TOWARDS A COMPREHENSIVE KNOWLEDGE MANAGEMENT SYSTEM ARCHITECTURE

by

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Abstract

Knowledge management has roots in a variety of disciplines, such as philosophy, psychology, social sciences, management sciences and computing. As a result, a wide variety of theories and definitions of knowledge and knowledge management is used in the literature. Irrespective of the theory or definition used, is it recognised that expert knowledge and insight are gained through experience and practice and that it is a key differentiator as an organisational asset.

This shift to knowledge as the primary source of value results in the new economy being led by those who manage knowledge effectively. Today's organisations are creating and leveraging knowledge, data and information at an unprecedented pace – a phenomenon that makes the use of technology not an option, but a necessity. It enables employees to deal with multifaceted environments and problems and make it possible for organisations to expand their knowledge creation capacity.

Software tools in knowledge management are a collection of technologies and are not necessarily acquired as a single software solution. Furthermore, these knowledge management software tools have the advantage of using the organisation's existing information technology infrastructure. Organisations and business decision makers spend a great deal of resources and make significant investments in the latest technology, systems and infrastructure to support knowledge management. It is imperative that these investments are validated properly, made wisely and that the most appropriate technologies and software tools are selected or combined to facilitate knowledge management.

The purpose of this interpretive case study is to consider these issues and to focus on an understanding of the key characteristics of a knowledge management system architecture by exploring and describing the nature of knowledge management.

Based on the findings of this study, a list of key characteristics that a knowledge management solution must comply with was collated, which expanded the existing knowledge management model towards describing a knowledge management system architecture.

Keywords

Knowledge, knowledge management, knowledge management process, knowledge management system, knowledge management system characteristics, knowledge management system architecture.

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Abbreviations

BI	Business Intelligence
DBMS	Database Management Systems
FAQ	Frequently Asked Questions
IS	Information Systems
IT	Information Technology
KM	Knowledge Management
KMS	Knowledge Management System
MTN	Mobile Telephone Networks
MTN SA	Mobile Telephone Networks South Africa
RP	Research Participant
USA	United States of America

Part I Introduction

Chapter 1 Introduction

Mark Shuttleworth is probably best known as the first African in space when he was one of the crew members of the Soyuz TM-34 launched from Baikonur in Kazakhstan in April 2002. In 1995, during his final year of studying towards a Finance and Information Systems Business Science Degree at the University of Cape Town, he founded an internet consulting business, Thawte, initially operating from his parents' garage. The focus of the business shifted towards internet security for electronic commerce and it became the first company outside of the United States of America (USA) that made a fully secure, encrypted, e-commerce web server available commercially. Thawte became one of the first companies recognised by both Netscape and Microsoft as a trusted third party for web site certification and assisted businesses around the world to accept secure transactions over the web (Shuttleworth, 2007). By 1999, Thawte was the leading certificate authority outside of the USA and was acquired – in the same year - by VeriSign for a record offer of $575 million (R3.5 billion) (Chase, 2005). VeriSign did not acquire physical assets such as the Thawte offices or the personal computers that employees worked on. Thawte offered something far more valuable than that: the intellectual capital of web site certification.

Stewart (1997 : xx) describes intellectual capital as "intellectual material - knowledge, information, intellectual property, experience – that can be put to use to create wealth". The relative significance of intellectual capital compared to their tangible peers shows an increase from 5% in 1978 to between 75% and 85% in 2004 (Kaplan and Norton, 2004, ValueBasedManagement.net, 2004). It is calculated as the difference between the market value and book value of a company (Sveiby, 1997, Becker, Huselid and Ulrich, 2001, Reinhardt, Bornemann, Pawlowsky and Schneider, 2001), as it represents the total knowledge of the employees in an organisation that gives it a competitive edge (Stewart, 1997). This ratio, specifically in the equity markets in the USA, has more than doubled in the ten years up to 1999 (Becker, Huselid and Ulrich, 2001).

Imagine that, in the same way that a disc failure on your personal computer or laptop erases all information in the file folders, all intellectual capital within your organisation is erased from the employees' minds and the organisation's storage media. There is no doubt that the market value of such an organisation will be affected severely as decisions in an organisation are made based on sufficient, relevant and accurate knowledge (Meyer and Botha, 2000). Stewart (1999) supports this notion that the management of knowledge turned out to be the most important economic responsibility of individuals, businesses and nations, as it forms a key component of what is acquired, produced and sold.

The question about knowledge that arises is why is knowledge so important? Knowledge assets are of much greater value than any tangible asset, which includes natural resources, large factories, equipment and land – all of which provided organisations with a competitive edge in the past (Quinn, Anderson and Finkelstein, 1996, Davenport and Prusak, 1998, Wind and Main, 1998, Alavi and Leidner, 2001). This knowledge asset provides the basis for creating sustainable competitive advantage in the knowledge age (Weiner and Brown, 1997, Nonaka, Toyama and Byosiere, 2001, Covey, 2004, Folkens and Spiliopoulou, 2004, Vandaie, 2007, Kothuri, May 2002). Furthermore, as new technologies, innovation, organisational flexibility and new and better forms of leadership propel the growth and earnings of knowledge-intensive companies, so the need to extract wealth from brainpower and knowledge (individual and organisational) becomes increasingly pressing. This importance of knowledge is confirmed by Becker et al (2001) who conclude that machinery and equipment are not the distinguishing aspects any more, but rather the capability to use it resourcefully. An organisation that kept its workforce skills and expertise could operate quickly even though it lost all of its equipment. An organisation that lost its workforce, while keeping its equipment, would never recover.

This shift to knowledge as the primary source of value results in the new economy being led by those who manage knowledge effectively - organisations that create, find and combine knowledge into new products and services faster than their competitors (Barclay and Murray, 1997, Moss-Kanter, 1997). According to Peter F. Drucker (Hibbard, 20 October 1997 : 46), a late professor of social science and management at Claremont Graduate University:

> We now know that the source of wealth is something specifically human: knowledge. If we apply knowledge to tasks we already know how to do, we call it productivity. If we apply knowledge to tasks that are new and different, we call it innovation. Only knowledge allows us to achieve those two goals.

Today's organisations are creating and leveraging knowledge, data and information at an unprecedented pace and the extraordinary growth in on-line information (Barclay and Murray, 1997, Olve, Roy and Wetter, 1999, Abar, Abe and Kinoshita, 2004), makes the use of technology not an option, but a necessity (Lindvall, Rus, Jammalamadaka and Thakker, 2001, Folkens and Spiliopoulou, 2004). This influence of technology on the maintenance of knowledge management actions is widely accepted, as technology adds value by reducing time, effort and cost in enabling people to share knowledge and information (Chua, 2004). It is especially relevant when it is closely aligned with organisational requirements - the way people work and are supported by and integrated with relevant processes (Wind and Main, 1998, Hoffmann, Loser, Walter and Herrman, 1999, Specialist-Library, 2005a). In addition to the growth in information technology (IT), organisations embark on employee information access projects, like the creation of knowledge bases, intranets, chat rooms, full-text indexing tools and document management tools as necessitated by knowledge management (Lindvall et al., 2001).

However, Nonaka, Reinmoller and Toyama (2001 : 829) identify several problems with the current use of software tools as the challenge for IT is to aid a dynamic process of knowledge creation, not a stagnant process of information management and often emphasises the efficiency of processing existing information rather than creating new knowledge. Furthermore, current IT-based knowledge management mainly focuses on knowledge that has been articulated in some tangible form and fails to deal with implied knowledge such as hunches and gut feelings (Nonaka, Reinmoller and Toyama, 2001). Less or no emphasis is placed on new visions and innovation as these knowledge management software tools extract profits through knowledge economies of scale by re-using existing knowledge only (Marwick, 2001, Nonaka, Reinmoller and Toyama, 2001). Knowledge management that relies only on such packaged tools, cannot gain sustainable competitive advantage due to the rapid dissemination of best practice in IT (Davenport and Prusak, 1998). A long-term view of fostering the knowledge-base competence of an organisation is required when selecting knowledge management software tools and IT is needed that aids an effective and efficient knowledge-conversion process while increasing the swiftness and ease of switching from one such process to another (Nonaka, Reinmoller and Toyama, 2001, Yu, Kim and Kim, 2004).

Knowledge management agility and optimal support of technology motivate the need for research in which the focus is on an understanding of the key characteristics of a knowledge management system architecture by exploring and describing the nature of knowledge management. Therefore, this study focuses on providing guidelines in the selection of knowledge management system technology.

1.1 Background

Organisations today realise that leveraging the already-accumulated corporate intellectual property is by far the lowest-cost way available to increase their competitive standing (Stewart, 1997, Koenig, 1998, Wind and Main, 1998, Frappaolo, 2006, Tsai and Chen, 2007) and to harness innovation (Nonaka and Takeuchi, 1995, Leonard and Straus, 1997, Krogh, Ichijo and Nonaka, 2000). Knowledge management practices make bottom line differences to all types of organisations (Frappaolo, 2006) and promote the methods and technologies that facilitate the efficient creation and exchange of knowledge at an organisation wide level (Krogh, Ichijo and Nonaka, 2000, Lee, Kim and Yu, 2001, Tsai and Chen, 2007). In such a knowledge-based economy with knowledge creation and innovation as the outcome, the infrastructure supporting knowledge management must not be forgotten, as the components of intellectual capital, namely know-how and experience, must be channelled and made available (Frappaolo, 2006).

The development and evolution of a large number of software tools have been facilitated based on the application of these technologies to the creation of knowledge management solutions (Lindvall et al., 2001, Xie, Zhang and Xu, 2006). Software tools in knowledge management are a collection of technologies and are not necessarily acquired as a single software solution as one tool is not necessarily ideal for all circumstances (Alavi and Leidner, 2001, Lindvall et al., 2001, Specialist-Library, 2005a). Furthermore, these knowledge management software tools have the advantage of using the organisation's existing IT infrastructure, such as Groupware, intranets and collaborative tools, e.g. e-mail, discussion boards and videoconferencing (Alavi and Leidner, 2001, Lindvall et al., 2001, Agostini, Albolino, Boselli, Michelis et al., 2003, Wessels, Grobbelaar and McGee, 2003, Vequist and Teachout, 2006).

Organisations and business decision makers spend a great deal of resources and make significant investments in the latest technology, systems and infrastructure to support knowledge management. It is imperative that these investments are validated properly, made wisely and that the most appropriate technologies and software tools are selected to facilitate knowledge management (Chua, 2004, Folkens and Spiliopoulou, 2004). There is a gap in the literature with regard to support for the selection of knowledge management system technology and guidelines for the selection of support are given.

1.2 Problem statement and purpose of this study

A complete and comprehensive knowledge management system is not purchased off the shelf as a single technology or software tool (Offsey, 1997, Alavi and Leidner, 2001, Agostini et al., 2003). This is in spite of the fact that software vendors label a plethora of software tools as knowledge management solutions in an attempt to make it more attractive to organisations (Lindvall et al., 2001, Westhuizen, 2002, Holm, Olla, Moura and Warhout, 2006). Effective knowledge management cannot take place without extensive behavioural, cultural and organisational change (Davenport and Prusak, 1998). Organisations have to consider all of these components when selecting technologies and software tools for knowledge management.

The following issues with regard to the selection of knowledge management system technology are significant:

- Software vendors promote and sell software as *knowledge management* software regardless of the context or requirements of the particular organisation – especially if an organisation does not have a knowledge management system requirement definition or checklist to evaluate it against.
- Organisations have different options to facilitate knowledge management i.e. to optimise and utilise existing technology and software as knowledge management tools or to buy technology or software tools to support knowledge management.
- Knowledge management tools do not necessarily consist of software only; technologies such as video-conferencing, a telephone or a portal as a single point of access can also be utilised.
- In order to ensure that the technology and software tools fulfil the knowledge management requirements, organisations must consider the definition of knowledge, knowledge management principles, knowledge management processes and the organisation's particular knowledge management requirements.
- All knowledge management requirements are not necessarily accomplished by a single technology or out-of-the-box software solution, but rather by a combination of

tools. Sometimes broad groups of people need to participate in the use of knowledge; at other times only a few individuals need take part.

- There is a necessity for a knowledge management system requirement definition consisting of a typical characteristic set that technology and software tools – or a variety of software tools – must comply with to be regarded as knowledge management tools. This requirement definition must also consider behavioural factors.
- Furthermore, there is a requirement to relate these characteristics to a typical knowledge management system architecture in order to ensure that an organisation's particular knowledge management requirements are fulfilled comprehensively and sustainably – whether existing technology and software tools are utilised, new technology is acquired or only the gaps that exist in the current organisational technology context are filled.

The main objectives of this study are to explore the nature of knowledge management and to investigate what the key characteristics are that technology must comply with to be characterised as a knowledge management solution. Furthermore, the goal is to investigate how these characteristics impact on the description of a typical knowledge management system architecture. Therefore, based on this context, a list of key characteristics that a knowledge management solution must conform to was compiled and utilised to describe a typical knowledge management system architecture.

1.3 Research questions

Based on the context and purpose of the research study, the primary research questions addressed by this study are:

- How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?
- What are the key characteristics that technology must conform to in order to be categorised as a knowledge management solution?
- How do knowledge management system characteristics contribute to a knowledge management system architecture description?

1.4 Rationale for the study

1.4.1 Scientific

The literature search has shown that knowledge is a multifaceted subject based on the dimensions of knowledge and as such, various and varied definitions exist for it (Davenport and Prusak, 1998, Newman and Conrad, 1999, Frappaolo, 2006). These definitions are discussed in more detail in Chapter 2 of this study. McCullough (2005) concludes that, based on the vast majority of academic research on knowledge management, there is a general difficulty for organisations to explain what they mean when they use the term knowledge management. It is also not easy to draw the line between regular IT and tools for knowledge management (Alavi and Leidner, 2001, Lindvall et al., 2001), although a variety of software tools have been devised and then imposed on organisations and people as knowledge management systems (Offsey, 1997, Lindvall et al., 2001, Westhuizen, 2002).

Therefore, according to Lindval, Rus et al (2001), it is better to evaluate how people naturally share information and to then build a system to support those activities (Davenport and Prusak, 1998, Krogh, Ichijo and Nonaka, 2000, Vequist and Teachout, 2006). The means to successful knowledge management lies in leveraging existing infrastructure by including what already exists and then integrating it (Tiwana, 1999). However, very few studies found in the literature approached knowledge management systems from this perspective. This study will contribute to changing this position.

1.4.2 Personal

The researcher has been fortunate to be exposed to the progression of mobile technology in South Africa since 1995 as an employee of Mobile Telephone Networks (Pty) Ltd (MTN).

The telecommunication regulator initially issued two mobile network licences and fierce competition, for network coverage as a start, was at the order of the day. Skills from mobile operators in Europe, the United Kingdom and the USA were optimised through shareholding and network engineers were trained at Ericsson in Sweden. By the late 1990's the race for market share in South Africa was well advanced while the regulator awarded a third mobile operator license in November 2001. The start-up of the third operator resulted in a skills grab situation and the importance of retaining employees in MTN became a major priority.

A secondary reason for retaining employees was mobile technology advancement – one can just compare the size of a handset in 1995 to devices that is available today. Digital cameras, access to e-mail, diary management, web and content provider access, to name but a few, are mostly standard features of devices used today. Device and offer knowledge of sales agents, call centre agents and mobile solution designers are key differentiators for ensuring a positive customer experience – and subsequently market share growth - in the mobile market today. This knowledge also fosters innovation in an environment where all mobile operators have access to the same mobile networks, devices and similar products and services. Innovation is a key differentiator and knowledge management processes play a key role in facilitating innovation cycles.

It is within this context that the researcher has experienced the impact of losing skills and knowledge in MTN in situations where research, projects and business analysis had to be initiated once more as the particular knowledge was not available to be applied again. The researcher realised the importance of not only properly managing tangible knowledge artefacts, but also documenting and sharing knowledge of key employees with robust software tools that facilitate and support these processes.

A more informed opinion will facilitate the achievement of better knowledge management through the establishment of a comprehensive knowledge management system, which complies with knowledge management system characteristics, in the MTN Group.

1.5 Research strategy

A detailed literature study was conducted in order to establish background on knowledge, knowledge management, knowledge management processes and knowledge management systems. Data collection for the initial set of knowledge management system characteristics was done by means of an extensive literature survey, and an initial set of knowledge management system characteristics was compiled.

Semi-structured interviews were conducted using open-ended questions in order to obtain perceptions from research participants on knowledge management system characteristics. The characteristics obtained from these interviews were compared to the list compiled based on the literature, and characteristics were either confirmed or updated with new information. In some instances, characteristic descriptions were updated and expanded after which they were grouped according to technology-classification perspectives and activities. Finally, the list of characteristics was associated to a conceptual framework for a knowledge management system architecture description.

The organisation that provided the context for this study is the MTN Group, a leading provider of communication services, offering cellular network access and business solutions globally. Launched in 1994, the MTN Group is a multinational telecommunications group, operating in 21 countries in Africa and the Middle East. As at the end of December 2006, MTN recorded more than 40 million subscribers across its operations. The MTN Group operates in Botswana, Cameroon, Côte d'Ivoire, Nigeria, Republic of Congo (Congo-Brazzaville), Rwanda, South Africa, Swaziland, Uganda, Zambia, Iran, Afghanistan, Benin, Cyprus, Ghana, Guinea Bissau, Guinea Republic, Liberia, Sudan, Syria and Yemen (MTN-Group, 2008).

The MTN Group believes that information and communication technologies are an indispensable catalyst for economic development - one that affords developing countries the opportunity to leapfrog many stages of modernisation from a technological perspective. In order to achieve this, MTN has adopted a two-fold expansion strategy of leveraging existing business and growing into new markets. One of the pillars of the growth strategy is to leverage common infrastructure to exploit new opportunities and knowledge. Expertise is often drawn from the South African operation, as it was the first company in the MTN Group.

Technological advancement of mobile phones is evident when looking at the change experienced over the past 14 years since the start-up of MTN South Africa (MTN SA). Convergence could ultimately see people using a single device for almost everything – from making and receiving calls to mobile face book and mobile television. The development of cost-effective and marketable growth products for MTN Group, the ability to recognise the best technology and the focus on retaining key employees and intellectual property within the Group are key components in staying ahead in an extremely competitive market.

1.6 Scope and limitations

1.6.1 Scope of the study

This study defines a set of characteristics that technology, software tools or systems must comply with to be categorised as knowledge management systems. This set of characteristics is based on the definition and nature of knowledge and knowledge management and integrates the unique requirements of a knowledge management solution. Finally, the set of characteristics is mapped to a knowledge management system architecture, building a comprehensive description of such an architecture.

