underlying theory or understanding of the world, which suggests a path of development. Discipline is hard work and there is no end point, but there is an entry point (Galaghan, 1991). The five disciplines are: building shared vision, personal mastery, working with mental models, team learning and systems thinking. Systems thinking is the fifth discipline and Senge considers it to be the most important. Quality can also be regarded as a discipline, a systemic process to be developed over time. In that sense, quality is not simply a measure, it becomes a whole strategic concept ready to be exploited for different approaches towards excellence in order to obtain competitive advantage (Pascale, 1999: 83).

The work of Peter Senge (1990) supported the view that excellence models are strongly related to quality. This increased the interest in those models during the 1990s. The first objective of these models is to rate different organisational practices in order to grant one of them a yearly prize. Besides, firms use these models to guide their efforts towards becoming excellent organisations. They present a holistic framework of management practices and help focus organisations on a variety of analytics and assessment criteria (Goasdoue, 2001: 1). Thus, the excellence models have provided standard frameworks for comparison and self-evaluation. The different excellence waves have taken into account, one way or the other, the changing management paradigm. This paradigm is characterised by the learning and systemic processes in support of business development approaches.

These approaches pave the way to combine diverse aspects for instance: strategy, Continuous Improvement and transfer of knowledge (Beechner & Hamilton, 1999: 333); vision, strategy and learning (Martensen & Dahlgaard, 1999: 627); or simply “hard” and “soft” dimensions (Peters & Waterman, 1982: 223). These efforts further pave the way towards the purpose of excellence and the ways to achieve excellence concurred by different management schools as the value maximisation notion as a possible purpose of excellence (Schaffer & Thomson, 1992: 83). The notion is concentrated in the “value discipline” of Treacy and Wiersema (1995) as referred to earlier in this thesis. The notion stated further that successful organisations focus their efforts on a particular area and excel at it, rather than trying to be all things to all people and failing to excel at anything. For the purpose of this study, the author proposes not to consider them separately, but just to be conscious of both perspectives towards building a theoretical platform and applying them appropriately during the application of the proposed model in practice.

It is clear from the above-mentioned studies, that what is needed to survive into the next millennium is the ability of organisations to reach a sufficiently mature stage of quality required to be truly competitive and to exhibit features across their business processes, of so called “excellent companies” (Kaye & Dyason, 1995: 524). Therefore business processes should be designed based on existing knowledge rather than vague impressions of how things work or tradition. McElroy (2003: 54) defines knowledge processing as "a set of social processes through which people in organisations create and integrate their knowledge".

3.3 Knowledge Management processes

Knowledge processes are made out of a series of activities that facilitate the evolution of knowledge toward greater consistency in producing needed results.

Knowledge processes are not Knowledge Management and they are not business processes. To a certain extent they are the operations required in any human social system to discover, create, refine, share, and evaluate knowledge for action. Knowledge processes are frequently ignored in many Knowledge Management initiatives as managers often impetuous to automate unrecognised and unobserved primitive knowledge processes. This also creates many unintended consequences by overlaying sophisticated technologies over elementary processes and simply increases the complexity of work and performance. Many definitions of Knowledge Management are what McElroy (2003: 47, 56) terms as being first-generation or supply-side approaches to Knowledge Management. The combined effects of Knowledge Management processes are best captures in the form of a knowledge development cycle.

For the purpose of this thesis, the knowledge management development cycle is defined as the process of knowledge creation (Nonaka, 1994: 14), knowledge adoption (Adler, 1989: 12), knowledge distribution (Prahalad & Hamel, 1990: 79) and knowledge review and revision (Crossan, Lane & White, 1999: 522). The four different phases of the knowledge development cycle are explained next.

- Knowledge creation refers to the ability to instigate original and functional solutions. Even thought some researchers argue that knowledge creation is basically an individual thought process (Crossan *et al,.* 1999: 522), some others have shown that knowledge creation by means of creativity can be learnt and taught (Marakas & Elam, 1997: 1136). Knowledge creation is not a systemic process that can be designed and forced (Lynn, Morone & Paulson, 1996: 8). The process is rather continuously evolving and emergent. Motivation, inspiration and pure chance play an important role in knowledge creation. The knowledge creation process is evaluated based on its originality and adaptive flexibility to facilitate the solution of a problem in different contexts. The process of knowledge creation and evaluation not only requires organisations to alter their cognitive

frameworks, but also forces organisational members to view the reality in new perspectives (Weick, 1995: 50).

- Depending on business objectives, an organisation may choose different knowledge adoption strategies: imitation, replication and substitution. Imitation has always been viewed as a defensive strategy for the organisation, however, when marketers are distinct and customers are more style-oriented than product-oriented, imitation may prove to be a successful strategy. The example of many Japanese firms illustrate the case in point, how over time Japanese firms had improved on the imitated Western knowledge and modified it to suit their national and organisational cultures (Aoki, 1988: 34). Replication is the strategy of duplicating one's experience learned in a project setting to other situations. Even though an organisation may find it difficult to duplicate all best practices learned at a situation to other situations, it can still adopt and analyse some of the experiences in different settings (Adler, Goldoftas & Levine, 1999: 43). Substitution is the strategy of offering alternate contributions of popular products, processes and practices that can offer almost similar functions. For instance, airlines offer ticket-less tickets instead of paper tickets and this practice does not encompass major breakthroughs in knowledge creation, it simply shows adoption of new practices on available knowledge.

- Knowledge needs to be distributed and shared throughout the organisation before it can be exploited at organisational level (Nonaka & Takeuchi, 1995: 74). To what extent an organisation succeeds in distributing knowledge depends on organisational culture and the amount of explicit knowledge available in the organisation. Organisations must create an environment that would make it simpler to convert tacit knowledge into explicit knowledge. It is widely believed that an

organisation is a distributed knowledge system, which comprises of knowledge clusters or components (Walsh & Ungson, 1991: 57).

- One of the important tasks for management becomes to review and replenish knowledge clusters continually in the organisation. The critical property of knowledge clusters is that they can be reviewed, revised and reconfigured (Spender, 1996: 45). Review and revision of knowledge is also important because a large part of knowledge, if not used, can easily be forgotten or ignored. This phase in the knowledge development process is of special concern to organisations, which are operating in highly dynamic technological and globally competitive environments.

Each phase in the knowledge development cycle, as described above, needs to be evaluated in the context of its features on repetition, standardisation, reliability and specifications.

The strategies mentioned above emphasize the growing of the organisation's capacity for distributing knowledge. According to Craig (2000: 36) "Knowledge Management includes a combination of software products and business practices that help organisations capture, analyze, and distil information". Similarly, Blair (2002) sees Knowledge Management as being a discipline of identifying, capturing, retrieving, sharing, and evaluating an enterprise's information assets.

The author concurs with Nonaka and Takeuchi's (1995: 71) articulation of their "spiral of knowledge creation" through four processes – socialisation, externalisation, combination and internalisation. Externalisation or knowledge transfer with an individual or group of individuals shares the knowledge or "know-how", thus establishing the right conditions for new knowledge to be created and consequently, the development of personal learning (Kakabadse, Kouzmin & Kakabadse, 2001: 137) through the knowledge development cycle.

3.3.1 Requirements, elements and values of Knowledge Management maturity

Assessment is the first step towards improvement; one can't improve what you can't measure – formally or informally. Against the above-mentioned four processes of the knowledge spiral, Knowledge Management maturity models reviewed in the literature are *ad hoc*, have not been empirically tested (Ehms & Langen, 2002; Harigpal & Satyadas, 2001: 449) and are used mainly in a practitioner setting. There also exists considerable confusion and lack of logical justification regarding the maturity scale, whether it is specific goals or practices defining each maturity level. Against the background of the Knowledge Management development cycle, as pointed out earlier in this section, distinct themes within knowledge will be used to form the unit of assessment for the purpose of benchmarking the Knowledge Management maturity level of an organisation.

Activities in respect of Knowledge Management are broadening throughout the organisation. The need thus arises, in addition to collecting information regarding the existence of Knowledge Management systems and related processes, Knowledge Management effectiveness needs to be judged by the perception of the persons who benefit from it, which can be translated into the Knowledge Management maturity level (Alavi & Leidner, 2001: 107). Consequently, provision should be made for at least two types of assessments that need to be performed for benchmarking the Knowledge Management maturity level. Firstly to confirm and record Knowledge Management systems, methods, and related processes – collectively referred to as the "Knowledge Management infrastructure" (Grover & Davenport, 2001: 19). Secondly to appraise the worth of Knowledge Management to the "knowledge workers." (Kulkarni, Ravindran & Freeze, 2004). This includes the knowledge worker's perception about the availability of the

Knowledge Management infrastructure and the efficacy of the Knowledge Management infrastructure in making a positive difference on their operations.

Section 4.5 contained in the next chapter depicts the progression from a lower level of Knowledge Management maturity to a higher level of Knowledge Management maturity. This implies that recognition of the value of knowledge or the existence of a knowledge-sharing culture is a precursor to the actual practice of sharing. Also, it does not work for an organisation to make knowledge-sharing a required part of work practices without the employees first recognising its value. The maturity levels do not pertain to any particular area of knowledge. General knowledge encompasses all that is defined as knowledge by an organisation. Knowledge is socially produced and reproduced and its manipulating processes in example, generation, mobilisation and application are constrained by the social and cultural contexts – and not just merely the maturity level attained.

Consequently, to operationalise the Knowledge Management maturity measurement, the key inter-organisational knowledge processes and elements, to generate knowledge in an organisation need to be mapped out against the goals of the different Knowledge Management maturity levels. Based on literature review (Firestone, 1999; Holsapple & Joshi, 2002: 477; Nissen *et al.*, 2000: 214) and on analysis of a number of Knowledge Management initiatives (Davenport & Prusak, 1998) Knowledge-manipulation (K-manipulation) processes can be classified into three main categories, namely K-generation, K-mobilization and K-application. Each of these categories will pose separate mechanisms, which will be treated as distinct constructs to realize their influences towards Knowledge Management maturity. From these findings, the direction taken for the maturity assessment of Knowledge Management in the proposed model will both be perceptual and factual kinds of assessments for assessing the Knowledge Management maturity of an organisation.

3.3.2 Inter-organisational knowledge processes

Knowledge-generation (K-generation) processes include all processes by which new knowledge is generated in an organisation. There are, however several types of knowledge generation, namely: *Acquisition* where new knowledge is acquired from external sources; *Externalisation* where the convertible tacit knowledge is conceptualised and other data sources are discovered in the organisation; *Synthesis* where the new knowledge is generated either by integrating the newly generated knowledge and validated knowledge with the existing knowledge, or by combining the existing knowledge and; *Production* where the new knowledge is produced by interacting with things in the cognitive domain of the organisation (Cook & Brown, 1999: 381).

Knowledge-mobilisation (K-mobilisation) processes include all processes that aim at increasing the visibility or accessibility of existing or newly generated knowledge by sharing it or transferring it from one knowledge provider or source to another knowledge seeker or target through space or time (Zack, 1999: 45).

Knowledge-application (K-application) processes include the processes by which knowledge is embodied in various forms. In particular where knowledge is used to develop a new product/service/business process or more specific to this research, to improve existing processes. Associated with these processes are the process of Knowledge-evaluation (K-evaluation), which includes all the activities that aim at justifying and measuring the business value of knowledge. The K-evaluation process may initiate a K-identification process which includes all the activities that develop the awareness of the need to create new Knowledge-things (K-things), to be discussed later in this section, or simply to update new K-things (Von Krogh *et al.*, 2000: 177).

3.3.3 The Knowledge Management spectrum classification

Most business processes operate on a continuum rather than a step transformation; consequently it is not surprising to find that some researchers have suggested that explicit and tacit knowledge should be considered to be at the ends of a spectrum of knowledge types, rather than being the only two categories on that spectrum (Beckman, 1999: 134). The application of an organisation's knowledge base either exploration vs. exploitation or internal vs. external knowledge, will distinguish the scale of innovation relative to the rest of the particular industry. Furthermore the classification of existing Knowledge Management approaches, in the form of a Knowledge Management spectrum has fostered the uptake of Knowledge Management towards Operational Excellence, by means of minimising overheads, eliminating intermediate production steps and optimising business processes (Binney, 2001: 35).

Nickols (2000: 17) recommends that Nonaka and Takeuchi's categories, as referred to in the previous section, should be further broken down according to whether they focus on declarative or procedural knowledge. The declarative knowledge as stored by the human memory presents two distinct types of knowledge, as separate divisions of the human memory. The first kind being factual knowledge, which is independent of time and place; constructed by semantic memory. With the second kind being theoretical knowledge of a specific moment in time and space and shaped by episodic memory (Tulvig & Schacter, 1990: 303). Binney (2001) provides a framework, The Knowledge Management spectrum, to help organisations make sense of the large diversity of material appearing under the header of Knowledge Management, and to facilitate the assessment of where they are in Knowledge Management terms. Binney's analysis is of importance to this research, as it reflects aspects of both the knowledge-centred classification of Knowledge Management and the business perspectives classification of Knowledge Management. In terms of the business perspectives, Binney's categories reflect activities that support a particular

perspective, for his “Innovation and Creation Knowledge Management” reflects Treacy and Wiersema’s strategy – a fundamental argument of this thesis. Binney’s Knowledge Management spectrum also supports Nonaka and Takeuchi’s knowledge spiral, as referred to earlier in this thesis, and makes use of explicit and tacit knowledge at all times in some way for the knowledge spiral to keep flowing. This view is supported by Hansen (Hansen, Nohria & Tierney, 1999: 106), who suggests that most organisations should operate with a mixture of an explicit codified knowledge strategy and a highly creative and customised strategy, but not in equal proportions. It would seem that Binney’s spectrum does identify different techniques that are applicable for different types of Knowledge Management, as shown in Table 3.1. The Knowledge Management spectrum would be most appropriate towards the construct of the proposed Knowledge Management maturity assessment framework, for organisations where two or more Knowledge Management techniques are followed, incorporating both a cognitive or community approach in order for their knowledge to continue to grow or improve. The cognitive approach implies knowledge in objective terms that can be expressed and codified, and is often expressed by the capture and codification of knowledge in computer systems. While the community approach emphasizes knowledge as socially constructed and is managed primarily by encouraging groups and individuals to communicate and share experiences (Scarbrough & Swan, 1999: 34).

The Knowledge Management spectrum makes the design of the Knowledge Management maturity assessment possible as it directs the ‘Operational Excellence’ value discipline against Knowledge Management activities, which will be used for the construct of the three layers namely the cognitive domain layer, functional domain layer and the Knowledge Management resources layer of the proposed model. The activities, including the construct of these layers will be used to direct Operational Excellence for current or future events, across the different organisational functions as greyed out in the Table 3.1.

Table 3.1 Binney's Knowledge Management Spectrum Applications and Knowledge Management Classifications mapped for Operational Excellence

Knowledge Management Spectrum:	Transactional: - Case Based Reasoning (CBR). - Help Desk Applications. - Customer Service Applications. - Order Entry Applications. - Service Agent Support Applications.	Analytic: - Data Warehousing. - Data Mining. - Business Intelligence. - Management Information Systems. - Decision Support Systems. - Customer Relationship Management.	Asset Management: - Intellectual Property. - Document Management. - Knowledge Valuation. - Knowledge Repositories. - Content Management.	Process: - TQM. - Benchmarking. - Best Practices. - Quality Management. - Business Process (Re) Engineering. - Process Automation. - Lessons.	Developmental: - Skills Development. - Staff Competencies. - Learning. - Teaching. - Training.	Innovation & Creation: - Communities. - Collaboration. - Discussion Forums. - Networking. - Virtual Teams. - Research and Development. - Multi-Disciplined Teams.
Knowledge Accessibility:	explicit		implicit		tacit	
Knowledge Conversion:	combination		externalisation		internalisation	socialisation
Social Learning Cycle (SLC)	Problem Solving	Scanning/ Abstraction	Impacting		Diffusion	Absorption
Knowledge Type	Mostly procedural	Mostly declarative	Declarative	Procedural	Either	Either
Value Disciplines	**Operational Excellence**	Customer Intimacy	Any	**Operational Excellence**	Any	Product Leadership
Knowledge Management Strategy Option 1	Knowledge Transfer	Customer Focused Knowledge	Intellectual Asset Management	Knowledge Transfer	Personal Knowledge Asset Responsibility	Knowledge Creation
Knowledge Management Strategy Option 2	Developing and transferring best practices	Creating a new industry from embedded knowledge	Creating a standard by realising proprietary knowledge	Developing and transferring best practices	Transferring best practices	Fostering and commercialising innovation
Knowledge Management Strategy Option 3	Conservative (exploiting existing knowledge)				Aggressive (creating new knowledge)	

Adopted from Binney, 2001: 33

Additionally the Knowledge Management spectrum provides a benchmark for the evolution of Continuous Improvement routines within the organisation, which will also be used to map the proposed model's three layers process grid. From Table 3.1 the Operational Excellence value discipline is visible against the greyed out area across the columns transactional, analytic, asset management and process. The greyed out spectrum area identified the Knowledge Management activities which will be used to identify the business processes, business rules as well as the differences between the knowledge processes and enabling technologies. These activities will be used for the construct of the three layers namely the cognitive domain layer, functional domain layer and the resources layer of the proposed Knowledge Management maturity assessment framework towards encouraging Operational Excellence.

3.4 Three layers and categories of the Knowledge Management maturity assessment framework

The basis for understanding and identifying the different layers of the Knowledge Management maturity assessment framework, as described above, for the purpose of modelling the dynamics of these processes it will necessitate the development of a framework for a single viewed process grid as methodology in the construct of the proposed model. This knowledge process grid will leverage Knowledge Management variables and enabling Continuous Improvement development routines towards value creation in the delivery of Operational Excellence. To facilitate this outcome the proposed model should be positioned as a self-assessment instrument covering most of the major areas of the cognitive domain layer, functional domain layer and the Knowledge Management resources layer to eventually bring the broad task of Knowledge Management maturity assessment to fruition. With the longer-term goal of this research to deliver a knowledge process grid, which suggests improvements in Knowledge Management practices and Continuous Improvement principles; assessing the

benefits associated with increasing the Knowledge Management maturity and enabling Continuous Improvement routines towards Operational Excellence.

3.4.1 The cognitive domain layer

The first layer, the *cognitive domain layer* is defined as the set of all relevant things, together with the set of possible relationships between them, towards which thought or action is directed or is communicated by members of the organisation, namely Business-things (B-things). A B-thing in the cognitive domain may be concrete or an abstract entity and it may be primitive or composite. Based on the interactions between an organisation and B-things in its cognitive domain a distinction is made between the internal cognitive domain and the external cognitive domain. The internal cognitive domain includes the set of all things that represent the self-image and self-consciousness of the organisation. The set of things that represent things such as consumer, supplier, competitors and partners are contained in the external cognitive domain. Each thing in the cognitive domain, namely B-thing is associated with certain knowledge that is needed to deal with it or act upon it. This knowledge is characterised in terms of one or more knowledge things (K-thing). A K-thing describes the knowledge about the knowledge associated with a B-thing, namely Meta-knowledge (Eriksson & Penker, 2002: 63; McDavid, 1999: 12; Davenport & Short, 1990: 11). The interaction and relationship between them is important, since knowledge associated with a B-thing is in constant change and is context-dependant.

3.4.2 The functional layer

While things in the cognitive domains of the organisation (B-things) are relatively stable, the associated knowledge and consequently K-things are in a state of continual change. The *functional layer* is composed of two categories of K-processes. The first category consists of the states the K-thing can have and the

second category consists of the processes that would cause the transitions of states, namely the K-manipulating processes. In addition to these processes there are the K-enabling processes which positively affect K-manipulating processes (Von Krogh *et al*., 2000: 64). Thus the functional layer is composed of two categories of K-processes. The K-thing can take different states, and the state transitions are caused by performing one or more K-manipulating processes (Zack, 1999: 45).

The following are K-manipulating processes, which will also be used to test the hypotheses of this research, namely:

3.4.2.1 Knowledge identification: Includes all the activities that develop the awareness of the need to create new K-things or to update existing ones. This process also includes activities that determine the form, the convertibility and the owner(s) of the required knowledge. Determining the knowledge gap by comparing knowledge needs with existing knowledge as well as identifying the possible internal and external sources of the required knowledge, are typical activities of this process.

3.4.2.2 Knowledge generation: This process includes all activities by which new knowledge is generated within the organisation. There are several modes of knowledge generation, namely acquiring the mode where new knowledge is acquired from external sources; the externalizing mode where the convertible tacit knowledge is conceptualised; the discovering mode where the knowledge hidden in data sources is discovered; the synthesizing mode where new knowledge is generated either by integrating or combining with existing knowledge and finally the producing (creation) mode where new knowledge is produced by interacting with things in cognitive

domains (O'Leary, 1998: 30). These interactions can be encouraged across the individual areas of the knowledge development cycle, to encourage a magnitude in the maturity level of each area of the knowledge development cycle.

3.4.2.3 Knowledge mobilisation: Means increasing the visibility of knowledge by sharing it or transferring it from the knowledge provider or owner to the knowledge seeker. The mode of mobilisation depends on the form of the available knowledge and the nature of the provider and seeker, as relevant across the individual areas of the knowledge development cycle. For explicit knowledge this process includes the activities that aim at increasing the visibility of the existing explicit knowledge that is stored in physical media. Examples of such activities are pushing/pulling, searching/retrieving and professional training. In the case of tacit knowledge the process may include activities such as socialisation, mentorship and apprenticeship (Cook & Brown, 1999: 381). The maturity level of Knowledge Management can be projected against these activities, for a collective maturity level to be attained for tacit – and explicit knowledge.

3.4.2.4 Knowledge elaboration: This process consists of all the knowledge activities intended to refine the newly generated explicit knowledge, this might include testing, labelling, indexing, abstracting, restructuring and maintaining the existing knowledge. This process will also be simulated by means of the self-assessment process of the proposed Knowledge Management maturity assessment model, across the individual areas of the knowledge development cycle for specific interest in maintaining existing knowledge.

3.4.2.5 Knowledge preservation and presentation: After knowledge has been generated or elaborated, it must be carefully preserved. The preservation activities depend on the form of the generated knowledge. In the case of explicit knowledge they may include activities such as formalising, codifying, organising and storing in different media. In the case of tacit knowledge, the preservation activities also depend on the bearers of the knowledge, for this some activities may include extending the ownership of the knowledge through mentorship or apprenticeship. Knowledge use is context-dependent, whether this context is related to the individual user or to the business process in which it will be used. Therefore, the effective use/re-use of knowledge depends on the degree to which the presented knowledge matches its contact-of-use. From this perspective, the knowledge presentation process aims to develop the capabilities for presenting explicit knowledge, with a degree of sufficient flexibility to render it meaningful and applicable across multiple contexts of use (Zack, 1999: 45).

3.4.2.6 Knowledge evaluation: Includes all activities that aim at justifying and measuring the business value of the knowledge. Von Krogh *et al.* (2000) have identified three types of knowledge justification, with a sub-set against the strategic justification in the form of justification of conceptual knowledge and justification of materialised or operational knowledge. This identification will be applied alongside the assessment of the individual areas of the knowledge development cycle, in determining the maturity level for which the conceptual knowledge is applied for products, services or processes of an organisation.

Each of the above-mentioned K-manipulating processes should be associated with one or more K-enabling process. The following are K-enabling processes, for which each will have an immense contribution for the individual areas of the knowledge development cycle, to underpin growth towards the maturity level of the areas independently. The following are K-enabling processes (Von Krogh, *et al.*, 2000: 51, 65):

- *Instilling knowledge-vision:* This process includes activities such as developing mental maps of the world in which organisational members live in or ought to live in, while setting normative, strategic and operational knowledge goals. Normative knowledge deals with the creation of a knowledge-sensitive corporate culture, in which sharing and development of know-how create the preconditions for effective Knowledge Management. The emphasis on strategic knowledge for this process is to define the organisational core capabilities and describe the future knowledge needs of the organisation. Operational knowledge goals make sure that normative and strategic knowledge goals will be translated into action, and should be directed purposefully to encourage maturity across the individual areas of the knowledge development cycle (Probst *et al.*, 2000).

- *Managing conversation:* It includes setting the guiding principles for holding fruitful conversations with respect to encouraging active participation, establishing conversational etiquette, editing and fostering innovative language. Across the individual areas of the knowledge development cycle, the necessity of this process will complete the participation of the members of an organisation. Additionally it will also set the longevity of deliverables of the assessed Knowledge Management maturity level, for achieving the next level of Knowledge Management maturity.

- *Mobilising knowledge activists:* The principal activity of this process consist of triggering K-manipulating activities across the different parts of an organisation, coordinating them and providing overall directions for them. These activities can be performed across the individual areas of the knowledge development cycle, as functions towards achieving higher maturity levels.

- *Creating the right context:* This process aims at setting physical, cyber and mental "shared spaces" – that enhances the existing interactions and foster new ones. K-manipulating processes are crucially dependent on social interactions among organisational members; hence organisational structures that foster solid and effective collaboration across the individual areas of the knowledge development cycle should be encapsulated whilst striving towards higher maturity levels.

- *Globalising local knowledge:* Supporting the creative approach to knowledge mobilisation, this process looks at reshaping the local knowledge to be readily re-used and reshaped by local experiences, expectations and justified by local values. It is this re-created activity of this process that will be applied across the individual areas of the knowledge development cycle, to move from one level of maturity to the next.

3.4.3 The Knowledge Management resources layer

The third layer, the *Knowledge Management resources layer* is composed of enabling technologies that can be grouped under the organisational and Information and Communication Technologies (ICT) and tools. These tools will support the K-manipulating and K-enabling processes of the functional layer at

different organisational levels and will be applied at different stages of the maturity process grid for the proposed Knowledge Management maturity assessment framework, in achieving Operational Excellence. It is the application of these technologies, for the salient features of knowledge and the associated K-manipulating processes, to keep track of various work and experience histories at the individual and organisational levels. The proposed Knowledge Management maturity assessment framework should integrate tracking of the various genre repertoires used by different groups and their changes (Brown & Duguid, 1989: 32). The proposed Knowledge Management maturity assessment framework will therefore identify and propose enabling technologies to provide specialised and customised solutions for individuals and communities, but also at the same time enable communication and transfer of knowledge between them across the different Knowledge Management maturity levels to be achieved (Orlikowski & Yates, 1994: 541, 550). The enabling technologies have to support reciprocity, complex, multi-directional, implicit negotiation inherent in shared practice towards achieving Operational Excellence.

The above definitions of the three-layer approach to Knowledge Management, illustrates that Knowledge Management is not a standalone concept, it is linked to organisational growth and learning and also draws upon innovation and shared knowledge concepts and practices. This linkage will be explored in more detail in subsequent conceptual syntheses for both Knowledge Management practices and Continuous Improvement routines, as shown in Figure 3.1, and will be discussed in the following section.

3.5 Continuous Improvement routines

This study aims to promote the notion that the above-mentioned layers, namely the cognitive domain layer, functional layer and resources layer of an organisation can be increasingly stimulated by focusing effort through

Continuous Improvement routines towards the associated inter-organisational knowledge processes towards Operational Excellence. These routines are viewed as clusters of behaviour which have become embedded in the organisation and which represent “the way we do things around here” (Nelson & Winter, 1982: 27). Such patterns belong to organisational culture and are formed as part of a complex, multi-level process in which underlying beliefs and values become artefacts, which reinforce the beliefs and behaviours (Schein, 1984). Over time ‘the way we do things around here’ becomes explicit in symbols, structures and procedures in the organisation, which in turn reinforce the underlying behavioural norms. These behaviours cluster around several core themes: behaviours associated with systematic finding and solving of problems, behaviours associated with monitoring and measuring processes and behaviours involving strategic targeting of Continuous Improvement. Developing Continuous Improvement routines involves two kinds of learning – improving and reinforcing behaviours within a particular routine cluster and adding new routines to the selection.