1.6.2 Limitations of the scope

The knowledge management system characteristics were derived from a qualitative study at MTN in South Africa with the main focus to understanding the particular case. As this was conducted as a single case study, further research is needed to generalise the list of characteristics derived as well as to establish whether these characteristics will also apply to smaller companies (Yin, 1984).

No software evaluation compared to the set of characteristics or knowledge management system architecture was concluded as part of this study, although examples of software tools that comply with the characteristics have been quoted from the literature.

1.7 Outline of the study

This study consists of six parts, eight chapters and one annexure as depicted in Figure 1. Part I consists of Chapter 1 and is the introduction to the study.

Part II, the theoretical framework, consists of chapters 2, 3 and 4. Chapter 2 focuses on the literature survey on knowledge management (KM), knowledge management principles, knowledge management processes, knowledge management systems (KMS) and exploring the nature of knowledge management. Chapter 3 contains the concepts for defining knowledge management system characteristics and the grouping of these characteristics. Chapter 4 provides the theoretical framework based on the literature for defining a layered system architecture in the context of a knowledge management solution.

Part III, the research plan and design, consists of Chapter 5 and defines the research strategy and methodology.

Part IV, the evidence and discussion, consists of Chapter 6, which provides an overview of the data analysed for the study.

Part V, the contribution, consists of Chapter 7 in which the focus is on the knowledge management system characteristics extracted from the literature and interviews, as well as the reflection of these characteristics mapped to a typical knowledge management system architecture.

Part VI, consisting of Chapter 8, is the conclusion of the study. One annexure containing the questionnaire and interview data form the last sections of the study and are available on a CD from the researcher.

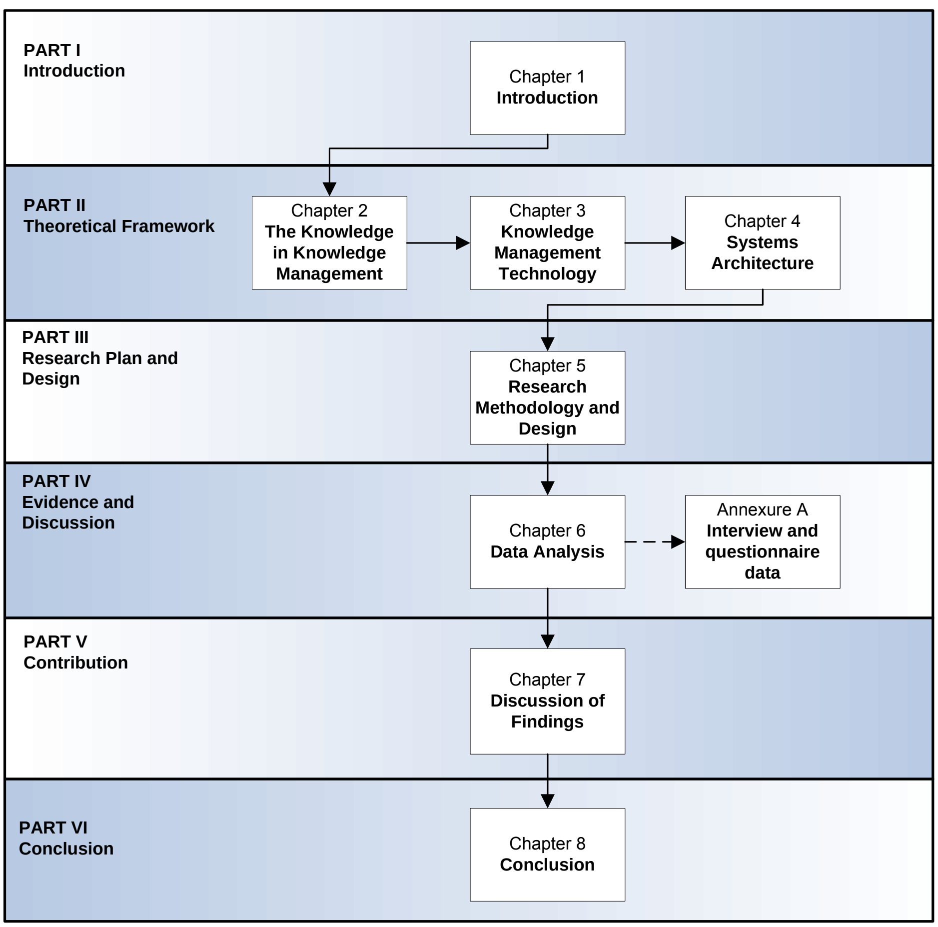

Figure 1: Outline of the study

Part II Theoretical Framework

Part II (figure 2) consists of chapters 2, 3 and 4 and provides an overview of the theoretical framework. Chapter 2 focuses on exploring the nature of knowledge and knowledge management and supports the first research question: "*How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?*" Chapter 3 distils the concepts for defining knowledge management technologies and system characteristics as related to the second research question: "*What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?*" Chapter 4 provides the theoretical framework for the third research question: "*How do knowledge management system characteristics contribute to a knowledge management system architecture description?*"

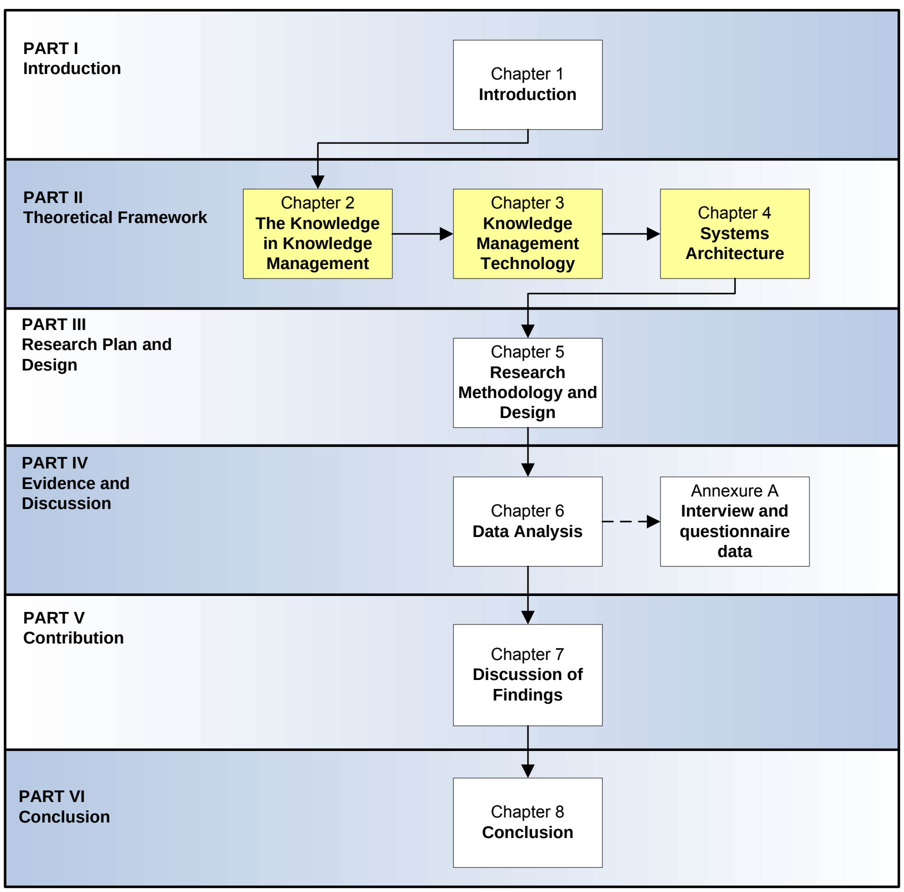

Figure 2: Part II outline

Chapter 2 The Knowledge in Knowledge Management

2.1 Introduction

While some epistemologists spent their lives trying to understand what it means to know something (Davenport and Prusak, 1998, Clarke and Rollo, 2001), Plato first introduced the concept of knowledge as justified, true belief in 400 B.C. (Meno, Phaedo and Theaetus as quoted by Nonaka and Takeuchi, 1995). Advances in knowledge described the achievements of the ancient Greek, Roman, Egyptian and Chinese civilisations and the transforming impact of the industrial revolution was characterised by the application of new knowledge in technology (Alavi and Leidner, 2001, Clarke and Rollo, 2001).

Today, diverse answers are obtained when asking employees[1] what knowledge is, but intuitively there is a sense that knowledge is something deeper and broader than merely data or information. Examples of such answers are:

- Network Engineer - “Oh, it is the unique insight that I have gained …”
- Manager: Warehouse – “Surely it is the judgement and insight that I use when taking decisions …”
- Chief Technology Officer – “I would say it is the application of the experience that I have gained over and above my theoretical or technical knowledge, as well as my insight and judgement in the environment that I am operating in ...”
- Call Centre Agent – “It must be what I have been trained on ...”
- Mailroom Supervisor – “It is what I know, whether I have learnt it in a book or experienced it on the job ...”
- Senior Manager: Business Architecture – “It is the experience that I have gained over the past years that I am applying in order to do my job …”
- Software Developer – “It is the unique expertise that I have in my field ...”

This chapter provides an overview of knowledge and the dimensions of knowledge, namely implicit and explicit knowledge. Knowledge management is then considered including an overview of knowledge management processes and implications in the organisational context as in relation to the first research question “*How does the nature of knowledge management contribute to a typical architecture of a knowledge*

[1] “Employees” refer to people working at MTN SA at the time of the study

management system?" This chapter closes with a brief overview of knowledge management barriers. Table 1 provides an overview of the chapter layout.

Table 1: Chapter 2 outline

Outline of Chapter 2			
Section	**Description**	**Sub-section**	**Sub-section description**
2.1	Introduction		
2.2	What is knowledge?	2.2.1	Data
		2.2.2	Information
		2.2.3	Knowledge and wisdom
2.3	What are the dimensions of knowledge?	2.3.1	Explicit knowledge
		2.3.2	Implicit and tacit knowledge
		2.3.3	The knowledge continuum
		2.3.4	Knowledge taxonomies
2.4	What is knowledge management?	2.4.1	Knowledge management processes
		2.4.2	Knowledge harvesting and discovery
		2.4.3	Knowledge creation
2.5	Knowledge management in an organisational context	2.5.1	Knowledge work
		2.5.2	The learning organisation
2.6	Knowledge management barriers		
2.7	Summary		

2.2 What is knowledge?

Michael Polanyi (1891–1976) was a medical scientist before he turned to philosophy at the age of 55 and was the first to articulate the concept of tacit versus explicit knowledge (Sveiby, 31 December 1997). As epistemological philosopher Polanyi (October 1962 : 601) stated that "there are things that we know but cannot tell" and with this opposed the epistemological view,[2] which holds that the only valid knowledge is that which can be articulated and tested by strictly impersonal methods. He argues that some of man's knowledge is tacit and cannot be articulated (Koenig, 1998, Smith, 2003, Moteleb and Woodman, 2007). To illustrate this he uses the examples of swimming and cycling – although someone knows how to swim or ride a bicycle, it does not mean that he/she can explain how to stay buoyant while swimming or how to keep balance on a bicycle (Polanyi, October 1962).

[2] This epistemological view can be described as "naïve objectivism" POLANYI, M. (October 1962) Tacit Knowing: Its Bearing on Some Problems of Philosophy. *Reviews of Modern Physics,* 34**,** 601-606.

The Compact Oxford English Dictionary of Current English (Soanes and Hawker, 2005) defines *knowledge* as **(1)** information and skills acquired through experience or education **(2)** the sum of what is known and **(3)** awareness or familiarity gained by experience of a fact or situation. These definitions point to the following broad areas when knowledge is considered:

- *Information and skills acquired through experience or education*: The term knowledge is used to refer to a *body of knowledge* that is articulated and captured in the form of books, papers, procedure manuals, computer programs and so on. It consists of codified, captured and accumulated facts, methods, principles and techniques (Covey, 1989, Davenport and Prusak, 1998, Nickols, 2001, Hinkelman, 2006).
- *The sum of what is known*: The second definition refers to what Sveiby (1997) calls the *capacity to act*. This is the understanding of facts, methods, principles and techniques in order to apply them in the course of making things happen (Godbout, 1999, Wilson and Snyder, 1999, Vandaie, 2007). As such is it not the knowledge that is the key differentiator, but rather the capacity to transform knowledge into replicable know-how.
- *Awareness or familiarity gained by experience of a fact or situation*: Lastly, knowledge is used to refer to a *state of knowing (Huysamen, 1999, Alavi and Leidner, 2001)*. This includes facts, methods, processes, principles and techniques that we are familiar with and that we apprehend, our know-how (Nickols, 2001, Covey, 2004).

For the purpose of this study, a more pragmatic approach has been followed and the following working description of knowledge has been explored:

> Knowledge is a fluid mix of framed experiences, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices and norms. (Davenport and Prusak, 1998 : 5):

What this definition makes clear is that knowledge is not singular, but rather a combination of various elements (Godbout, 1999, Hahn and Subramani, 2000, Moteleb and Woodman, 2007), that it is fluid, but can also be formally structured and that it is different from information and data, although it is related to both concepts (Davenport and Prusak, 1998, Clarke and Rollo, 2001, Kothuri, May 2002).

2.2.1 Data

Data essentially consists of structured recordings of transactions and events (Godbout, 1999, Alavi and Leidner, 2001) and is presented without context (Godbout, 1999, Clarke and Rollo, 2001). As such it does not carry inherent meaning as it is a set of distinct, objective facts about events and the same symbol or fact used in different contexts, might have different meanings (Davenport and Prusak, 1998 : 2, Clarke and Rollo, 2001). It provides no judgement or interpretation and no sustainable basis of action (Davenport and Prusak, 1998, Alavi and Leidner, 2001).

Organisations today store data captured by different departments in some kind of a technology system and some industries, e.g. telecommunication, banking, government tax services and electricity companies, are heavily dependent on it.

2.2.2 Information

Information, on the other hand, is data with relevance and purpose added, and it expands the concept of data in a broader context (Drucker, January - February 1988). Once data is placed within some interpretive context, it acquires meaning and value in various ways (Davenport and Prusak, 1998, Alavi and Leidner, 2001, Clarke and Rollo, 2001, Lindvall et al., 2001). Table 2 summarises methods that transform data into information by adding value to it, namely contextualisation, categorisation, calculation, correction and condensation.

Table 2: Mechanisms to transfer data into information (Davenport and Prusak, 1998)

Mechanisms to transfer data into information	
Contextualisation	The purpose for which the data was gathered
Categorisation	The units of analysis of the data
Calculation	Data may have been analysed mathematically or statistically
Correction	Errors have been removed from the data
Condensation	Data may have been summarised in a more concise form

Contextualisation refers to the reason for the data collection, while categorisation clarifies the key components of the data and calculation indicates whether the data was statistically derived or mathematically calculated. Correction refers to the fact that errors were removed from the data. Condensation indicates that the data has been summarised, and the information can be reflected in a variety of forms, such as presentations, statements, diagrams, charts or statistics.

According to Wilson and Snyder (1999), there are two types of information: support information and guidance information. Support information includes expressive explanations that provide a basis for understanding, e.g. who, what, when, where, with what, why. Descriptive information illustrates how a task should be achieved.

2.2.3 Knowledge and wisdom

Information becomes individual knowledge when it is accepted and retained as appropriate representations of the relevant knowledge (Godbout, 1999, Lindvall et al., 2001, Frappaolo and Capshaw, July 1999). Knowledge comes with insights, framed experiences, intuition, judgement and values and encompasses the scope of understanding and skills that are mentally created by people (Clarke and Rollo, 2001).

Knowledge artefacts are often represented as information and circulated, shared or transferred as such (Lambe, 2002). Figure 3 illustrates this range between data, information and knowledge as discussed in sections 2.2.1 and 2.2.2.

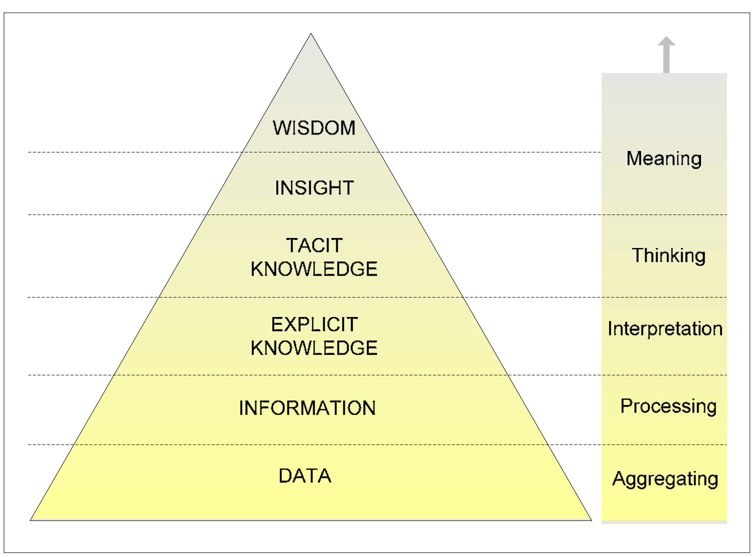

Figure 3: Data, information and knowledge (Clarke and Rollo, 2001)

Knowledge value is increased through analytical thought processes as data and information are processed, understood and connotation added (Wilson and Snyder, 1999, Alavi and Leidner, 2001, Clarke and Rollo, 2001). Once meaning is added to knowledge, insight and wisdom are the ultimate level of understanding and the optimum use of knowledge. Knowledge processes can always be improved, but wisdom is necessary to determine which processes will add the most value to organisational objectives (Clarke and Rollo, 2001).

2.3 What are the dimensions of knowledge?

Polanyi's concept of knowledge identifies two different, mutually exclusive, dimensions of knowledge, namely focal knowledge and tacit knowledge, and emphasises that human beings switch between tacit knowing and focal knowing every second of their lives (Polanyi, October 1962). Focal knowledge is knowledge about the phenomenon or object that is in focus and tacit knowledge is knowledge that is used as a tool to handle or improve what is in focus (Sveiby, 31 December 1997).

Cognitive psychologists divide knowledge into two categories: declarative and procedural (Alavi and Leidner, 2001, Nickols, 2001, Moteleb and Woodman, 2007). Declarative knowledge entails descriptions of facts or of methods and procedures and it can be and has been articulated. Procedural knowledge on the other hand manifests itself in the doing of something and is reflected in motor (manual) skills or cognitive (mental) skills.

According to Hinkelman (2006), in addition to the categories of knowledge, the dimensions of knowledge refer to two types of knowledge, as depicted in Figure 4. The first type is the kind that has been articulated and recorded as documented and formal knowledge. Such document databases, knowledge bases, manuals and handbooks are examples of *explicit* knowledge (Sveiby, 1997, Davenport and Prusak, 1998, Alavi and Leidner, 2001, Nickols, 2001). The second kind is reflected in a person's internal state, as well as that same person's capacity to act. Knowledge that is in the heads of people and people's experiences that can be articulated are examples of *implicit* knowledge. Implicit knowledge that cannot be articulated is *tacit* knowledge (Davenport and Prusak, 1998, Frappaolo, 2006, Polanyi, October 1962). Any structured process as depicted in Figure 4 can therefore contain knowledge work – implicit and explicit – supported by an employee's know-how, organisational processes and IT.