To manage, maintain and develop a new way of Continuous Improvement work or routine the following factors will be considered when developing the next level of constructed Continuous Improvement levels as proposed by the Knowledge Management maturity assessment framework, namely (Rapp, 2002 :23):

- *Simplicity:* The work with Continuous Improvement should not be too overwhelming nor too time consuming for each person involved.
- *Adaptability:* The work with Continuous Improvement will have periods of decline and it will change over time in terms of focuses and which people are active and in what roles. For the design of the self-assessment process of the proposed Knowledge Management maturity assessment framework, the workplace, equipment or product quality should be used as

guiding factors during the assessment towards equating the level of Continuous Improvement ability of an organisation.

- *Commitment of champions and management:* The champion can change over time and it is important to keep looking for people suitable to act as champions and inspirations for newly found Continuous Improvement routines.

Bessant, Caffyn and Gallagher (2001: 67) complement the above mentioned, towards building the essential abilities for sustainable Continuous Improvement:

- Align Continuous Improvement behaviour and organisational context.
- Link Continuous Improvement to strategic goals.
- Ongoing improvement of Continuous Improvement routines and work direction.
- Facilitate the learning organisation at all levels.

To create a sustainable development of inter-organisational knowledge processes, five practical principles will be applied for each of the individual areas of the knowledge development cycle (Docherty, Forslin & Shani, 2002: 37). These five principles are:

- Active choice of workplaces across the different areas of the organisation.
- Active value creation for all areas of the organisation.
- Wide vision and variable design focus for sustainability.
- Sustainability through active balance and integration.
- Sustainability through active experimentation, learning and reflexivity.

Where active means that there must be a conscious, considered, committed decision on a principal level of all the members of the organisations to follow, implement and develop a sustainable work system towards achieving Operational Excellence. Figure 3.2. illustrates the influence of the Continuous Improvement routine on the K-creation process with the perceived effect towards Operational Excellence, with the core Continuous Improvement ability being used in the execution of the K-creation process. Furthermore the fusion of the activities of K-creation with appropriate and available Continuous Improvement routines is shown.

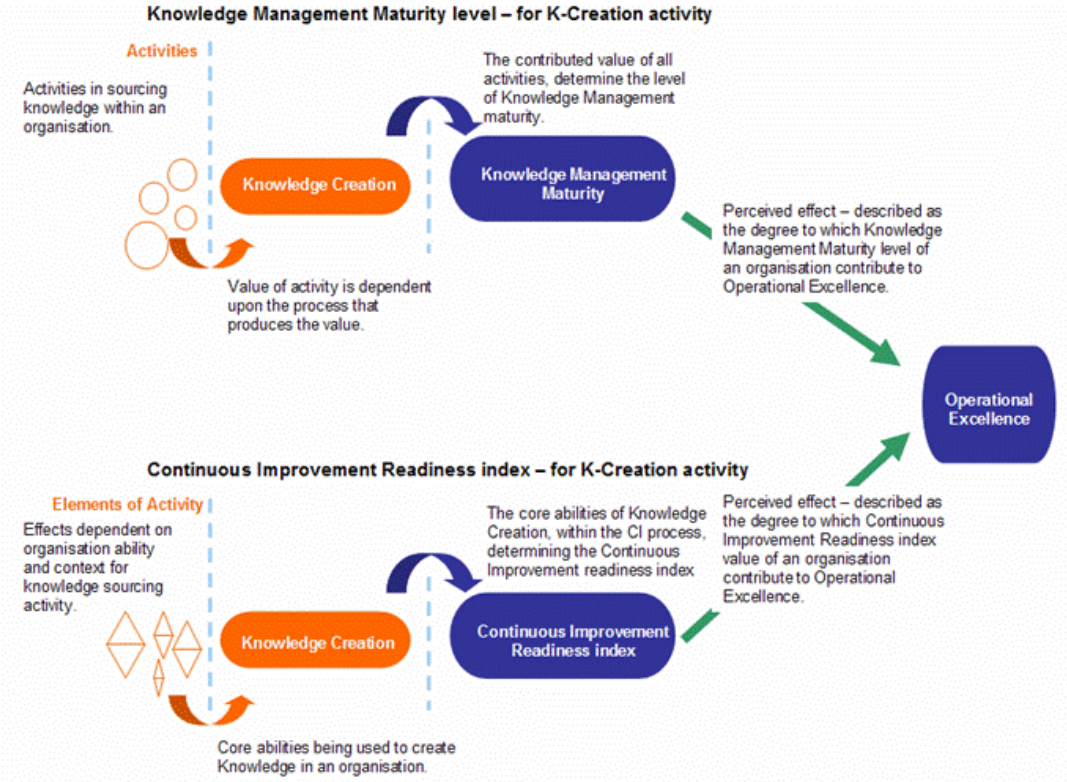


Figure 3.2 K-creation process with supportive Continuous Improvement routines towards Operational Excellence

Self-constructed

Against the background of Continuous Improvement clusters and behaviours, new driving forces to reinforce the development of existing Continuous Improvement routines or fostering new ones, in support of elements for the cognitive - , functional – and resources layer of Knowledge Management must be accomplished. This will be achieved by measuring the Continuous Improvement level, to be improved against the organisation's ability and context for the specific knowledge activity involved.

Bessant *et al.* (2001) show that Continuous Improvement is accomplished on different levels in different organisations. They stress that Continuous Improvement work can be described in a staged development model from an unstructured Continuous Improvement project until the situation. When Continuous Improvement is part of the culture; in the way we do things and for which the improvement were reviewed and evaluated over a period the creation of a learning organisation is established which is most conducive for lasting Continuous Improvement. Section 4.3 in the following chapter underpins these findings around the development of Continuous Improvement, and is reminiscent of a culture of innovation, which is accommodating of the Knowledge Management development cycle. Furthermore the proposed Knowledge Management maturity assessment framework will apply the staged development of Continuous Improvement towards the construct of the knowledge process grid, as guide towards achieving Operational Excellence. The perceptual construct of the proposed model, in dealing with the above-mentioned Knowledge Management concepts and Continuous Improvement behaviours and routines, will be discussed in the next section.

3.6 Perceptual concept of the proposed model

Models are vital tools representing the essential characteristics of reality as well as imaginary ideals, thereby playing an important role in decision-making. Business today requires better information across a wider scope than that of traditional, and often linear, measures to achieve an understanding of the factors that create the foundations of future success (Fawcett, Smith & Cooper, 1997: 410). Therefore business models are a representation of management thinking and practices that allows businesses to see, understand and run their activities in a distinct and specific way. Business operates in surroundings of contextual shift and what is required of a business model is to remain unchanged and retain its power of explanation. In Platonic terms, what this signifies is the crucial difference between “being” and “becoming” (Chaharbaghi *et al.*, 2003: 375). Where “being” relates to the essential, unchanging qualities that all business models share and “becoming” refers to the contextualization of these qualities. Thus, a specific model is an imperfect copy of the underlying qualities from which it emerged. This occurs because, while a specific business model still retains the seeds of its conception within it, the process of contextualisation constantly moves it away from the origin. Additionally, due to the increasingly dynamic nature of the context within which business operate and the associated focus on the micro-level, the problems business face soon present themselves as problems without solutions. The only means through which to ease this situation is to turn to the higher level of abstraction provided by the meta-model.

Therefore the basic principles of the self-assessment process of the proposed model will manifest themselves through the three interrelated strands typical to that of a meta-model, namely the way of thinking, the operational system and capacity for value generation (Chaharbaghi *et al.,* 2003: 376). The proposed model will be positioned as a mechanism through which business can create and exploit new elements for shaping the cognitive domain layer, functional layer and

Knowledge Management resources layer to exploit Knowledge Management practices and Continuous Improvement principles for achieving Operational Excellence.

Following the above-mentioned and theory build leading to this point, the perceptual concept of the proposed model is put forward in Figure 3.2. The OODA cyclical assessment loop, as referred to in section 1.3 of this thesis, will be used to lead the user of the proposed model to obtain a current state of Knowledge Management maturity and Continuous Improvement ability level of an organisation. The proposed model consists essentially of three main areas, indicated in Figure 3.3 as A, B and C. The area around A is concerned with the maturity assessment of the Knowledge Management state from a perceptional perspective. This area then leads to the identification of the inter-organisational processes which can be encouraged by means of assessing the Continuous Improvement routines and behaviours unlocking the full potential of the individual Knowledge Management development cycle elements. This area of the proposed model will recognise the necessary ideals for the construct of a knowledge process grid, across the cognitive layer, functional layer and Knowledge Management resources layers as indicated in area C in Figure 3.3. This allows a detailed diagnosis of the maturity of both Knowledge Management and Continuous Improvement, so that a tailored improvement plan can be produced, building on specific strengths of Knowledge Management practices and Continuous Improvement principles towards achieving Operational Excellence.

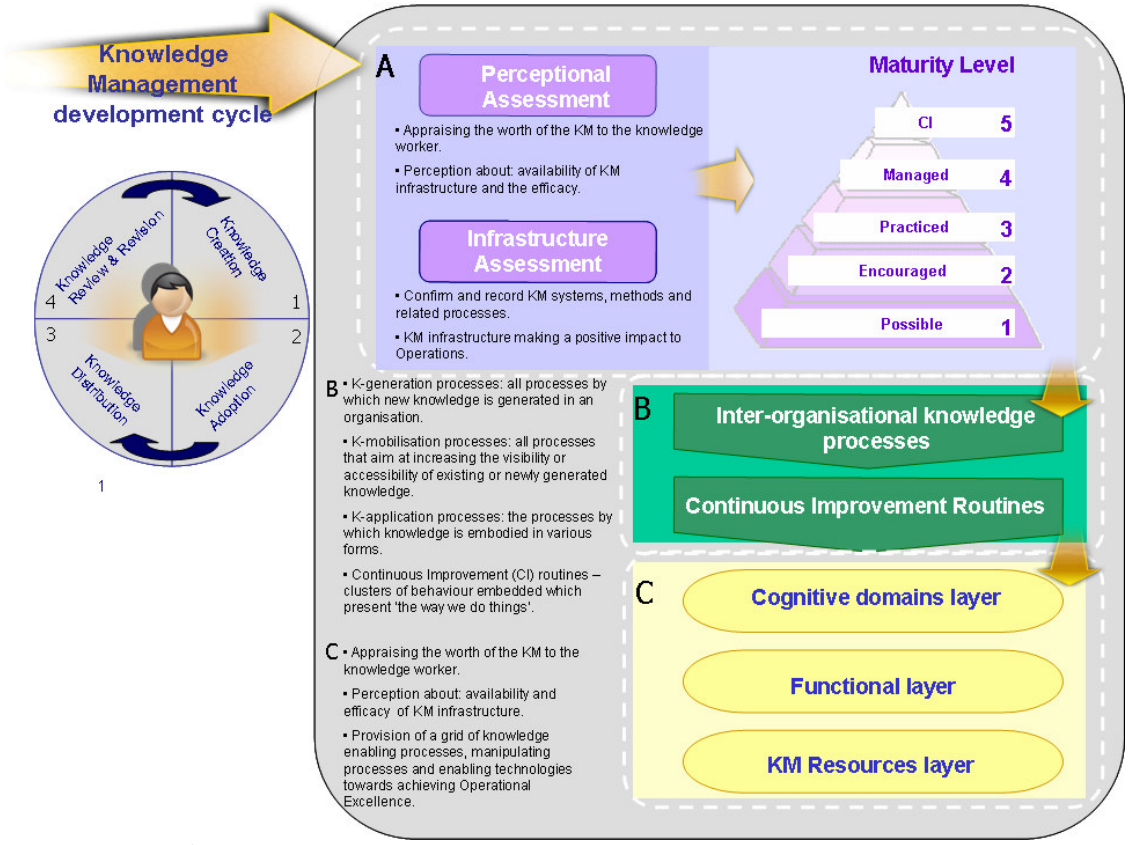


Figure 3.3 Seminal view of proposed model construct areas

Self-constructed

The above figure portrays the main areas of the proposed model, for which the next chapter will provide the necessary information and reasoning around the construct of the proposed model.

3.7 Summary

This chapter concludes the first section of this thesis, and focused on providing an understanding of Quality Management, Knowledge Management concepts and introducing certain underpinning Continuous Improvement characteristics. In theory, the foundation for creating the building blocks towards the seminal building areas were related through meaning associations with the central

theme of the study. The chapter concluded with a representation of the perceptual concept and design approach of the proposed model, aligning the features and attributes of Knowledge Management and Continuous Improvement. The following chapter will discuss the construct of the proposed model, based on the fundamental understanding of business models and in particular that of the concept of a meta-model for business models. It will also provide insight around the outcome of the proposed model's knowledge process grid for mapping of knowledge processes and associated Continuous Improvement routine capabilities in achieving Operational Excellence.

Chapter 4 – Construct of proposed model

The analysis of the relevant business models brings forth various patterns, which highlight the relationship between the meta-model for business models and other relevant business models. This chapter will dispute the positioning of the proposed model within the seminal view of the meta-model, fostering the power of explanation and enabling business to elevate their thinking to a higher level in achieving Operational Excellence. The proposed model will take advantage of the meta-model characteristics by enabling business to question their existing Knowledge Management maturity and Continuous Improvement ability against the three strands of the meta-model. The three strands of the meta-model are presented, with suggestions on how the proposed model could influence each strand in the creation of Operational Excellence. In light of the nature of sense making, the Knowledge Management practices and Continuous Improvement principles will be tabled, and sense making will be explained and applied to allow the user of the proposed model to take action and incorporate Knowledge Management and Continuous Improvement information into mental frameworks that will guide further action. The chapter will conclude with the proposed model's process grid for the mapping of the associated Knowledge Management maturity level and Continuous Improvement ability value against the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer as a hybrid model in achieving Operational Excellence.

4.1 Business Models

Models are fundamental tools representing the essential characteristics of authenticity as well as invented ideals, thereby playing an important role in decision making. According to Asher (1983: 189), "we all employ models by which we operate our world. Our models are our conceptual understanding of the

parts important to us. The model serves as a kind of filter, eliminating or straining out extraneous or confusing data, while highlighting meaningful patterns." While this function of models is true generally, what is often ignored is the relationship between the inception and development of specific models and the underlying assumptions and context that govern their creation. It is precisely this relationship that the proposed model will try and take advantage of as this relationship determines the meaning, legitimacy and impact of models. Business models are a representation of management thinking and practices that help business see, understand and run their activities in a discrete and specific way. Furthermore, it is the context that gives business models their meaning and determines their validity and usefulness. Driven by rapid developments in the fields of knowledge and technology, the external framework within which businesses now operate is changing at an ever-increasing rate. This in turn requires businesses to change their underlying business models at a faster rate. The problem is now one where the models that worked in the past may not necessarily work today and today's models, in all likelihood, will not work in the near future (Chaharbaghi *et al.*, 2003: 372).

This entails that behind changes in business models should exist a model itself, a meta-model, the identification and analysis of which reveal the birth, exploitation and end of business models. The proposed model should indeed be shaped around identification and application of this meta-model, which will result in businesses changing their focus of Knowledge Management and Continuous Improvement from a fixed state of being to a process of becoming, allowing them to adapt naturally to their environment which is changing at an ever-increasing rate. Therefore a comprehensive understanding of this meta-model is necessary, to ensure the reusability of the proposed model even after the business environment has changed.

4.2 Sense making through adoption

Sense making is defined as the cyclical process of taking action, extracting information from stimuli resulting from that action and incorporating information and stimuli from that action into the mental frameworks that guide further action. This definition is aligned with several existing perspectives. Waterman (1990: 41) referred to sense making as the structuring of the unknown. Sense making has been described as the placing of stimuli into a framework (Starbuck & Milliken, 1988: 45; Dunbar, 1981: 95; Goleman, 1985: 24) that is used to direct interpretation. Sense making is the recurring process of forming anticipations and assumptions and the subsequent interpretation of experiences that deviate from these anticipations and assumptions (Louis, 1990: 226).

Sense making helps us to examine the adopter's mental processes, providing a lower-level view of adoption. Whereas other approaches focus on the adoption decision and its antecedents and consequences, sense making focuses on the adopter, for example the mental frameworks and the antecedents and products of those frameworks (Seligman, 2006: 110). The sense making perspective provides a look at the adopter's mental conception capacity. It is meant to complement, not replace other perspectives on adoption for all application purposes of the proposed model. Additionally the proposed model will also draw from the innovation-decision process, a subset of sense making, described by Rogers (1995: 161) as "..the process through which an individual (or other unit) passes (1) from first knowledge of an innovation, (2) to forming an attitude toward the innovation, (3) to a decision to adopt or reject, (4) to implementation of the new idea, and (5) to confirmation of this decision".

Weick (1995: 61) discusses seven properties of sense making, each of which will be discussed in the context of the proposed model and subsequent assessment framework for both Knowledge Management maturity and Continuous Improvement ability values of an organisation. These seven properties are also

incorporated in Figure 4.1, under the area ‘Sense making Properties’ as part of the seminal view of the proposed model’s construct.

4.2.1 Grounded in identity construction

This property of sense making is concerned with the notion that sense making is grounded in identity construction, meaning that a primary purpose behind finding meaning, or sense, is to create identities for oneself and for others. From the perspective of the self-assessment framework of the proposed model, and in support of Kaye and Dyason (1998: 390) characteristics of frameworks and models, the proposed model will profile the current against the desired performance level; hence creating identities for oneself and others in the organisation around Knowledge Management practices and Continuous Improvement routines or principles. The underlying Knowledge Management development cycle, as described in Chapter 3, lends itself to the arrangement of specific identities surrounding the activities required for each cycle of the knowledge development process, strengthening this identity construction property. For identity construction concerns itself with challenging one’s own paradigm for looking at things differently especially for the different cycles of knowledge development.

4.2.2 Retrospection

Sense making is retrospective, meaning that a person makes sense of the past, not the immediate present. If sense making is part of adoption, then adoption involves retrospection, which implies that behavioural intention, especially when measured before subjects actually use a technology, may be a weak indicator of actual enduring adoption behaviour since there is no real experience yet with the system. This implication is supported by Pfeffer’s (1982: 44) “emergent” view of action in organisations. Another implication of retrospective sense making is that adoption attitudes may be formed by past adoption experiences or similar

experiences in which the subject learned to use a complex tool. Experience of self-efficacy may, therefore, include past successes and failures at using various other complex technologies as published by Agarwal and Prasad (1999: 361) and experiences at adapting to new ways of working. The proposed model will achieve this property by means of OODA-loop cycles of observation, orientation, decision and action (described in Chapter 2). The OODA-loop, adopted for the construct of the self-assessment framework of the proposed model, encourages the users to identify answers and measure the effectiveness of their response. The retrospective analysis of the end result of the proposed model, will allow the users to identify the enabling activities moving forward towards Operational Excellence against the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer as a hybrid and systemic model in achieving Operational Excellence.

4.2.3 Enactive of sensible environments

Sense making is enactive of sensible environments, meaning that a person over time influences the work environment, and then is influenced by it because the environment is a source of stimuli (Weick, 1995: 56). Therefore, the user manages the compatibility of the personal work environment with system usage. One implication of enactment is the garbage-in, garbage-out principle. If the user does not enter data into an information system correctly, the system may fail to live up to the expectations and adoption may suffer. Another implication is that although compatibility of the system with the user's current behaviours is known to have an influence on attitudes toward the system (Taylor & Todd, 1995: 144), the user has an influence over those behaviours. The proposed model will facilitate this property of sense making, by characteristics of knowledge itself through the variety and diversity of the bearers of organisational knowledge. Moreover, the proposed model will assess the climate of the situation and people involved, rather than the absolute truth and hard facts (Von Krogh *et al.*,2000).

4.2.4 Focused on and by extracted cues

According to Weick (1995: 50) “Extracted cues are simple, familiar structures that are seeds from which people develop a larger sense of what may be occurring”. This property of sense making will be commissioned around the comparison of what is noticed to what is understood, so that what is noticed can be mentally classified as being “like”, “unlike”, “an example of” for Knowledge Management activities and Continuous Improvement routines during the assessment and application of the proposed model; for cue extraction involves both noticing and classification (Seligman, 2006: 113). The assessment process of the proposed model will provide the user with key Knowledge Management and Continuous Improvement influencing factors in achieving Operational Excellence. These key factors will be presented in the form of cues for the relevant Knowledge Management areas and Continuous Improvement routines. The key factors will be selected purposefully to ensure that the proposed model usefulness and adoption may not be diminished during the reuse of the proposed model within the same business environment.

Tables 4.1 and 4.2, illustrate key Knowledge Management and Continuous Improvement factors and the possible influences on Operational Excellence, which will be used for shaping or influencing the design of the proposed model.

Table 4.1 Influencing Knowledge Management factors and Operational Excellence

Key Factors	Influence Operational Excellence through
Knowledge	Source for innovation; Knowledge-based competitive advantage; Asset in the form of intellectual capital; Internalized and applied for effective internal operations; Sustainable advantage, as it generates increasing returns and continuing advantage; Strategic resource, enabling role for winning strategies; Acquiring knowledge of competitive environment.
Elements that enable or influence knowledge	The organisation's knowledge base captured electronically (Content); The processes knowledge workers used to achieve the organisation's goal (Processes); The Information Technology that facilitate the identification, creation and diffusion of knowledge (Technology); The measures and metrics captured to determine if Knowledge Management improvement is occurring or if benefit is being derived (Measurement); The environment and culture in which Knowledge Management process must transpire.
Organisational knowledge processes	There are three key knowledge processes that are consistently referred to in the literature: knowledge creation; knowledge sharing; and knowledge exploitation. i. Creation process is all factors that go into creating new knowledge. ii. Knowledge sharing process is generally agreed as a key knowledge process and deals with transferability of knowledge. iii. Exploitation of knowledge described as converting knowledge into valuable products.
Status of Knowledge Management in an organisation	Sets of measurements to assess activities and acceptance in knowledge communities; Knowledge Management maturity assessment to provide overview on status and deficiencies; Profound and comprehensive approach to give directions in all major Knowledge Management aspects; Knowledge Management planning and intellectual capital overview.
Sustainability	Continuous learning; Continuous effort for continuous change; Idea of sustaining change by working on diminishing the forces against change; Necessity to live with change and evolving improvement effort.

Adopted from Callon, 1996; Davenport & Short, 1990; Floyd & Wooldridge, 1999; Grant, 1996; Skyrme, 2006; Tiwana, 2000; Weick, 1995; Zack, 1999

Table 4.2 Influencing Continuous Improvement factors and Operational Excellence

Key Factors	Influence Operational Excellence through
Incremental innovation	Based on the premise that all human beings are capable of creative problem-solving; Translation of 'kaizen' to Western term Continuous Improvement.
Continuous Improvement behaviours	A suite of behaviours which evolve over time; Continuous Improvement measures in exploring the extent to which Continuous Improvement behaviours become 'routinised'; Routines as clusters of behaviour.
Different Approaches implementing Continuous Improvement	Reporting and measurements towards performance and practice correlation.
Purposive Continuous Improvement	Purposive quest to retain and improve competitiveness, productivity and innovativeness in uncertain technological and market circumstances; Core abilities are measured during Continuous Improvement mapping studies through the presence or absence of selected behaviours.
Evolving routines for Continuous Improvement	'Organisational culture' and are formed as part of a complex, multi-level process in which underlying beliefs and values become enacted; Underlying the principle of Continuous Improvement is a belief that all individuals can make a contribution to problem-solving innovation within the organisation; Oriented towards applied research.

Adopted from de Lange-Ros, 1999; Imai, 1997; Kirton, 1980; Nelson & Winter, 1982; Nutt, 1984; Sabherwal & Robey, 1983

4.2.5 Social

Rice and Anderson (1994: 137) demonstrated that social worlds affect adoption attitudes. Socialising also allows for the sharing of symbolism, another form of representation and communication through cues (Stryker & Statham, 1985: 317; Prasad, 1993: 1404). From a sense making perspective, the social property will very much be influenced by the informational cues being communicated during social interactions and affect on the adoption of the proposed model for

sustainable Operational Excellence. The form in which these cues are communicated will also impact and affect the adoption of the application of the proposed model (Stryker & Statham, 1985: 361). For modelling the dynamics of these cues for both Knowledge Management and Continuous Improvement the proposed model construct will greatly depend on the social interaction-intensiveness of the knowledge (K-) processes. Therefore, each K-manipulating process should be associated with one or more K-enabling process (Von Krogh *et al.,* 2000), which produce both cultural and organisational enabling conditions encouraging social interaction-intensiveness. The proposed model will deliver this sense making property, by means of the provision of a process grid which will combine socialisation and externalisation situations for the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer as a hybrid model in achieving Operational Excellence.

4.2.6 Ongoing

Sense making is ongoing because sense is continually being made and remade. The environmental or contextual conditions under which employees work change over time as well (Seligman, 2006: 114). The implication of this sense making property for the construct of the proposed model is that Knowledge Management initiatives such as the assessment of the Knowledge Management maturity level of an organisation should begin by specifying the meaning-making context of the assessment itself and build from there towards the output of the proposed model. The output being a knowledge process gird encourages the generation, transfer, application and re-invention of knowledge towards the next level of knowledge maturity in achieving Operational Excellence. Since organisations do not operate in static environments, knowledge needs to be put under tests for checking the validity and reliability as an ongoing event (Bhatt, 2000: 24). The final analysis of the proposed model, will contribute to reviews and revisions against the unified processes of the cognitive domain layer, functional layer and Knowledge

Management resources layer as a hybrid model in achieving Operational Excellence.

4.2.7 Driven by plausibility rather than by accuracy

Sense making relies on plausibility (the notion that a given understanding is justifiable) rather than accuracy (the notion that a given understanding is in better alignment with the facts of a situation than any other understanding). In cases of ambiguity or uncertainty, multiple plausible understandings are justifiable. Preference plays a role in the sense maker's process of choosing from the known justifiable understandings. Weick (1995) quotes Fiske's (1992: 879) statement that sense making "takes a relative approach to truth, predicting that people will believe what can account for sensory experience but what is also interesting, attractive, emotionally appealing, and goal relevant". The proposed model will achieve this property of sense making, by means of identifying the best strategy appropriate in achieving Operational Excellence, for knowledge needs reviewing and refining in making knowledge more active and relevant for organisations.

4.3 Mapping of Knowledge Management maturity levels and Continuous Improvement ability values

The proliferation of many different Knowledge Management maturity models adopting different definitions and assumptions has made their selection and application difficult for practitioners and their study complex for researchers. In addition, many of them have been criticized as *ad-hoc* in their development (Kulkarni *et al.*, 2004: 242). For this reason, an objective of the proposed model is to review, compare, evaluate and integrate existing Knowledge Management practices of an organisation within the context of clear definitions for important concepts of Knowledge Management, as well as to provide an assessment

instrument for evaluating the organisation's Knowledge Management maturity level. The assessment instrument provided along with the proposed model can also serve as a diagnostic instrument pinpointing aspects that necessitate improvement. It will identify essential activities and their priorities and indicate how to progress to the next level of Knowledge Management maturity, against the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer as a hybrid model in achieving Operational Excellence. This information can form part of a Knowledge Management maturity profile to motivate organisational participants to improve on Knowledge Management and inform Knowledge Management investment, together with identification of Continuous Improvement routines available in the organisation. As the descriptions of maturity levels include the characterisation of the activities to be achieved, key distinctions of Knowledge Management areas as well as Continuous Improvement areas can be ranked and compared, making benchmarking possible.

The Knowledge Management Capability Assessment (KMCA) levels of Kulkarni *et al.* (2004: 254), will be used for assessment of the different levels of Knowledge Management achieved by an organisation. The selection of this KMCA was made based on the staged representation for progression alongside the maturity levels of Knowledge Management. Additionally the KMCA model makes use of an organisational view, rather than a technology skewed approach in assessing the different phases of the knowledge development cycle. Each level of Knowledge Management maturity is described by a set of characteristics, as tabled in Table 4.3. The KMCA model referenced for the Knowledge Management maturity levels for the proposed model, indicates five levels of Knowledge Management maturity with a set of common characteristics for each level (Bruin & Roseman, 2005: 4).

However, it is observed that different sets of characteristics are specified in different Knowledge Management maturity models. For the purpose of the

proposed model, the list of common characteristics will be adopted, as it is representative of the important aspects of each level of Knowledge Management maturity.

Table 4.3 Common characteristics and maturity levels

Description	Knowledge Management Maturity
Lack of awareness of the need of Knowledge Management.	Level 1
Aware of importance of Knowledge Management to organisation.	Level 2
Knowledge Management activities are stable and practiced, and individual Knowledge Management roles are defined.	Level 3
Common organisational Knowledge Management strategy with Knowledge Management training in place.	Level 4
Continual improvement of Knowledge Management practices and tools, existing Knowledge Management can be adapted flexibly to meet new challenges.	Level 5

Adopted from Bruin & Roseman, 2005: 4

Corresponding to each of the above characteristics, each Knowledge Management maturity level also identified key performance areas with relevant activities that will be used to identify the corresponding area for either the cognitive domain layer, functional layer or Knowledge Management resources layer presenting the associated activities and unified processes for achieving Operational Excellence.

Supporting the above Knowledge Management maturity levels and characteristics, the proposed model will be structured as a descriptive model in that it describes the essential attributes within the meta-model of business models, which would fit an organisation at a particular Knowledge Management maturity level. It is also a normative model in that the key practices characterise the ideal types of behaviour that would be expected in an organisation

implementing Knowledge Management. Following the above understanding of Knowledge Management maturity levels, in the same way the next section will now discuss the Continuous Improvement ability values of an organisation.

Following Nelson and Winter (1982: 15), routines as clusters of behaviour are noted which have become embedded in the organisation and which represent the way things are done. This leads to the understanding that these routines will exploit tangible and intangible assets in achieving a competitive advantage. What makes a firm at the end more competitive is not the location, buildings or equipment but what it knows about and how it behaves (Bessant *et al.*, 2001: 67, 70). Building these embedding routines is an extended learning process. The progress is from individual behaviours to routines which constitute particular abilities within an organisation. The ability to find and solve problems systematically involves the ability to share knowledge across the organisation, different levels of development of Continuous Improvement abilities. Bessant and Francis (2000: 34) viewed the evolution of Continuous Improvement capability as the development of a resource within the organisation which is firm specific, hard to copy and must be learned.

The proposed model will also correlate the control of knowledge with the Continuous Improvement capability, especially in its more developmental form with improved performance. The proposed model will also focus on the development and the reinforcement of behaviours of Continuous Improvement routines, aligning the role of Knowledge Management enabling processes to Continuous Improvement routines and relevant Continuous Improvement principles. Different Knowledge Management maturity levels will constitute the relevant enablers of constituent behaviours of Continuous Improvement enabling the evolution of improvement abilities of the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer towards Operational Excellence. The following section will explore the mapping of the Knowledge Management maturity level and Continuous Improvement

ability values, on a single grid against the unified process of the cognitive domain layer, functional layer and Knowledge Management resources layer.

Table 4.4 Continuous Improvement principles with associated Continuous Improvement ability values

Associated Continuous Improvement principles	Continuous Improvement ability value
• Continuous Improvement happens as a result of learning curve effects associated with a particular new product or process – and then fades out again. • No formal efforts or structure. • No knowledge connection exists. • Non-participation and inactivity.	CI1 – Pre-Continuous Improvement Interest
• Formal attempts to create and sustain Continuous Improvement. • Use of formal problem-solving process. • Use of participation, some knowledge transfer. • Structured idea management system. • Often parallel system to operations. • Can extend to cross-functional work but on an *ad-hoc* basis.	CI2 – Structured CI
• All of the above, plus formal deployment of strategic goals. • Monitoring and functional measurement system of Continuous Improvement against goals. • Uptake of knowledge that is shared amongst staff.	CI3 – Goal Oriented CI
• All of the above, plus responsibility for transfer to problem-solving unit. • High level of experimentation. • New knowledge and innovation.	CI4 – Proactive CI
• Continuous Improvement as the dominant way of life. • Automatic capture and share of learning and knowledge. • Everyone actively involved in innovation process. • Incremental and radical innovation.	CI5 – Full CI Capability

Adopted from Bessant, Caffyn & Gallagher, 2001: 76

4.4 Mapping of the unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer

This section is now used to illustrate the three categories of elements for the proposed model, which will be used to plot relevant processes and activities that will best describe the level of Knowledge Management maturity and Continuous Improvement ability level currently explored for an organisation. Sense making, as describe Section 4.2 will be achieved as the user of the proposed model will be able to view the next set of variables for the three categories in achieving the next level of excellence towards Operational Excellence.

The first category, which represents the first layer, includes knowledge about the things in organisation cognitive domains. The second category includes the processes needed to manipulate the elements of the first layer; here the distinction is around Knowledge (K)- manipulating processes together with K-enabling processes. These processes together constitute the second layer: the functional one. Finally, the third layer includes the elements which support the elements of the second layer: the resources layer (Abou-Zeid, 2002: 488). Section 2.6, contained in Chapter 2 of this thesis, introduced features of a Knowledge Management system and provided in-depth information of the three layers applicable to this section. The following section will incorporate the learning thus far, and provide the necessary relationship of the proposed knowledge process grid develop in accordance to the characteristics of the three layers separately.

4.4.1 The cognitive domain layer

This domain is defined (Abou-Zeid, 2002: 490) as the set of all relevant things, together with the set of possible relationships between them, toward which thought or action is directed or is communicated by the members of the

organisation, for instance Business (B) – things. For a B-thing may be concrete or an abstract entity and it may be primitive or complex. Based on the nature of the interactions between an organisation and B-things in its cognitive domain, a distinction is made between the internal cognitive domain and external cognitive domain of an organisation. Under the external cognitive domain the set of all B-things with which an organisation can interact, while conserving its identify. This set includes role-players such as consumers, suppliers, competitors and partners with the associated business channels. Subsequently, the set of all things that represent the self-image and self-consciousness of the organisation is called the organisation's internal cognitive domain. This set includes things such as business purpose, business outcomes, business processes, resources and business rules (Abou-Zeid, 2002: 488). The proposed model will assess the associated knowledge with B-things in terms of level of maturity of the Knowledge (K) – things characterised as one or more K-thing, required by the B-thing to deal or act upon towards Operational Excellence. B-things are in constant change and are context dependent, and will be influenced by the behavioural learning process which takes place over time by means of the development of Continuous Improvement. Table 4.5 identifies the relationship between the cognitive domain elements and that of Knowledge Management development levels, and Table 4.6 identifies the relationship between the cognitive domain elements and Continuous Improvement ability levels.

4.4.2 The functional domain layer

This domain is composed of two categories, the first category consists of the Knowledge (K) – enabling processes and the second category consists of the K-manipulating processes. K-enabling processes positively affect the K-manipulating processes (Von Krogh *et al.,* 2000). Each K-manipulating process will be associated with one or more K-enabling process. An extension of Von Krogh *et al.* (2000) knowledge enabling grid will be used to construct this domain

in relation to Knowledge Management maturity and Continuous Improvement ability levels of the proposed model. Von Krogh's grid shows the links between K-manipulating processes and K-enabling processes and to what degree each K-enabling process affects the related K-manipulating process. The proposed model will assess the knowledge development cycle, where each K-thing can exist in different states that correspond to the states of the knowledge associated with B-things. The state transitions of a K-thing are caused by performing one or more K-manipulating process. Associated Continuous Improvement routines of individual, group or function will be used to foster solid and effective collaboration of K-enabling and K-manipulating processes for every cycle of the knowledge development cycle. Table 4.5 identifies the relationship between the functional domain elements and that of Knowledge Management development levels, and table 4.6 identifies the relationship between the functional domain elements and Continuous Improvement ability levels.

4.4.3 Knowledge Management Resources layer

This layer is dominated of enabling technologies under the seminal of ICT and specific tools that support K-manipulating and K-enabling processes of the functional layer at different organisational levels. The proposed model will encourage the terms of specialised and customised solutions for individuals and communities with the intention to enable communication and transfer of knowledge, to leverage the context sensitivity of knowledge (Abou-Zeid, 2002: 492). Through the assessment of Knowledge Management maturity level and the Continuous Improvement ability level of an organisation, resources would be able to be identified for each level attained in realising the knowledge objectives through the utilisation of knowledge resources. Table 4.5 identifies the relationship between the resources layer elements and that of Knowledge Management development levels, and Table 4.6 identifies the relationship between the resources layer elements and Continuous Improvement ability

levels. The purpose of the low -, medium – and high development of knowledge maturity and Continuous Improvement abilities as tabled below will be used during the link of the Knowledge Management maturity level and Continuous Improvement ability value for mapping purposes. The following section also explores the interaction and intensiveness of the different development levels for each of the three layers, as tabled below.

Table 4.5 Knowledge development and associated layer

	Knowledge Development	
First Layer: Cognitive Domain Layer	*High development*: - Knowledge Management procedures are an integral part of the organisational and individual processes. - Value of knowledge is reported to the stakeholders.	*Cognitive elements:* - Ownership attributes of a K-thing which involves the bearers or the sources of available or required knowledge used. - Value attribute of a K-thing as business value of actualised knowledge used. - Visibility attribute of a K-thing as list of individuals and collectives who can access the knowledge used.
	Medium development: - Organisation uses Knowledge Management procedures and tools. - Organisation recognises that Knowledge Management brings some benefits to the business.	*Cognitive elements:* - The mode of generation attribute of a K-thing by which the new knowledge is generated, i.e. acquisition, externalisation, discovery, synthesis and creation used. - Mode of mobilisation attribute of a K-thing in which the organisational knowledge, whether explicit or tacit, is preserved used.
	Low development: - Does not demonstrate relationship between importance of Knowledge Management and achievement of the organisational goals.	*Cognitive element:* - The actualisation attribute of a K-thing as a list of products, services or the processes in which the available or the required knowledge is/will be used.
Second Layer: Functional Layer	*High development:* - Knowledge collection tools capture feedback, best practices and lessons learned from resources on the front-line. - Knowledge is shared, reused, analysed and optimised. - Focus on inter-organisational co-operation and exploiting common ways of knowledge creation. - Knowledge Management forms the structural backbone for enterprise-wide innovation and employee self-actualisation.	*Functional elements:* - K-enabling process of globalising local knowledge by means of K-manipulating processes of K-mobilisation. - K-enabling process of creating the right context by means of K-manipulating processes of K-presentation. - K-enabling process of mobilising knowledge activities by means of K-manipulating process of K-evaluation. - K-enabling process of managing conversation by means of K-manipulating processes of K-generation.
	Medium development: - Focus on creating knowledge that is of interest to future business needs. - Broad-based approach to Knowledge Management, technology is secondary.	*Functional elements:* - K-enabling process of mobilising knowledge activities by means of K-manipulating processes of K-evaluation. - K-enabling process of managing conversation by means of K-manipulating processes of

	- Challenge is to understand future business needs and make forecasts on business environment	K-generation.
	<u>Low</u> development: Focus on internals (defining, scanning, codifying and distributing knowledge). - Knowledge Management still considered information management. - Challenge is to codify and deploy discovered knowledge. -	*Functional elements:* - K-enabling process of instilling knowledge vision by means of K-manipulating processes of K-identification. - K-enabling process of instilling knowledge vision by means of K-manipulating processes of K-generation.
Third Layer: Knowledge Management Resources Layer	*<u>High</u> development:* - Information is digitised and delivered from managers to staff via structured e-mail broadcasts and web portals. - Clear defined roles and deliverables. - Resources aware that they are accountable for achieving goals set by the management.	*Resource elements:* - K-externalisation mode (generation). - K-synthesis mode (generation). - K-maintenance mode. - K-mobilisation. - K-identification. - K-evaluation. - K-preservation.
	<u>Medium</u> development: - Measure retention of information delivered to staff via collection tools.	*Resource elements:* - K-identification. - K-evaluation.
	<u>Low</u> development: - Content publishing and management system in place.	*Resource elements:* - K-mobilisation.

Adopted from Pee *et al.*, 2000; Abou-Zeid, 2002

Table 4.6 Continuous Improvement ability and associated layer elements

	Continuous Improvement ability	
First Layer: Cognitive Domain Layer	*High level ability:* - Generating the ability to enable learning to take place and be captured at all levels. - The ability to strategically manage the development of Continuous Improvement. - The ability to move Continuous Improvement activity across organisational boundaries.	*Cognitive elements:* - People learn from their experiences, both positive and negative. - The organisation articulates and consolidates (captures and shares) the learning of individuals and groups. - Ongoing development of the Continuous Improvement system is supported by senior management, sufficient budget is allowed.
	Medium level ability: - Shared problem solving. - Ability to create consistency between Continuous Improvement values and organisational structures and procedures.	*Cognitive elements:* - People understand and share an holistic view of process understanding and ownership. - Continuous Improvement projects with outside agencies (customers, suppliers) are taking place. - Individual/group responsible for designing the Continuous Improvement system designs it to fit within the current structure and infrastructure.
	Low level ability: - Ability to articulate the basic values of Continuous Improvement.	*Cognitive element:* - People make use of some formal problem-finding and solving cycle.
Second Layer: Functional Layer	*High level ability:* - The ability to lead, direct and support the creation and sustaining of Continuous Improvement behaviours. - Ability to link Continuous Improvement activities to the strategic goals of the company.	*Functional elements:* - Managers support the Continuous Improvement process through allocation of time, money, space and other resources. - Individuals and groups assess their proposed changes against departmental or company objectives to ensure they are consistent with them
	Medium level ability: - The ability to generate sustained involvement in Continuous Improvement. - There is a formal commitment to building a system which will develop Continuous Improvement across the organisation	*Functional elements:* - People use appropriate tools and techniques to support Continuous Improvement. - People use measurement to shape the improvement process. - People initiate and carry through Continuous Improvement activities – they participate in the process.

		- Continuous Improvement activities are part of main business activities.
	Low level ability: - Continuous Improvement ability is ad hoc basis. - Continuous Improvement is not recognised as a formal process.	*Functional elements:* - At problem solving level people seek to find a solution based on why the problem occurs rather than blaming someone else. - Problems are solved randomly.
Third Layer: Knowledge Management Resources Layer	*High level ability:* - Extensive and widely distributed learning behaviour. - Systematic finding and solving problems and capturing and sharing of learning. - Learning organisation model and embedded structure.	*Resource elements:* - Designated individuals use organisational mechanisms to deploy the learning that is captured across the organisation. - People and teams ensure that their learning is captured by making use of mechanisms provided for doing so. - Individuals seek out opportunities for learning/personal development.
	Medium level ability: - Commitment to linking Continuous Improvement behaviour established at local level, to the wider strategic concerns of the organisation.	*Resource elements:* - Focus includes cross-boundary and even cross-enterprise problem-solving. - Ideas are responded to in a clearly defined and timely fashion – either implemented or dealt with. - Individuals and groups monitor/measure the results of their improvement activity and the impact it has on strategic and departmental objectives.
	Low level ability: - Pre-Continuous Improvement interest in the concept has been triggered. - Implementation of Continuous Improvement initiatives are on an ad hoc basis.	*Resource elements:* - People at all levels demonstrate a shared belief in the value of small steps and that everyone can contribute, by themselves being actively involved in making and recognising incremental improvement. - People make use of some formal problem-finding and solving cycle. - Solutions tend to realise short-term benefits.

Adopted from Bessant *et al.,* 2001; Abou-Zeid, 2002

4.5 Proposed model's knowledge process grid

The proposed knowledge process grid presents a staged representation for a more comprehensive overview of Knowledge Management development towards Operational Excellence, due to the inherent complexity of Knowledge Management and because it is more difficult to build from a continuous structure only. Klimko (2001: 269) suggests that such a staged representation is better established and simpler to use, for Knowledge Management development purposes. The proposed knowledge grid suggests that the conditions for attaining each level of Knowledge Management maturity and Continuous Improvement ability levels may evolve for all unified processes of three layers described in the previous section. An important aspect of the knowledge-based theory of an organisation is that competitive advantage resides in the application of knowledge rather than in the knowledge itself (Bontis, 2002; Grant, 1996). In this sense, the ultimate aim of the proposed model is the direct and instrumental use of knowledge to improve Operational Excellence. The proposed model's knowledge grid will facilitate this by means of the application of Knowledge Management practices and Continuous Improvement principles more like moving targets to encourage Continuous Improvement and excellence rather than a definite end by themselves.

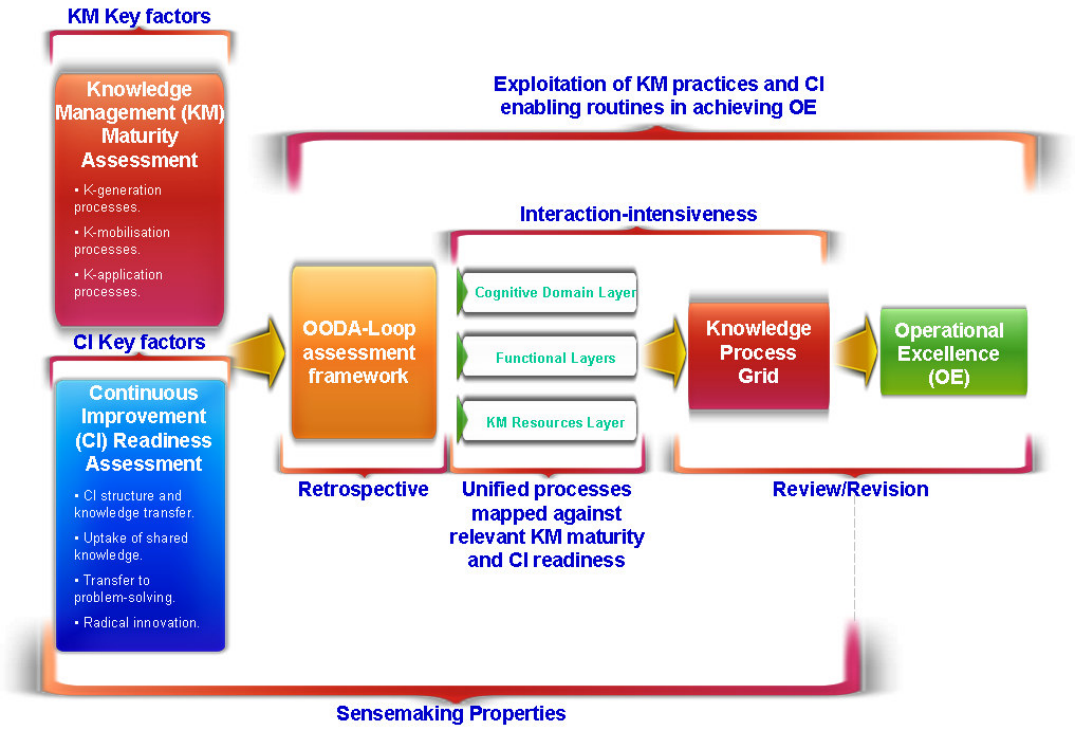


Figure 4.1 The properties and assessment capabilities of the proposed model
Self-constructed

The model shown in Figure 4.1 illustrates the idea behind an integrated Knowledge Management and Continuous Improvement assessment. The ability to simultaneously engage in both sense making and retrospective activities is made possible in the existence of ambidextrous review, revision and properly aligned unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer. The identification of appropriate organisational routines, which are normally deeply embedded within groups of individuals and supported contributions of other resources, will be identified by the proposed model. This will contribute to better control of those routines by management of an organisation, to apply the routines most effectively towards Operational Excellence (Grant, 1996: 375). The proposed knowledge process grid supports the view that to sustain continuous growth, organisations need to

progress step-by-step to attain higher levels of knowledge maturity and Continuous Improvement levels. This can be achieved by systematically addressing the appropriate elements for both the knowledge development and improvement abilities for the unified processes across the three layers, as described in the above and tabled in Table 4.5 and Table 4.6.

The proposed model acknowledges that disturbances in any of the three layers would result in a change in Knowledge Management maturity and Continuous Improvement levels, but that the impact might differ among the different levels of low -, medium – and high development of both Knowledge Management maturity assessment framework, as portrayed in Table 4.5 and Table 4.6. The proposed knowledge process grid creates an understanding of how knowledge works through enabled routines of improvement throughout an organisation therefore allows you to reap the highest rewards from Operational Excellence: the ability to adapt successfully through constant reinvention and optimisation, to innovate and to react to the latest trend earlier and more decisively than others.

4.6 Summary

This chapter presented the concept of a meta-model for business models with the appropriateness of the three strands for the construct of the proposed model. This followed an in-depth analysis of the three layers of the reference Knowledge Management system, which will be used for the identification of development elements for both Knowledge Management maturity and Continuous Improvement ability levels. This analysis indicated the associated Knowledge Management practices and Continuous Improvement principles towards creating Operational Excellence. This chapter also concentrated on the concept of unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer that will be utilised in the creation of Operational

Excellence. The chapter further concluded with an illustrated view of the properties and assessment capabilities of the proposed model, with output towards a knowledge process grid to encourage the user to move to the next level of Knowledge Management maturity and Continuous Improvement ability levels for delivering Operational Excellence.

The next chapter will look into the research approach, methodology and instrument that will be used to obtain feedback from the participants. It will also present the design to the research and shall discuss threats to validity.

Chapter 5 – Research Design and Data Collection strategy

This chapter describes the methodology used for this research, the development of the survey instrument and the administration of the survey. The analysis of the data collected for this study describes what conditions existed for the participants with regard to their use of Knowledge Management and Continuous Improvement variables. A description of the selected analytic process used to examine the quantitative data collected from a theoretical basis for both the scientific approach, as well as a philosophical studying instrument perspective is provided. This will lead to the next chapter where the qualitative analysis from the survey will be presented to support the answers to the research questions and hypotheses of the study. To support answers to the research questions the following areas will be discussed in this chapter. Firstly, a preliminary discussion regarding data collection strategies and the depicted methodology aspects towards effective data collection. Secondly, data collection instruments and theoretical basis for the questionnaire design. Finally, the preferred questionnaire and data collection methodology for this study, with the subsidiary research questions will be presented. This chapter will also provide a conclusion and prelude to the qualitative analysis provided in the following chapter.

5.1 Research design

Although research is central to both business and academic activities, there is no consensus in the literature on how it should be defined. One reason for this is that research means different things to different people (Hussey & Hussey, 1997: 1). According to the Britannica online Encyclopaedia research means the "investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical

application of such new or revised theories or laws". However from many different definitions offered, there appears to be agreement that research is a process of enquiry and investigation, it is systematic and methodical and research increases knowledge (Hussey & Hussey, 1997: 2). The choice of a research design is directly managed and influenced by several factors. These include, among the central ones, the research problem and purpose the research setting and unit of analysis. Furthermore, it is important that the selected research design must guarantee that the facts and data to be collected are significant to the questions of the study, and that the approach to be followed covers competing concerns of the respective study.

There has been a wide-ranging contest among researchers, on the relative value of qualitative and quantitative inquiry (Patton, 1990: 483). A qualitative variable is a non-numerical attribute of an individual or object. Qualitative research or phenomenological inquest uses a naturalistic approach that seeks to recognise phenomena in context-specific settings (Hussey & Hussey, 1997: 184). Qualitative research, generally defined, means "any kind of research that produces findings not arrived at by means of statistical procedures or other means of quantification" (Strauss & Corbin, 1990: 17). The use of either qualitative or quantitative measures on a study should account for the respective strengths and limitations with respect to the nature of the study in question. It is claimed that one particular method might be more suitable in a particular field of investigation than the other. Quantitative approaches are claimed to be unsuitable for research in social sciences, and qualitative approaches are predestined for lack of rigor, questionable validity and reliability (Armstrong, 1999: 18). Armstrong asserts that the grounds behind such criticism can be attributed to data collection methods supposed to be loaded with bias and further subjectivity rather than objectivity.

From the traditional, positivist paradigm of the natural sciences can be drawn upon to achieve criteria such as objectivity, testability and replicability. Kaplan

and Maxwell (1994: 46) argue that the endeavour of understanding a phenomenon from the point of view of the participants and its particular social and institutional context is largely lost when textual data are quantified. The researcher can therefore have a reasonable degree of confidence in the findings, and can build upon them as 'true' knowledge. However, it can be argued that if the Knowledge Management field is to address the real-world and the problems that are typical of human organisations and their application of knowledge, the use of interpretivist and both qualitative of nature is an imperative (Remenyi & Williams, 1996: 131).

Positivists normally relate objective methods, where physics can be represented as ‘state of the art’, in example the norm of how science should be practiced. To do this, Arvidsson and Rosengren (1992: 3) argue that characteristic factors for positivism should be fulfilled and contented, namely:

- Quantification of results to support research
- Formalisation of fundamental concepts and theories
- Use of objective techniques and methods
- Empirical observations to determine the validity of the theory

Two main research philosophies or research paradigms exist, although considerable overlapping of these paradigms occurs. The corresponding paradigms are labelled ‘positivist’ and ‘phenomenological’ (Collis & Hussey, 2003: 47). The positivistic paradigms involve numerous attitudes about how researchers conclude meaningful wisdom to others. This paradigm is supported on the assumption that nobody is perfect and that all individual beings are imperfect. Realism is the central thought of this paradigm: it searches for truths in the research environment, particularly for this study the perceptions and different opinions of respondents about the impact of Knowledge Management maturity and Continuous Improvement on Operational Excellence.

To find general ideas about Knowledge Management and continuous improve use in an organisation that could result in a theory from which a deductive reasoning can be made, a more inductive approach was pursued. An inductive approach was also selected because a theoretical base already exists for both the study field of Knowledge Management and Continuous Improvement and enriched from an empirical approach, for which the theory could be hypotheses on to see if they were satisfying according to reality. The weakness with induction is that the idea is to generate general conclusions from a specific case, and this causes a lessening of the underlying structure. Only a superficial mechanical linkage is obtained (Alvesson & Sköldberg, 1993: 284). Hermeneutics, on the other hand, value the general ability to interpret. This can be depicted as the ability to reach a deeper knowledge of the investigated problem in order to describe the problem as a whole. Hermeneutics put a user's own interpretation and perception of reality in the spotlight.

Following from the above and the purpose of this study in question in Chapter 1, and given the nature of the problem definition of this research, the positivistic-oriented approach seems most appropriate to test the perceptions and opinions of respondents on the areas of Knowledge Management and Continuous Improvement for the process level, leadership and culture level and support systems level of an organisation. A positivistic-oriented approach is relevant to the purpose of the creation of how Knowledge Management maturity and Continuous Improvement routines, focusing on Operational Excellence can be implemented in a sustainable way in an organisation since it represents clearly explained knowledge that assumes that the reality is objective. Recognition of the underlying truths therefore resides in either seeing that a statement makes sense by itself and is reliable with assumptions made from such, or by recognising that it is sustained by empirical confirmation (Jankowicz, 2005: 110). The positivistic

paradigm originated from the conviction that human behavioural studies should be carried out in a similar way to studies in the natural sciences. This conviction is built on the assumption that social reality is autonomous of the research objectives and exists despite the consequence of whether the researcher is aware of it. The ontological debate around 'what is reality?' can be reserved separate from the epistemological question of 'how do we obtain knowledge of that reality?' In applying a positivistic research methodology, the act of examining reality has no outcome on the reality itself (Blumberg, Cooper & Schindler, 2005: 18-19; Collis & Hussey, 2003: 52). The overall research design for this study underpins the scientific inquiry of the phenomena investigated and is discussed in the following section.