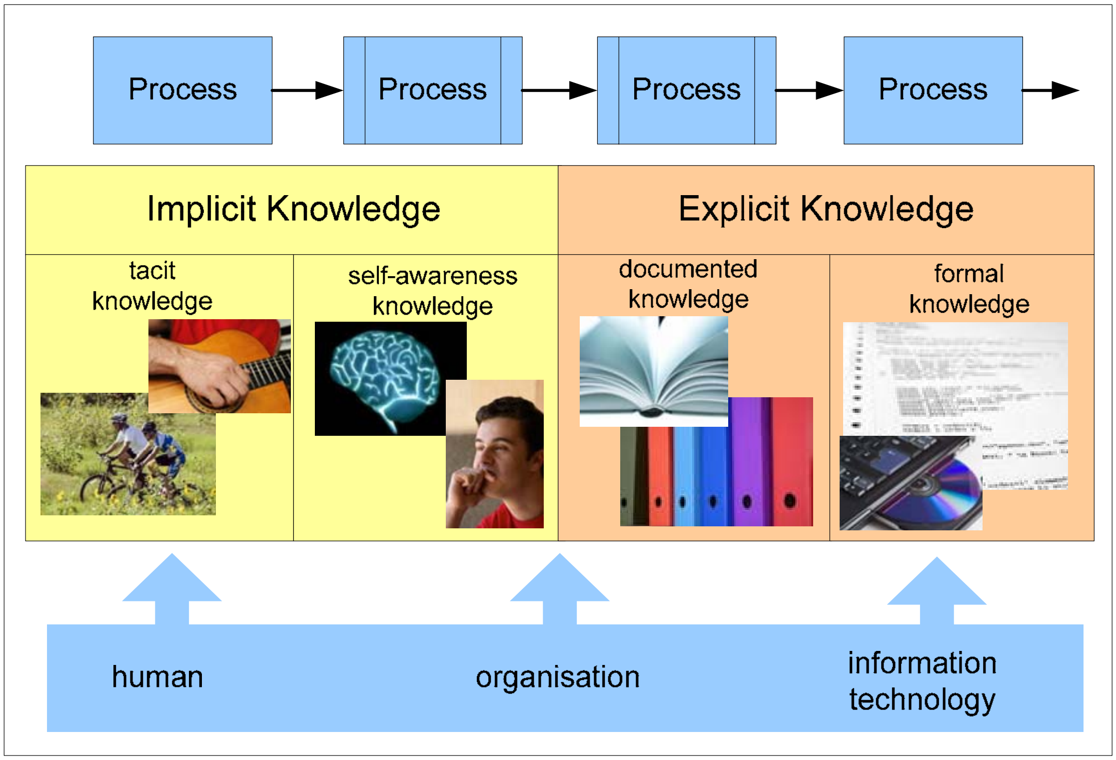

Figure 4: Types of knowledge (Hinkelman, 2006)

Both knowledge *about* (process knowledge) and knowledge *in* (functional knowledge) a process is relevant as illustrated in Figure 5 (Hinkelman, 2006). Knowledge *about* the process contains steps to be followed and workflow, it addresses optimisation and is repeatable. Knowledge *in* the process deals with exceptional, unpredictable situations and focuses on decision-making and problem-solving knowledge. Interaction between process and functional knowledge also takes place and refers to the generating of new knowledge, accessing knowledge from external sources, embedded knowledge in processes, products, services and transferring existing knowledge in the organisation (Hinkelman, 2006, Murray, March - April 2004). Knowledge processes in this instance refer to storage, retrieval, usage, etc. of knowledge.

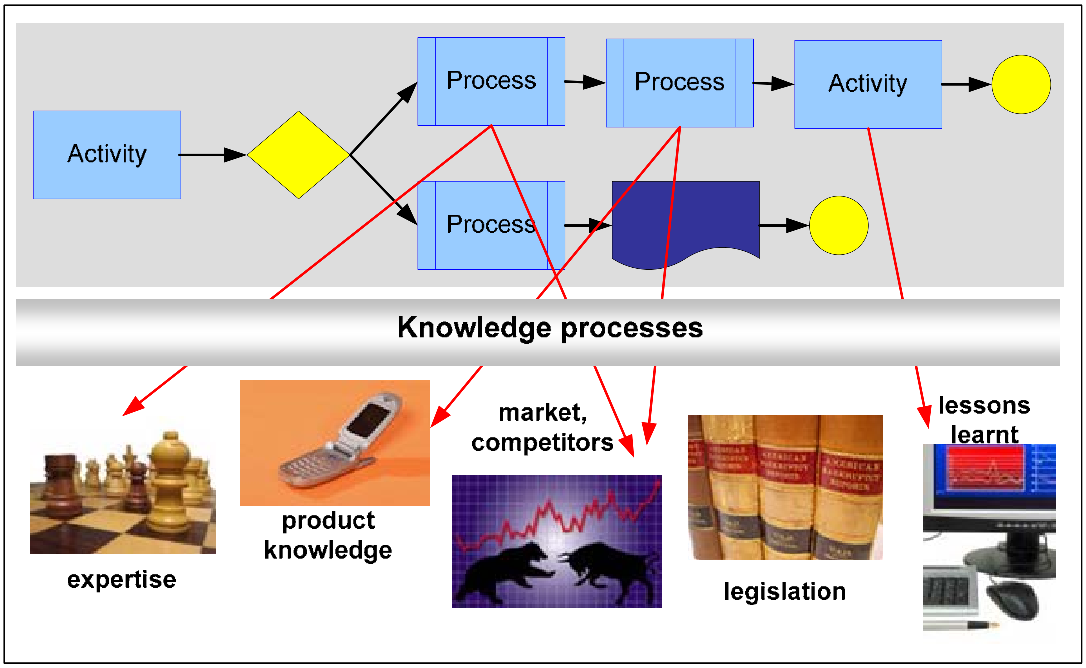

Figure 5: Integrated knowledge view (Hinkelman, 2006)

2.3.1 Explicit knowledge

As early as in primary school, learners learn the formula for calculating the circumference of a circle in the Mathematics class. This formula, $2\pi r$, is an example of explicit knowledge. Explicit knowledge can therefore be defined as knowledge that has been articulated in the form of text, diagrams, product specifications and so on (Clarke and Rollo, 2001, Nickols, 2001). Nonaka, Toyama et al (2001) refer to explicit knowledge as formal and systematic, like a computer program.

In organisations today, explicit knowledge is found in best practices documents, formalised standards by which goods and services are procured and even within performance agreements that have been documented in line with company and divisional goals and objectives.

2.3.2 Implicit and tacit knowledge

Implicit knowledge is far less tangible than explicit knowledge and refers to knowledge deeply embedded into an organisation's operating practices (Kotelnikov, 2001, Kothuri, May 2002). This is often the knowledge that is observed by a work-study consultant or task analyst and made explicit by documenting the knowledge.

Tacit knowledge, as a dimension of implicit knowledge, includes relationships, norms and values. It is knowledge that cannot be articulated and it is much harder to detail, copy or distribute. In fact, in this instance the knowing is in the doing (Clarke and Rollo, 2001, Kotelnikov, 2001). Tacit knowledge can provide competitive advantage to organisations as it is protected from competitors (Hahn and Subramani, 2000, Wessels, Grobbelaar and McGee, 2003), unless key individuals are lured away, of course (Lindvall et al., 2001).

2.3.3 The knowledge continuum

If the continuum between explicit and tacit knowledge is considered, then the range between documented information that can facilitate action and the know-how embedded within the minds of the employees in the organisation, are considered (Heijden, 1996, Dix, Wilkinson and Ramduny, 1998, Frappaolo and Capshaw, July 1999). Figure 6 shows how one can move along this knowledge continuum that guides actions and informs decisions – from easily accessible books, databases, formulas, etc. to expertise, values and belief systems (Moteleb and Woodman, 2007, Braunstein, June 2004).

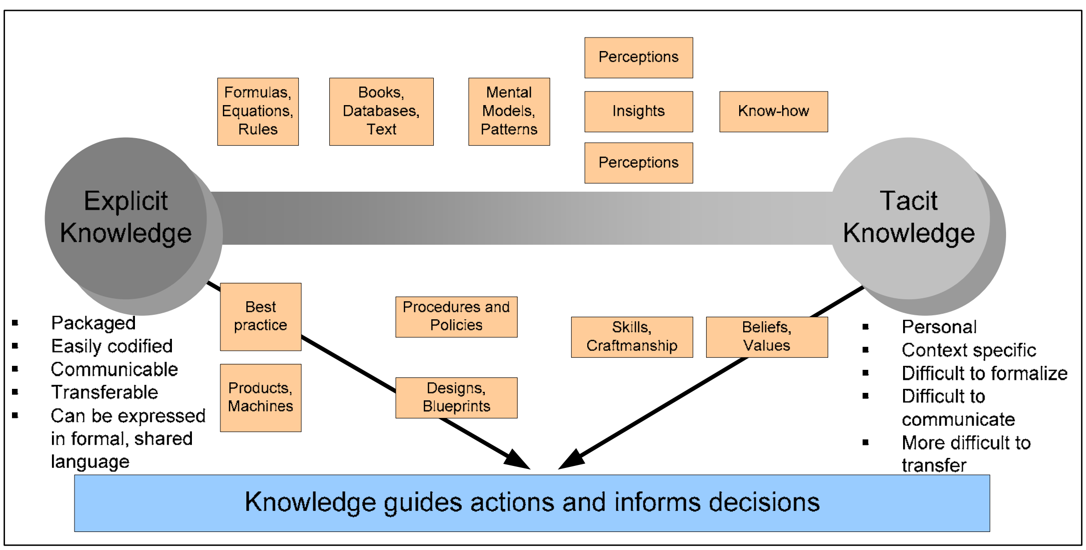

Figure 6: The explicit and tacit knowledge continuum (Braunstein, June 2004)

Based on the knowledge continuum, is it increasingly important from an organisational perspective that a greater amount of knowledge resides within the physical domains of the organisation rather than in the minds of people (Kothuri, May 2002). This growing awareness was captured in a survey concluded by The Delphi Group in 1999 when organisations were asked: “What is the primary repository for knowledge within the organisation?” (Clarke and Rollo, 2001). The result of this study shows that, on average, 42% of corporate knowledge is housed exclusively in the minds of employees (Kothuri, May 2002).

2.3.4 Knowledge taxonomies

The different types and classification of knowledge, as discussed in sections 2.3.1, 2.3.2 and 2.3.3, expand the scope of knowledge provisioning. An understanding of knowledge and knowledge taxonomies is important, since theoretical developments in the knowledge management arena are influenced by the distinction between the different types of knowledge (Alavi and Leidner, 2001).

These knowledge taxonomies consist of different types of knowledge based on the dimensions of knowledge. This is depicted in Table 3. Cognitive tacit knowledge refers to someone’s beliefs, technical tacit knowledge includes one’s expertise and explicit knowledge refers to articulated knowledge. Individual, social and pragmatic knowledge types point to knowledge inherent to an individual, inherent to a group and useful knowledge for an organisation respectively. Lastly, know-about, know-how, know-why, know-when and know-with refer to knowledge types declarative, procedural, causal, conditional and relational respectively.

Table 3: Knowledge taxonomies and examples (Alavi and Leidner, 2001)

Knowledge taxonomies and examples		
Knowledge types	**Definitions**	**Examples**
Tacit	Knowledge is rooted in actions, experience and involvement in specific context.	Best means of dealing with specific customer.
Cognitive tacit	Mental models.	Individual’s belief on cause-effect relationships.
Technical tacit	Know-how applicable to specific work.	Surgery skills.
Explicit	Articulated, generalised knowledge.	Knowledge of major customers in a region.
Individual	Created by and inherent in the individual.	Insights gained from completed project.
Social	Created by and inherent in collective actions of a group.	Norms for inter-group communication.
Declarative	Know-about	What drug is appropriate for an illness.

Knowledge taxonomies and examples		
Knowledge types	**Definitions**	**Examples**
Procedural	Know-how	How to administer a particular drug.
Causal	Know-why	Understanding why the drug works.
Conditional	Know-when	Understanding when to prescribe the drug.
Relational	Know-with	Understanding how the drug interacts with other drugs.
Pragmatic	Useful knowledge for an organisation.	Best practices, project experiences, engineering drawings, market reports.

Knowledge taxonomies inform the design of knowledge management systems by focusing on the need for support of the different types of knowledge, as well as the flows among these different types (Alavi and Leidner, 2001).

2.4 What is knowledge management?

Knowledge management is a multifaceted subject based on the dimensions of knowledge discussed in Section 2.3, and therefore there are various and varied definitions for it (Newman and Conrad, 1999). There is a general difficulty for organisations to explain what they mean when they use the term knowledge management as indicated by a vast majority of academic research on knowledge management (Alavi and Leidner, 2001, McCullough, 2005).

Sveiby (1997: 37) defines the management of knowledge as "the art of creating value by leveraging intangible assets". Meyer and Botha (2000: 278) define it as "the management of corporate processes designed to create, disseminate and protect knowledge in support of sound decisions leading to profit". Godbout (1999) defines knowledge management by suggesting that it is not knowledge that gives the competitive edge, but the capacity to transform knowledge into competencies and replicate know-how. According to Drucker (Edersheim, 2007), the most direct use of knowledge within an organisation is to build its own capabilities, and that the application of knowledge to knowledge is the critical factor in productivity moving forward. Lindvall, Rus et al (Agresti as quoted by Lindvall et al., 2001 : 3) define knowledge management as "the practice of transforming the intellectual assets of an organisation into business value".

For the purpose of this study, the following definition of knowledge management as suggested by Choo (February 2000), will be used: "[A] framework for designing an organisation's goals, structures and processes so that the organisation can use what it knows to learn and to create value for its customers and community". The key components and implication of this definition are expanded in Table 4 with additional references added to enhance the description.

Table 4: Knowledge management defined

Knowledge management definition	
Framework for designing an organisation's goals, structures and processes	Knowledge is derived from and embedded in structures and work processes (O'Leary, 1998, Hoffmann et al., 1999, Agostini et al., 2003)
Use what it knows	It is evident that knowledge has no intrinsic value of its own – it is only relevant when it is used i.e. the real value of knowledge is measured in its application (Kotelnikov, 2001, Agostini et al., 2003, Moteleb and Woodman, 2007).
To learn	Moss-Kanter (1997) suggests that organisations should create an environment in which employees are motivated to make their personal knowledge accessible to others, to share what they feel, articulate what they know and make others aware of their ways of working. Employees should gather and maintain lessons learnt in order to avoid repeating mistakes, but rather repeat successes (Lindvall et al., 2001, Preece, Flett, Sleeman, Curry et al., 2001).
To create value	Knowledge management is based on affecting the richness of an organisation's knowledge, to its decisions (Clarke and Rollo, 2001) and it improves the performance of individuals and organisations (Finneran, 2007) by maintaining and leveraging the present and future value of knowledge assets (Barclay and Murray, 1997, Newman and Conrad, 1999).

2.4.1 Knowledge management processes

Individual knowledge becomes a knowledge asset and creates economic value when it is converted into organisational knowledge through knowledge management processes (Godbout, 1999, Clarke and Rollo, 2001, Xie, Zhang and Xu, 2006). There are different ways of presenting knowledge management processes (Antonova and Gourova, 2006), varying from two generic processes, namely knowledge production and knowledge integration (Firestone and McElroy, 2003, as quoted by Antonova, 2006), to a life cycle model of three to eight steps or phases (Katz, 1998, Clarke and Rollo, 2001, Lindvall et al., 2001, Alavy, 2004, Folkens and Spiliopoulou, 2004). Nonaka and Takeuchi (1995) developed a knowledge creation model consisting of four processes (see the detailed description in section 2.4.3). Although several knowledge management process definitions exist, a generic knowledge management process requires that individual knowledge is represented, transferred, made accessible and used. Three different perspectives of knowledge management processes consist of a *process* view, a *technology* view and a *supply chain* view.

Firstly, a cycle of knowledge from a *process point of view* (Figure 7) includes four steps, namely find or create knowledge from several sources, organise and catalogue the knowledge, share and distribute it and use and apply it (Clarke and Rollo, 2001).

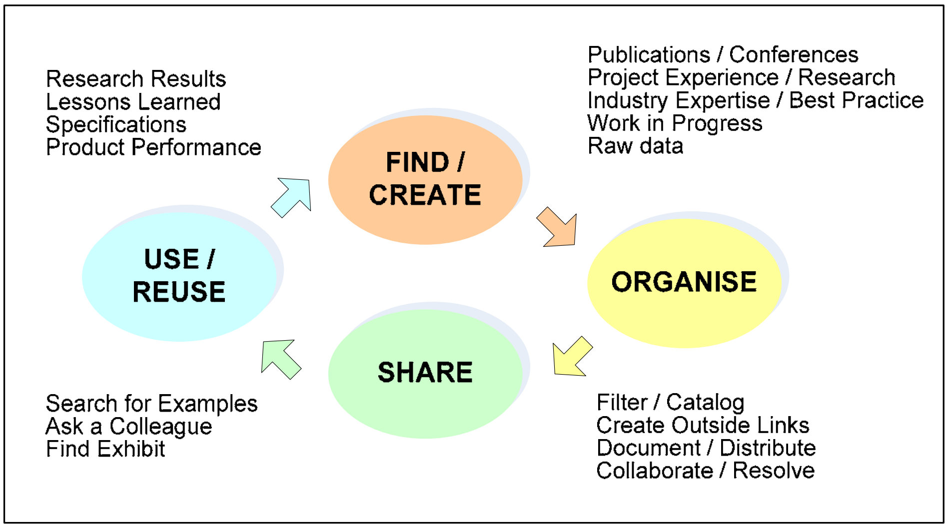

Figure 7: The cycle of knowledge: process view (Clarke and Rollo, 2001)

Secondly, Bergeron (2003, as quoted by Antonova, 2006) proposes knowledge management processes that are described related to technologies. Such a cycle of knowledge from a *technology point of view* (Figure 8) includes steps such as acquisition, use and modification that provide the opportunity to translate, transfer, archive or dispose of knowledge (Bergeron, 2003, as quoted by Antonova, 2006).

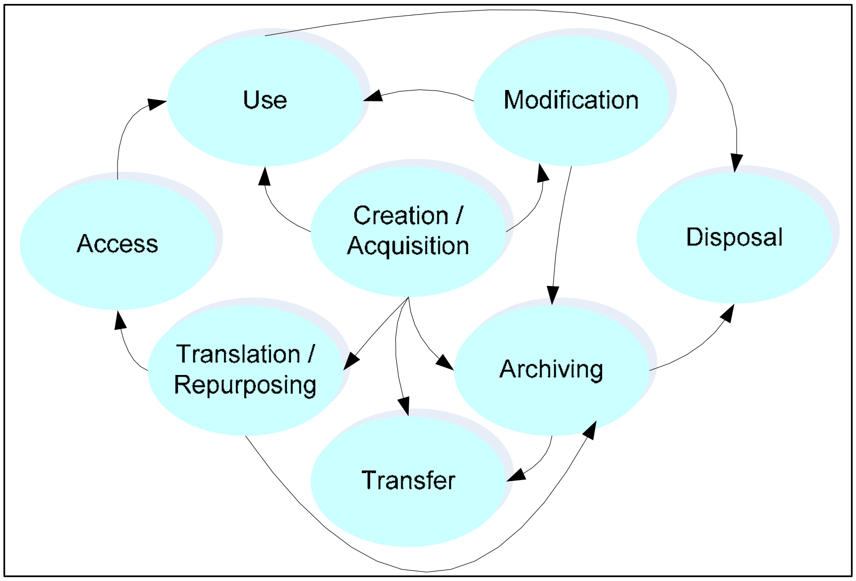

Figure 8: Knowledge management process: technology view (Bergeron, 2003)

Thirdly, by applying Bloom's taxonomy of cognition to knowledge management systems (Rademacher, 1999, Salisbury, 2003), knowledge management processes are summarised by the *knowledge supply chain view* (Figure 9) labelled the "six C's of the knowledge supply chain" (Rademacher, 1999, Greenwood, June 1998). The first four steps namely, create, clarify, classify and communicate, depend on an individual and the last two, namely, comprehend and create, depend upon teamwork.

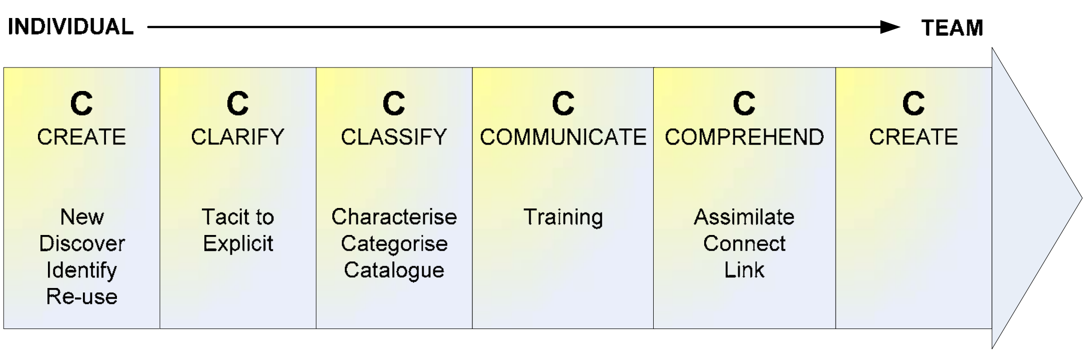

Figure 9: KM process: knowledge supply chain view (Rademacher, 1999)

The following two sections in this document explore two specific knowledge management processes namely, knowledge harvesting discussed in Section 2.4.2, and knowledge creation, discussed in Section 2.4.3.

2.4.2 Knowledge harvesting and discovery

Knowledge assets are an output from the knowledge conversion and knowledge discovery processes. Undocumented human long-term memory does not become an organisational asset until it is harvested and shaped into a knowledge asset (Dix, Wilkinson and Ramduny, 1998, Alavi and Leidner, 2001, McManus, Snyder and Wilson, 2003). Knowledge harvesting is an approach that allows tacit knowledge or know-how of experts and top performers in an organisation to be captured with the ultimate goal to describe an individual's decision-making process with enough clarity that someone else could repeat the steps of the process and achieve the same results (Eisenhart, 2001, Specialist-Library, 2005b). This know-how can then be made available to others through learning and training programmes, operational manuals and knowledge management databases.

This is a useful process to apply when an organisation wants to establish what it knows e.g. when an employee leaves the organisation or transfers to another department, or when knowledge is required to support a process of change or improvement (Specialist-Library, 2005b). Learner First Inc. developed a nine-stage knowledge harvesting process which is a proprietary solution to knowledge creation. The nine stages are identification, elicitation, capture, organisation, application, recording and sharing of knowledge (Kothuri, May 2002). The last two steps are evaluation and improvement of the knowledge creation process. Table 5 provides an overview of the nine stages and steps, as well as a brief description of each step.

Table 5: Knowledge harvesting stages (Kothuri, May 2002)

Knowledge Harvesting Stages		
Stage	**Step**	**Description**
Stage 1	Identification of knowledge	This is the initiating step of the knowledge harvesting process and involves determining who the top performing people are and what their critical activities consist of. It involves mapping the organisation's key processes and the individuals who hold the best know-how.
Stage 2	Elicitation of knowledge	This is probably the most difficult stage of the process as this phase deals with extracting information from key performers or experts about the activities they perform and the rules that they use in decision-making. The activities of the experts elicited in this way are mapped logically as part of the knowledge harvesting process.
Stage 3	Capture of knowledge	This stage in its ideal form makes a permanent copy of the memory of the organisation's experts. The information obtained in stage 2 is distilled and key decision rules are stored.
Stage 4	Organisation of knowledge	The knowledge captured in the previous stages must be arranged in a coherent or systematic form in order to allow anyone in the organisation to retrieve the required information quickly and efficiently.

Knowledge Harvesting Stages		
Stage	**Step**	**Description**
Stage 5	Application of knowledge	The purpose of creating knowledge assets in an organisation is to ensure that the application of expert knowledge by top performers is replicable by all. This phase allows individuals to seek assistance or advice for specific tasks or outputs and in the process enhances their own learning.
Stage 6	Recording of knowledge	Once an application has been created, it evolves and is refreshed as learning in an organisational context takes place. This stage records the learning that took place, causing the database of knowledge to grow and collects and preserves information on a particular subject.
Stage 7	Sharing of knowledge	The value of knowledge that has been captured, is that it can be – or rather should be – shared. This process of sharing is likely to lead to the capturing of other knowledge, the use of previous knowledge and the creation of new knowledge.
Stage 8	Evaluation of knowledge creation process	The ultimate output of this stage is to evaluate the contribution to organisational performance as evaluation happened during application and sharing. Evaluation should be continuous as the knowledge base must be kept up to date, relevant and as small as possible.
Stage 9	Improvement of knowledge creation process	The focus of this stage is the improvement of the entire process and includes the improvement of both the stored knowledge as well as its application. By improving the flow of knowledge throughout the organisation, the value to individuals or teams is enhanced.

Another process for generating knowledge from data is knowledge discovery, which uses tools from artificial intelligence, mathematics and statistics to analyse both text and data. The auditing firm Price Waterhouse has developed an application that scan through approximately 1 000 newsletters each night to extract knowledge about management changes by applying knowledge discovery principles (O'Leary, 1998, Marwick, 2001).

2.4.3 Knowledge creation

Knowledge and continuous learning are critical elements of success in the new economy (Senge, 1990). The management of knowledge is inherently linked to the sharing of knowledge between individuals and to the collaborative processes involved (Edersheim, 2007).

Most explicit knowledge bases in organisations today are reflected as business process repositories – as an input-process-output cycle - as it is the current paradigm in which organisations process information (Kotelnikov, 2001). Organisational learning actually results from a process in which individual knowledge is transferred, enlarged and shared and is characterised as a spiral of knowledge conversion from tacit to explicit (Nonaka and Takeuchi, 1995, Nonaka, Toyama and Byosiere, 2001).

Figure 10 illustrates the spiral of knowledge conversion from tacit to explicit knowledge on the one axis to individual to inter-organisational knowledge on the other axis. Knowledge conversion initiates at the individual level and is expanded through interactions to include a diversity of perspectives that ultimately represent shared knowledge at an organisational level (Nonaka and Takeuchi, 1995).

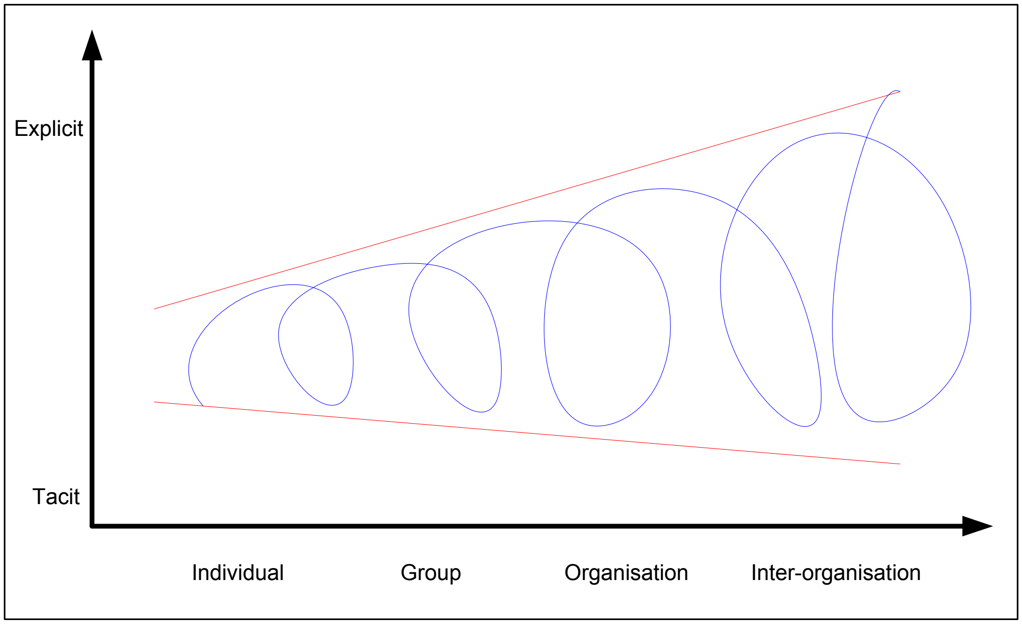

Figure 10: Knowledge conversion process (Nonaka and Takeuchi, 1995)

Furthermore, Nonaka and Takeuchi (1995) defined a model that is based on the fundamental assumption that knowledge is created and expanded through social interaction between implicit – specifically tacit - and explicit knowledge, known as knowledge conversion. Based on Nonaka's theory (1995), the process of knowledge conversion progresses through four different modes (Figure 11): socialisation (tacit to tacit), externalisation (tacit to explicit), combination (explicit to explicit) and internalisation (explicit to tacit).

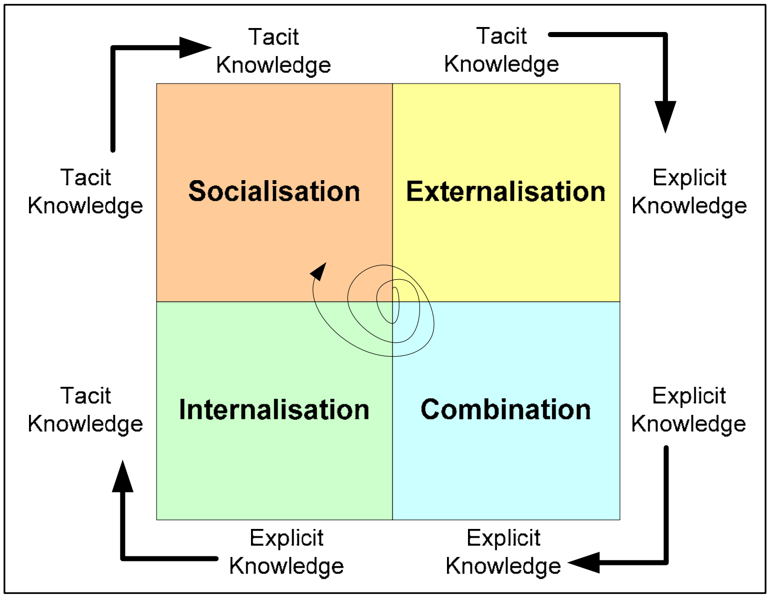

Figure 11: Nonaka's four modes of knowledge creation (Nonaka and Takeuchi, 1995)

Socialisation includes shared information and experiences, as well as the sharing of tacit knowledge between people through observation, imitation and practice. This kind of knowledge sharing often takes place among people who have a common culture and can work together effectively. As mentioned before, tacit knowledge is difficult and, in some cases, impossible to convert into explicit knowledge. *Externalisation* is the process whereby tacit knowledge is articulated as explicit knowledge through collaboration with others by means of conceptualisation and extraction. The use of technology to manage and search explicit knowledge bases is well established, and explicit knowledge is shared not only via document management systems, e-mails, in meetings, etc., but also through education, learning and training interventions. *Combination* is the enrichment of the collected information by re-configuring it or enhancing it by sorting, adding, combining or categorising it so that it is more usable. In order to act on information, individuals should understand and *internalise* it. This involves the process of creating their own tacit knowledge. The process is closely related to learning-by-doing through studying documents or attending training in order to re-experience to some degree what others have previously learned. Individuals are given the opportunity to create new knowledge by combining their existing tacit knowledge with knowledge of others (Nonaka and Takeuchi, 1995).

Knowledge assets, as described in Chapter 1 of this study, are the inputs and outputs of this knowledge creation process in an organisation. According to Nonaka, Toyama et al (2001), knowledge assets are categorised into four types: experiential, conceptual, routine and systemic knowledge assets.

Firstly, *experiential* knowledge assets refer to tacit knowledge shared through common experiences like skills and know-how of individuals, care, love, trust and security and energy, passion and tension. Secondly, *conceptual* knowledge assets refer to explicit knowledge articulated through images, symbols and language, like product concepts, designs or brand equity. Thirdly, *routine* knowledge assets include tacit knowledge routinised and embedded in actions and practices like know-how in daily operations, organisational routines and organisational culture. Lastly, *systemic* knowledge assets include systemised and packaged explicit knowledge like documents, specifications, manuals, databases and patents and licences (Nonaka, Toyama and Byosiere, 2001).

These knowledge assets are dynamic, and new ones can be created using existing ones (Nonaka, Toyama and Byosiere, 2001, Hicks, Dattero and Galup, 2006, Beesley and Cooper, 2008). Therefore, to manage the creation and exploitation of knowledge effectively, an organisation must map its knowledge stocks (Grey, 1999, Reinhardt et al., 2001). The organisation must manage the knowledge creation process in such a way that knowledge created becomes part of the knowledge assets of the organisation and the basis for a new cycle of knowledge creation (Nonaka, Toyama and Byosiere, 2001, Hicks, Dattero and Galup, 2006, Beesley and Cooper, 2008).

2.5 Knowledge management in an organisational context

Organisations today face the challenge of creating an infrastructure that facilitates knowledge transfer – both explicit and implicit. Explicit knowledge is easy to identify based on the definitions above, but implicit – and specifically tacit – knowledge transfer, remains an area of focus. Organisations have to manage this process in order to enable the organisation to transform tacit knowledge into explicit knowledge and make it available and accessible company-wide (Gordon, 1999, Clarke and Rollo, 2001).

One of the essential elements of an organisation is the employees and the teams or departments of employees that work together. This refers to different dimensions (Figure 12) of knowledge within the organisational domain. The different dimensions have three different modes of knowledge conversion: along the y-axis is knowledge as held by the individual or the entire team, along the x-axis the implicit and explicit types of knowledge and the third dimension represents whether knowledge is internal to the organisation or external to it (Kothuri, May 2002).

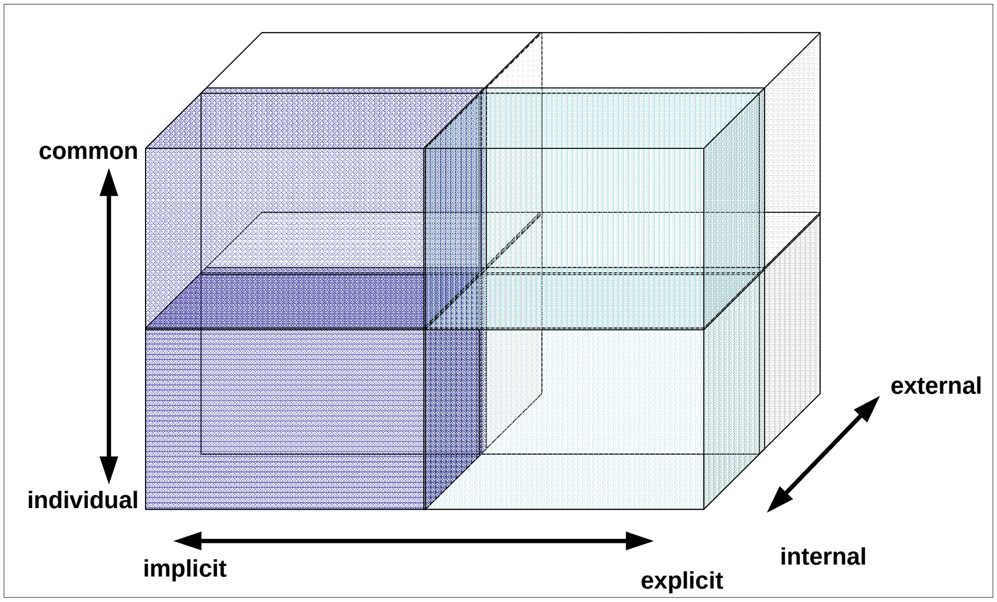

Figure 12: Organisational dimensions of Knowledge (Kothuri, May 2002)

The rest of this section explores key components of knowledge management, namely knowledge work (Section 2.5.1) and learning in an organisational context (Section 2.5.2), as well as barriers of knowledge management in organisations (Section 2.5.3).

2.5.1 Knowledge work

Knowledge management is defined in Section 2.4 of this thesis as a framework for designing an organisation's goals, structures and processes so that the organisation can use what it knows to learn and to create value for its customers and community (Choo, February 2000). In addition to this framework, organisations must take key strategic steps to define and quantify the source and nature of the bodies of knowledge that need to be included in the knowledge management framework (Wilson and Frappaolo, 1999). The organisation must protect itself from knowledge leaving the organisation in order to optimally use what it knows across all perspectives – vision and strategy, roles and skills, policies and procedures and tools and platforms as depicted in Figure 13 (Holloway, 2000, Lindvall et al., 2001).