5.2 Theoretical bases

A scientific inquiry must be headed and conducted by a suitable scientific method or advance for inquiry. The concept for a scientific method can be complicated and perplexing. Science can have many altering meanings depending on the viewpoint from which the observer is trying to describe it. The following is a set of definitions of science most suitable and relevant in explanation for the kind of scientific approach assumed in this research – a description of science by purpose and process.

5.2.1 The systematic observation of natural events and conditions in order to determine facts about them and to prepare laws and principles based on these facts. The organised body of knowledge that is imitative from such observations and that can be established or tested by further investigation (Morris, 1992: 253).

5.2.2 Science is a rational action passed on by humans that is intended to discover information about the natural world in which humans live and the

traditions in which this information can be organised into meaningful patterns. Science engages more than the attainment of knowledge. Science is concerning a deeper and often functional understanding of the world. It tends to be a methodical and prearranged inquiry into the natural world and its phenomena. A primary endeavour of science is to gather evidence in the form of data (Ziman, 1984: 4).

Involving the above definitions to the research work, the following pattern can be recognised and will be used as framework for the research setup. The research setup will systematically view a phenomenon in a single case study. Some facts will be discovered about the phenomenon. The facts will be organised into a meaningful guide, and can be considered as observing Knowledge Management events and Continuous Improvement activities in a specified organisational environment to discover associations towards Operational Excellence. Analyse the affect of these associations with each other, and organise the facts into a meaningful form towards concluding findings.

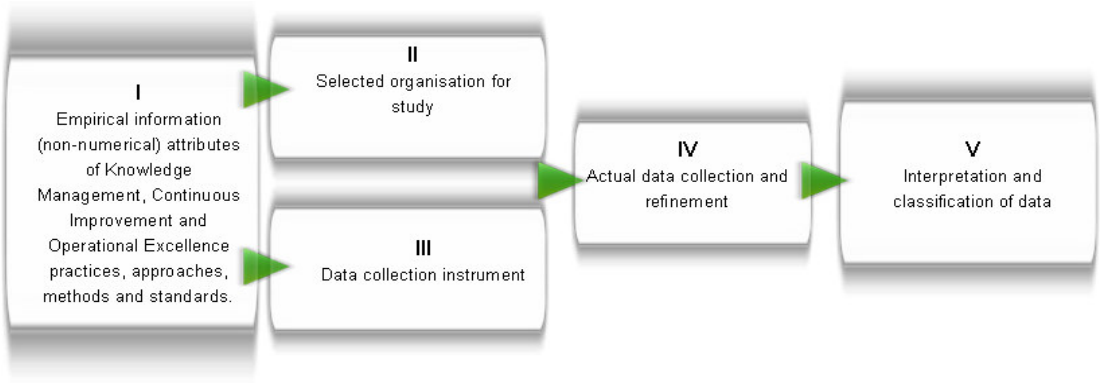


Figure 5.1 Research setup

Self-constructed

Concerning the above definitions and conclusions drawn from the theoretical bases towards the applicability to this study, a five-stage approach will be

followed as portrayed in Figure 5.1. The following subsections of this chapter provide the detail for each of the separate stages as portrayed in Figure 5.1.

Stage I empirical information (non-numerical) – Pragmatic qualitative data collection in the form of literature review of three core disciplines namely Knowledge Management, Continuous Improvement and Operational Excellence and their specialisation with several findings of ideals and concerns within organisations. The empirical information was selected with the aim of achieving data based on experience use of Knowledge Management and Continuous Improvement and observation on the impact and influence Knowledge Management and Continuous Improvement might have towards Operational Excellence.

Stage II select organisation - The research setup will systematically view a phenomenon in a single case study. The choice of PriceWaterHouseCoopers was based on the fact that good progress in the area of Knowledge Management was already achieved by them and that the next steps in maturing Knowledge Management practices might be the next stage towards excellence. PriceWaterHouseCoopers is also involved in the Knowledge Management Practitioners Group (KMPG) of the Western Cape, and participation by means of facilitating knowledge sharing events and providing expertise to sessions undertaken. PriceWaterHouseCoopers also involved many levels of knowledge workers, and possesses the characteristics of a learning organisation. These characteristics underpin Senge's (1990: 3) definitions of a learning organisation namely where new and expansive patterns of thinking are nurtured, where collective aspiration is set free and where people are continually learning to see the whole together. Additionally PriceWaterHouseCoopers has a global footprint, which allows for some interesting assessment based on regional feedback and link to the overall objective of this research.

Stratified sampling method will be applied, with the stratums consisting of the respective staff grades for partner/director, senior manager, manager, senior consultant/assistant manager or consultant. The stratums were selected based on the characteristics of a stratum namely that the population of the stratum share at least one common characteristic. The stratified sampling overcome under-representation or over-representation, as each identifiable strata of the population is taken into account (Walliman, 2005: 277).

Stage III data collection instrument - The questionnaire comprised rating, nominal and ordinal scale statements where respondents will be required to use ranking for some statements as contained in the set questionnaire. Linked to a six-point Likert-type rating scale and grouped under three levels, namely, process level leadership and culture level and support system level that followed statements that are used to permit the respondent to express associated opinions on a particular task or function of Knowledge Management and Continuous Improvement, as levers towards achieving Operational Excellence.

Stage IV actual data collection and refinement – As described earlier, the methodology referred to the entire process of the research, this stage is concern with the collection of original data to supplement the secondary data you have collected. A suitable sample and identification of variables for data collection purpose will be examined. The measurement scale for recoding and describing the quantitative data will be decided upon.

Stage V interpretation and classification of data - This stage amounted to interpretations and classification of the collected data and highlighting a way forward given the observations made with regard to Knowledge Management practices and Continuous Improvement principles within the framework of the meta-model of business models, discussed in Chapter 4. The output of this combination against the setting of previous chapters, is presented in Chapter 6 and is meant to address the fundamental elements of the proposed model in

accordance with the influencing factors of both Knowledge Management maturity and Continuous Improvement ability on three layers of an organisation, namely the cognitive domain layer, functional domain layer and the Knowledge Management resources layer.

5.3 Research strategies and methodological aspects

When conducting a research project, the researcher is in need of a strategy for how to conduct such study. The choice of research strategy depends on what kind of questions are to be answered and on the problem to be solved.

According to Yin (1994: 27), there are five different research strategies:

- Experiment
- Survey
- Archival analysis
- History
- Case study

If the research questions are “how”- or “why” based, it is likely to lead to the use of case studies. Since the main problem is “how” – based on the main theme around ‘How does Knowledge Management maturity and Continuous Improvement ability impact Operational Excellence?’, a case study was suitable for this research. A case study is also a relevant research strategy when a phenomenon can be studied in a real life situation, as is the case for this research requirement (Yin, 1994: 35). A case study gives a deeper understanding and a more holistic view of the studied research problem, which the researcher aims to achieve. In order to solve the problem, the researcher will need to go intensely into an organisation’s Knowledge Management maturity and Continuous Improvement routines: consequently, a case study is needed.

Research methods underpin the appropriate research strategy and are designed to assist researchers to understand people and the social and cultural backgrounds within which they exist. It is further envisaged to have such an understanding, which will not only facilitate the explanation of the phenomenon of interest for Knowledge Management maturity and Continuous Improvement ability in the environment under study, but also to calculate and direct it.

The research strategy adopted a qualitative approach (Patton, 1990: 423) at first, using a naturalistic inquiry method towards qualitative data collection in the form of literature review of three core disciplines namely Knowledge Management, Continuous Improvement and Operational Excellence, and their specialisation with several findings of ideals and concerns within organisations. Revising issues informing this work, was drawn from the above-mentioned literature. Critical reviews and analyses were drawn from the literature as a starting point to highlight the collective concerns of Knowledge Management and Continuous Improvement pertaining to Operational Excellence. The literature review spanned the body of journals, abstracts, relevant book sections and references from articles across the works of knowledge engineering, organisational learning, and social construct for both the technical and evolutionary dimensions of both Knowledge Management and Continuous Improvement creation. International and national data searches were done for both Knowledge Management principles and Continuous Improvement practices through the Nelson Mandela Metropolitan University databases portal for: Sabinet, Emerald, Kovsidex, SEALS and the Britannica Online Encyclopaedia.

Kruger (2003: 18) demonstrates that “quantitative methods allow us to summarize vast sources of information and facilitate comparisons across categories and over time”. However the research is frequently conceded in an unnatural, artificial environment so that a level of management can be applied to the effect. This level of control might not normally be in place in the real world yielding laboratory results as opposed to real world results. In addition

predetermined answers will not inevitably replicate how people in reality feel about a subject and in some cases might just be the closest contest. There are several important reasons why a quantitative approach could be of interest, specifically for this research. The potential for presenting figures connected to the research area; in this study it would concern figures that describe the results of Knowledge Management development process application, at different geographical locations towards achieving Operational Excellence and utilising available organisational routines of improvement in support of Knowledge Management practices. Additionally the ability to measure in numbers and in terms of the current application and results for effective Knowledge Management practices and Continuous Improvement principles in order to achieve Operational Excellence. Quantitative methods only deal with issues acknowledged at the beginning of the research, in this case variables that might influence Knowledge Management maturity and Continuous Improvement routines in an organisation, as this is when the questions are decided and documented (McCullough, 1997). The questions can also be 'quite complex and require considerable investment for proper understanding and use' (Kruger, 2003: 19). Kruger also cautioned that individuals could 'tune out elaborate statistics, creating difficulties in the utilisation of the products of research'. Furthermore Amaratunga, Baldry and Newton (2002: 17) state that 'there is a strong suggestion within the research community that research, both quantitative and qualitative, is best thought of as complementary and should therefore be mixed in research of many kinds'.

It seems that the reasons as discussed above, for a quantitative and a qualitative approach are both strong and supportive of the purpose and research questions of this study. The researcher’s choice is therefore to combine these two, even if qualitative parts predominate. Due to the complexity of the subjects of Knowledge Management and Continuous Improvement, the researcher will also apply triangulation. According to Collis and Hussey (2003: 78), the use of different research approaches, methods and associated techniques in the same study is known as triangulation. Triangulation is hence applied to overcome the

potential bias and sterility of a single-method approach, a possibility the researcher expected to avoid for this study. In support of triangulation, this study will apply a quantitative research method to collect data, which can be analysed in numerical form. A set questionnaire will be used where respondents can provide feedback by means of a Likert scale selection for set statements. Answers can then be coded and statistical analysis used to give respondents in the form of averages, ratios and ranges (Gosling & Edwards, 1995: 16).

5.4 Data collection instruments

An on-line Internet based questionnaire was designed and directed to collect data, in the form of self-assessment framework. Advantages of self-assessments through questionnaires are their perceptible simplicity, versatility and low cost as a method of data gathering (Shaughnessy & Zechmeister, 1997: 321). On-line Internet based survey and assessments also create an environment where participants can feel truly part of the research, as respondents are more reluctant to participate and willing to express their opinions more unreservedly. According to Neuman (1997: 23), a questionnaire is an instrument used to measure variables. Wellman and Kruger (1999: 74) are of the opinion that quality questionnaire design determines the quality of responses. In order to ensure quality responses the questionnaire used for this study focused on the key dimensions of this study as stated in the objectives.

The questionnaire comprises rating scale statements where respondents will be required to use ranking. The questionnaire included three kinds of questions. The first type is phrased in descriptive statements; respondents answered using a six-point Likert-type agreement scale (1 = strongly disagree, 6 = strongly agree). The second type is multiple-choice questions; respondents can choose one or more applicable answers. The questions will be grouped under three categories namely, development and culture, process and support system. Each of these

categories will present statements that are used to permit the respondent to express associated opinions on a particular application or function of Knowledge Management and Continuous Improvement relevant to the workspace of the respondent. The statements as articulated in the set questionnaire deal with perceptions of expectations and actual tasks linked to Knowledge Management maturity and Continuous Improvement routines within an organisation, evaluating the degree to which it is used to create Operational Excellence.

The structure of the questionnaire is firstly development statements, followed by process statements and finally support system statements plus contextual questions. Development and process questions were put at the beginning to reflect the logic of the theoretical structure for this study; moreover, because respondents are more familiar with the situation of activities towards knowledge development and associated processes of improvement within their workspace, they only need to choose the appropriate scale according to the real situation. Including easy questions at the beginning is very important to make respondents comfortable and cooperative with the study. Business processes of Knowledge Management and Continuous Improvement at the support system level and the overall organisational level are relatively complicated since respondents need to recall the current situation of such support system within their workspace; therefore these questions were left for the last group. All first three parts used the six-point Likert-type agreement scale questions, meaning respondents did not need to shift their understanding of the requirements to answer these questions. For additional contextual questions, multiple-choices questions were used.

The interval and scaled questionnaire will enable the researcher to perform the statistical data analysis as discussed in the previous section (Cooper & Schindler, 2003: 227; Hussey & Hussey, 1997: 163). A pilot with a small number of skilled and specialised professionals will be used to pilot the questionnaire prior to publication on the Internet to the respondents. The pilot will also include people that are similar of background to those of the research sample. This will

allow for any changes to be made to the questionnaire in order to encourage the necessary steps required to ensure the reliability, validity and generalisability of the research (Cooper & Schindler, 2003: 231; Collis & Hussey, 2003: 59; Hussey & Hussey, 1997: 163). When conducting the survey, a cover section explaining the purpose of the study and instructions on how to access and use the on-line Internet link will be e-mailed to respondents.

5.5 Data collection and refinement

Chalmers (1999: 120) noted that if logical knowledge is to be understood as being derived from the truth, then “derive” must be understood in an inductive rather than a deductive sense An essential ability in this consideration is to be able to distinguish the characteristics of a good inductive argument from the observable facts; as it is clear that not all generalisations are justified. Insufficient evidence may lead to false endings or opinions. For this reason the researcher has selected a data collection instrument that is designed to capture information supporting the processes of the development cycle for Knowledge Management and the possible corresponding Continuous Improvement activities and support systems towards enabled routines in the creation of Operational Excellence. The Knowledge Management process and Continuous Improvement activities were examined upon at different levels as explained earlier within an organisation and where applicable Knowledge Management processes and Continuous Improvement activities were harmonised, against the three organisational areas as captured in the questionnaire. The use of computer aided software called Statistical Package for the Social Sciences (SPSS version 16.0) will be applied to examine the missing value analysis (MVA), descriptive statistics and exploratory analysis (EFA) towards concluding the descriptive statistics for this study.

5.6 Descriptive statistics

Descriptive statistics are ways of representing important aspects given the observations made with regard to Knowledge Management maturity and Continuous Improvement ability in previous chapters, for the aspects associated with the social-technical side of the research methodology. The two aspects most commonly dealt with in this way are the level of the distribution and its spread or dispersion (Robson, 2002: 271). Statistics summarising the level of the distribution are known as measures of central tendency (i.e., mean); those summarising the spread of the distribution are called measures of variability (i.e., range, variance, standard deviation). Estimated standard deviation indicates the level of agreement among the respondents when they have answered a particular question or statement. When using a seven-point scale, if the estimated standard deviation is smaller than 1.0, this implies that the respondents were quite consistent in their opinions. If the deviation is larger than 3.0 it will signify that significant variability exists in their opinions.

In addition, the skewness and kurtosis of the distribution are also summarised within descriptive statistics, which are considered less than the context of the normal distribution (Robson, 2002: 335). Multivariate normal distributions for indicator variables are considered a fundamental assumption for many multivariate techniques used in structured equation modelling. Whilst a distribution is symmetrical, the skewness of that distribution is zero. With a positive skew, when stretching to the right side a positive number will be observed. And with a negative skew, when stretching to the left side a negative number will be observed. The larger the absolute number is, the larger the skewness is. Skewness values larger than +1 or smaller than -1 indicate a considerably skewed distribution. Meanwhile, for a standard normal distribution, the kurtosis is zero. A large positive number implies that the distribution is excessively pointed, while a large negative number means the distribution is excessively level. Kurtosis values larger than +3 or smaller than -3 are considered problematic (Hair, Money, Samouel & Page, 2007:109). The output of

the descriptive statistics for this study will be subject to further interpretation leading to Chapter 7, the final chapter of this study. The final interpretation and conclusion are intended to deal with the primary impact and influence of Knowledge Management maturity and Continuous Improvement routines of an organisation relevant to the objective for this study, that of achieving Operational Excellence.

5.7 Conceptual model for assessing the impact of Knowledge Management and Continuous Improvement on Operational Excellence

The identification and development of reliable measures of each theoretical construct were based on key factors for Knowledge Management and Continuous Improvement as described in section 3.5 of this study, and the influence on Operational Excellence. Extensive review of academic articles (namely Davenport & Prusak, 1998; De Lange-Ros, 1999; Nelson & Winter, 1982; Schein, 1984; Teece, 2000; Zack, 1999) informed the development of the associated knowledge construct items as well as the associated Continuous Improvement construct items as portrayed in Table 5.1. While the development of the associated Operational Excellence construct items were borrowed from an existing operational framework and scale of Binney (2001: 33). Table 5.1 lists all the items used to measure constructs in the proposed model for assessing the impact of Knowledge Management and Continuous Improvement on Operational Excellence.

Table 5.1 Constructs and items of the conceptual model for assessing the impact of Knowledge Management and Continuous Improvement on Operational Excellence

Constructs	Items
Knowledge generation (kgen)	**kgen1:** The organisation works on its skill for generating, acquiring and applying knowledge that may be used as a potential revenue-generating asset. **kgen2:** Knowledge is generated as a source for organisational power, and the generated knowledge is stored on an IT system. **kgen3:** A general understanding of the concepts of Knowledge Management exists in the organisation. **kgen4:** Resources are allocated to increase the organisation's knowledge.
Knowledge mobilisation (kmob)	**kmob1:** The sharing of knowledge in teams is encouraged by all members of the organisation. **kmob2:** The organisation hones its skill towards the mobilisation of knowledge in support of the organisation's strategy. **kmob3:** Knowledge is shared across teams with the organisation being competent to apply matured knowledge towards creating excellence. **kmob4:** Formal networks exist in the organisation to disseminate knowledge across teams.
Knowledge enabling processes (kenad)	**kenab1:** Individuals that share knowledge are recognised and work teams encourage the sharing of knowledge by other team members. **kenab2:** Formal processes are used to capture knowledge as part of lessons learned and learning, and this knowledge is retained and applied across the organisation. **kenab3:** Key customer knowledge assets are identified, preserved and maintained. **kenab4:** Clear ownership of Knowledge Management initiatives. **kenab5:** Easy access to knowledge required to enable work functions and a routine of sharing knowledge exists in the organisation.
Knowledge application (kapp)	**kapp1:** People have a general understanding of Knowledge Management and the associated concepts and are trusted to apply their knowledge in support of the organisation strategy. **kapp2:** Knowledge is applied and experience shared to bring fresh insight to clients with individuals that re-use knowledge are recognised.
Continuous Improvement routines (cirout)	**cirout1:** Routines are present that support development of knowledge.
Stages of Continuous Improvement evolution (stageci)	**stageci1:** Practical guidelines are made available to advance routines of improvement. **stageci2:** Employees are looking at various routines for

	problem solving. **stageci3:** Knowledge and experience are used to promote improvement in operational services by means of methods and principles that encourage collaborative work and discussions.
Continuous Improvement characteristics (cichar)	**cichar1:** Formal ways and processes exist to increase learning and improvement and time is allowed to participate in continuous capability improvement activities. **cichar2:** Routines are embedded in the culture of the organisation that is focused on improvement by means of established improvement principles. **cichar3:** The organisation is occupied with improvement practices with resources adequately provided their capabilities for both an individual and at workgroup level.
Knowledge Management (knowman)	**knowman1:** Knowledge is seen as a potential revenue-generating asset towards Operational Excellence and is measured and resources are allocated to increase the effort of Knowledge Management development. **knowman2:** Training and development for Knowledge Management development are undertaken. **knowman3:** Explicit knowledge is gathered as part of post completion reporting by employees. **knowman4:** The organisation is able to apply matured knowledge within the organisation to create excellence. **knowman5:** Future knowledge requirements are systematically assessed. **knowman6:** Knowledge Management initiatives have defined responsibilities and funding. **knowman7:** Procedural knowledge is available within a supportive environment (support system).
Continuous Improvement (contimpr)	**contimpr1:** Organisational problem solving is developed by means of Continuous Improvement practices. **contimpr2:** Continuous Improvement is used to generate new knowledge within the context of the organisation. **contimpr3:** Individuals improve the potential of their personal work process on continuous bases. **contimpr4:** Access by entire organisation to institutional memory towards creating improvement that is continuous **contimpr5:** Continuous Improvement behaviours are built on by the organisation.
Operational Excellence (operexcel)	**operexcel1:** Knowledge is documented for post-delivery of activities as lessons learned for future Operational Excellence and practical guidelines are used to foster improvement of operational activities. **operexcel2:** Technology enables linkage of organisational resources towards achieving Operational Excellence. **operexcel3:** Future operational plans include knowledge requirements and the organisation executes this plan systematically. **operexcel4:** Systems are available to provide the right information to the right people at the right time.

Based on the above discussion, the following conceptual model for assessing the impact of Knowledge Management and Continuous Improvement on Operational Excellence is proposed, in Figure 5.2.

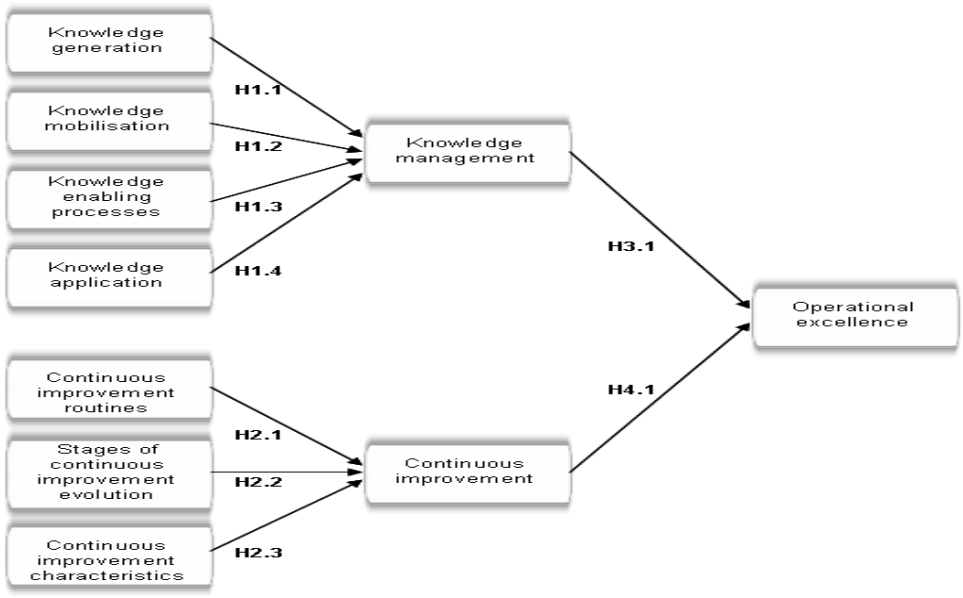


Figure 5.2 Conceptual models for hypotheses testing

Self-constructed

Figure 5.2 additionally indicates the relationships between the construct areas and the hypotheses and evidence of the study. The first group of hypotheses relates to Knowledge Management activities for the generation, mobilisation, application and enabling processes required to influence the impact of Knowledge Management on Operational Excellence. These hypotheses are discussed in the next section to follow, with clear indication of such in Figure 5.2.

H1.1: Knowledge generation is positively associated with Knowledge Management interventions within the organisation towards mature knowledge development.

The local deployment of knowledge is inextricably set within a process of rediscovery and linked to the knowledge generation process, which is concerned with the development of networks within the organisation that will build on the concept of reflecting practices in achieving collaborative knowledge experiences (Bate & Robert, 2002: 643).

H1.2: Knowledge mobilisation processes share by design an interactive dialogue and engagement between the producers and users of the knowledge and is directly involved in the development of Knowledge Management practices towards achieving mature knowledge across all areas of operations of an organisation.

It is by interaction that knowledge is enacted and mobilised in an organisation's Knowledge Management practices, be it explicit or tacit and individual or collective – it can hold its relation to actual social reality, not separated from it as presented by Winograd and Flores (1986: 389). The knowledge mobilisation process therefore needs to be up-to-date with knowledge and to be mobilised through current Knowledge Management practices of an organisation. It is for this reason that the hypothesis directs Knowledge Management practices unconditional to the creation of the appropriate level of maturity for Knowledge Management to influence Operational Excellence positively for the purpose of knowledge mobilisation.

H1.3: Knowledge enabling processes are positively associated with the actions required to transfer casual knowledge for improved Knowledge Management practices.

Seeley (2002: 12) maintains that useful Knowledge Management arrives from involving knowledge actions to processes that produce value. Successful processes will also tie casual tacit knowledge into these actions and will be built within an organisational context and culture that supports these actions or activities (Marchand, Kettinger & Rollins, 2000: 69). Simply capturing, storing and transferring knowledge does not routinely lead to organisational performance improvement (Swan, 2003: 271). Successful processes really are knowledge facilitated (Smith & McKeen, 2004: 25); however to date this is not well developed in organisations. An understanding of the context may also improve the process outcomes and execution (El Sawy & Josefek, 2003: 425) and may clarify the issues adjoining problems and doubts in the process.

H1.4: Knowledge application is associated with matured Knowledge Management practices.

As stated earlier local deployment of knowledge is inextricably set within a process of rediscovery, where successful acts of knowledge integration, data processing and information diffusion contributes to matured Knowledge Management of an organisation.

H2.1: Routines are available through which employees can simplify production processes or improved customer services through greater empowered employees, towards a total integrated effort for improving performance at every level of the organisation.

Nelson and Winter (1982: 14) urbanised the basic notion of a routine, defined as 'all regular and predictable behaviour patterns'. These routines cover activities that range from well-specified technical routines for producing things, through procedures for hiring and firing, ordering new inventory, or stepping up production of items in high demand, to policies regarding investment, research and development, or advertising, and business strategies about product diversification and overseas investment.

H2.2: Stages of Continuous Improvement evolution are positively associated with an organisation's ability to improve over time.

Understanding of the ability of an organisation towards improvement over time can be achieved by exploring how Continuous Improvement evolves as companies gain experience. Testing the ability of an organisation to move towards Continuous Improvement is derived from the first objective of improvement namely how experience with Continuous Improvement relates to the context, practices and outcomes of improvement development for an organisation. Secondly it is derived from what can be learned about the path of evolution towards Continuous Improvement (Gertsen, 2001: 303).

H2.3: Continuous Improvement characteristics should be mature of nature and support an effective set of improvement principles focused on team work and discovery towards individual co-operation.

A change in management style would best facilitate the approach required to satisfy the characteristics required for effective Continuous Improvement that is required to be present within the organisation. This approach is best described by Tushman and Anderson (1986: 439) as the Goldilocks principle, where some restrictions in resources is necessary for creativity – not too little and not too much for providing support at a high level towards creating Continuous Improvement characteristics in building lasting improvement.

H3.1: That Knowledge Management is positively connected towards Operational Excellence.

H4.1: That Continuous Improvement is positively associated with Operational Excellence.

Both H3.1 and H4.1 indicates a positive relationship between knowledge production and knowledge utilisation with respect to the learning objectives of improvement towards Operational Excellence. With the analogy of this relationship on the development, expansion, protection and renewal of knowledge and then swiftly making such available to market in a stream of rapidly and continually improved products and services which may lend itself to Operational Excellence (Stewart, 1997: 105).