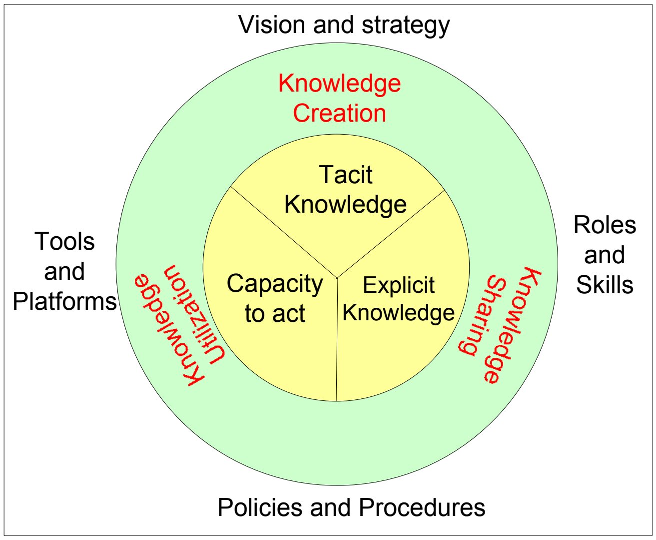

Figure 13: Managing knowledge: elements and enablers (adapted) (Choo, February 2000)

An understanding of knowledge in organisations, the modes and context of conversion of knowledge and the technologies used in this conversion are tactical approaches to knowledge creation. A strategic knowledge creation solution encompasses all of these steps in one seamless and complete procedure for knowledge work (Hoffmann et al., 1999, Marwick, 2001, Vequist and Teachout, 2006, Kothuri, May 2002).

According to Naisbitt (1982, as quoted by Nickols, 2000), white-collar workers first out-numbered blue-collar workers in the USA in 1956 where the ratio of manual workers to knowledge workers was 2 : 1 in 1920 and 1 : 2 by 1980. The number of knowledge workers in the computer industry in the USA was estimated at 72% based on a testimony before a senate sub-committee (Nickols, 2000). This new type of worker requires a different type of management (Garvin, 1998, Westhuizen, 2002, Frappaolo, 2006, Edersheim, 2007) and although knowledge is not new, the recognition of knowledge as a corporate asset, is new (Stewart, 1997, Davenport and Prusak, 1998, Hoffmann et al., 1999). Davenport (1998) concludes that there is currently a greater need than in the past to optimise organisational knowledge and to obtain as much value as possible from it. Table 6 summarises the definition of manual work and knowledge work (Nickols, 2000).

Table 6: Manual work vs. knowledge work (Nickols, 2000)

Manual work	Knowledge work
Materials-based	Information-based
Manual work process consists of converting materials from one form to another	Knowledge work process consists of converting information from one form to another
Tangible results	Often intangible
Works *with* knowledge, information	Works *with* and *on* knowledge, information
Working behaviours are public	Working behaviours are private
Visibility of working is high	Visibility of working is low
Results almost always immediate	Results are not so apparent and rarely immediate
Relatively simple matter to observe linkage between manual worker, tools or equipment being used and materials being processed	Linkage between behaviour and results not apparent
Locus of control over work with manager	Locus of control over work shifted to worker
Political[3] and positional[4] balance of power	Political and professional[5] balance of power
Worker is focus of control	Work is focus of control
Compliance is measure of performance	Contribution is measure of performance
Efficiency, the ability to get things done is key measure	Effectiveness, the ability to get the right thing done is key measure

A major difference between knowledge work and manual work is that knowledge work is information-based and manual work is materials-based. A manual work process, regardless of how much skill and knowledge is required of the worker, consists of converting materials from one form to another with tangible results. Knowledge work, on the other hand, consists of converting information from one form to another with frequently intangible results (Stewart, 1997, Nickols, 2000). This difference in work output informs how these workers will be performance managed and how they will be measured (Krogh, Ichijo and Nonaka, 2000, Edersheim, 2007).

2.5.2 The learning organisation

Senge presented tools and ideas for the learning organisation during the early 1990s. He claimed that learning organisations can be built "where people continually expand their capacity to create results they truly desire, where new and expansive patterns of

[3] Power derived from relationships among people
[4] Power derived from formally constituted authority
[5] Power derived from specialist knowledge

thinking are nurtured, where collective aspiration is set free and where people are continually learning how to learn together" (Senge, 1990 : 3). He identified five key dimensions for building organisations that can truly *learn* namely systems thinking, personal mastery, mental models, building shared vision and team learning.

The learning organisation creates an environment where the behaviours and practices involved in continuous learning, are actively encouraged and facilitated. This process of continuous learning includes the exchange of both explicit and implicit knowledge (Senge, 1990, Garvin, 1998, Kotelnikov, 2001, Marwick, 2001, Salisbury, 2003, Asgarkhani, 2004, Vequist and Teachout, 2006). Compared to a learning organisation, a coaching organisation goes beyond this exchange and also focuses on how to unlock the inner power of people in the organisation in order to make them innovators and self-leaders (Hoffmann et al., 1999, Kotelnikov, 2001). Figure 14 illustrates these different levels of knowledge management from an industrial organisation to a learning organisation where the focus is on learning for everyone. The next stage entails moving from a teaching organisation where both learning and teaching take place to a coaching organisation where coaching is added to the learning and teaching dimensions.

Kotelnikov (2001) defines unique advantages of such a coaching organisation. The first advantage entails ensuring enhanced development of individuals and collective tacit knowledge through cross-coaching conversations. The second advantage is creating enhanced teamwork through facilitating a better understanding among team members and fostering a deeper integration of their activities (Agostini et al., 2003). The third advantage is ensuring improved development of people and the utilisation of their talents by building their personal capabilities (Yu, Kim and Kim, 2004) and the last advantage is creating better employee empowerment by developing them as self-leaders (Edersheim, 2007).

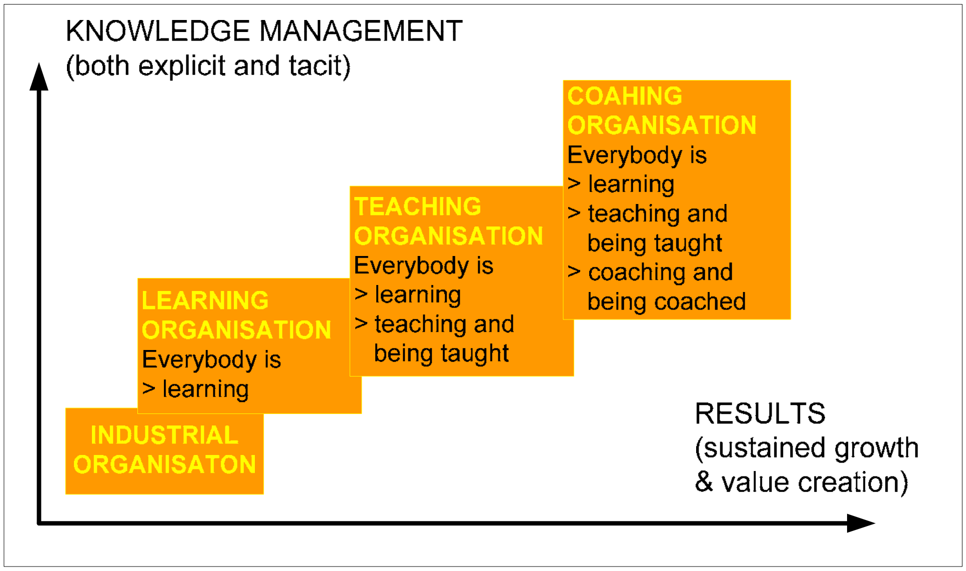

Figure 14: Different levels of knowledge management (Kotelnikov, 2001)

2.6 Knowledge management barriers

Organisations in the new economy deal with two major management tasks given the dynamics of hyper-competition and globalisation: the resulting re-invention of businesses and pressure for innovation, as well as the related re-alignment of corporate activity (Barclay and Murray, 1997, Kothuri, May 2002).

Further changes in this landscape that organisations need to deal with include global integration (Kotelnikov, 2001, Kothuri, May 2002) and geographic distribution associated with the globalisation of markets and growth in organisational scope – organisations have to do more with less and at an accelerating pace of change (Barclay and Murray, 1997, Gordon, 1999). Obstacles for knowledge management reveals three main groups of factors when staff attrition due to downsizing and reengineering, growing knowledge-intensity of products and services and the revolution in IT are considered (Barclay and Murray, 1997, McCullough, 2005). The first factor refers to flaws in the organisational knowledge management process (Murray, 2004), the second factor points to misconceptions of the role of technology in the process (Moteleb and Woodman, 2007) and the third factor is a disregard of the importance of the human factor in realising a successful knowledge managing and knowledge-sharing culture (McCullough, 2005).

Van der Westhuizen (2002) describes some of the opponents of successful knowledge management as follows:

- *The empowered middle manager*. A middle manager that forms part of a cross-functional value chain running an autonomous operation as if his/her small section is the whole business, creates internal competition rather than focusing on the external competitors.
- *The knowledge management software vendor*. The software vendor becomes an enemy of knowledge management if software products are sold as if it is a solution.

In addition to obstacles of knowledge management that organisations deal with, there aer also barriers to sharing knowledge as summarised in Table 7. These barriers are organisation specific and include organisational hierarchy, geographical barriers, human nature and personality.

Motivating users of a knowledge management system to contribute their knowledge to the system is critical for the success of the overall knowledge management initiative (Muller, Spiliopoulou and Lenz, 2005). In view of the barriers to sharing knowledge, the motivation of people to share their knowledge remains a challenge (Muller, Spiliopoulou and Lenz, 2005, Frappaolo, 2006). Any knowledge management initiative in an organisation must address and alleviate these barriers to optimise knowledge sharing as it forms the basis of value creation and leveraging of the intangible assets of the organisation.

Table 7: Summary of knowledge management barriers

Knowledge management barriers	
Hierarchy (Andrew and Westhuizen, 1999, Kotelnikov, 2001)	• Implicit assumption that wisdom accrues to those with the most impressive organisational titles • Inequality in status among the participants in a knowledge sharing session is a strong inhibitor for tacit knowledge sharing, especially when aggravated by different frameworks of reference
People and Human Nature (Godbout, 1999, Krogh, Ichijo and Nonaka, 2000, Marwick, 2001, Muller, Spiliopoulou and Lenz, 2005, Frappaolo, 2006)	• Knowledge transfer is often a case of *who* you know versus *what* you know • Sharing one's best thinking, data, understanding and opinion with others diminishes one's personal competitive advantage • Improving by generating new ideas continuously while getting rid of old conventional ideas is difficult due to resistance to change • Use of other people's knowledge often presents a problem as the notion of "it-was-not-invented-here" is difficult to break down
Geographical barriers (Kotelnikov, 2001, Marwick, 2001)	• Distance – both physical and time – is a strong inhibitor for tacit knowledge sharing.
Personality (Kotelnikov, 2001, Marwick, 2001, McCullough, 2005, Muller,	• Strong preference for analysis over intuition discourages employees to offer ideas without hard facts to back it up

Knowledge management barriers	
Spiliopoulou and Lenz, 2005)	• Penalties for failure discourage experimentation

2.7 Summary

In this chapter, the focus was on exploring the nature of knowledge, knowledge management and knowledge management processes in relation to the first research question "*How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?*".

The nature of knowledge was explored compared with data that consists of structured recordings of transactions and information where meaning is added to data. Information becomes knowledge when it is accepted and retained as suitable representations of the relevant knowledge. The value of knowledge can be increased through analytical thought processes, as data and information are processed, understood and connotation added. Wisdom is the ultimate level of understanding and the optimum use of knowledge.

Various dimensions of knowledge, namely explicit, implicit and tacit knowledge were considered. Explicit knowledge is knowledge that has been articulated in some tangible form, while implicit knowledge refers to less tangible, embedded knowledge. Implicit knowledge can be made explicit by documenting it. Tacit knowledge is a dimension of implicit knowledge and includes know-how, beliefs and values. It is knowledge that cannot be articulated and that can provide a competitive advantage to organisations.

A range of elements of knowledge management was considered in this chapter and it was established that organisations create value by transforming knowledge into competencies, by learning and by replicating know-how. Knowledge management processes facilitate the creation of economic value by converting individual knowledge into organisational knowledge. Three different views of knowledge management processes, namely a process view, a technology view and a supply chain view were considered (Section 2.4.1) and two specific knowledge management processes, namely knowledge harvesting (Section 2.4.2) and knowledge creation (Section 2.4.3), were investigated.

Knowledge management in an organisational context focused on the organisational dimensions of knowledge and employees with individual knowledge as an essential element of teams that work together. Organisations must gain an understanding of the source and nature of knowledge in the organisation in order to optimally use its know-how, to learn and to create a strategic knowledge solution for knowledge work. Organisational learning includes the exchange of both explicit and implicit knowledge and creates an environment where these practices and behaviours are actively encouraged and facilitated.

Chapter 2 concludes with a view of knowledge management barriers and the identification of flaws in the organisational knowledge management processes, with organisational hierarchy, human nature, geographical barriers and misconceptions of the role of technology as some of the obstacles to knowledge management.

Chapter 3 Knowledge Management Technology

3.1 Introduction

Technology is a key enabler of knowledge management as it extends the reach and enhances the speed of knowledge transfer (Wilson and Snyder, 1999, Chua, 2004, Yu, Kim and Kim, 2004). Technology permits the knowledge of an individual or group to be structured and codified and allows distribution of knowledge across the world (Davenport and Prusak, 1998, Wessels, Grobbelaar and McGee, 2003). Knowledge management technology is a broad concept and organisations apply a wide variety of technologies to the objectives of knowledge management (Davenport and Prusak, 1998, Lindvall et al., 2001).

This chapter provides an overview of knowledge management technology and focuses on systems as an enabler of knowledge management in relation to the second research question "*What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?*". The last sections in this chapter provide a general outline of knowledge management software tools and the classification thereof. Table 8 provides an overview of the chapter layout.

Table 8: Chapter 3 outline

Outline of Chapter 3			
Section	**Description**	**Sub-section**	**Sub-section description**
3.1	Introduction		
3.2	Software tools enablement		
3.3	Knowledge management systems	3.3.1	Solution characteristics
		3.3.2	Information systems
3.4	Knowledge management software tools	3.4.1	Application of knowledge management tools
		3.4.2	Key dimension of knowledge management tools
3.5	Knowledge management technologies classification		
3.6	Summary		

3.2 Software tools enablement

Explicit knowledge is found in reports, documents and manuals and can easily be gathered and stored as a knowledge base (Dix, Wilkinson and Ramduny, 1998, O'Leary, 1998, Clarke and Rollo, 2001). Organisations use groupware applications to collect, store and share their explicit knowledge, and once this has reached a sufficient level of efficiency, collaborative technologies such as intranet, the internet, extranet, e-mail, video-conferencing and tele-conferencing are used to assist in the growth of tacit knowledge transfer (O'Leary, 1998, Clarke and Rollo, 2001, Wessels, Grobbelaar and McGee, 2003). In order to enable organisations to retrieve captured knowledge, knowledge route maps and directories are developed to create an understanding of the location of knowledge (Alavi and Leidner, 2001, Clarke and Rollo, 2001). Knowledge networks are created using virtual business environments such as chat rooms, team web sites and learning communities (O'Leary, 1998, Alavi and Leidner, 2001, Clarke and Rollo, 2001) with the development of specific applications of technology such as databases, workflow systems, personal productivity applications and enterprise information portals (Wilson and Snyder, 1999, Wessels, Grobbelaar and McGee, 2003)

According to Lindval, Rus et al (2001), software tools enable the capturing of knowledge by converting it from unpredictable and tacit to predictable and explicit, they support storage and organisation through distributed databases and document-management technology and facilitate reliable and secure access from various locations. They also support efficient search and retrieval via search engines and databases enhanced with artificial intelligence techniques and facilitate collaboration between people who are not geographically collocated.

3.3 Knowledge management systems

3.3.1 Solution characteristics

Although knowledge management tools are enhancements of existing technologies, true knowledge management technologies differ in several important aspects from the traditional workflow, document management and intranet to groupware solutions (O'Leary, 1998, Hahn and Subramani, 2000, Tsai and Chen, 2007, Frappaolo and Capshaw, July 1999). The characteristics of a knowledge management solution is summarised in Table 9 listing the characteristic, a description of the characteristic and an example to illustrate the characteristic (Frappaolo and Capshaw, July 1999).

Table 9: KM solution characteristics (Frappaolo and Capshaw, July 1999)

Knowledge management solution checklist	
Characteristic	**Description and example**

Knowledge management solution checklist	
Context sensitive	• Solution should be able to understand the context of the knowledge requirement and tailor response accordingly • E.g. should be able to understand and respond differently between *animal reproduction* and *document reproduction*
User sensitive	• Solution should be able to organise the knowledge in the way most useful to the specific knowledge seeker • E.g. should give knowledge relevant to knowledge seeker's current knowledge level, facilitating easier understanding
Flexible	• Solution should be able to handle knowledge of any form as well as different subjects, structures and media • E.g. if knowledge seeker wants to learn about gramophone records, it should supply knowledge on the technology as well as purchasing trends and examples of famous recordings
Heuristic	• Solution should constantly learn about its users and the knowledge it possesses as it is used i.e. continually refine itself as a user's pattern of research is tracked by the system • Its ability to provide a knowledge seeker with relevant knowledge should therefore improve over time • E.g. if the solution responds to many requests on a particular subject, it should learn how to assist multiple users in more depth on that subject
Suggestive	• Solution should be able to deduce what the knowledge seeker's knowledge needs are • E.g. suggest knowledge associations the user is not able to do

According to Frappaolo and Capshaw (July 1999), the main characteristics of a knowledge management solution are context sensitivity, user sensitivity and flexibility, as well as heuristic and suggestive. *Context sensitivity* refers to an understanding of the connotation of the knowledge and *user sensitivity* to the optimal way in which users will retrieve knowledge. *Flexibility* enables the knowledge management solution to incorporate different media, structures and topics. *Heuristic* refers to the capability of the solution to build a profile of the user based on user interactions and *suggestive* the capability to deduce what the user's knowledge requirements are when seeking knowledge.

3.3.2 Information systems

There are various views of knowledge and knowledge management based on the discussions in previous sections of this thesis and technology as an enabler of knowledge management, is established. According to Tsai and Chen (2007 : 258), knowledge management systems are ...

> ... more than just information systems or IT-enabled tools in support of knowledge management activities. Instead, a knowledge management system must be a socio-technical system as a whole which comprises the knowledge

itself (the intellectual capital of the organisation), organisational attributes (intangibles such as trusting culture), policies and procedures, as well as some form of electronic storage and retrieval systems.