5.8 Summary

In this chapter, discussion and justification for the research methodology to be used to examine problem has been addressed. The discussion has involved good judgment of research methods upon the important scientific considerations to be aware of and articulate the technique or approaches this study will follow to carry out the research. In addition, units of analyses and data sources as well as research steps involved in the research process were presented and discussed. Thus, the discussion covered in this chapter, as outlined here has attempted to provide assertion that suitable measures will be pursued to arrive at the conclusions that the research will present in its findings. This was based on other literature within the theoretical framework and used to conduct the development of the hypotheses and a model based on these hypotheses. The next chapter will aim at explaining the observed situation as presented in the data collected from the correspondents by means of the set questionnaire. Final conclusions and

possible future research will be discussed with the focus on the hypotheses for this study

Chapter 6 – Results and analysis of the survey

In this chapter, survey results concerning the impact of the Knowledge Management and Continuous Improvement on Operational Excellence within PriceWaterHouseCoopers are presented and discussed. The survey instrument was designed to collect data to assist with describing what the perceived level of understanding is under participants of the on-line survey in respect to Knowledge Management and Continuous Improvement across the development and culture, process and support system categories in order to gain an understanding of the particular components to address the hypotheses of this study. The previous chapter described how the combination of qualitative and quantitative research methods, including triangulation was used to check the validity of the findings. The quantitative data are mostly presented in this chapter in the form of statistical charts and tables to provide a statistical description of the phenomenon occurring within Knowledge Management and Continuous Improvement as captured within the work environment. This chapter will conclude in synthesising findings from the statistical description, analysis and interpretations made so far in an attempt to establish a means that can help in the evaluation and formation of the proposed knowledge process grid as part of the proposed model for possible impact towards Operational Excellence.

6.1 Research categories and coefficient alpha value

Three research categories were purposefully identified and developed during the construct of the survey instrument with associated Likert-type questions that will be used as the scale to describe the findings and dimensions of the received values from the respondents across the development and culture category, process category and support system category. This section of the descriptive data analysis assesses the data received across the research categories,

determining the internal consistencies determined by calculating the value of coefficient alpha (Cronbach's alpha) as measure to the reliability of the responses received. Cronbach's alpha reliability coefficient normally ranges between 0 and 1. However, there is actually no lower limit to the coefficient. The closer Cronbach's alpha coefficient is to 1.0 the greater the internal consistency of the items, hence the responses against the research categories for this study. George and Mallery (2003: 231) provide the following rules of thumb towards the Cronbach's alpha value, namely $\alpha > .9$ – Excellent, $\alpha > .8$ – Good, $\alpha > .7$ – Acceptable, $\alpha > .6$ – Questionable, $\alpha > .5$ – Poor, and $\alpha < .5$ – Unacceptable.

Table 6.1 Alpha coefficients for internal consistency across research categories

Dependent variables	Independent variables	α Coefficient alpha	Lowest item mean	Highest item mean	Scale		
					Mean	S.D.	Kurtosis
Development and culture	11	**0.72**	7.5	7.8	1.727	1.737	2.106
Process	15	**0.71**	7.5	7.6	1.2	1.207	3.012
Support System	13	**0.74**	7.46	7.6	1.38	1.809	2.801

Self-constructed by means of NCSS software

From Table 6.1 the alpha coefficients are within the 'Acceptable' value range and for the total of 47 responses received ($n = 47$) and used to determine the lowest item mean and highest item mean. Furthermore the kurtosis for the process research category is higher than 3, indicating a symmetric distribution. With the development and culture research category as well as the support system research category kurtosis value fairly close which also verifies symmetry of the survey data received.

6.2 Stratified sample size

The respondents form part of the stratified sample size for the purpose of this research. The stratified sampling frame was used in order to provide a reasonable representation of the organisation by staff grade for where most knowledge workers with in-depth insight to the research topic were employed, the distribution across the total sample is showed on Table 6.2.

Table 6.2 Stratified sample selection

Staff Grade	Response %	Response Count
Partner/Director	26.0%	13
Senior Manager	18.0%	9
Manager	26.0%	13
Senior Consultant/Assistant Manager	8.0%	4
Consultant	8.0%	4
Other (not specified)	14.0%	7

Self-constructed

6.3 Likert-type questions findings

This section reports on the findings to the Likert-type questions for the development and culture category, process category and support system category dimensions. These Likert-type questions formed the measurement scales as reported in Table 6.1. The responses to each of the questions in the

scales follow a typical pattern. The multiple-question dimension of the survey is reported in a later section of this chapter reporting on what the best ways for acquiring knowledge, benefits of using knowledge, what would like to be achieved with knowledge, which Knowledge Management initiatives were started and perceived level of agreement on business opportunities being missed out by not exploiting knowledge successfully.

There is much to be understood for having an initial discovery of the data and descriptive statistics can provide a general understanding. Descriptive statistics for all variables are displayed in tables to follow. The statistics are grouped into three categories: development and culture (Table 6.3), process (Table 6.5) and the support system (Table 6.7). These tables detail the responses to each of the questions for the dependent variables of the development and culture, process and support system categories. The tables provide for brief descriptive statistics for each of the responses collected which will be used towards formulating the descriptive findings.

Graphs 6.1- 6.3 indicates tabular representation of the respondents input to the questions, based on the 6-points scale of the Likert scale used and will form part of the descriptive analysis and findings.

Table 6.3 The dependent variable 'development and culture' questions and categories

Items/Questions	Cultural/Character category
1. cichar1 - The organisation allocates a recommended amount of time for individuals to participate in Continuous Improvement activities.	Continuous Improvement characteristic
2. cichar2 - Routines for innovation are embedded in the culture of organisation to deal with improvements.	Continuous Improvement characteristic
3. cirout1 - Recording and sharing knowledge is routine and second nature.	Continuous Improvement routines
4. kapp1 - My organisation trusts me in the application of knowledge in support of their strategy.	Knowledge Application
5. kapp2 - I use the knowledge and experience of other PwC people to bring about fresh insight to my clients.	Knowledge Application
6. kenab1 - I'm recognised for sharing and re-using knowledge.	Knowledge Enabling
7. kenab2 - There exists a formal process of knowledge capture which is used to capture learning and ideas.	Knowledge Enabling
8. kgen2 - Retaining knowledge is viewed as a source for organisational power.	Knowledge Enabling
9. kgen3 - People at all levels in the organisation have a general understanding of the concept of 'Knowledge Management'.	Knowledge Generation
10. kmob1 -The people I work with encourage me to share knowledge with others.	Knowledge Mobilisation
11. stageci1 - The organisation provide for practical guidelines on how to foster improvement routines through assessing previous lessons learned.	Stages of Continuous Improvement

Table 6.4 The dependent variable 'development and culture'

Descriptive Statistics: Development and Culture variables

Variable	N	N*	Percent	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
kenabl	6	0	100	7.83	4.03	9.87	0.00	0.00	4.00	16.75
kgen2	6	0	100	7.83	3.30	8.08	2.00	2.00	4.00	15.25
kmobl	6	0	100	7.83	3.52	8.61	0.00	0.75	4.50	18.25
kappl	6	0	100	7.67	3.90	9.56	0.00	0.00	4.50	15.25
kgen3	6	0	100	7.83	2.36	5.78	1.00	1.00	9.00	12.75
ciroutl	6	0	100	7.83	2.33	5.71	1.00	1.00	9.00	13.25
kapp2	6	0	100	7.67	3.92	9.61	0.00	0.00	4.50	15.25
kenab2	6	0	100	7.67	2.30	5.65	1.00	1.00	8.50	13.25
cicharl	6	0	100	7.67	2.22	5.43	0.00	3.75	7.00	12.25
cichar2	6	0	100	7.67	2.54	6.22	0.00	3.00	7.00	12.00
stagecil	6	0	100	7.50	2.17	5.32	0.00	2.25	8.50	11.25

Variable	Maximum	Skewness	Kurtosis
kenabl	25.00	1.31	0.87
kgen2	22.00	1.39	0.94
kmobl	19.00	0.68	-2.01
kappl	25.00	1.48	1.93
kgen3	15.00	-0.29	-1.65
ciroutl	14.00	-0.41	-1.93
kapp2	25.00	1.45	1.81
kenab2	14.00	-0.31	-1.86
cicharl	16.00	0.27	0.56
cichar2	18.00	0.75	0.83
stagecil	15.00	-0.14	-0.32

Statistic Software output

The descriptive statistics in Table 6.4 show that the means for all the 6-point scales measuring resources are above the midpoint of 3. Test for normality of each variable were also carried out at this point. Even though minor departures from the normality level may be adequate, distributions with heavier than-normal tails can compromise statistical approximations. The results obtained for this section conform to a suitable range, for which Hair *et al.* (2007: 187) agreed the suitable range for skewness is from -1 to 1, and for kurtosis it is from -3 to 3.

The allocation of time and the reality of routines of improvement as preconditions of the Continuous Improvement characteristics of the organisation were perceived to be generally good, with a higher level of agreement of the existence of routines for the recording and sharing of knowledge. The relatively high means for the knowledge application items indicate that the respondents perceived the organisation to trust them in the application of knowledge which

may bring fresh insight to their clients. Knowledge enabling and generating activities were perceived by respondents to by some means exist in the organisation, with the formal capturing processes to be perceived fully present in the organisation.

The positive skewness (0.68) for the question around knowledge mobilisation (kmob1) indicates values to be skewed towards the right side resulting in the right tail to be longer relatively to the left tail for the data collected. The respondents perceived that other employees do encourage them to share knowledge with a possible result of further movement of knowledge into application, for knowledge sharing this is a critical component of knowledge mobilisation as clarified by Lesser and Fontaine (2004: 14).

Graph 6.1 Tabular representation of the dependent variable 'development and culture' with n=46

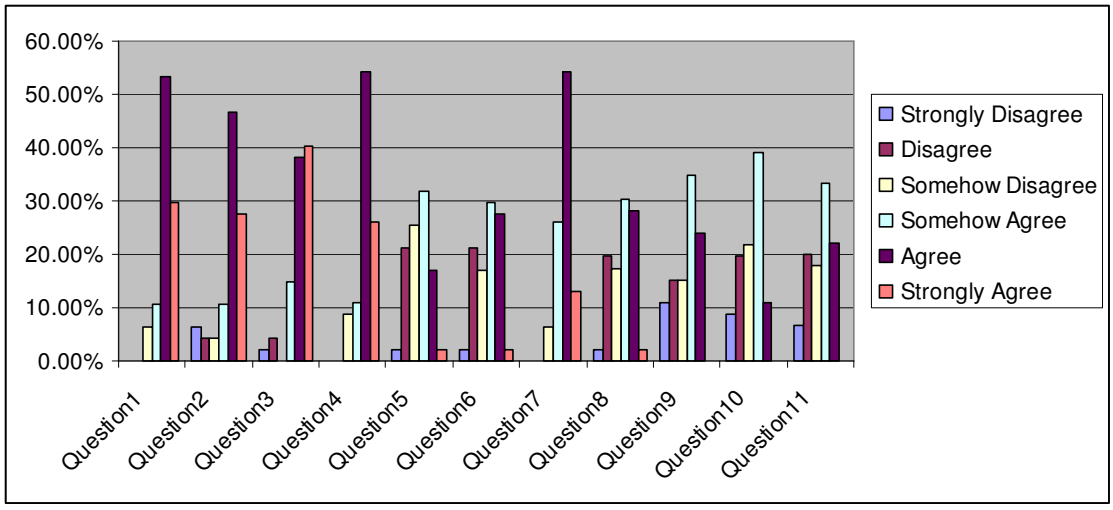


Table 6.5 The dependent variable 'process'

Items/Questions	Process category
1. contimpr2 - Individuals are committed to continual improvement and are constantly generating new ideas within the organisational context.	Continuous Improvement
2. contimpr3 - Individuals continuously improve the capability of their personal work processes.	Continuous Improvement
3. contimpr1 - The organisation is engaged with future improved practices to develop organisational problem solving..	Continuous Improvement
4. kenab3 - Key knowledge assets such as customer knowledge is identified, preserved and maintained.	Knowledge enabling
5. kgen4 - The organisation allocates resources toward efforts that measurably increase its knowledge.	Knowledge generation
6. kmob2 - The organisation hones its skills for generating, acquiring and applying knowledge by learning from other organisation's learning processes.	Knowledge mobilisation
7. knowman1 - The organisation understands the revenue generating potential of its knowledge assets.	Knowledge Management
8. knowman2 - Training and development programs in Knowledge Management behaviours are undertaken from point of recruitment.	Knowledge Management
9. knowman3 - The organisation carries out after action reports to gather explicit knowledge on success / failure factors on work accomplished.	Knowledge Management
10. knowman4 -The organisation exhibits the ability to apply matured knowledge within the organisation.	Knowledge Management
11. knowman5 - The organisation systematically assesses its future knowledge requirements and executes plans to meet them.	Knowledge Management
12. operexcel1 - The organisation provide for practical guidelines on how to foster improvement through assessing previous lessons learned.	Operational Excellence
13. operexcel2 - When a team completes a task, it distils and documents what it has learned.	Operational Excellence
14. stageci2 -Employees are involved in looking for ideas in traditional and non-traditional places for problem solving purposes.	Stages of Continuous Improvement
15. stageci3 - Management establishes areas and methods to encourage collaborative work and discussions amongst teams.	Stages of Continuous Improvement

Table 6.6 The dependent variable 'process'

Descriptive Statistics: Process variables

Variable	N	N*	Percent	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
contimprl	6	0	100	7.67	2.26	5.54	2.00	3.50	5.50	13.75
stageci2	6	0	100	7.67	3.14	7.69	0.00	0.75	5.50	16.00
knowman1	6	0	100	7.67	2.60	6.38	0.00	3.00	6.00	13.50
kenab3	6	0	100	7.67	2.62	6.41	1.00	2.50	6.00	14.00
knowman2	6	0	100	7.67	1.61	3.93	2.00	3.50	8.50	11.25
kgen4	6	0	100	7.67	2.68	6.56	2.00	2.75	4.50	15.50
knowman4	6	0	100	7.67	3.11	7.61	0.00	0.75	7.00	12.75
operexcel1	6	0	100	7.67	2.64	6.47	0.00	0.75	8.00	13.25
knowman4	6	0	100	7.50	3.06	7.50	0.00	3.00	4.50	13.50
operexcel2	6	0	100	7.67	3.35	8.21	0.00	0.00	5.50	16.25
contimpr2	6	0	100	7.67	3.13	7.66	0.00	1.50	6.00	13.50
knowman5	6	0	100	7.67	2.04	5.01	2.00	2.75	8.00	10.75
stageci3	6	0	100	7.50	2.64	6.47	2.00	2.75	4.50	14.25
contimpr3	6	0	100	7.67	4.18	10.23	0.00	0.75	3.50	15.00
kmob2	6	0	100	7.67	2.55	6.25	1.00	1.00	8.00	13.00

Variable	Maximum	Skewness	Kurtosis
contimprl	16.00	0.84	-1.11
stageci2	19.00	0.71	-1.26
knowman1	18.00	0.78	0.27
kenab3	17.00	0.53	-1.55
knowman2	12.00	-0.54	-1.30
kgen4	17.00	0.91	-1.64
knowman2	21.00	1.11	1.50
operexcel1	17.00	0.16	-0.91
knowman4	21.00	1.41	1.89
operexcel2	20.00	0.71	-1.16
contimpr2	21.00	1.15	1.15
knowman5	16.00	0.71	0.80
stageci3	18.00	1.11	-0.43
contimpr3	27.00	1.78	3.07
kmob2	16.00	0.11	-1.98

Statistic Software output

Continuous Improvement is generally considered to be moderately sufficient based on contimpr1 (M=7.6, SD=5.54), contipmr2 (M=7.67, SD=7.66), and contimpr3 (M=7.6, SD=6.4). While Knowledge Management, especially for knowman4 (M=7.6, SD=10.23) for the ability of the organisation to apply knowledge, to be perceived relatively inadequate by all respondents. Under the questions pertaining to Operational Excellence operexcel1 (skewness = 0.519) and operexcel2 (skewness of 0.71) the respondents perceived the organisation to be adequate in providing practical guidance and documenting what was learned once a task was complete, for future application and use. These controls can be arranged in a problem-solving life cycle called the knowledge life cycle

that produces and integrates knowledge across the proposes model's unified processes of the cognitive domain layer, functional layer and Knowledge Management resources layer (Firestone, 2003: 103).

With the item under question stageci2 (kurtosis = -1.26) presenting data variance that is due to infrequent extreme – in this case the respondents indicated that employees are looking in either traditional or non-traditional places for problem solving purposes which is in contrast to a more even spread of data for stageci3 (kurtosis = -0.43), where respondents perceived that management is establishing areas and methods towards collaborative work as a stage towards Continuous Improvement principles. The identification, exploitation and sharing of known routines of improvement to all members of the organisation will deliver successful means and ways towards problem solving to all members of the organisation, and may be worthwhile pursuing by the organisation.

No more that 2.13% of the responses collected across all dependant variables for this category indicated 'Strongly Disagree' ratings. This is a very positive indication as the data suggested that formal processes are in place and in use to address Continuous Improvement and Knowledge Management elements.

Graph 6.2 Tabular representation of the dependent variable 'process' with *n=46*

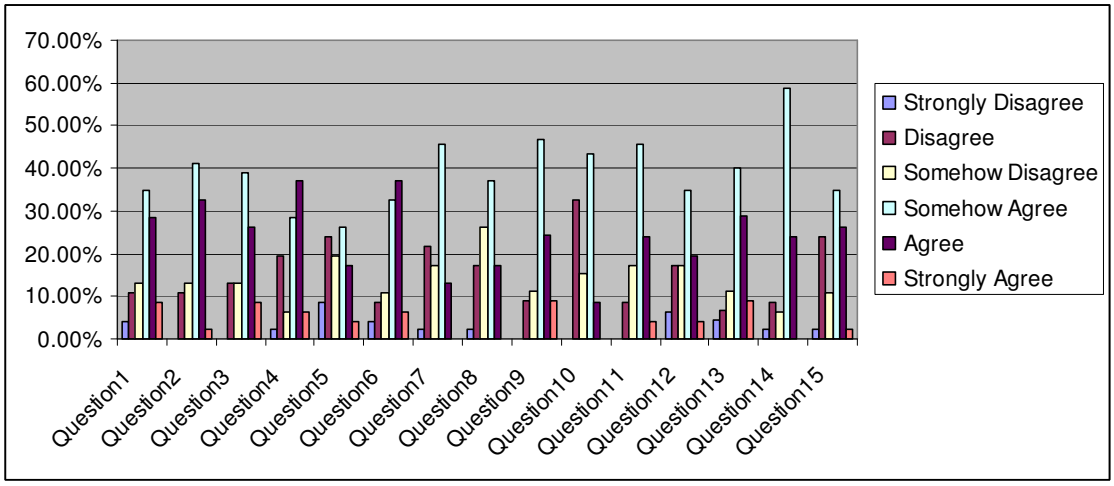


Table 6.7 The dependent variable 'support system'

Items/Questions	Support system category
1. cichar3 - Adequate resources are provided for continuously improving individual and workgroup capabilities.	Continuous Improvement characteristics
2. contimpr4 - Technology creates an institutional memory that is accessible to the entire organisation.	Continuous Improvement
3. contimpr5 - The organisation places an effort in building and maintaining Continuous Improvement behaviours.	Continuous Improvement
4. kenab4 - There is a clear ownership of Knowledge Management initiatives either by business units or by the whole business.	Knowledge enabling
5. kenab5 - I can easily find the information I need to do my job.	Knowledge enabling
6. kgen1 - The organisation provide for technology to effectively store knowledge.	Knowledge generation
7. kmob3 - There is a good team intra-communication and sharing of knowledge.	Knowledge generation
8. kmob4 - Formal networks exist to facilitate dissemination of knowledge.	Knowledge generation
9. knowman6 - There are defined responsibilities and budget for Knowledge Management initiatives.	Knowledge Management
10. knowman7 - A support system for ideas or learning linked with procedural ("know-how') knowledge is available to all employees.	Knowledge Management
11. operexcel4 -Current technology links all members of the organisation to one another.	Operational Excellence
12. operexcel5 - The organisation systematically assesses its future knowledge requirements and executes plans to meet them.	Operational Excellence
13. operexcel6 - Technology is a key enabler in ensuring that the right information is available to the right people at the right time.	Operational Excellence

Table 6.8 The dependent variable 'support system'

Descriptive Statistics: Support System variables

Variable	N	N*	Percent	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
operexcel4	46	0	100	6.67	1.41	3.44	2.00	3.50	7.00	10.00
contimpr4	6	0	100	6.67	1.82	4.46	1.00	3.25	5.50	12.00
kenab4	6	0	100	6.67	1.61	3.93	1.00	3.25	6.50	11.00
knowman6	6	0	100	6.67	1.87	4.59	1.00	4.00	6.00	9.00
operexcel5	6	0	100	6.67	2.39	5.85	2.00	2.75	5.00	9.75
cichar3	6	0	100	6.67	2.39	5.85	1.00	2.50	5.00	11.00
kenab5	6	0	100	6.50	3.01	7.37	1.00	1.00	3.00	13.75
operexcel6	6	0	100	6.67	2.36	5.79	0.00	1.50	6.00	12.50
contimpr5	6	0	100	6.67	2.25	5.50	2.00	2.00	4.50	12.75
knowman7	6	0	100	6.67	1.73	4.23	1.00	1.75	8.00	10.25
kmob3	6	0	100	6.67	2.51	6.15	1.00	2.50	4.50	11.25
kgenl	6	0	100	6.67	2.35	5.75	1.00	1.00	5.50	13.25
kmob5	6	0	100	6.67	2.80	6.86	1.00	1.00	4.00	13.50

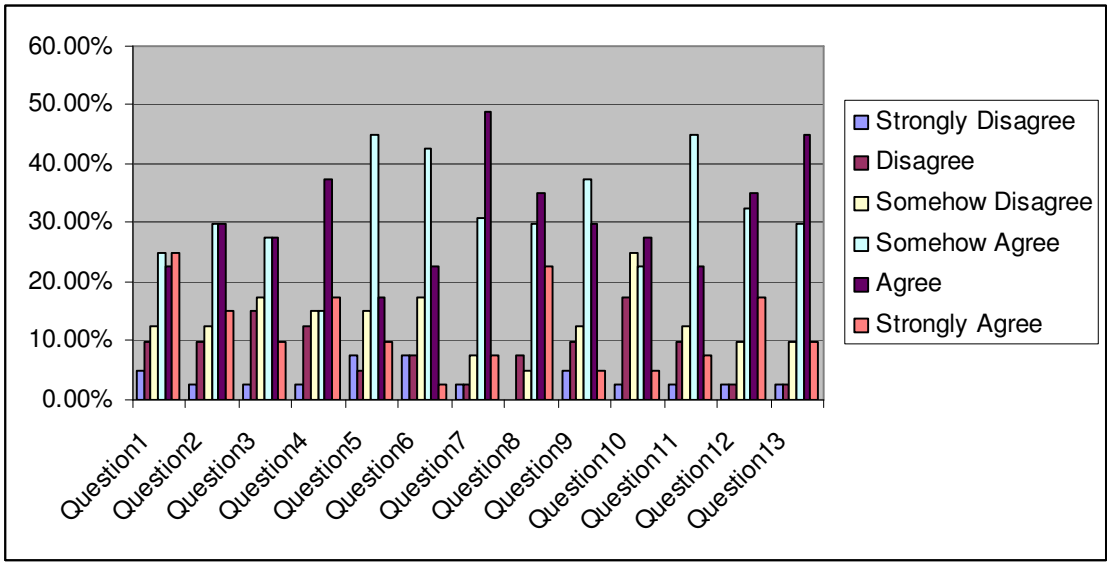
Variable	Maximum	Skewness	Kurtosis
operexcel4	10.00	-0.28	-2.23
contimpr4	12.00	0.33	-1.45
kenab4	11.00	-0.19	-1.02
knowman6	15.00	1.21	3.00
operexcel5	18.00	1.92	4.01
cichar3	17.00	1.25	1.39
kenab5	19.00	1.28	0.27
operexcel6	14.00	0.17	-2.27
contimpr5	15.00	0.91	-1.18
konwman7	11.00	-0.61	-1.84
kmob3	18.00	1.56	2.44
kgenl	14.00	0.42	-2.02
kmob5	18.00	1.12	-0.10

Statistic Software output

The relatively positively evaluation of the items operexcel4 (SD = 6.153, skewness = 1.414), operexcel5 (SD = 5.570, skewness = 0.305) and operexcel6 (SD = 6.860, skewness = 2.109) in Operational Excellence is encouraging, at least for the questions asked. There seemed to be considerable effort on technology to link all members of the organisation for which technology is also the key enabler in ensuring the right information is available, as perceived by all respondents. Future knowledge requirements and plans to meet such was perceived adequate and based on systematic assessments done by the organisation. The items measured for this section are consistent to the recommendations made by Von Krogh *et al.* (2000: 175) as elements towards unlocking contextual knowledge towards innovation and development.

The existence of ownership of Knowledge Management initiatives towards enabling knowledge (kenab4) was perceived to be current and will have a direct consequence towards fostering inter-organisational knowledge processes. Additionally clear ownership of Knowledge Management initiatives can overcome the major challenge of managing knowledge, as the challenge is less the creation of knowledge and more the capture and integration of knowledge in delivering value to the organisation (Grant, 1996: 375).

Graph 6.3 Tabular representation of the dependent variable 'support system' with *n=46*



6.4 Responses to open-ended questions

The open-ended questions provided at the end of the survey gave respondents the opportunity to provide comments relating to the following Knowledge Management practices:

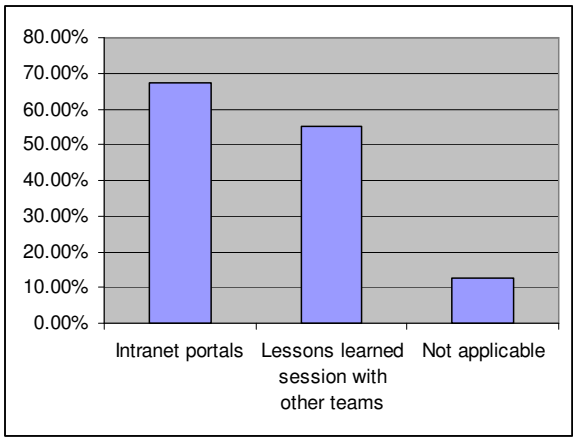
- The acquisition of knowledge.
- The benefits of knowledge.

- The overall objective of Knowledge Management.
- The initiative/s in Knowledge Management.
- The exploitation of knowledge.
- The purpose of knowledge creation.
- The management of knowledge assets.
- Knowledge exchange.
- Learning from previous knowledge.

Respondents were asked to indicate through which medium they prefer to acquire knowledge.

The acquisition of knowledge: *Do you acquire tacit knowledge form?*

Graph 6.4 Open-ended questions for acquisition of tacit knowledge with *n=40*

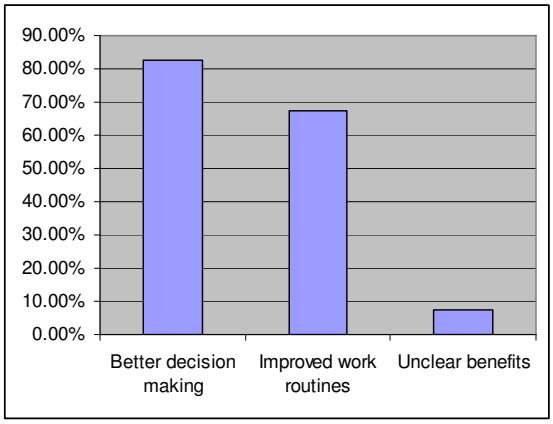


It was considered important to identify any significant differences in acquiring tacit knowledge by means intervention of technology, or by means of team interaction namely sharing of lessons learned. In total 67.5% of the respondents indicated that they prefer using intranet portals for acquiring tacit knowledge, with 55.0% relying on lessons learned to acquire tacit knowledge.

Following an understanding of where the respondents prefer to acquire tacit knowledge, the perceived benefits in using knowledge in their teams were tested.

The benefits of knowledge: *What are the perceived benefits of using knowledge in your team?*

Graph 6.5 Open-ended questions for the perceived benefits of using knowledge with *n=40*

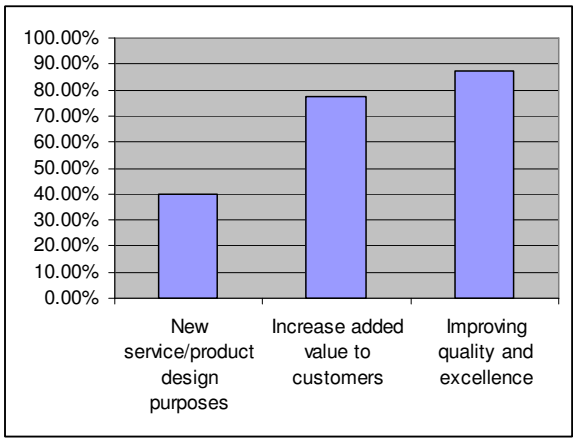


Respondents indicate a rather high response for ‘Better decision making’ (82.5%) leading the ‘Improved work routines’ (67.5%) with ‘Unclear benefits’ (7.5%) being the lowest perceived benefits of using knowledge in their team.

At company level the respondents were asked to indicate the objectives of implementing Knowledge Management, with the aim to understand the direct recognition of Knowledge Management for the development of service/product or the application of knowledge in delivery customer value add. Respondents were also asked to indicate if Knowledge Management was to be implemented to improve quality and excellence.

The overall objectives of Knowledge Management: *What does your company like to achieve by implementing Knowledge Management?*

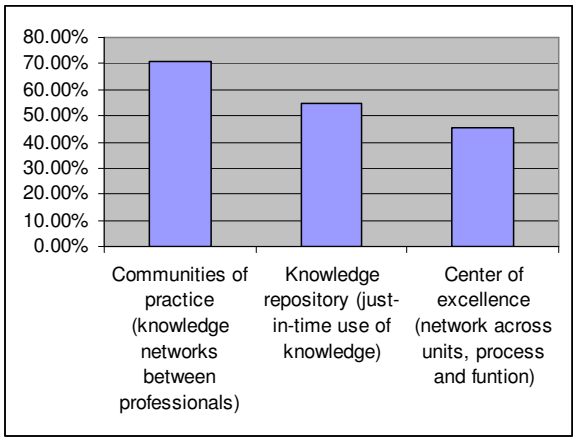
Graph 6.6 Open-ended questions for the perceived objectives of implementing Knowledge Management with *n=40*



Respondents indicated flexibility with close proximity of 'Increase added value to customers' (77.5%) and 'Improving quality and excellence' (87.5%) as perceive objectives to be achieved by implementing Knowledge Management for the company. With 40% of the respondents indicating that 'New service/product design purposes' should be achieved with Knowledge Management implementation. The overwhelming perceived value for the improvement of quality and excellence is reminiscent of the main hypothesis of this study where the application of Knowledge Management practices will bring about improved excellence.

The initiative/s started in Knowledge Management: *Which Knowledge Management initiative started in the last year in your organisation?*

Graph 6.7 Open-ended questions for assessing the initiative/s started in the last year in the organisation with *n=40*



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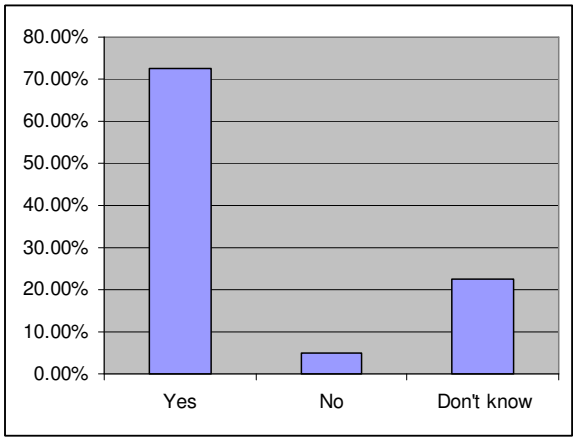
The importance of Knowledge Management practices in support of building 'Communities of practice' to facilitate networks between professionals were selected by 71% of the respondents. This feedback support the three-layer approach for establishing a process grid in support of Knowledge Management and Continuous Improvement, with specific attention to the resource layer of practices to be used in manipulating both Knowledge Management and Continuous Improvement leading onto Operational Excellence.

It was also important to the researcher to assess if the respondents perceived any opportunities that might be missed in not exploiting available knowledge.

The exploitation of Knowledge Management: *Do you believe you may be currently being missing out on business opportunities by failing to successfully exploit available knowledge?*

Graph 6.8 Open-ended questions for assessing the possibility in missing put on opportunity by not successfully exploiting available knowledge *n=40*



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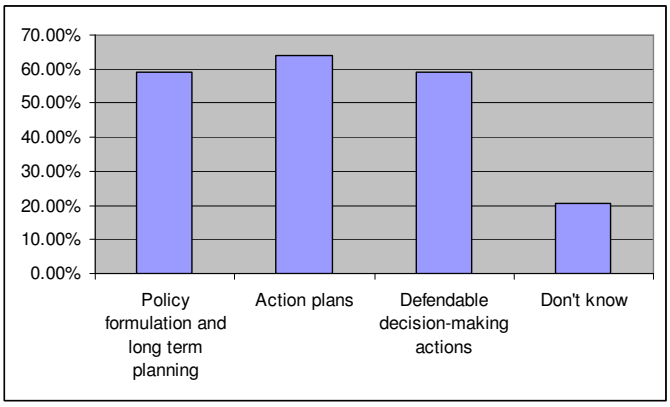
The respondents indicated that they perceive to be missing out on business opportunities 'Yes' (72.5%) by not successfully exploiting available knowledge.

The purpose of knowledge creation: *The organisation produces knowledge for the purpose of?*

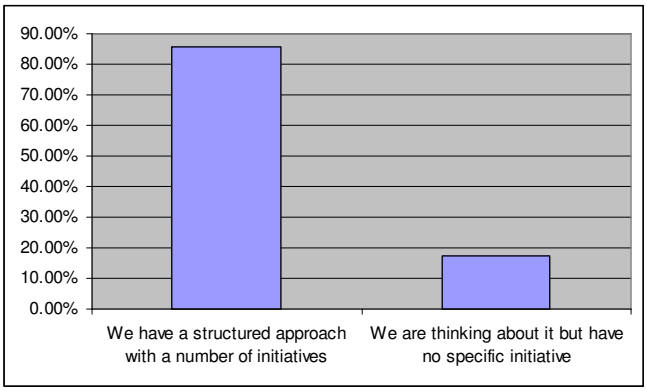
Graph 6.9 Open-ended questions for assessing the purpose of knowledge creation by the organisation *n=40*



The production of knowledge for the purposes of 'Action plans' (64.1%), followed by 'Defendable actions' (59.0%) and 'Policy formulation and long term planning' (59.0%) were perceived by the respondents. With 20% of the respondents perceived a 'Don't know' reason for the creation and production of knowledge by the organisation.

The management of knowledge assets: *What is your company doing to manage and improve your individual and corporate knowledge assets?*

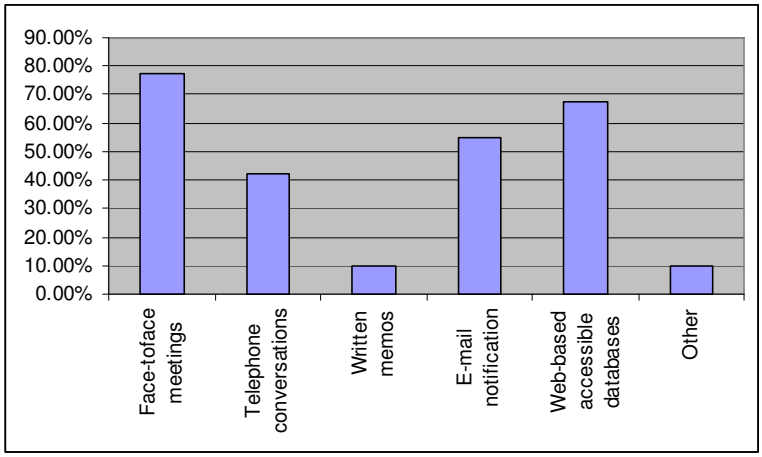
Graph 6.10 Open-ended questions for the management of knowledge assets by the organisation *n=40*



The respondents revealed a positive perception in possessing a 'We have a structured approach with a number of initiatives' (85.0%) status for the management of knowledge assets and only 17% indicated that they believe to be 'We are thinking about it but have no specific initiative' status.

Knowledge exchange: *The most effective way to exchange knowledge in my organisation is through?*

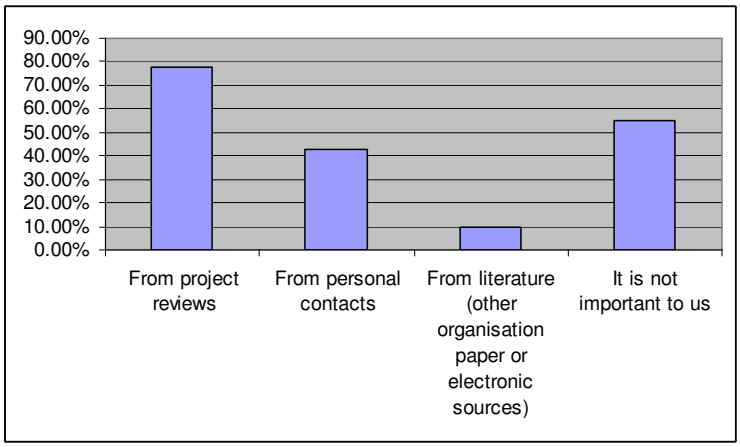
Graph 6.11 Open-ended questions for the most effective way to the exchange of knowledge *n=40*



The respondents associated face-to-face meetings or contact with Knowledge Management with various other systems (telephone, e-mail, web-based DB). Generally respondents associated Knowledge Management with information technology infrastructure and systems; this is consistent with the fact that Knowledge Management systems can be accomplished with different technologies to underpin the knowledge development of the organisation and compel knowledge maturity (Alavi & Leidner, 2001: 107).

Learning from previous knowledge: *How does the organisation learn from previous tasks completed?*

Graph 6.12 Open-ended questions for learning from previous knowledge *n=40*



Lastly, the responses were nebulous to an extend in terms of whether the organisation learn from previous tasks completed, perhaps indicating a root concern absent concrete processes on how to address this. The majority of respondents reached an agreement that project reviews is a key activity from which the organisation extract learning.

6.5 Tests of hypotheses

The following section presents standardised parameter estimates, with significance levels for the path estimates of the hypothesis network, which were based on the model (Figure 5.2) and was described in the previous chapter to be used for non-hypothesised linkage between the key areas of the model. The significance value (α) for this research was set at 5% (0.05) and where the p-level for all overall areas of constructs for the model is smaller than the α-value the null hypothesis is rejected. When used, the null hypothesis is alleged

adequate to explain the data unless statistical evidence, in the form of a hypothesis test, indicates otherwise — that is, when the researcher has a certain degree of confidence, usually 95% to 99%, that the null hypothesis does not explain the data (Ioannidis, 2005).

Appendix B point to all the statistical values and boundaries that was used to construct the hypothesis network across dependant variable groups, with the associated *p* values as indicated in Table 6.9.

Table 6.9 The areas of construct towards the hypothesis network and related measurement items

Areas of Constructs	Items	*P* value
Knowledge generation (kgen)	**kgen1:** The organisation work on its skill for generating, acquiring and applying knowledge that may be used as a potential revenue-generating asset. **kgen2:** Knowledge is generated as a source for organisational power, and the generated knowledge is stored on IT system **kgen3:** A general understanding of the concepts of Knowledge Management exists in the organisation. **kgen4:** Resources are allocated to increase the organisation's knowledge.	$p = 0.022$
Knowledge mobilisation (kmob)	**kmob1:** The sharing of knowledge in teams is encouraged by all members of the organisation. **kmob2:** The organisation hones its skill towards the mobilisation of knowledge in support of the organisation's strategy. **kmob3:** Knowledge is shared across teams with the organisation being competent to apply matured knowledge towards creating excellence. **kmob4:** Formal networks exist in the organisational to disseminate knowledge across teams.	$p = 0.002$
Knowledge enabling processes (kenad)	**kenab1:** Individuals that share knowledge are recognised and work teams encourage the sharing of knowledge by other team members. **kenab2:** Formal processes are used to capture knowledge as part of lessons learned and learning, and this knowledge is retained	$p = 0.054$

	and applied across the organisation. **kenab3:** Key customer knowledge assets are identified, preserved and maintained. **kenab4:** Clear ownership of Knowledge Management initiatives. **kenab5:** Easy access to knowledge required to enable work functions and a routine of sharing knowledge exists in the organisation.	
Knowledge application (kapp)	**kapp1:** People have a general understanding of Knowledge Management and the associated concepts and are trusted to apply their knowledge in support of the organisation strategy. **kapp2:** Knowledge is applied and experience shared to bring fresh insight to clients with individuals that re-use knowledge are recognised.	$p = 0.002$
Continuous Improvement routines (cirout)	**cirout1:** Routines are present that support development of knowledge.	$p = 0.027$
Stages of Continuous Improvement evolution (stageci)	**stageci1:** Practical guidelines are made available to advance routines of improvement. **stageci2:** Employees are looking at various routines for problem solving. **stageci3:** Knowledge and experience are used to promote improvement in operational services by means of methods and principles that encourage collaborative work and discussions.	$p = 0.0521$
Continuous Improvement characteristics (cichar)	**cichar1:** Formal ways and processes exist to increase learning and improvement and time is allowed to participate in continuous capability improvements activities. **cichar2:** Routines are embedded in the culture of the organisation that is focused on improvement by means of established improvement principles. **cichar3:** The organisation is occupied with improvement practices with resources adequately provided their capabilities for both an individual and at workgroup level.	$p = 0.011$
Knowledge Management (knowman)	**knowman1:** Knowledge is seen as a potential revenue-generating asset towards Operational Excellence and is measured and resources are allocated to increase the effort of Knowledge Management development. **knowman2:** Training and development for Knowledge Management development are	$p = 0.013$

	undertaken. **knowman3:** Explicit knowledge is gathered as part of post completion reporting by employees. **knowman4:** The organisation is able to apply matured knowledge within the organisation to create excellence. **knowman5:** Future knowledge requirements are systematically assessed. **knowman6:** Knowledge Management initiatives have defined responsibilities and funding. **knowman7:** Procedural knowledge is available within a supportive environment (support system).	
Continuous Improvement (contimpr)	**contimpr1:** Organisational problem solving is developed by means of Continuous Improvement practices. **contimpr2:** Continuous Improvement is used to generate new knowledge within the context of the organisation. **contimpr3:** Individuals improve the potential of their personal work process on continuous bases. **contimpr4:** Access by entire organisation to institutional memory towards creating improvement that is continuous of nature. **contimpr5:** Continuous Improvement behaviours are build by the organisation.	$p = 0.0177$
Operational Excellence (operexcel)	**operexcel1:** Knowledge is documented for post-delivery of activities as lessons learned for future Operational Excellence and practical guidelines are used to foster improvement of operational activities. **operexcel2:** Technology enables linkage of organisational resources towards achieving Operational Excellence. **operexcel3:** Future operational plans include knowledge requirements and the organisation executes this plan systematically. **operexcel4:** Systems are available to provide the right information to the right people at the right time.	$p = 0.045$

From the above computed *p* values, the hypothesis network (Figure 5.2) was updated to identify those linkages for which the null hypothesis will be rejected or not. The null hypothesis for the network as portray in Figure 6.1, is the reverse of

what the researcher actually believes; and it is put forward to allow the data to contradict it. In this research on the effect of Knowledge Management and Continuous Improvement on Operational Excellence, the researcher expects that Knowledge Management and Continuous Improvement to have a contributing factor towards Operational Excellence. However some relationships within the hypothesis network, from which the null hypothesis can not be rejected, and hence not be a viable possibility concluding the expectations of the researcher.

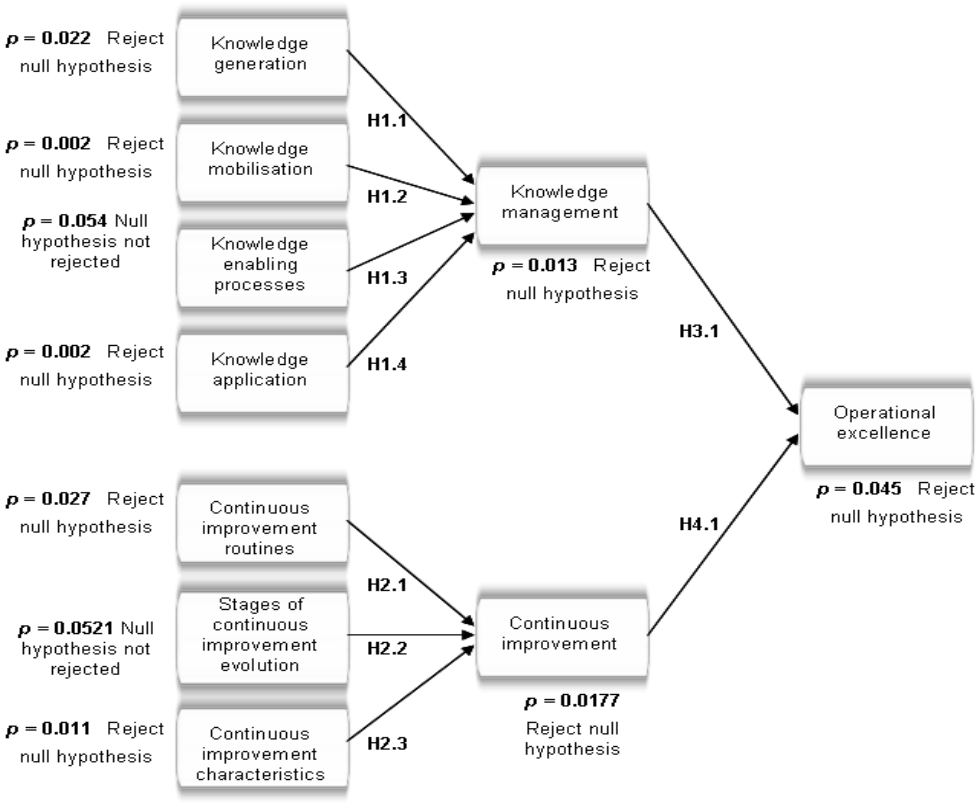


Figure 6.1 Hypothesis network and associated *p* values

The paths of knowledge generation, knowledge mobilisation and knowledge application of the hypothesis network are all good fits to the data observed with the null hypothesis being rejected; the observed and theoretical correlation matrices are similar. The results of the hypotheses testing for knowledge generation, knowledge mobilisation and knowledge application confirm these as

being factors of production and the management of the organisational environment to support the creation of collective knowledge towards achieving Knowledge Management. Items measuring knowledge enabling processes within the settings of the theoretical aspects of this research delivered less significant values towards hypothesis testing, and therefore the hypothesis for this link can not be rejected.

The subsequent paths for Continuous Improvement routines and Continuous Improvement characteristics presented acceptable significant levels with the *p* value under 0.05; the null hypothesis can be rejected - the observed and theoretical correlation matrices are similar. Continuous Improvement routines and Continuous Improvement characteristics are identified as influencing factors in determining Continuous Improvement readiness for the organisation. With stages of Continuous Improvement evolution within the settings of the theoretical aspects of this research delivered less significant values towards hypothesis testing, and therefore the hypothesis for this link can not be rejected.

The paths linking Continuous Improvement (p = 0.0177) and Knowledge Management (p = 0.013) provide for good justifications as contributing factors towards Operational Excellence. Seamless integration of the items for both the areas of Continuous Improvement and Knowledge Management were perceived by the respondents; observed and theoretical correlation matrices are similar for these areas. The results observed for the Continuous Improvement path as well as the Knowledge Management path maintain the predication of the researcher that both these links participate a dominant role in achieving Operational Excellence.

With respect to Knowledge Management practices the hypothesis network proposed at least three domains that of knowledge generation, knowledge mobilisation and knowledge application as important input to the proposed process grid of knowledge development and associated layer elements, as

explained in Chapter 4 and described in Table 4.5. From a Continuous Improvement principles perspective it is apparent that elements from Continuous Improvement routines and Continuous Improvement characteristics are associated with the organisation Continuous Improvement ability, as discussed in Chapter 4 and depicted in Table 4.6. These findings are also a result of the deliberate design of processes, tools, structures and environments with the intent to increase, renew, share or improve the use of knowledge represented in any of the three elements for structural, human and social of intellectual capital (Seemann *et al.,* 1999: 27, 31).

In the next chapter, a further discussion will be conducted based on the results of both qualitative and quantitative data followed by the concluding remarks to the proposed model and implications of this research with possible opportunities towards future research purposes.

6.6 Summary

The quantitative and qualitative survey analyses were examined in this chapter, with a detailed analysis of the quantitative data collected by means of an on-line questionnaire. Each of the responses to the questionnaire that provided quantitative data were analysed under the research constructs and appropriate subsidiary items. The qualitative analysis section for responses to the open-ended questions on Knowledge Management practices and Continuous Improvement principles was examined in order to obtain additional information around these topics. The items from the various structures analysed in this chapter assisted with determining what factors contributed to Knowledge Management practices and Continuous Improvement principles in achieving Operational Excellence. From the results collected the respondents indicated strengths and areas needing attention in terms of knowledge and improvement development, design and delivery within the current management systems being used. The respondents were also able to relate what management strategies

influenced successful creation of matured and practical knowledge. The findings of the dependant variable areas for the development and culture category, process category and support system category were summarised separately and was discussed against the theoretical background to this research. From the statistical analysis of the on-line questionnaire data collected, together with the range of literature review the final arguments and suggestions concluding this research will be discussed in Chapter 7. Converting all the assessed data collected and statistical analysis concluded, the proposed model for sustainable Operational Excellence through Knowledge Management practices and Continuous Improvement principles will be provided and discussed in the final chapter to follow.

Chapter 7 – Analysis, conclusions and further research

This chapter provides conclusions based on the analysis presented in Chapter 6, implications for Knowledge Management practices and Continuous Improvement principles for achieving Operational Excellence the limitations of this study and future research directions from this research. The author will also make use of this final chapter to reflect on personal experience and growth gained in completing this research.

7.1 Conclusions

In the beginning of the first chapter of this research, it was recommended that there exists interdependencies between Knowledge Management and Continuous Improvement in attaining Operational Excellence. Many researchers have made substantial contributions to the field of Knowledge Management, but the emphases were mostly on what the meaning of Knowledge Management is and the certainty and necessity of Knowledge Management for an organisation's survival in the knowledge era. Knowledge Management strategies, tools, measurements and the possible impact of Knowledge Management are widely recognised by researchers in this field. However, there are some inadequacies about the credence that Knowledge Management practices through inter-organisational processes may result in Operational Excellence. Furthermore, the absence of integrating a specific Knowledge Management maturity level with the associated Continuous Improvement effort or routine, as stated to be a necessary to enhance competitiveness, is absent in most Operational Excellence literature reviewed.

Given the close similarities between Continuous Improvement, work development and quality management it is not surprising to find that the results of this research

also echoed the reality that organisations who wants to capture the knowledge that the workers have, to save costs, drive growth and fertilize cross learning. Knowledge as an asset is gaining more and more recognition as we progress towards a more competitive world of excellence. However there has been little effort towards recognising and appreciating of the fact that elements within the cognitive domain layer, functional layer and Knowledge Management resources layer of an organisation can be increasingly stimulated by focusing effort through Continuous Improvement routines and matured inter-organisational knowledge processes in achieving Operational Excellence. The research further reverberates the argument put forward that there is reasonable doubt as to whether Knowledge Management maturity and Continuous Improvement readiness with logical relationships have been sufficiently dealt with in business models facilitating Operational Excellence. In fact, it was observed in literature reviews and results obtained that the relationship between Knowledge Management practices and Continuous Improvement principles were treated separately in initiatives towards excellence. This means that it is even more important to have a model available that incorporates Knowledge Management practices and Continuous Improvement principles in a holistic way, which will allow for organisations to create the exact level of participation required in achieving and maintaining Operational Excellence.

7.2 Implications and further research

The need for improved Operational Excellence places different strains on organisations everywhere. Organisations have to provide knowledgeable and improved behaviour that necessitates efforts on developing Knowledge Management and Continuous Improvement strategies and to implement these strategies in their workplace. The development of approaches for capturing, sharing and effectively using knowledge requires an appreciation of how tacit and

explicit knowledge is created, captured, shared and used in an organisation. Organisations therefore have turned to explicit and systematic knowledge management practices to make available the intellectual capital needed to perform effectively, internally and relative to their stakeholders. The proposes model will facilitate the developed of the broad components collectively required to understand both the area of Knowledge Management and Continuous Improvement to build the organisation strategy in achieving Operational Excellence. The proposed model allows for a streamlined approach in assessing both Knowledge Management maturity as well as Continuous Improvement ability of an organisation for the identification of the elements required to meet Operational Excellence. The outcomes of the proposed model will provide for a comprehensive and appropriate gird of processes that makes it possible for the organisation to resolve Knowledge Management development issues within the context of the Continuous Improvement ability of the organisation.

Furthermore a people-centric approach for the identification of examples to build, apply and deploy knowledge and the understanding of improvement routines to support of such knowledge in support of Operational Excellence within an organisation will be also be achieved by using the proposed model. The model provides for standard building blocks around the cognitive domain layer, functional domain layer and Knowledge Management resources layer of an organisation that can be implemented cohesively in attaining Operational Excellence. Operational Excellence solely on parochial, divisional or departmental perspectives can be counterproductive and sometimes even wasteful of time and money. Those improvement efforts that lead to true Operational Excellence should recognise the Knowledge Management and Continuous Improvement significances and efforts toward the broader issues affecting an organisation operation. The proposed model compliments this realisation by decomposing the elements for the cognitive domain layer, functional domain layer and resources layer, within the context of the organisation in achieving Operational Excellence.

The result can provide valuable references for academic rationale as well. Based upon the lack of literature about work on a single model or framework towards Operational Excellence by means of combining Knowledge Management practices and Continuous Improvement principles, the research model and related results may provide reference for academic research and a possible development framework. This research is proposing the need for a broader and more influential approach to the field of business management in applying Knowledge Management and Continuous Improvement towards Operational Excellence.

Yet, there is certain insufficiency in the course of this research. Future research may further work on a more complete model with more variables and constructs, or collect a bigger sample of data for model validation. This might reveal additional resources that might proof to be more generalised given the complexity of the field of Knowledge Management, which might be more useful and applicable to be interpreted for the greater contexts of Operational Excellence. Future research should also consider other factors and variables that may contribute to a Knowledge Management practices and Continuous Improvement principles. Measuring additional variables under the suggested Knowledge Management process grid may add to the model's ability to explain variance in measures of Knowledge Management maturity and Continuous Improvement readiness.

7.3 Limitations

There are limitations to this research. Knowledge Management practices were measured using a subjective norm scale. A more comprehensive measure of Knowledge Management maturity processes may be needed to represent this

construct. All data were collected via an on-line questionnaire so common method variance may be a limiting factor. In addition the data collected were selected from a very small sample size based on a stratified sample type, perhaps limiting its generalisation to other types of organisations. Due to the complexity of the model and the number of associated variables included the results need further confirmation using possible multiple samples and additional measures of Knowledge Management maturity and Continuous Improvement readiness elements. By making use of bigger sample size, one could also embark on re-testing of the Knowledge Management constructs and associated elements that underpin the framework of the proposes model.

The specific benefits for businesses in using the proposed model would manifest itself around speeding-up the uptake of sharing knowledge and creating a dynamic set of improvement routines, which can then be reapplied in fostering excellence. Furthermore critical success factors can be provided as the most valuable asset of a business is in what it knows, across all aspects of the operational platform of an organisation. While there are many excellent reasons to choose customer intimacy or product-to-market excellence as an organisation's value proposition, the present inefficiencies of process and workflow design without Knowledge Management and Continuous Improvement would further suggests that the proposed model will encourage Operational Excellence and it is believe to actually improving it in the short term directly.