These specific implications of knowledge and knowledge management for knowledge management systems are important, as these different views lead to different perceptions and definitions of knowledge management systems (Offsey, 1997, Asgarkhani, February 2004). Alavi and Leidner (2001) provide a summary of these different views, as depicted in Table 10:

Table 10: Knowledge perspectives and their implications (Alavi and Leidner, 2001)

Perspectives		Implications for KM	Implications for KMS
Knowledge, data and information	Data is facts, raw numbers. Information is processed / interpreted data. Knowledge is personalised information.	KM focuses on exposing individuals to potentially useful information and facilitating assimilation of information.	KMS will not appear radically different from existing IS, but will be extended toward helping with user assimilation of information
State of mind	Knowledge is the state of knowing and understanding.	KM involves enhancing individual's learning and understanding through provision of information.	Role of IT is to provide access to sources of knowledge rather than knowledge itself.
Object	Knowledge is an object to be stored and manipulated.	Key KM issue is building and managing knowledge stocks.	Role of IT involves gathering, storing and transferring knowledge.
Process	Knowledge is a process of applying expertise.	KM focus is on knowledge flows and the process of creation, sharing and distributing knowledge.	Role of IT is to provide link among sources of knowledge to create wider breadth and depth of knowledge flows.
Access to information	Knowledge is a condition of access to information.	KM focus is organised access to and retrieval of content.	Role of IT is to provide effective search and retrieval mechanisms for locating relevant information.
Capability	Knowledge is the potential to influence action.	KM is about building core competencies and understanding strategic know-how.	Role of IT is to enhance intellectual capital by supporting development of individual and organisational competencies.

Although knowledge management initiatives rely on IT as an important enabler, not all information technologies apply to knowledge management (O'Leary, 1998, Alavi and Leidner, 2001). If it is considered that people (knowledge workers and managers), technologies (manual and computer-based technologies) and knowledge itself interact to comprise a knowledge management system (Tsai and Chen, 2007), then Alavi and Leidner's (2004 : 114) definition is more appropriate as a generic definition: "knowledge management systems refer to a class of information systems (IS) applied to managing organisational knowledge."

3.4 Knowledge management software tools

Software tools play a significant role in facilitating knowledge management in organisations although knowledge management comprises much more than software tools (Offsey, 1997, Wessels, Grobbelaar and McGee, 2003, Frappaolo, 2006). Software tools provide good support to knowledge management systems, a variety of software tools are available today and a growing number of software tools are introduced that are instrumental in facilitating knowledge management (Davenport and Prusak, 1998, Hoffmann et al., 1999, Krogh, Ichijo and Nonaka, 2000, Salisbury, 2003).

3.4.1 Application of knowledge management tools

The key applications of knowledge management are based on a framework that positions its primary role as the association of organisational knowledge among different entities and summarises it into four functions: intermediation, externalisation, internalisation and cognition (Frappaolo and Capshaw, 1999). *Intermediation* refers to the association of people to people i.e. connecting those who are looking for certain knowledge to those who are able to provide this knowledge. This function is primarily positioned in the area of tacit knowledge based on its interpersonal focus. *Externalisation* refers to the association of information source to information source. This function focuses on explicit knowledge and provides a way to capture and organise this knowledge according to a specific ontology into a knowledge repository. *Internalisation* refers to the association of explicit knowledge to knowledge seekers and involves the extraction of relevant knowledge from the external repository through filtering. Lastly, *cognition* refers to the association of knowledge to process and the purpose of systems to make decisions based on available knowledge.

Frappaolo (2006) expands these functions by showing how commonly-used technologies, reflected on the explicit side of the diagram (Figure 15) form part of a knowledge management solution. All solutions listed on the tacit side are human-based.

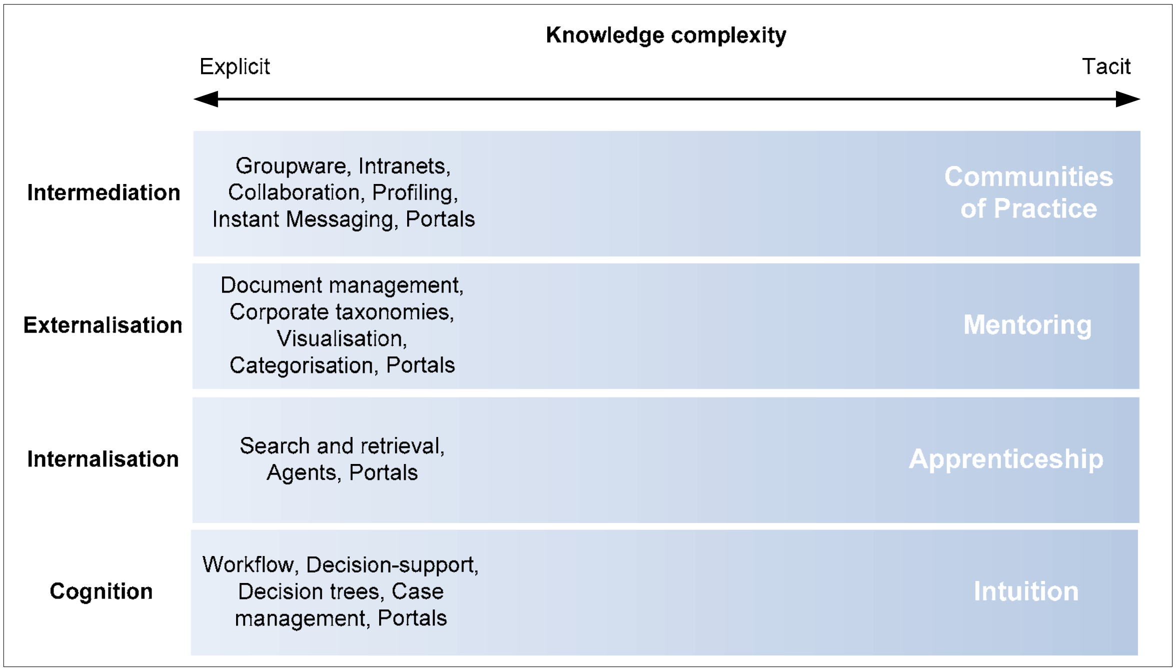

Figure 15: Application of technology to knowledge management (Frappaolo, 2006)

3.4.2 Key dimensions of knowledge management tools

Typical knowledge management processes were discussed in Section 2.4.1 and a variety of system tools may be drawn upon for support of different knowledge management processes (Offsey, 1997, Alavi and Leidner, 2001, Specialist-Library, 2005a). Wessels, Grobbelaar et al (2003) summarise the key dimensions of knowledge management software tools into four dimensions. The first dimension is *office automation systems* that distribute knowledge electronically, e.g. word processors, electronic schedulers, web publishing software, voicemail and e-mail. The second dimension is *groupware, intranets and extranets* that allow people to share knowledge. The tird dimension is *knowledge work systems* that aid in the creation of new knowledge, e.g. computer-aided design software and virtual reality systems, and the last dimension is *artificial intelligence software* that aids in the capturing and codification of knowledge, e.g. expert systems.

Lindvall, Rus et al (2001) expand these dimensions and include typical examples of software that fall within the knowledge management software category including document, content and competence-management software, collaboration- and customer support tools, data- and knowledge discovery technology, intellectual property, expert networks, portals and e-learning solutions. These dimensions are summarised in Table 11 with examples of each.

Table 11: Knowledge management software and examples (Lindvall et al., 2001)

Knowledge management software tools	
Dimensions of knowledge management software	**Examples of each dimension**[6]
Document and content management	Microsoft sharepoint, Xerox DocuShare, Lotus Domino Suite of Tools
Competence management	Skillscape Competence Manager, Knowledge-Mail
Collaboration tools	Lotus and Netmeeting, Fraunhofer's Chat Tool, Groupsystems
Customer support	Remedy Customer Support, AskIt and AskMe, Xerox Eureka
Data and knowledge discovery	Autonomy VoiceSuite, Spotfire, The Visual Query Interface (VQI), digiMine Analytic Services
Intellectual property	PatentCafe, Dennemeyer & Co, Xerox ContentGuard
Expert networks	Abuzz, Teltech
E-learning management systems	Hyperwave eLearning Suite, Scenarios, Firstdoor Enterprise Solution, Tutor.com
Portals	OptimalView, Axielle Portal tool

3.5 Knowledge management technologies classification

Different ways of classifying knowledge management technologies are utilised in the literature and Antonova, Gourova et al (2006) categorised technological solutions according to the following knowledge management processes:

- generation of knowledge
- storing, codification and representation of knowledge
- knowledge transformation and knowledge use
- transfer, sharing, retrieval, access and searching of knowledge

Generation of knowledge refers to activities for knowledge creation, acquisition and capturing. Knowledge content generation tools, e.g. word processors, multimedia editors, graphics programs and image and sound editors, as well as knowledge discovery tools, e.g. data mining tools that facilitate generation of knowledge from text and numeric data, contribute to the generation of knowledge. Data capturing tools e.g.

[6] This is not an exhaustive list of examples.

bar code readers, enable the capturing of knowledge ensuring that information is translated into machine-readable form (Alavi and Leidner, 2001, Bergeron, 2003).

Storing of knowledge refers to several technologies for the storage of data, information and knowledge as databases, knowledge bases, data warehouses and knowledge warehouses, data marts and data repositories. C*odification and representation* of knowledge indicates aspects like human-readable knowledge, e.g. case-based reasoning systems, manuals or newsletters, rule-based models, e.g. procedural models, semantic nets or production models, as well as knowledge organisation technologies and ontologies such as topic maps, skills maps and controlled vocabularies.

Knowledge transformation and knowledge use point to the transformation of knowledge once it is extracted for the knowledge repository. This includes business intelligence technologies that automate and integrate as much as possible, expert systems to guide users to recommended solutions, decision support systems that allow managers and other knowledge workers to make decisions by reviewing and manipulating the data stored, enterprise resource planning, enterprise resource management and customer relationship management tools, as well as visualisation tools, e.g. graphics and animation tools.

Transfer, sharing, retrieval, access and searching of knowledge includes web technologies for knowledge access and transfer, enterprise information portals integrating access to knowledge and applications, interface tools enabling information retrieval out of a database, search engines to find information, intelligent agents to connect knowledge seekers to knowledge available by using pattern matching technology and electronic technologies that support person-to-person and team collaboration.

3.6 Summary

This chapter focused on an overview of knowledge management technology and in particular technology as an enabler of knowledge management in relation to the second research question "*What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?*"

Software tools consisting of document-management applications, collaborative technologies, knowledge network solutions and groupware applications contribute to the growth of tacit knowledge transfer and enable organisations to capture, store and retrieve knowledge in a secure environment. Knowledge management tools are enhancements of existing technologies although true knowledge management technologies differ in several aspects from traditional technologies. Some of these aspects include an understanding of the context of knowledge, organisation of knowledge in the way most useful to the knowledge seeker, capability of the solution to constantly learn about its users and the ability to deduce what the knowledge seeker's knowledge needs are.

The specific nature of knowledge and knowledge management discussed in Chapter 2 lead to different definitions of knowledge management systems that in general refer to a class of IS applied to managing organisational knowledge. Some of these specific knowledge and knowledge management impacts are the access to sources of knowledge rather than the knowledge itself, support in user assimilation of information, providing effective search and retrieval mechanisms in locating relevant information and the enhancement of intellectual capital by supporting the development of individual and organisational competencies. A variety of software tools are available that provide support to knowledge management systems through four main functions, namely the association of people to people, the association of information source to information source, the association of explicit knowledge to knowledge seekers and the association of knowledge to process.

Chapter 3 concludes by considering different ways of classifying knowledge management technologies and specifically describes the classification according to a knowledge management process.

Chapter 4 Software and Systems Architecture

4.1 Introduction

In a typical knowledge management system, a knowledge base that documents and organises the knowledge in the organisation, expert lists, a tracking system of individuals of the organisation and their collective knowledge must be maintained (Lindvall et al., 2001). It has been established in Chapter 3 that a wide variety of technologies are applied to the objectives of the management of knowledge and that organisations can utilise existing IT infrastructure in order to facilitate knowledge management. If an organisation utilises technology as part of a knowledge management implementation based on a knowledge management view, they may have difficulty in selecting from a vast array of technology solutions. Conversely, if an organisation chooses a specific software tool based on a technology view but is ignorant of knowledge management processes, then either approaches could result in a solution that does not meet the organisational requirements for a knowledge management system. A knowledge management system architecture that seeks to bridge this gap van be developed (Chua, 2004). By applying technologies – some of it already existing in an organisation - to knowledge management and by applying knowledge management theory in creating these tools, a three-tiered knowledge management system architecture is defined consisting of three layers namely infrastructure services, knowledge services and presentation services (Chua, 2004).

This chapter provides an overview of key concepts within architecture definition and specifically for knowledge management system architectures in relation to the third research question: "*How do these knowledge management characteristics relate to a conceptual architecture of a knowledge management system?*" An overview of key concepts within architecture definition and evaluation criteria is provided, as well as evaluation questions for evaluating an architecture. A general overview of possible knowledge management system architectures is discussed and an example of such an architecture is given. The last section of this contains the architecture evaluation criteria applied in order to evaluate a model knowledge management architecture. Table 12 provides an overview of the chapter layout.

Table 12: Chapter 4 outline

Outline of Chapter 4	
Section	**Description**
4.1	Introduction
4.2	Key concepts within architecture description
4.3	Knowledge management system architectures
4.4	Knowledge management system architecture evaluation
4.5	Summary

4.2 Key concepts within architecture description

There is a considerable body of literature on the topic of software system architectures (Garlan and Shaw, 1994, Kruchten, 1995, Lankhorst, 2005, Finneran, 2007). Fowler

(2003) indicates that architecture is a subjective topic as it is about a shared understanding of a system's design, the major components of the system and the way they interact. Yourdon, Whitehead et al (1995 : 189) defines system architecture as "the overall organisation of a system into components or sub-systems". For the purposes of this study, Gerber's definition will be used:

> An architecture is a model of a system within a specified context, depicting the components necessary to realise the system from a particular perspective or view. The architecture of a system includes the organisation or structure of the identified modular components, their defining features or properties, as well as the relationships and interfaces between components and outside entities. (2006 : 157)

An example of such an architecture is the architecture of the ADIPS-based knowledge management system (Abar, Abe and Kinoshita, 2004).

The key concepts within architecture description and definition are a model of a system within a particular perspective, illustrating the components necessary to understand the system from a specific context. The architecture of a system includes the structure of the identified components with their defining features, as well as the relationships and interfaces between the components and outside entities (Gerber, 2006).

Kruchten (1995) introduced a view model consisting of a framework of five viewpoints namely logical view, development view, process view, physical view and scenarios in order to describe architectures (see Figure 16). The use of multiple viewpoints is based on the observation that such a view model allows the separate addressing of functional and non-functional requirements, as well as dealing with various stakeholders of architecture e.g. the end-user, developers and system engineers.

The *logical view* primarily captures the services that the system should provide to its users and supports the functional requirements. The style used for the logical view is an object-oriented style. The *process view* considers the non-functional requirements and captures the concurrency, distribution and synchronisation aspects of the design. The style utilised for the process view is process decomposition. The *development view* focuses on the actual software module organisation and the software development environment and the notation used is sub-system decomposition adopting a layered style for this view. The *physical view* primarily describes the non-functional requirements of the system, e.g. scalability, reliability and performance and takes the mapping of software onto hardware and its distribution into account. The elements constituting the four views work together seamlessly by the use of *scenarios* – occurrences of general use cases - as an abstraction of the most important requirements (Kruchten, 1995, Lankhorst, 2005).

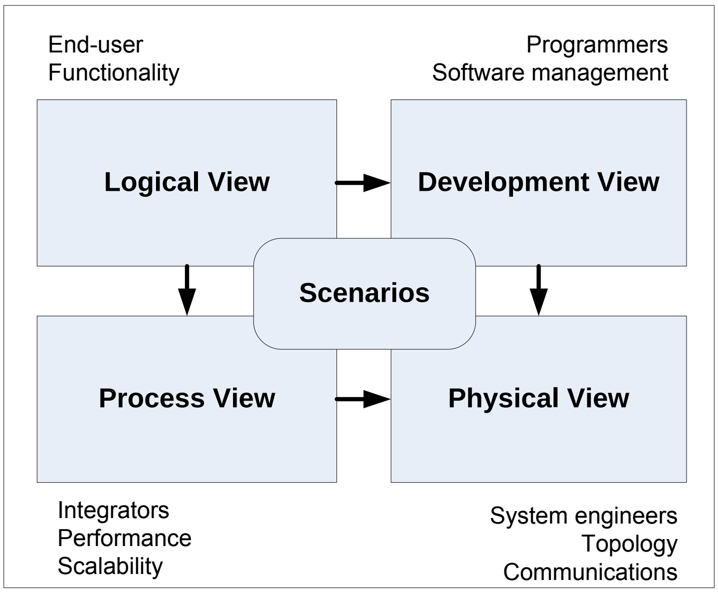

Figure 16: The "4+1" view model (Kruchten, 1995)

Gerber (2006 : 169 - 170) also defines evaluation criteria for layered architectures including relevant questions that may be used in the evaluation. Table 13 provides an overview of the criteria for layered architecture evaluation and a description of each criterion and lists the relevant evaluation questions.

Table 13: Evaluation criteria and questions for layered architectures (Gerber, 2006)

Evaluation criteria and questions for layered architectures		
Evaluation criteria	**Description**	**Evaluation questions**
Clearly defined context	The context is the result of the identified view that is used to analyse the system. The context or view determines the important aspects of the system at that level. It also aids the identification of the main components required to realise the system, the component properties, the structure or organisation of the components, as well as the relationships between the identified components.	• Is it possible to identify the context from the description of the architecture?
Appropriate level of abstraction and	The architecture model should be at a sufficiently high level of abstraction so that the	• Can the system within the context be viewed as a whole?

Evaluation criteria and questions for layered architectures		
Evaluation criteria	**Description**	**Evaluation questions**
hiding of implementation details	system or sub-system under review can be viewed as a whole. Only the aspects of the system that are relevant at a certain level of abstraction should be visible at that level. The hiding of implementation details supports the notion of an appropriate level of abstraction since implementation details should be hidden in an architectural model.	• Are there any components / properties / relationships / structures in the architecture model that could be removed without losing important information at this level of abstraction? • Are any implementation details visible in the description of the components / properties / relationships of the architecture?
Clearly defined functional layers	This criterion relates to the determination of the architectural components and their grouping into the appropriate layers. This grouping should be the result of functional decomposition and should support system development principles such as tight cohesion of related functional components.	• Does the layer description specify a *function* of the layer within the system? • Is the function of the layer clear from its description and position in the architecture? • Could the layer be removed without compromising the integrity of the system?
Appropriate layering, including well defined interfaces and dependencies	This criterion relates to the organisation of the identified layers. The layers must clearly build on one another and their relationships and dependencies should be distinguishable. A layer should only access layers below it. This criterion also includes the specification of dependencies or access rules between layers, which is used to determine whether the architecture is open or closed.	• Do the layers clearly build on one another? • Does a specific layer inly require functionality defined by lower layers and not those of upper layers? • Is it possible to determine whether the layered architecture is open or close?
Modularity	Components and hence layers should be modular. It should be possible to change the implementation of a layer as long as interfaces and functionality remain the same.	• Is it possible to replace the implementation of a layer with another implementation of the same functionality and interfaces without compromising the integrity of the layered architecture?

4.3 Knowledge management system architecture

A knowledge management system should accommodate the dynamic nature of knowledge (Moteleb and Woodman, 2007). In order to achieve this Chua (2004), Gauvin, Boury-Brisset et al (2004), Xie, Zhang et al (2006) and Abar, Abe et al (2004) suggest a three-tier architecture that identifies three distinct services supported by knowledge management technologies (depicted in Table 14). The first tier is presentation services (interface layer or user tier), the second tier is knowledge services (intelligence layer or business tier) and the third tier is infrastructure services (structured resource layer or data tier).

Table 14: KMS architecture

KMS architecture	
Tier	**Tier description**
Presentation	• Primarily concerned with enhancing the interface between the user and information /

KMS architecture	
Tier	**Tier description**
services Interface layer User tier	knowledge sources • Personalisation involves gathering of user-information and delivering appropriate content to meet specific user needs aligned to user profile • Help users better understand the information and knowledge available by providing subject-based browsing and easy navigation
Knowledge services Intelligence layer Business tier	• Promote and support process of generating new knowledge • Encourage flow of knowledge among members of the organisation • Ensure ease of access to knowledge repositories • Support knowledge creation through exploitation, exploration and codification • Support the knowledge sharing process through a social network analysis and collaborative tools • Support knowledge reuse such as content management and concept mapping
Infrastructure services Structured resource layer Data tier	• Refers to basic technology platform and features • Technology enabled store or knowledge repository that can support less structured information • Typically populated with data, documents or drawings • Facilitate communication between users, collaboration among users and workflow management

The user tier is primarily concerned with enhancing the interface between the knowledge seeker and the knowledge sources. The business tier promotes and supports the processes of generating knowledge and sustains knowledge reuse and the data tier refers to the technology platform and features.

An example of such a three-tier architecture is depicted in Figure 17 based on the development of a situational awareness knowledge portal to support the Canadian National Defence Command Center. The purpose of this portal was to monitor and direct strategic-level operations by providing each individual with a customised, mission-oriented knowledge desktop that offered access to the right, contextual information from multiple sources and contributed to the building and sharing of the collective battle space knowledge. Elements of the knowledge portal environment were integrated into a three-tier architecture: a set of tools at the user tier, a set of supporting services at the business tier and external heterogeneous sources at the data tier (Gauvin, Boury-Brisset and Auger, 2004).

The set of tools at the user tier in this example architecture consisted of communication, working, task support, specialist task and administration tools that allowed users to conduct virtual teamwork, manage documents and content, access frequently asked question (FAQ) libraries, conduct mission analysis and personalise individual portals. The supporting services at the business tier consisted of knowledge and administration services, where knowledge services included services such as search, retrieval and integrated access, ontology, collaboration and content services. Administration services included security, integration and configuration services. The data tier consisted of an assortment of external sources such as content storage and applications.

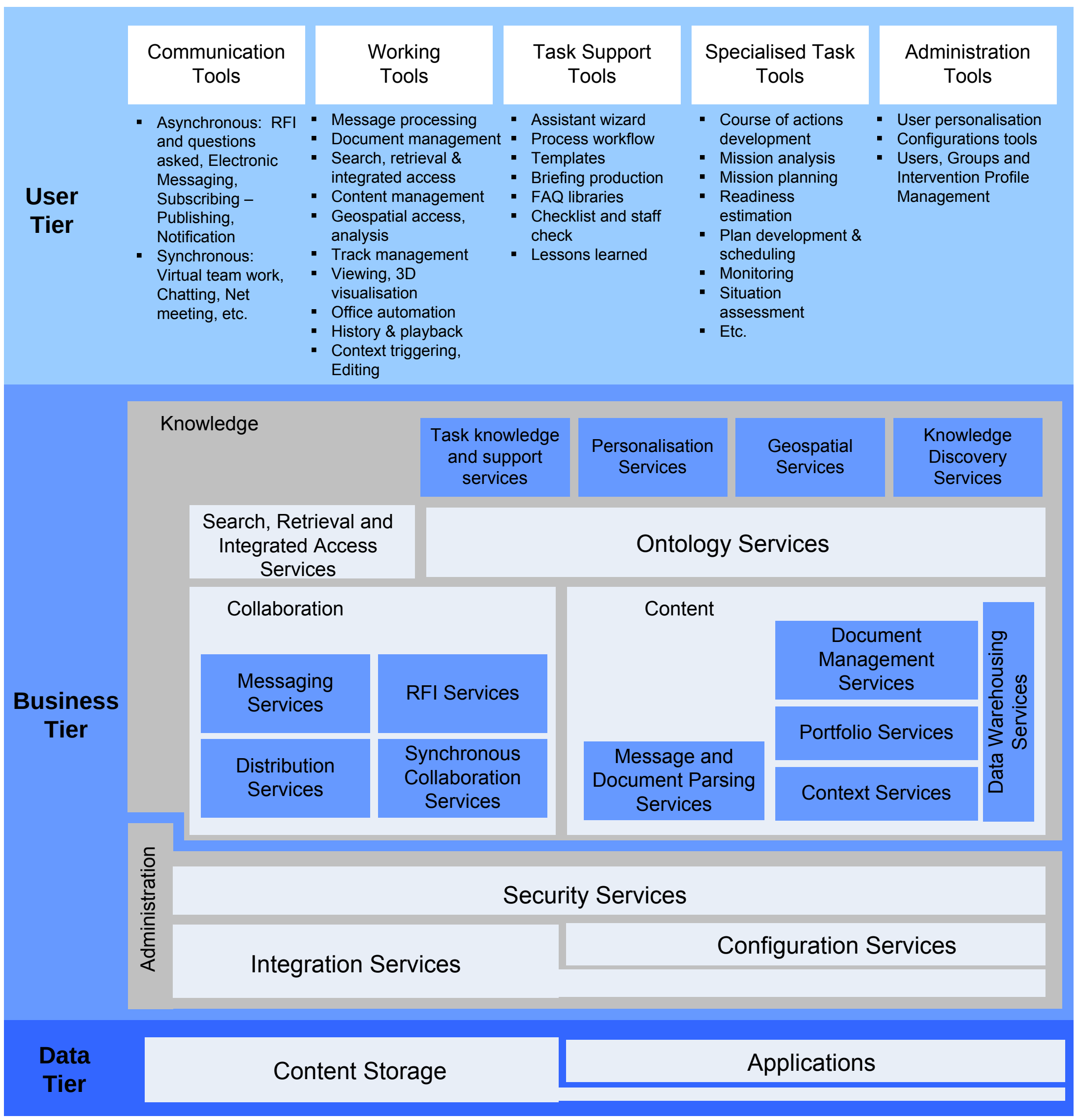

Figure 17: Knowledge environment framework (Gauvin, Boury-Brisset and Auger, 2004)

4.5 Knowledge management system architecture evaluation

A good knowledge management system should support the complete knowledge flow in the knowledge application life cycle and must be supported by a collection of technologies for authoring, indexing, classifying, storing, contextualising and retrieving information, as well as for collaboration and application of knowledge. Furthermore, a user-friendly front-end and a robust back-end are necessities for knowledge management. A knowledge management architecture model depicting these requirements is shown in figure 18 (Lindvall, Rus and Sinha, 2003).

The lowest layer handles sources of explicit knowledge that encompass knowledge objects, i.e. sources of explicit (e.g. documents, manuals, proposals, email messages) or implicit knowledge (e.g. people's expertise). Standard authoring tools like word processors and database management systems support this layer. The infrastructure layer is supported by web browsers, file servers, email tools, internet and intranet services, while knowledge repositories are managed by document- and content-management systems according to the context of the organisation. This is defined in a knowledge map that forms part of the organisational taxonomy layer and is supported by classifying and indexing tools. Data and knowledge discovery, collaboration service and expert network tools support the next layer, i.e. the knowledge management services layer. The knowledge portal supports knowledge distribution with different applications such as e-learning management, intellectual property management or customer relationship management (Lawton as quoted by Lindvall et al., 2001, Lindvall, Rus and Sinha, 2003).

The boundary between IT and knowledge management tools in this architecture model is unclear, although knowledge management is considered to be the higher levels starting at the knowledge repository layer. IT is then considered to constitute the lower levels below the knowledge repository layer. When evaluating systems from a knowledge management perspective, these upper layers of the architecture are considered (Lindvall, Rus and Sinha, 2003).

Regardless of the architecture used, all tools used in knowledge management have to address security since knowledge is such a valuable asset (Lindvall et al., 2001). This is implemented using inherent mechanisms in each tool or by using specific tools in addition to the existing system (Alavi and Leidner, 2001).

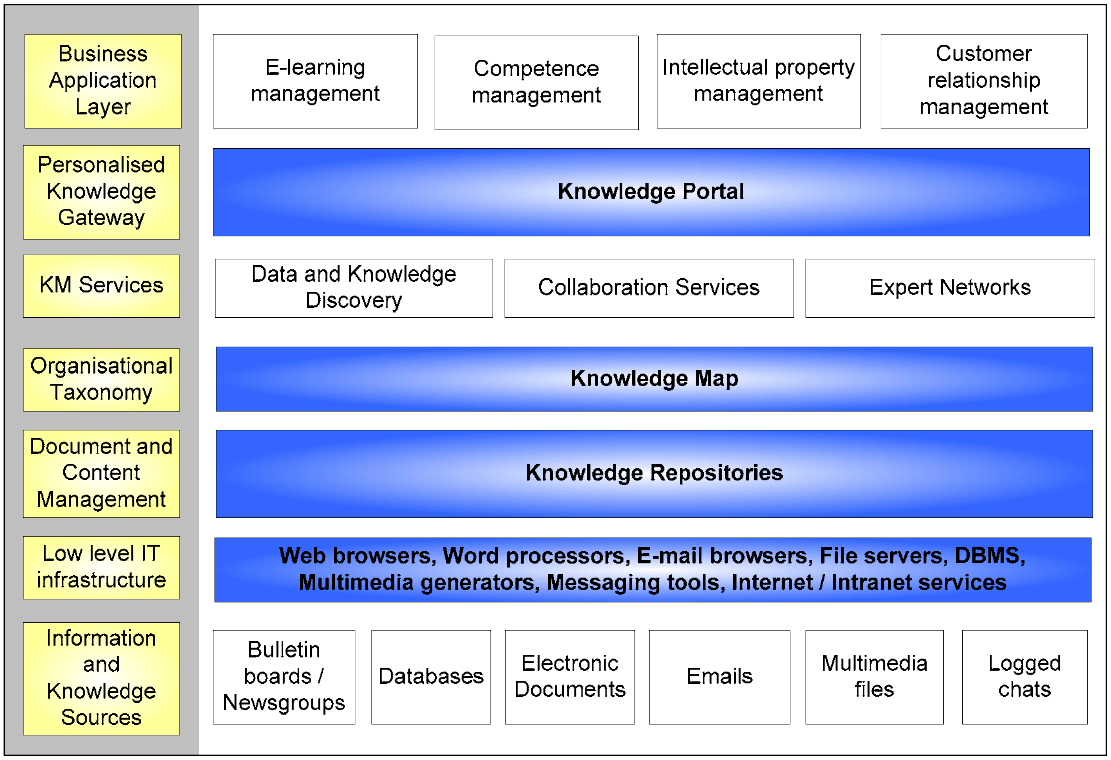

Figure 18: A KM architecture model (Lawton (2001) as quoted by Lindvall, Rus and Sinha, 2003)

The criteria defined in Section 4.2 can be used to design new architectures or to evaluate existing ones. In order to establish whether the knowledge management architecture model discussed in this section and depicted in Figure 18 constitutes an architecture within IS, the proposed criteria (Section 4.2) were used to assess the model (Lindvall, Rus and Sinha, 2003, Gerber, 2006) as shown in Table 15.

Table 15: KMS architecture evaluation (Lindvall, Rus and Sinha, 2003, Gerber, 2006)

Evaluation criteria (Gerber, 2006)	Knowledge management architecture model (Lindvall, Rus and Sinha, 2003)
Clearly-defined context	**Conform to:** The context of the knowledge management architecture model is clearly defined as the system support of the entire knowledge flow in the knowledge application process for further learning and innovation.
Appropriate level of abstraction and hiding of implementation details	**Conform to:** All the layers required for network interaction are identified and the network is represented as a whole and no unnecessary information is displayed on any layer.
Hiding of implementation details	**Conform to:** No implementation detail is visible on the architecture description and only a relevant level of abstraction is visible.
Clearly defined functional layers	**Conform to**: Seven layers have been defined with a well-defined functionality description of each. The layer position within the architecture supports this functionality.

Evaluation criteria (Gerber, 2006)	Knowledge management architecture model (Lindvall, Rus and Sinha, 2003)
Appropriate layering, including well defined interfaces and dependencies	**Conform to**: Each layer of the seven layers identified build on to the layer immediately below. Each layer has an interface specification.
Modularity	**Conform to:** Different implementations of the layers exist and can be interchanged without negatively influencing the integrity of the architecture.

4.6 Summary

The goal of this chapter was to obtain a knowledge management system architecture that can be used in relation to the third research question: "*How do knowledge management system characteristics contribute to a knowledge management system architecture description?*"

In order to achieve this goal, key concepts within architecture description were considered and a model that describes an architecture from five viewpoints namely logical, development, process, physical and scenarios was defined. Criteria and questions for evaluating layered architectures was discussed before a three-tiered knowledge management system architecture were described and illustrated with an example from the Canadian National Defence Force's situational awareness knowledge portal.

This chapter concluded with a list of the layered architecture evaluation criteria in Section 4.2 applied to the knowledge management architecture model depicted in Section 4.4. From the analysis summarised in Table 15 is it established that the knowledge management architecture model proposed by Lindvall, Rus et al conforms to all specified criteria for an architecture in IS. This architecture model is used as a framework in Section 7.3.1 where the knowledge management system characteristics collated in sections 7.2.1, 7.2.2, 7.2.3 and 7.2.4 are mapped to the relevant components of the model architecture. The view model defined for architecture description in Section 4.2 is used in Section 7.4 to describe a knowledge management system architecture based on this characteristic map.

Part III Research Plan and Design

Part III (Figure 19) of this study consists of Chapter 5 and describes the research plan and design of the thesis.

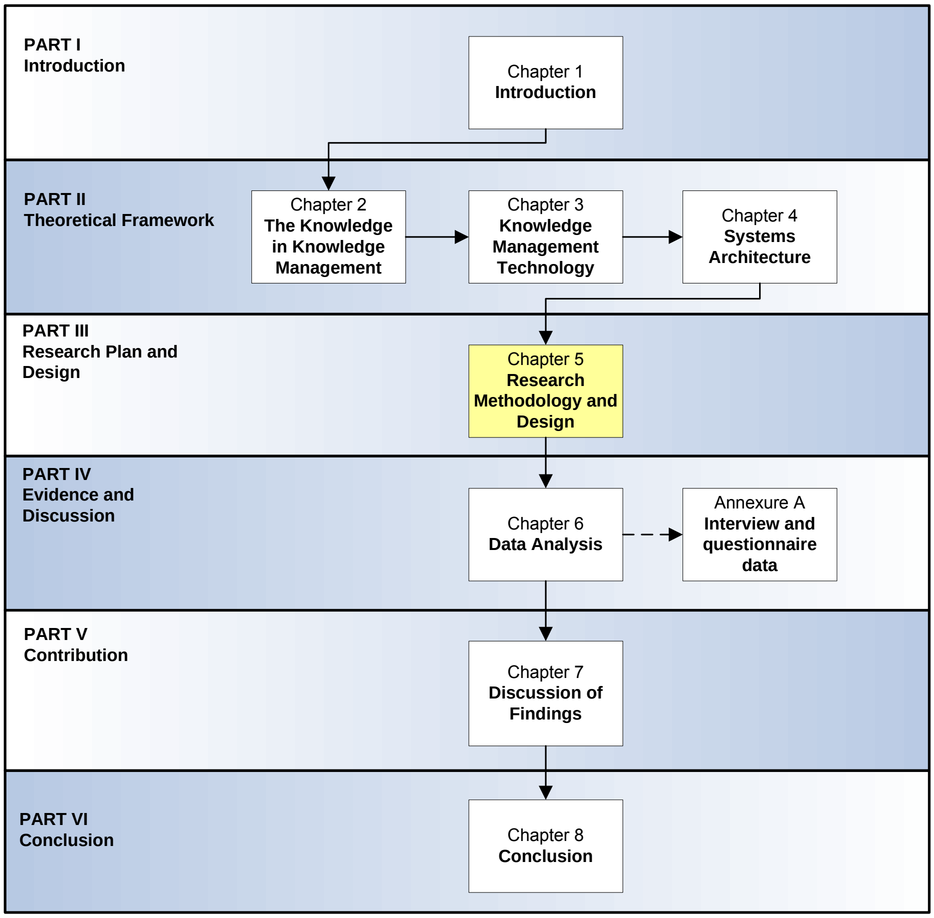

Figure 19: Part III outline

Chapter 5 Research Methodology and Design

5.1 Introduction

Since the main focus of a research study is to uncover and discover patterns that will help explain and achieve the aim and objectives of the envisaged research, a methodological approach is required to facilitate the research process. The area of IS research is a relatively new field of study, which emerged in the 1960s as an area mainly concerned with a technical focus, e.g. automating the back office (Pather and Remenyi, 2004, Whitman and Woszcynski, 2004, Kuechler, Vaishnavi and (Sr), 2007). In the 1980s the focus shifted to the management of IS and in the 1990s the focus broadened to the relationship between IS and organisations as a whole (Whitman and Woszcynski, 2004). Information Systems as a field of study includes issues such as communication and collaboration between people and organisations, inter-organisational systems, electronic commerce and the internet (Myers and Avison, 2002, Pather and Remenyi, 2004) and reputable scholarly journals, prestigious international conferences and national and inter-national conferences contribute to this field (Khazanchi and Munkvold, 2000, Whitman and Woszcynski, 2004). A great number of and diverse research methods are used to study information systems phenomena based on the incredible scope of the field and both quantitative and qualitative research are published in IS journals (Myers, 1997, Trauth and Jessup, 2000, Villiers, 2005).

The purpose of this chapter is to provide background to the philosophical stances of research, to present an overview of qualitative research in Information Systems and to describe the particular research methodology and design used for this specific research study. The research strategy is described in the context of the research participant selection, data collection, the interview process, interview questions, interview transcription and interview data analysis. The last section covers the issues of ethics and anonymity.