7.4 Personal reflection

One important 'take home message' is that this the nature of this research has enhanced my professional understanding and development specifically within the field of Knowledge Management.

The importance of transferability of inter-organisational processes for Knowledge Management and Continuous Improvement within the different domains of an

organisation, towards achieving compelling results of excellence is a difficult and overlooked task by business professionals. Through the journey of discovery needed for this research I've accomplished to underpin the necessary elements required in manipulating the Knowledge Management practices and Continuous Improvement principles to impact Operational Excellence of an organisation. This research has empowered me with the necessary theory and appreciation towards the construct of a proposed business model in addressing the increasing need towards achieving Operational Excellence.

As Wheatley (1992: 7) says so expressively: "There are no recipes or formulas, no checklists or advice that describes 'reality'. There is only what we create through engagement with others and events". The reality in concluding this research successfully, was to gain an in-depth understanding of elements and processes required across the cognitive domain layer, functional domain layer and resources layer of an organisation to build an effective business model against the background of the meta-model of business models and subsequently applying the proposed model as assessment tool in gauging Knowledge Management maturity and Continuous Improvement ability in achieving Operational Excellence. The design of Java-based standalone application of the proposed model will be the final test of the concept and acceptance of the knowledge process grid, within the context of an organisation's operational activities. Such standalone Java-application will bring together the earnings and conclusions of this study, and will facilitate a user-friendly approach in addressing the issues in the development of Operational Excellence.

- End -

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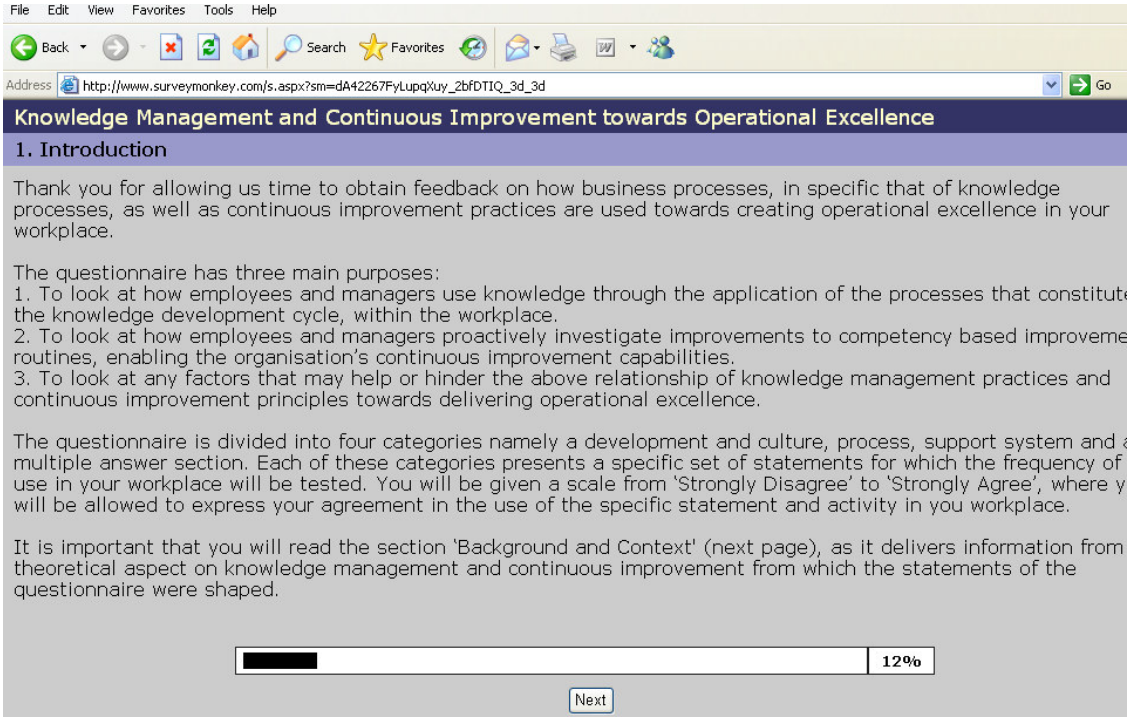
Appendix A On-line survey

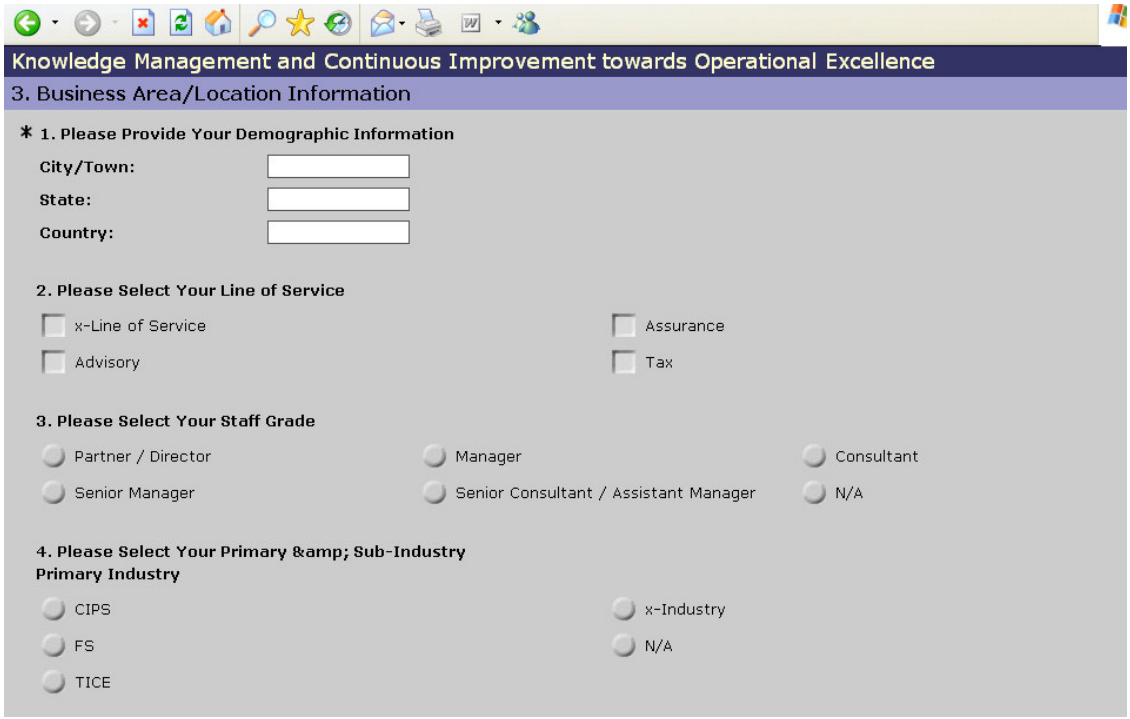
This appendix indicates screen shots from the on-line survey designed for the purpose of this research. The on-line survey was hosted on SurveyMonkey services, with the respective link to the on-line survey:

http://www.surveymonkey.com/s.aspx?sm=dA42267FyLupqXuy_2bfDTIQ_3d_3d

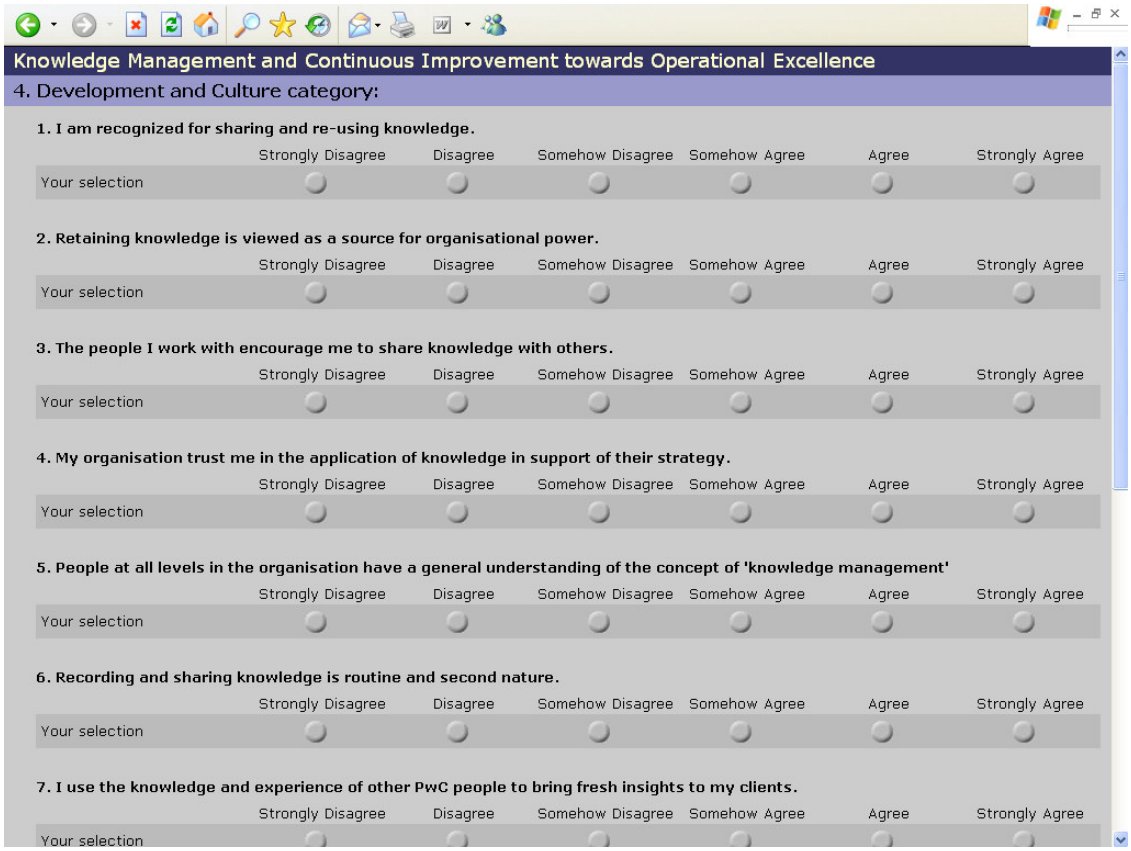
The 'Introduction' screen:



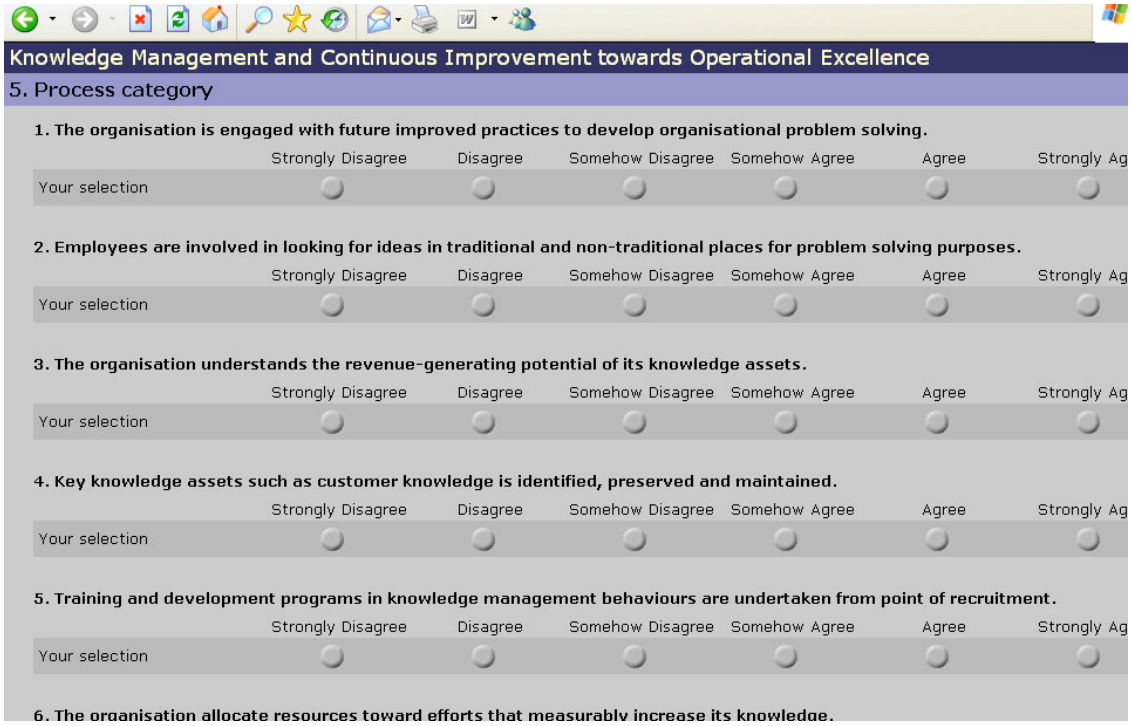
The ‘Demographic Information’ screen:



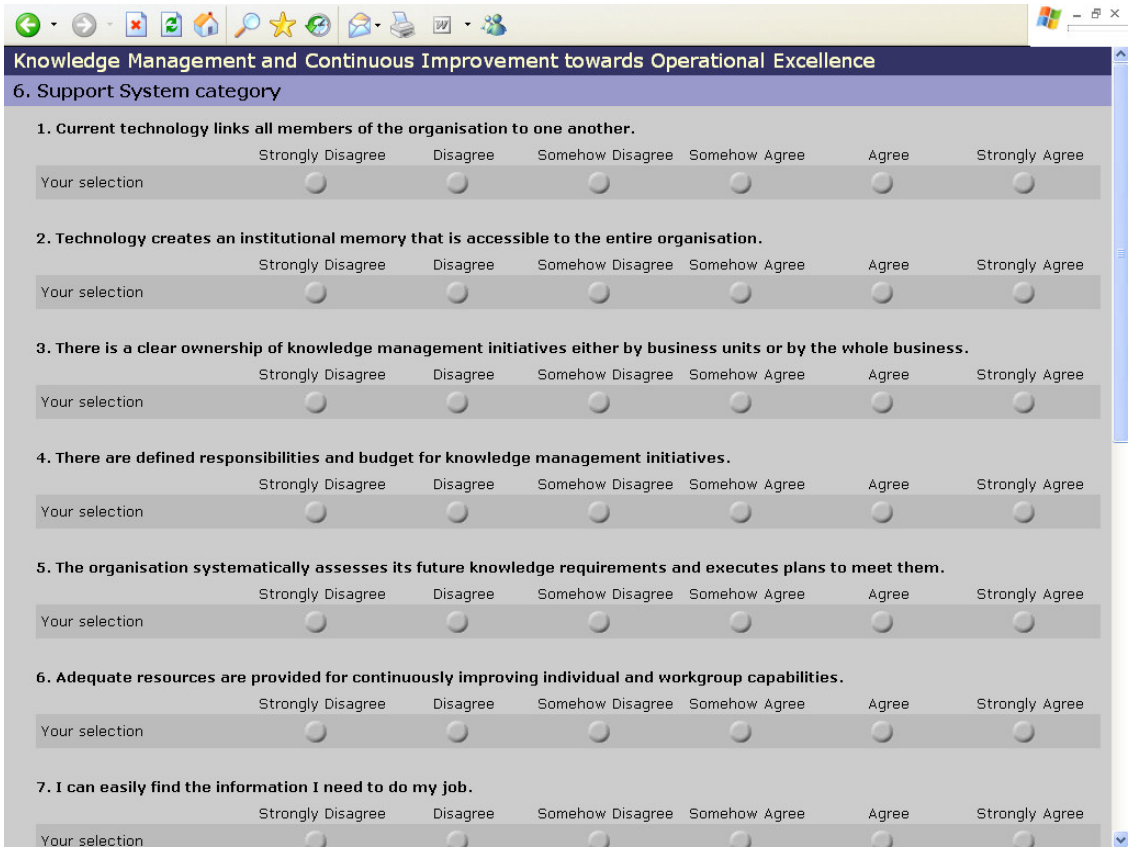
The ‘Development and Culture category’ screen:



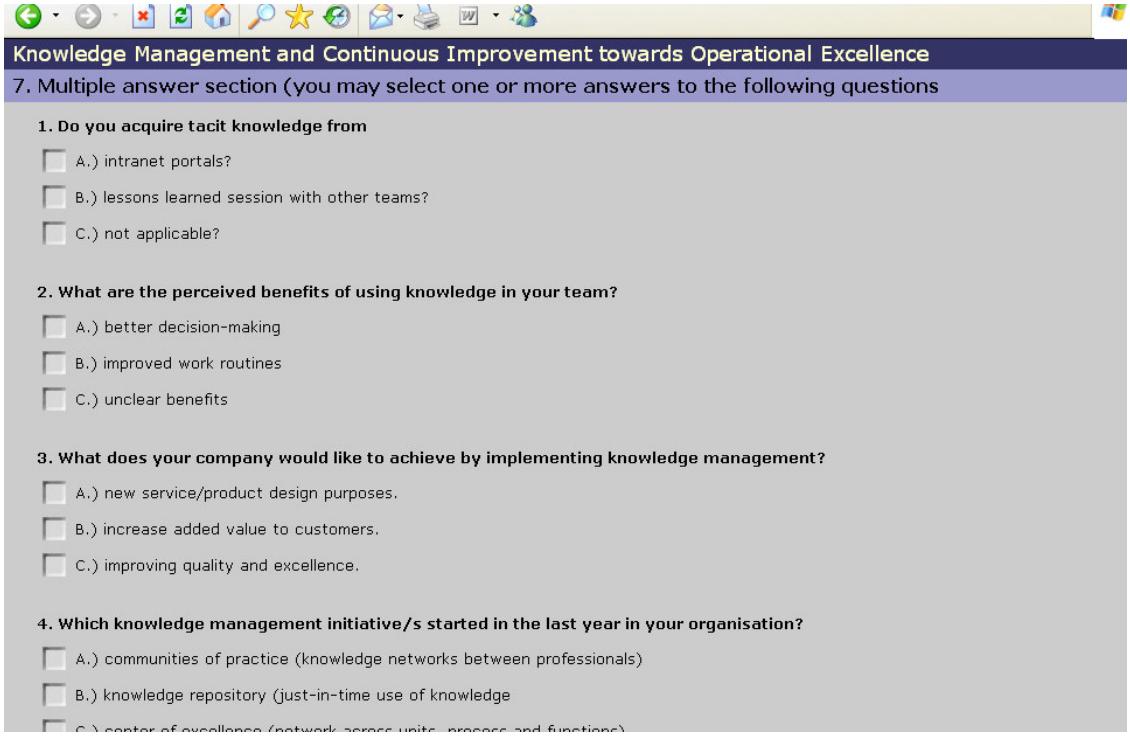
The ‘Process Category’ screen:



The ‘Support System category’ screen:



The ‘Multiple answer section’ screen:



Appendix B Statistical results from using statistical analysis software

Statistics on the development and culture dependant variables:

Series #1 (Var1)

Count	6	LCL	3.051568
Mean	6.666666667	UCL	10.28177
Standard Deviation	3.444802849	Skewness	-0.20604
Standard Error (of Mean)	1.406334874	Skewness Standard Error	0.690066
Minimum	2	Kurtosis	1.378993
Maximum	10	Kurtosis Standard Error	0.835573
Range	8	Alternative Skewness (Fisher's)	-0.28214
Sum	40	Alternative Kurtosis (Fisher's)	-2.22794
Sum Standard Error	8.438009244	Coefficient of Variation	0.51672
Total Sum Squares	326	Mean Deviation	3
Adjusted Sum Squares	59.33333333	Second Moment	9.888889
Geometric Mean	5.746239857	Third Moment	-6.40741
Harmonic Mean	4.757709251	Fourth Moment	134.8519
Mode	10	Median	7
Variance	11.86666667	Median Error	0.71957
		Significance Level	0.05

Series #2 (Var2)

Count	6	LCL	1.989118
Mean	6.666666667	UCL	11.34422
Standard Deviation	4.457203907	Skewness	0.241371
Standard Error (of Mean)	1.819645875	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	1.646547
Maximum	12	Kurtosis Standard Error	0.835573
Range	11	Alternative Skewness (Fisher's)	0.330511
Sum	40	Alternative Kurtosis (Fisher's)	-1.44757
Sum Standard Error	10.91787525	Coefficient of Variation	0.668581
Total Sum Squares	366	Mean Deviation	3.555556
Adjusted Sum Squares	99.33333333	Second Moment	16.55556
Geometric Mean	5.084605814	Third Moment	16.25926
Harmonic Mean	3.364485981	Fourth Moment	451.2963
Mode	12	Median	5.5
Variance	19.86666667	Median Error	0.931046
		Significance Level	0.05

Series #3 (Var3)

Count	6	LCL	2.539479
Mean	6.666666667	UCL	10.79385
Standard Deviation	3.932768321	Skewness	-0.13847

Standard Error (of Mean)	1.605545944	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	1.792955
Maximum	11	Kurtosis Standard Error	0.835573
		Alternative Skewness	
Range	10	(Fisher's)	-0.18961
Sum	40	Alternative Kurtosis (Fisher's)	-1.02055
Sum Standard Error	9.633275663	Coefficient of Variation	0.589915
Total Sum Squares	344	Mean Deviation	3
Adjusted Sum Squares	77.33333333	Second Moment	12.88889
Geometric Mean	5.224151649	Third Moment	-6.40741
Harmonic Mean	3.445618397	Fourth Moment	297.8519
Mode	11	Median	6.5
Variance	15.46666667	Median Error	0.821499
		Significance Level	0.05

Series #4 (Var4)

Count	6	LCL	1.849921
Mean	6.666666667	UCL	11.48341
Standard Deviation	4.589843861	Skewness	0.887197
Standard Error (of Mean)	1.87379591	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	3.169925
Maximum	15	Kurtosis Standard Error	0.835573
		Alternative Skewness	
Range	14	(Fisher's)	1.214845
Sum	40	Alternative Kurtosis (Fisher's)	2.995614
Sum Standard Error	11.24277546	Coefficient of Variation	0.688477
Total Sum Squares	372	Mean Deviation	2.888889
Adjusted Sum Squares	105.3333333	Second Moment	17.55556
Geometric Mean	5.161116163	Third Moment	65.25926
Harmonic Mean	3.442622951	Fourth Moment	976.963
Mode	6	Median	6
Variance	21.06666667	Median Error	0.958753
		Significance Level	0.05

Series #5 (Var5)

Count	6	LCL	0.523508
Mean	6.666666667	UCL	12.80983
Standard Deviation	5.853773712	Skewness	1.404118
Standard Error (of Mean)	2.389793111	Skewness Standard Error	0.690066
Minimum	2	Kurtosis	3.516344
Maximum	18	Kurtosis Standard Error	0.835573
		Alternative Skewness	
Range	16	(Fisher's)	1.922668
Sum	40	Alternative Kurtosis (Fisher's)	4.006003
Sum Standard Error	14.33875866	Coefficient of Variation	0.878066
Total Sum Squares	438	Mean Deviation	3.888889
Adjusted Sum Squares	171.3333333	Second Moment	28.55556
Geometric Mean	5.126120837	Third Moment	214.2593

Harmonic Mean		4.142465753	Fourth Moment	2867.296
Mode	#N/A		Median	5
Variance		34.26666667	Median Error	1.22277
			Significance Level	0.05

Series #6 (Var6)

Count		6	LCL	0.523508
Mean		6.666666667	UCL	12.80983
Standard Deviation		5.853773712	Skewness	0.912616
Standard Error (of Mean)		2.389793111	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	2.621099
Maximum		17	Kurtosis Standard Error	0.835573
			Alternative Skewness	
Range		16	(Fisher's)	1.249651
Sum		40	Alternative Kurtosis (Fisher's)	1.394874
Sum Standard Error		14.33875866	Coefficient of Variation	0.878066
Total Sum Squares		438	Mean Deviation	4.333333
Adjusted Sum Squares		171.3333333	Second Moment	28.55556
Geometric Mean		4.613232363	Third Moment	139.2593
Harmonic Mean		3.031132075	Fourth Moment	2137.296
Mode		3	Median	5
Variance		34.26666667	Median Error	1.22277
			Significance Level	0.05

Series #7 (Var7)

Count		6	LCL	-1.23314
Mean		6.5	UCL	14.23314
Standard Deviation		7.368853371	Skewness	0.931376
Standard Error (of Mean)		3.008321791	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	2.235127
Maximum		19	Kurtosis Standard Error	0.835573
			Alternative Skewness	
Range		18	(Fisher's)	1.27534
Sum		39	Alternative Kurtosis (Fisher's)	0.269121
Sum Standard Error		18.04993075	Coefficient of Variation	1.13367
Total Sum Squares		525	Mean Deviation	6
Adjusted Sum Squares		271.5	Second Moment	45.25
Geometric Mean		3.564753954	Third Moment	283.5
Harmonic Mean		2.14084507	Fourth Moment	4576.563
Mode	#N/A		Median	3
Variance		54.3	Median Error	1.539248
			Significance Level	0.05

Series #8 (Var8)

Count		6	LCL	0.595641
Mean		6.666666667	UCL	12.73769
Standard Deviation		5.785038173	Skewness	0.126239
Standard Error (of Mean)		2.361731945	Skewness Standard Error	0.690066
Minimum		0	Kurtosis	1.363074

Maximum		14	Kurtosis Standard Error	0.835573
Range		14	Alternative Skewness (Fisher's)	0.17286
Sum		40	Alternative Kurtosis (Fisher's)	-2.27437
Sum Standard Error		14.17039167	Coefficient of Variation	0.867756
Total Sum Squares		434	Mean Deviation	5
Adjusted Sum Squares		167.3333333	Second Moment	27.88889
Geometric Mean		4.566854483	Third Moment	18.59259
Harmonic Mean		5.458483755	Fourth Moment	1060.185
Mode	#N/A		Median	6
Variance		33.46666667	Median Error	1.208412
			Significance Level	0.05

Series #9 (Var9)

Count		6	LCL	0.893181
Mean		6.666666667	UCL	12.44015
Standard Deviation		5.501514943	Skewness	0.662554
Standard Error (of Mean)		2.24598407	Skewness Standard Error	0.690066
Minimum		2	Kurtosis	1.739195
Maximum		15	Kurtosis Standard Error	0.835573
Range		13	Alternative Skewness (Fisher's)	0.907239
Sum		40	Alternative Kurtosis (Fisher's)	-1.17735
Sum Standard Error		13.47590442	Coefficient of Variation	0.825227
Total Sum Squares		418	Mean Deviation	4.555556
Adjusted Sum Squares		151.3333333	Second Moment	25.22222
Geometric Mean		4.932424149	Third Moment	83.92593
Harmonic Mean		3.75	Fourth Moment	1106.407
Mode		2	Median	4.5
Variance		30.26666667	Median Error	1.149188
			Significance Level	0.05

Series #10 (Var10)

Count		6	LCL	2.230809
Mean		6.666666667	UCL	11.10252
Standard Deviation		4.226897996	Skewness	-0.44225
Standard Error (of Mean)		1.725623881	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	1.512029
Maximum		11	Kurtosis Standard Error	0.835573
Range		10	Alternative Skewness (Fisher's)	-0.60557
Sum		40	Alternative Kurtosis (Fisher's)	-1.83991
Sum Standard Error		10.35374328	Coefficient of Variation	0.634035
Total Sum Squares		356	Mean Deviation	3.444444
Adjusted Sum Squares		89.33333333	Second Moment	14.88889
Geometric Mean		4.901103475	Third Moment	-25.4074
Harmonic Mean		3.085027452	Fourth Moment	335.1852
Mode	#N/A		Median	8

Variance		17.86666667	Median Error	0.882939
			Significance Level	0.05
Series #11 (Var11)				
Count		6	LCL	0.20887
Mean		6.666666667	UCL	13.12446
Standard Deviation		6.153589738	Skewness	1.141024
Standard Error (of Mean)		2.512192491	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	2.978948
Maximum		18	Kurtosis Standard Error	0.835573
Range		17	Alternative Skewness (Fisher's)	1.562411
Sum		40	Alternative Kurtosis (Fisher's)	2.438597
Sum Standard Error		15.07315495	Coefficient of Variation	0.923038
Total Sum Squares		456	Mean Deviation	4.555556
Adjusted Sum Squares		189.3333333	Second Moment	31.55556
Geometric Mean		4.619670965	Third Moment	202.2593
Harmonic Mean		3.076923077	Fourth Moment	2966.296
Mode	#N/A		Median	4.5
Variance		37.86666667	Median Error	1.285397
			Significance Level	0.05
Series #12 (Var12)				
Count		6	LCL	0.632032
Mean		6.666666667	UCL	12.7013
Standard Deviation		5.750362307	Skewness	0.305978
Standard Error (of Mean)		2.347575582	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	1.45171
Maximum		14	Kurtosis Standard Error	0.835573
Range		13	Alternative Skewness (Fisher's)	0.418978
Sum		40	Alternative Kurtosis (Fisher's)	-2.01584
Sum Standard Error		14.08545349	Coefficient of Variation	0.862554
Total Sum Squares		432	Mean Deviation	4.666667
Adjusted Sum Squares		165.3333333	Second Moment	27.55556
Geometric Mean		4.1483135	Third Moment	44.25926
Harmonic Mean		2.361081081	Fourth Moment	1102.296
Mode		1	Median	5.5
Variance		33.06666667	Median Error	1.201168
			Significance Level	0.05
Series #13 (Var13)				
Count		6	LCL	-0.533
Mean		6.666666667	UCL	13.86634
Standard Deviation		6.860515044	Skewness	0.817971
Standard Error (of Mean)		2.800793538	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	2.109406
Maximum		18	Kurtosis Standard Error	0.835573
Range		17	Alternative Skewness	1.120052

			(Fisher's)	
Sum		40	Alternative Kurtosis (Fisher's)	-0.09757
Sum Standard Error		16.80476123	Coefficient of Variation	1.029077
Total Sum Squares		502	Mean Deviation	5.555556
Adjusted Sum Squares		235.3333333	Second Moment	39.22222
Geometric Mean		3.888322594	Third Moment	200.9259
Harmonic Mean		2.273684211	Fourth Moment	3245.074
Mode	#N/A		Median	4
Variance		47.06666667	Median Error	1.433063
			Significance Level	0.05

Statistics on the process dependant variables:

Series #1 (Var1)

Count		6	LCL	1.855155
Mean		7.666666667	UCL	13.47818
Standard Deviation		5.537749242	Skewness	0.613511
Standard Error (of Mean)		2.260776661	Skewness Standard Error	0.690066
Minimum		2	Kurtosis	1.761323
Maximum		16	Kurtosis Standard Error	0.835573
			Alternative Skewness	
Range		14	(Fisher's)	0.840084
Sum		46	Alternative Kurtosis (Fisher's)	-1.11281
Sum Standard Error		13.56465997	Coefficient of Variation	0.722315
Total Sum Squares		506	Mean Deviation	4.555556
Adjusted Sum Squares		153.3333333	Second Moment	25.55556
Geometric Mean		6.068002664	Third Moment	79.25926
Harmonic Mean		4.776728757	Fourth Moment	1150.296
Mode	#N/A		Median	5.5
Variance		30.66666667	Median Error	1.156757
			Significance Level	0.05

Series #2 (Var2)

Count		6	LCL	-0.39875
Mean		7.666666667	UCL	15.73209
Standard Deviation		7.685484153	Skewness	0.521017
Standard Error (of Mean)		3.137585767	Skewness Standard Error	0.690066
Minimum		0	Kurtosis	1.711392
Maximum		19	Kurtosis Standard Error	0.835573
			Alternative Skewness	
Range		19	(Fisher's)	0.713432
Sum		46	Alternative Kurtosis (Fisher's)	-1.25844
Sum Standard Error		18.8255146	Coefficient of Variation	1.002454
Total Sum Squares		648	Mean Deviation	6.222222
Adjusted Sum Squares		295.3333333	Second Moment	49.22222
Geometric Mean		4.521970094	Third Moment	179.9259
Harmonic Mean		4.037780401	Fourth Moment	4146.407
Mode	#N/A		Median	5.5

Variance	59.06666667	Median Error	1.605388
		Significance Level	0.05

Series #3 (Var3)

Count	6	LCL	0.974371
Mean	7.666666667	UCL	14.35896
Standard Deviation	6.377042157	Skewness	0.570721
Standard Error (of Mean)	2.603416559	Skewness Standard Error	0.690066
Minimum	0	Kurtosis	2.235625
Maximum	18	Kurtosis Standard Error	0.835573
Range	18	Alternative Skewness (Fisher's)	0.781492
Sum	46	Alternative Kurtosis (Fisher's)	0.270572
Sum Standard Error	15.62049935	Coefficient of Variation	0.831788
Total Sum Squares	556	Mean Deviation	4.888889
Adjusted Sum Squares	203.3333333	Second Moment	33.88889
Geometric Mean	5.607931591	Third Moment	112.5926
Harmonic Mean	8.307692308	Fourth Moment	2567.519
Mode	6	Median	6
Variance	40.66666667	Median Error	1.332073
		Significance Level	0.05

Series #4 (Var4)

Count	6	LCL	0.941539
Mean	7.666666667	UCL	14.39179
Standard Deviation	6.408327915	Skewness	0.389242
Standard Error (of Mean)	2.616188916	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	1.61157
Maximum	17	Kurtosis Standard Error	0.835573
Range	16	Alternative Skewness (Fisher's)	0.532992
Sum	46	Alternative Kurtosis (Fisher's)	-1.54959
Sum Standard Error	15.6971335	Coefficient of Variation	0.835869
Total Sum Squares	558	Mean Deviation	5.333333
Adjusted Sum Squares	205.3333333	Second Moment	34.22222
Geometric Mean	5.114614224	Third Moment	77.92593
Harmonic Mean	3.135575407	Fourth Moment	1887.407
Mode	3	Median	6
Variance	41.06666667	Median Error	1.338608
		Significance Level	0.05

Series #5 (Var5)

Count	6	LCL	3.539479
Mean	7.666666667	UCL	11.79385
Standard Deviation	3.932768321	Skewness	-0.3978
Standard Error (of Mean)	1.605545944	Skewness Standard Error	0.690066
Minimum	2	Kurtosis	1.696641
Maximum	12	Kurtosis Standard Error	0.835573
Range	10	Alternative Skewness	-0.54472

			(Fisher's)	
Sum		46	Alternative Kurtosis (Fisher's)	-1.30146
Sum Standard Error		9.633275663	Coefficient of Variation	0.51297
Total Sum Squares		430	Mean Deviation	3.111111
Adjusted Sum Squares		77.33333333	Second Moment	12.88889
Geometric Mean		6.508777153	Third Moment	-18.4074
Harmonic Mean		5.170837867	Fourth Moment	281.8519
Mode	#N/A		Median	8.5
Variance		15.46666667	Median Error	0.821499
			Significance Level	0.05
Series #6 (Var6)				
Count		6	LCL	0.779724
Mean		7.666666667	UCL	14.55361
Standard Deviation		6.562519841	Skewness	0.663219
Standard Error (of Mean)		2.679137506	Skewness Standard Error	0.690066
Minimum		2	Kurtosis	1.580874
Maximum		17	Kurtosis Standard Error	0.835573
			Alternative Skewness	
Range		15	(Fisher's)	0.90815
Sum		46	Alternative Kurtosis (Fisher's)	-1.63912
Sum Standard Error		16.07482504	Coefficient of Variation	0.855981
Total Sum Squares		568	Mean Deviation	5.555556
Adjusted Sum Squares		215.3333333	Second Moment	35.88889
Geometric Mean		5.592683439	Third Moment	142.5926
Harmonic Mean		4.258872651	Fourth Moment	2036.185
Mode	#N/A		Median	4.5
Variance		43.06666667	Median Error	1.370816
			Significance Level	0.05
Series #7 (Var7)				
Count		6	LCL	-0.31641
Mean		7.666666667	UCL	15.64974
Standard Deviation		7.607014307	Skewness	0.812044
Standard Error (of Mean)		3.105550586	Skewness Standard Error	0.690066
Minimum		0	Kurtosis	2.657086
Maximum		21	Kurtosis Standard Error	0.835573
			Alternative Skewness	
Range		21	(Fisher's)	1.111938
Sum		46	Alternative Kurtosis (Fisher's)	1.499833
Sum Standard Error		18.63330352	Coefficient of Variation	0.992219
Total Sum Squares		642	Mean Deviation	5.333333
Adjusted Sum Squares		289.3333333	Second Moment	48.22222
Geometric Mean		4.64775709	Third Moment	271.9259
Harmonic Mean		4.168734491	Fourth Moment	6178.741
Mode	#N/A		Median	7
Variance		57.86666667	Median Error	1.588996
			Significance Level	0.05

Series #8 (Var8)

Count	6	LCL	0.87635
Mean	7.666666667	UCL	14.45698
Standard Deviation	6.470445631	Skewness	0.119337
Standard Error (of Mean)	2.641548367	Skewness Standard Error	0.690066
Minimum	0	Kurtosis	1.830804
Maximum	17	Kurtosis Standard Error	0.835573
Range	17	Alternative Skewness (Fisher's)	0.163408
Sum	46	Alternative Kurtosis (Fisher's)	-0.91015
Sum Standard Error	15.8492902	Coefficient of Variation	0.843971
Total Sum Squares	562	Mean Deviation	4.777778
Adjusted Sum Squares	209.3333333	Second Moment	34.88889
Geometric Mean	4.852531429	Third Moment	24.59259
Harmonic Mean	4.309859155	Fourth Moment	2228.519
Mode	8	Median	8
Variance	41.86666667	Median Error	1.351583
		Significance Level	0.05

Series #9 (Var9)

Count	6	LCL	-0.37426
Mean	7.5	UCL	15.37426
Standard Deviation	7.503332593	Skewness	1.026888
Standard Error (of Mean)	3.063222704	Skewness Standard Error	0.690066
Minimum	0	Kurtosis	2.79157
Maximum	21	Kurtosis Standard Error	0.835573
Range	21	Alternative Skewness (Fisher's)	1.406125
Sum	45	Alternative Kurtosis (Fisher's)	1.892078
Sum Standard Error	18.37933622	Coefficient of Variation	1.000444
Total Sum Squares	619	Mean Deviation	5.666667
Adjusted Sum Squares	281.5	Second Moment	46.91667
Geometric Mean	5.141821483	Third Moment	330
Harmonic Mean	7.155394941	Fourth Moment	6144.729
Mode	4	Median	4.5
Variance	56.3	Median Error	1.567339
		Significance Level	0.05

Series #10 (Var10)

Count	6	LCL	-0.9532
Mean	7.666666667	UCL	16.28653
Standard Deviation	8.21380951	Skewness	0.521692
Standard Error (of Mean)	3.353273691	Skewness Standard Error	0.690066
Minimum	0	Kurtosis	1.74634
Maximum	20	Kurtosis Standard Error	0.835573
Range	20	Alternative Skewness (Fisher's)	0.714357
Sum	46	Alternative Kurtosis (Fisher's)	-1.15651

Sum Standard Error		20.11964214	Coefficient of Variation	1.071366
Total Sum Squares		690	Mean Deviation	6.555556
Adjusted Sum Squares		337.3333333	Second Moment	56.22222
Geometric Mean		4.508650257	Third Moment	219.9259
Harmonic Mean		11.77570093	Fourth Moment	5520.074
Mode		0	Median	5.5
Variance		67.46666667	Median Error	1.715747
			Significance Level	0.05
Series #11 (Var11)				
Count		6	LCL	-0.3714
Mean		7.666666667	UCL	15.70473
Standard Deviation		7.659416862	Skewness	0.841322
Standard Error (of Mean)		3.12694384	Skewness Standard Error	0.690066
Minimum		0	Kurtosis	2.537882
Maximum		21	Kurtosis Standard Error	0.835573
Range		21	Alternative Skewness (Fisher's)	1.152028
Sum		46	Alternative Kurtosis (Fisher's)	1.152157
Sum Standard Error		18.76166304	Coefficient of Variation	0.999054
Total Sum Squares		646	Mean Deviation	5.666667
Adjusted Sum Squares		293.3333333	Second Moment	48.88889
Geometric Mean		4.954106353	Third Moment	287.5926
Harmonic Mean		5.919914576	Fourth Moment	6065.852
Mode	#N/A		Median	6
Variance		58.66666667	Median Error	1.599943
			Significance Level	0.05
Series #12 (Var12)				
Count		6	LCL	2.412497
Mean		7.666666667	UCL	12.92084
Standard Deviation		5.006662228	Skewness	0.51945
Standard Error (of Mean)		2.043961296	Skewness Standard Error	0.690066
Minimum		2	Kurtosis	2.418232
Maximum		16	Kurtosis Standard Error	0.835573
Range		14	Alternative Skewness (Fisher's)	0.711286
Sum		46	Alternative Kurtosis (Fisher's)	0.803177
Sum Standard Error		12.26376777	Coefficient of Variation	0.653043
Total Sum Squares		478	Mean Deviation	3.444444
Adjusted Sum Squares		125.3333333	Second Moment	20.88889
Geometric Mean		6.172327377	Third Moment	49.59259
Harmonic Mean		4.773480663	Fourth Moment	1055.185
Mode		8	Median	8
Variance		25.06666667	Median Error	1.04582
			Significance Level	0.05
Series #13 (Var13)				
Count		6	LCL	0.706981

Mean		7.5	UCL	14.29302
Standard Deviation		6.473020933	Skewness	0.814254
Standard Error (of Mean)		2.64259973	Skewness Standard Error	0.690066
Minimum		2	Kurtosis	1.993751
Maximum		18	Kurtosis Standard Error	0.835573
Range		16	Alternative Skewness (Fisher's)	1.114964
Sum		45	Alternative Kurtosis (Fisher's)	-0.43489
Sum Standard Error		15.85559838	Coefficient of Variation	0.863069
Total Sum Squares		547	Mean Deviation	5.333333
Adjusted Sum Squares		209.5	Second Moment	34.91667
Geometric Mean		5.513146299	Third Moment	168
Harmonic Mean		4.23785089	Fourth Moment	2430.729
Mode	#N/A		Median	4.5
Variance		41.9	Median Error	1.352121
			Significance Level	0.05

Series #14 (Var14)

Count		6	LCL	-3.06977
Mean		7.666666667	UCL	18.4031
Standard Deviation		10.23067284	Skewness	1.3024
Standard Error (of Mean)		4.176654695	Skewness Standard Error	0.690066
Minimum		0	Kurtosis	3.19672
Maximum		27	Kurtosis Standard Error	0.835573
Range		27	Alternative Skewness (Fisher's)	1.783384
Sum		46	Alternative Kurtosis (Fisher's)	3.073768
Sum Standard Error		25.05992817	Coefficient of Variation	1.334436
Total Sum Squares		876	Mean Deviation	7.555556
Adjusted Sum Squares		523.3333333	Second Moment	87.22222
Geometric Mean		3.908315508	Third Moment	1060.926
Harmonic Mean		3.506148549	Fourth Moment	24319.74
Mode	#N/A		Median	3.5
Variance		104.6666667	Median Error	2.137041
			Significance Level	0.05

Series #15 (Var15)

Count		6	LCL	1.107344
Mean		7.666666667	UCL	14.22599
Standard Deviation		6.250333324	Skewness	0.076764
Standard Error (of Mean)		2.551687895	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	1.462417
Maximum		16	Kurtosis Standard Error	0.835573
Range		15	Alternative Skewness (Fisher's)	0.105114
Sum		46	Alternative Kurtosis (Fisher's)	-1.98462
Sum Standard Error		15.31012737	Coefficient of Variation	0.815261
Total Sum Squares		548	Mean Deviation	5.333333

Adjusted Sum Squares	195.3333333	Second Moment	32.55556
Geometric Mean	4.683932772	Third Moment	14.25926
Harmonic Mean	2.462303746	Fourth Moment	1549.963
Mode	1	Median	8
Variance	39.06666667	Median Error	1.305605
		Significance Level	0.05

Statistics on the support system dependant variables:

Series #1 (Var1)			
Count	6	LCL	3.051568
Mean	6.666666667	UCL	10.28177
Standard Deviation	3.444802849	Skewness	-0.20604
Standard Error (of Mean)	1.406334874	Skewness Standard Error	0.690066
Minimum	2	Kurtosis	1.378993
Maximum	10	Kurtosis Standard Error	0.835573
Range	8	Alternative Skewness (Fisher's)	-0.28214
Sum	40	Alternative Kurtosis (Fisher's)	-2.22794
Sum Standard Error	8.438009244	Coefficient of Variation	0.51672
Total Sum Squares	326	Mean Deviation	3
Adjusted Sum Squares	59.33333333	Second Moment	9.888889
Geometric Mean	5.746239857	Third Moment	-6.40741
Harmonic Mean	4.757709251	Fourth Moment	134.8519
Mode	10	Median	7
Variance	11.86666667	Median Error	0.71957
		Significance Level	0.05

Series #2 (Var2)			
Count	6	LCL	1.989118
Mean	6.666666667	UCL	11.34422
Standard Deviation	4.457203907	Skewness	0.241371
Standard Error (of Mean)	1.819645875	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	1.646547
Maximum	12	Kurtosis Standard Error	0.835573
Range	11	Alternative Skewness (Fisher's)	0.330511
Sum	40	Alternative Kurtosis (Fisher's)	-1.44757
Sum Standard Error	10.91787525	Coefficient of Variation	0.668581
Total Sum Squares	366	Mean Deviation	3.555556
Adjusted Sum Squares	99.33333333	Second Moment	16.55556
Geometric Mean	5.084605814	Third Moment	16.25926
Harmonic Mean	3.364485981	Fourth Moment	451.2963
Mode	12	Median	5.5
Variance	19.86666667	Median Error	0.931046
		Significance Level	0.05

Series #3 (Var3)			
Count	6	LCL	2.539479
Mean	6.666666667	UCL	10.79385
Standard Deviation	3.932768321	Skewness	-0.13847
Standard Error (of Mean)	1.605545944	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	1.792955

Maximum	11	Kurtosis Standard Error	0.835573
Range	10	Alternative Skewness (Fisher's)	-0.18961
Sum	40	Alternative Kurtosis (Fisher's)	-1.02055
Sum Standard Error	9.633275663	Coefficient of Variation	0.589915
Total Sum Squares	344	Mean Deviation	3
Adjusted Sum Squares	77.33333333	Second Moment	12.88889
Geometric Mean	5.224151649	Third Moment	-6.40741
Harmonic Mean	3.445618397	Fourth Moment	297.8519
Mode	11	Median	6.5
Variance	15.46666667	Median Error	0.821499
		Significance Level	0.05

Series #4 (Var4)

Count	6	LCL	1.849921
Mean	6.666666667	UCL	11.48341
Standard Deviation	4.589843861	Skewness	0.887197
Standard Error (of Mean)	1.87379591	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	3.169925
Maximum	15	Kurtosis Standard Error	0.835573
Range	14	Alternative Skewness (Fisher's)	1.214845
Sum	40	Alternative Kurtosis (Fisher's)	2.995614
Sum Standard Error	11.24277546	Coefficient of Variation	0.688477
Total Sum Squares	372	Mean Deviation	2.888889
Adjusted Sum Squares	105.3333333	Second Moment	17.55556
Geometric Mean	5.161116163	Third Moment	65.25926
Harmonic Mean	3.442622951	Fourth Moment	976.963
Mode	6	Median	6
Variance	21.06666667	Median Error	0.958753
		Significance Level	0.05

Series #5 (Var5)

Count	6	LCL	0.523508
Mean	6.666666667	UCL	12.80983
Standard Deviation	5.853773712	Skewness	1.404118
Standard Error (of Mean)	2.389793111	Skewness Standard Error	0.690066
Minimum	2	Kurtosis	3.516344
Maximum	18	Kurtosis Standard Error	0.835573
Range	16	Alternative Skewness (Fisher's)	1.922668
Sum	40	Alternative Kurtosis (Fisher's)	4.006003
Sum Standard Error	14.33875866	Coefficient of Variation	0.878066
Total Sum Squares	438	Mean Deviation	3.888889
Adjusted Sum Squares	171.3333333	Second Moment	28.55556
Geometric Mean	5.126120837	Third Moment	214.2593
Harmonic Mean	4.142465753	Fourth Moment	2867.296
Mode	#N/A	Median	5

Variance	34.26666667	Median Error	1.22277
		Significance Level	0.05

Series #6 (Var6)

Count	6	LCL	0.523508
Mean	6.666666667	UCL	12.80983
Standard Deviation	5.853773712	Skewness	0.912616
Standard Error (of Mean)	2.389793111	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	2.621099
Maximum	17	Kurtosis Standard Error	0.835573
Range	16	Alternative Skewness (Fisher's)	1.249651
Sum	40	Alternative Kurtosis (Fisher's)	1.394874
Sum Standard Error	14.33875866	Coefficient of Variation	0.878066
Total Sum Squares	438	Mean Deviation	4.333333
Adjusted Sum Squares	171.3333333	Second Moment	28.55556
Geometric Mean	4.613232363	Third Moment	139.2593
Harmonic Mean	3.031132075	Fourth Moment	2137.296
Mode	3	Median	5
Variance	34.26666667	Median Error	1.22277
		Significance Level	0.05

Series #7 (Var7)

Count	6	LCL	-1.23314
Mean	6.5	UCL	14.23314
Standard Deviation	7.368853371	Skewness	0.931376
Standard Error (of Mean)	3.008321791	Skewness Standard Error	0.690066
Minimum	1	Kurtosis	2.235127
Maximum	19	Kurtosis Standard Error	0.835573
Range	18	Alternative Skewness (Fisher's)	1.27534
Sum	39	Alternative Kurtosis (Fisher's)	0.269121
Sum Standard Error	18.04993075	Coefficient of Variation	1.13367
Total Sum Squares	525	Mean Deviation	6
Adjusted Sum Squares	271.5	Second Moment	45.25
Geometric Mean	3.564753954	Third Moment	283.5
Harmonic Mean	2.14084507	Fourth Moment	4576.563
Mode	#N/A	Median	3
Variance	54.3	Median Error	1.539248
		Significance Level	0.05

Series #8 (Var8)

Count	6	LCL	0.595641
Mean	6.666666667	UCL	12.73769
Standard Deviation	5.785038173	Skewness	0.126239
Standard Error (of Mean)	2.361731945	Skewness Standard Error	0.690066
Minimum	0	Kurtosis	1.363074
Maximum	14	Kurtosis Standard Error	0.835573
Range	14	Alternative Skewness	0.17286

			(Fisher's)	
Sum		40	Alternative Kurtosis (Fisher's)	-2.27437
Sum Standard Error		14.17039167	Coefficient of Variation	0.867756
Total Sum Squares		434	Mean Deviation	5
Adjusted Sum Squares		167.3333333	Second Moment	27.88889
Geometric Mean		4.566854483	Third Moment	18.59259
Harmonic Mean		5.458483755	Fourth Moment	1060.185
Mode	#N/A		Median	6
Variance		33.46666667	Median Error	1.208412
			Significance Level	0.05
Series #9 (Var9)				
Count		6	LCL	0.893181
Mean		6.666666667	UCL	12.44015
Standard Deviation		5.501514943	Skewness	0.662554
Standard Error (of Mean)		2.24598407	Skewness Standard Error	0.690066
Minimum		2	Kurtosis	1.739195
Maximum		15	Kurtosis Standard Error	0.835573
			Alternative Skewness	
Range		13	(Fisher's)	0.907239
Sum		40	Alternative Kurtosis (Fisher's)	-1.17735
Sum Standard Error		13.47590442	Coefficient of Variation	0.825227
Total Sum Squares		418	Mean Deviation	4.555556
Adjusted Sum Squares		151.3333333	Second Moment	25.22222
Geometric Mean		4.932424149	Third Moment	83.92593
Harmonic Mean		3.75	Fourth Moment	1106.407
Mode		2	Median	4.5
Variance		30.26666667	Median Error	1.149188
			Significance Level	0.05
Series #10 (Var10)				
Count		6	LCL	2.230809
Mean		6.666666667	UCL	11.10252
Standard Deviation		4.226897996	Skewness	-0.44225
Standard Error (of Mean)		1.725623881	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	1.512029
Maximum		11	Kurtosis Standard Error	0.835573
			Alternative Skewness	
Range		10	(Fisher's)	-0.60557
Sum		40	Alternative Kurtosis (Fisher's)	-1.83991
Sum Standard Error		10.35374328	Coefficient of Variation	0.634035
Total Sum Squares		356	Mean Deviation	3.444444
Adjusted Sum Squares		89.33333333	Second Moment	14.88889
Geometric Mean		4.901103475	Third Moment	-25.4074
Harmonic Mean		3.085027452	Fourth Moment	335.1852
Mode	#N/A		Median	8
Variance		17.86666667	Median Error	0.882939
			Significance Level	0.05

Series #11 (Var11)

Count		6	LCL	0.20887
Mean		6.666666667	UCL	13.12446
Standard Deviation		6.153589738	Skewness	1.141024
Standard Error (of Mean)		2.512192491	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	2.978948
Maximum		18	Kurtosis Standard Error	0.835573
Range		17	Alternative Skewness (Fisher's)	1.562411
Sum		40	Alternative Kurtosis (Fisher's)	2.438597
Sum Standard Error		15.07315495	Coefficient of Variation	0.923038
Total Sum Squares		456	Mean Deviation	4.555556
Adjusted Sum Squares		189.3333333	Second Moment	31.55556
Geometric Mean		4.619670965	Third Moment	202.2593
Harmonic Mean		3.076923077	Fourth Moment	2966.296
Mode	#N/A		Median	4.5
Variance		37.86666667	Median Error	1.285397
			Significance Level	0.05

Series #12 (Var12)

Count		6	LCL	0.632032
Mean		6.666666667	UCL	12.7013
Standard Deviation		5.750362307	Skewness	0.305978
Standard Error (of Mean)		2.347575582	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	1.45171
Maximum		14	Kurtosis Standard Error	0.835573
Range		13	Alternative Skewness (Fisher's)	0.418978
Sum		40	Alternative Kurtosis (Fisher's)	-2.01584
Sum Standard Error		14.08545349	Coefficient of Variation	0.862554
Total Sum Squares		432	Mean Deviation	4.666667
Adjusted Sum Squares		165.3333333	Second Moment	27.55556
Geometric Mean		4.1483135	Third Moment	44.25926
Harmonic Mean		2.361081081	Fourth Moment	1102.296
Mode		1	Median	5.5
Variance		33.06666667	Median Error	1.201168
			Significance Level	0.05

Series #13 (Var13)

Count		6	LCL	-0.533
Mean		6.666666667	UCL	13.86634
Standard Deviation		6.860515044	Skewness	0.817971
Standard Error (of Mean)		2.800793538	Skewness Standard Error	0.690066
Minimum		1	Kurtosis	2.109406
Maximum		18	Kurtosis Standard Error	0.835573
Range		17	Alternative Skewness (Fisher's)	1.120052
Sum		40	Alternative Kurtosis (Fisher's)	-0.09757

Sum Standard Error		16.80476123	Coefficient of Variation	1.029077
Total Sum Squares		502	Mean Deviation	5.555556
Adjusted Sum Squares		235.3333333	Second Moment	39.22222
Geometric Mean		3.888322594	Third Moment	200.9259
Harmonic Mean		2.273684211	Fourth Moment	3245.074
Mode	#N/A		Median	4
Variance		47.06666667	Median Error	1.433063
			Significance Level	0.05

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