The contents of this chapter are outlined in Table 16:

Table 16: Chapter 5 outline

Outline of Chapter 5			
Section	**Description**	**Sub-Section**	**Sub-section description**
5.1	Introduction		
5.2	Information systems research	5.2.1	Philosophical perspectives
		5.2.2	Qualitative research methods
5.3	Conducting and evaluating interpretive field studies in information systems		
5.4	Research methodology and design	5.4.1	Research questions
		5.4.2	Research methodology
		5.4.3	Research strategy
		5.4.4	Data Collection
		5.4.5	Ethics and anonymity
5.5	Summary		

5.2 Information systems research

Gallupe (2007 : 21) defines IS research as “the study of the planning, design, development, use and management of information systems in organisations”. Major technological advancement, the interdisciplinary nature of the field, the large variety of interest groups and the impact on people in organisations are changing the nature of IS and hence the forms of IS research (Khazanchi and Munkvold, 2000, Villiers, 2005). Much of the IS research being conducted today is concerned with the ongoing relations among IT, individuals, organisations (Orlikowski and Baroudi, 1991) and human computer interaction (Khazanchi and Munkvold, 2000).

Different research paradigms and models are based on varying philosophical foundations (Olivier, 1997) and two major threads are debated in researching IS phenomena: positivism and interpretivism. The positivist paradigm is equated with the method whereby knowledge is discovered by controlled empirical means and is mostly operationalised using quantitative methods. The interpretive paradigm aims to find underlying meaning and is appropriate for studies of complex human behaviour and social phenomena (Khazanchi and Munkvold, 2000, Villiers, 2005). Interpretive research originated from the social sciences, lends itself mainly to qualitative studies and is now accepted in Information Systems research (Villiers, 2005, Klein and Myers, March 1999).

Qualitative and quantitative research methods are not mutually exclusive (Villiers, 2005) and Trauth and Jessup (2000) conclude that a variety of research benefits are derived from adopting mixed research method approaches in Information Systems as each research method has different assumptions and procedures and complement one another. Figure 20 shows leading research methods on a positivist (e.g. theorem proving, mathematical modelling and simulation and field experiments) to interpretivist (e.g. focus groups, ethnography and document and artefact studies) axis reflecting quantitative to qualitative research methods with an overlap between the two.

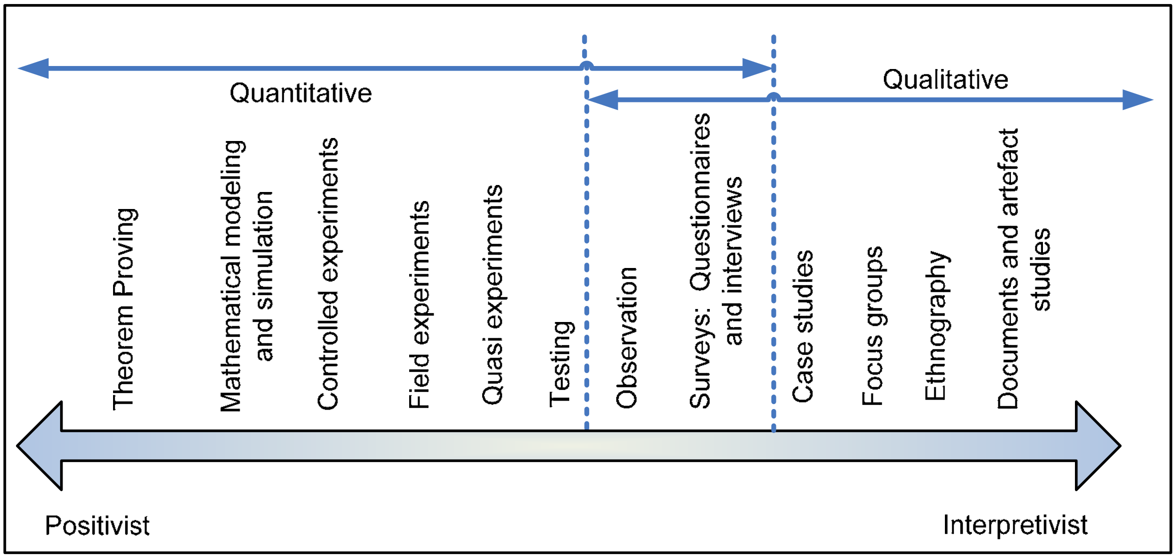

Figure 20: Research methods/strategies (Villiers, 2005)

According to De Villiers (2005), the field of IS research is a multi-perspective discipline that can engage with an assortment of research methods, with a domain that includes scientific, technological, engineering, organisational, managerial, psychological and societal aspects.

5.2.1 Philosophical perspectives

All research – whether qualitative or quantitative – is based on underlying assumptions about which research methods are appropriate and what constitutes valid research. It is important to know what these research assumptions are in order to conduct research. As one of the data sources of this particular research study is human beings, the qualitative and in particular interpretive research paradigm is explored further.

The underlying assumption of qualitative methods is that multiple realities exist in any given situation and these multiple perspectives – that of the researcher and individuals being investigated – are included in the study (Myers, 2007). The goal is to uncover and discover patterns that will help to explain the phenomenon of interest (Myers and Avison, 2002, Villiers, 2005). Qualitative research involves the use of qualitative data such as interviews, documents, participant observation data, pictures or objects to understand and explain social phenomena (Myers, 1997). Myers and Avison (2002) suggest three categories based on the underlying research epistemology:[7] positivist, interpretive or critical, as illustrated in Figure 21.

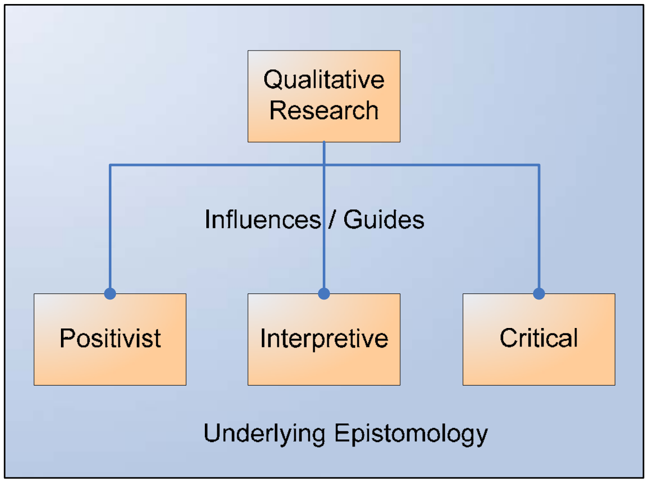

Figure 21: Underlying philosophical assumptions

The underlying epistemology of positivist research is that reality is objective and testable and that it can be described by measurable properties. The research focus is therefore on testable propositions. The fact that access to reality is only gained through social constructs such as language, consciousness and shared meaning forms the underlying epistemology for interpretive research in which the research focus is on meaning. The underlying epistemology of critical research is that reality is historically constituted, produced and re-produced by people and that it focuses on oppositions, conflicts and contradictions in contemporary society and seeks to eliminate the causes of alienation and domination. The research focus in this instance is on critique (Myers and Avison, 2002).

5.2.2 Qualitative research methods

There are various qualitative research methods just as there are various philosophical perspectives that can inform qualitative research. A research method is an approach of examination which moves from the fundamental philosophical beliefs to research design and data collection. The choice of research method impacts the way *in which* data will be collected by the researcher (Myers, 1997).

[7] Refers to the assumptions about knowledge and how it can be obtained MYERS, M. D. (1997) Qualitative Research in Information Systems. *MIS Quarterly.*

Olivier (1997) and Myers (1997) discuss qualitative research methods namely appreciative inquiry, action research, case studies, ethnography and participant observation, grounded theory, hermeneutics and semiotics, as summarised in Table 17 with a brief description of each method.

Table 17: Qualitative research methods

Research method	Research method description
Appreciative inquiry	Researcher acts as facilitator with technique that can be used to improve wider range of contexts *Discovery* – an "appreciation" of what already exists *Dream* – what could be *Design* – formulates vision and strategy *Delivery* – implement plans
Action research	Iterative method for determining current situation of interest and then designing an intervention Researcher collaborates with practitioners and deliberately intervenes Contributes to both research and practice
Case study	Explores a single entity or phenomenon bounded by time and activity Collects detailed information through variety of data collection methods over sustained period of time
Ethnography and participant observation	Researcher studies an intact group of individuals in a natural setting over a specific period of time Observes what people are doing as well as what they say they are doing – participant observer
Grounded theory	Seeks to develop theory that is grounded in data systematically gathered and analysed Rigorous and detailed method
Hermeneutics	Theory of interpretation of meaning Primarily concerned with the meaning of text or text-analogue[8]
Semiotics	Study of signs Inherently interpretive of nature

Myers and Avison (2002) conclude that action research, case studies, ethnographic research and grounded theory are mostly used in IS research. These approaches are explored further in the next sections.

5.2.2.1 Action research

The action research approach emanates from the behavioural sciences and aims to bridge the gap between research and practice (Baskerville and Wood-Harper, 1996, Villiers, 2005) in that it tries to fulfil the needs of the study subjects as well as generate

8 A text-analogue is anything that can be treated as a text such as a human artefact, action, organisation or culture.

new knowledge (Myers and Avison, 2002, Kock, Avison, Baskerville, Myers et al., January 1999). Researchers work closely with practitioners working within the study subject system (Baskerville and Wood-Harper, 1996) and a key aspect is the collaborative nature of the undertaking (Kock et al., January 1999). The research commences with the identification of a situation or problem that calls for action (Villiers, 2005).

An example of action research takes place at Lancaster University, where Checkland extensively used action research in the methodology of systems development (Baskerville and Wood-Harper, 1996).

5.2.2.2 Case study

Yin (1984: 23) defines the case study research method as "an empirical enquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used". Based on work done by well-known case study researchers like Robert E. Stake, Helen Simons and Robert K. Yin, Soy (1997) proposes six steps that should be used in case study research, as reflected in Table 18, in which the steps and the guidelines for each step for the researcher are listed.

Table 18: Six steps in case study research (Soy 1997)

#	Steps	Guidelines for the researcher
1	Determine and define the research questions	Establish firm research focus of a complex phenomenon or object by formulating questions about the situation being studied, determining the purpose of the study Case study research generally answers questions beginning with "how" or "why"
2	Select the cases and determine data gathering and data analysis techniques	Key element is selection of single or multiple cases; when using multiple cases, each case should be treated as a single case Determine what evidence to gather from multiple sources and what analysis techniques to use Ensure that the study is well constructed to ensure construct validity[9], internal validity[10], external validity[11] and reliability[12] Ensure that procedures used are well documented and that it can be repeated over and over with the same results
3	Prepare to collect	Advance preparation to organise data systematically as large number of data is generated

[9] Requires the researcher to use the correct measures for the concepts being studied.
[10] Requires the researcher to establish a chain of evidence forward and backward.
[11] Reflects whether or not findings are generalisable beyond the immediate case or cases; utilises techniques such as cross-case examination and with-in case examination along with literature review.
[12] Refers to stability, accuracy and precision of measurement.

#	Steps	Guidelines for the researcher
	the data	from multiple sources Consider conducting a pilot study to remove obvious problems and barriers prior to initiating the field work Identify key people, prepare letters of introduction and establish rules for confidentiality
4	Collect data in the field	Collect and store multiple sources of evidence comprehensively and systematically in formats that can be referenced and sorted so that converging lines of inquiry and patterns can be uncovered Mandatory to maintain the relationship between the issue and the evidence Clearly document any renegotiation of arrangements with the objects of the study or addition of questions to interviews as the study progresses
5	Evaluate and analyse the data	Examine raw data in order to find linkages between the research object and outcomes with reference to the original research questions Remain open to new opportunities and insights Sort data in many different ways or triangulate data in order to strengthen research findings and conclusions Treat the evidence fairly to produce analytic conclusions answering the original "how" and "why" research questions
6	Prepare the report	Report data in way that transforms a complex issue into one that can be understood, allowing the reader to reach an understanding independent of the researcher Use representative audience groups to review and comment on the draft document

The first step is to determine and define the research questions about the situation being studied and to determine the purpose of the study. The second step is to select the cases and to establish whether a single or multiple case study design will be used, as well as to determine the data-gathering and data-analysis techniques. Thirdly, the systematic organisation of a large amount of data must be planned in advance and consideration must be given to conducting a pilot study to remove obvious problems and barriers prior to initiating the field work. The fourth step is collecting data in the field and maintaining the relationship between the issue and the evidence. The fifth step is to evaluate and analyse the data and the last step is to prepare the report in such a way that a complex issue is transformed into one that can be understood, allowing the reader to reach an understanding independent of the researcher.

An example of case study research is Larsen and Myers's research on a business process re-engineering project that also involved the implementation of an enterprise resource planning software package. Although the project seemed to be successfully implemented, it soon changed to failure as the long-term implication of the change was a major concern. The purpose of their research was to study the business process re-engineering project in depth, focusing on business process re-engineering processes, internal and external issues that influenced the process, the outcomes of the process and participant evaluation of the project (Larsen and Myers, 1999).

5.2.2.3 Ethnographic research

Ethnographic research evolved from the discipline of social and cultural anthropology where researchers are required to spend a significant amount of time immersing themselves in the lives of people they are studying in their natural setting (Myers, 1997, Olivier, 1997). The researcher becomes a participant in the true sense of the word (Olivier, 1997) and attempts to understand the phenomena through accessing the meaning that participants assign to them (Orlikowski and Baroudi, 1991).

Ethnography is more widely used in the study of information systems in organisations. Examples include the study of the development of information systems and aspects of information systems management (Myers, 1997).

5.2.2.4 Grounded theory

Grounded theory is a research method that develops theory that is grounded in data that has been systematically gathered and analysed (Myers, 1997, Olivier, 1997). It involves the discovery of concepts and hypotheses as theory emerges from contextual data (Villiers, 2005) and there is a continuous interplay between data collection and analysis (Myers, 1997).

Grounded theory approaches are used more commonly in Information Systems research as it is valuable in developing context-based, process-orientated descriptions and explanations of incidents (Myers, 1997).

5.3 Conducting and evaluating interpretive field studies in Information Systems

Interpretive research attempts to understand phenomena through the meanings that people assign to it (Olivier, 1997). Interpretive researchers therefore begin with the assumption that access to a given or socially constructed reality is only gained through social constructs such as language and shared meaning (Myers and Avison, 2002). Critical consideration must be given to the way in which parties influence one another given the interaction between the researcher and research participant (Olivier, 1997).

Klein and Myers (March 1999) propose a set of seven principles for conducting and evaluating interpretive field studies in Information Systems (summarised in Table 19).

Table 19: Principles for conducting and evaluating interpretive field studies in IS (Klein and Myers March 1999)

#	Principles for interpretive field research
1	**The fundamental principle of the hermeneutic circle:** This principle is fundamental to all the other principles and suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form.
2	**The principle of contextualisation:** Requires critical reflection of the social and historical background of the research setting so that the intended audience can see how the current situation under investigation emerged.
3	**The principle of interaction between the researchers and subjects:** Requires critical reflection on how the research materials were socially constructed through the interaction between the researcher and participants.
4	**The principle of abstraction and generalisation:** Requires relating the idiographic details revealed by the data interpretation through the application of principles 1 and 2 to theoretical, general concepts that describe the nature of human understanding and social action.
5	**The principle of dialogical reasoning:** Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings with subsequent cycles of revision.
6	**The principle of multiple interpretations:** Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study.
7	**The principle of suspicion:** Requires sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.

The first principle suggests that all human understanding is achieved by fluctuating between considering the interdependent meaning of parts and the whole that they form. The second principle requires a critical reflection of the social and historical background of the research setting and the third principle deals with the interaction between researchers and subjects. Principle four focuses on abstraction and generalisation, while principle five, dialogical reasoning, requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings. Principle six deals with possible multiple interpretations among participants, and the last principle refers to sensitivity to possible prejudice in the narratives collected from the participants.

5.4 Research methodology and design

This section details the specific research methodology and design that was utilised for this study.

5.4.1 Research questions

As described in Chapter 1 and based on the context and purpose of the research study, the primary research questions addressed by this study are:

- How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?
- What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?
- How do knowledge management system characteristics contribute to a knowledge management system architecture description?

5.4.2 Research methodology

The research methodology chosen can be described as an interpretive case study, as the study attempted to learn from the current situation in real life (Olivier, 1997, Larsen and Myers, 1999) and the results are expressed using descriptive statements (Olivier, 1997). This study has an interpretive perspective, as it is based on the interpretation of individuals in their natural settings (Orlikowski and Baroudi, 1991, Larsen and Myers, 1999). The case study method is used when the researcher intentionally wants to cover contextual situations that might be highly applicable to the phenomenon of study (Yin, 1984). Yin (1984) defines five components of research design that are important for case studies namely the questions, the propositions, the unit(s) of analysis, the logic linking the data to the propositions and the criteria for interpreting the findings. The unit of analysis in this single case study is the organisation, with the objective to distil the key knowledge management system characteristics in the MTN SA context towards evaluating knowledge management solutions and defining a comprehensive knowledge management system architecture.

In order to confirm the research methodology envisaged for this study, the approach described by Van der Merwe (2005) was used as depicted in Table 20.

Table 20: Research approach characteristics and the research questions [adapted from (Merwe, 2005)]

Approach	Characteristics	Research question 1	Research question 2	Research question 3
Action research	Focus on what practitioners do			
	Explicit criteria	☑		
	Practitioners and researchers with mutual goals			
	Apply theory with goal to enhance		☑	
Case study	Investigator has little control	☑	☑	☑

Approach	Characteristics	Research question 1	Research question 2	Research question 3
	Contemporary phenomenon with real-life context		☑	☑
	Explores a single entity or phenomenon bounded by time and activity	☑	☑	☑
	Study life cycles	☑	☑	
Ethnographic research	Active participation			
	Observational data	☑	☑	☑
	Social contact with participants			
	Extended depth study			
	Limited to one field study	☑	☑	☑
Grounded theory	Start with a phenomena			
	Data sampling with perspective			
	Theoretical account of the general features	☑		
	Generation of theories of process, sequence, and change pertaining to organisations, positions, and social interaction			

Van der Merwe (2005) matched available research strategies, with characteristics of each, and data-collection methods against research questions. This study can be characterised as a case study problem with some application in the ethnographic research domain based on the researchers close involvement with the case study and its context by applying Van der Merwe’s approach to this research and by evaluating the result of the criteria list.

5.4.3 Research strategy

This research leans toward case study research, as depicted in Table 20 and Section 5.4.2, and more specifically toward interpretive case study. The purpose of this study was to establish knowledge management system characteristics towards evaluating knowledge management solutions and describing a knowledge management system architecture. The approach taken for this study (figure 22) consisted of three work streams that ultimately consolidated towards an architecture description for a knowledge management system.

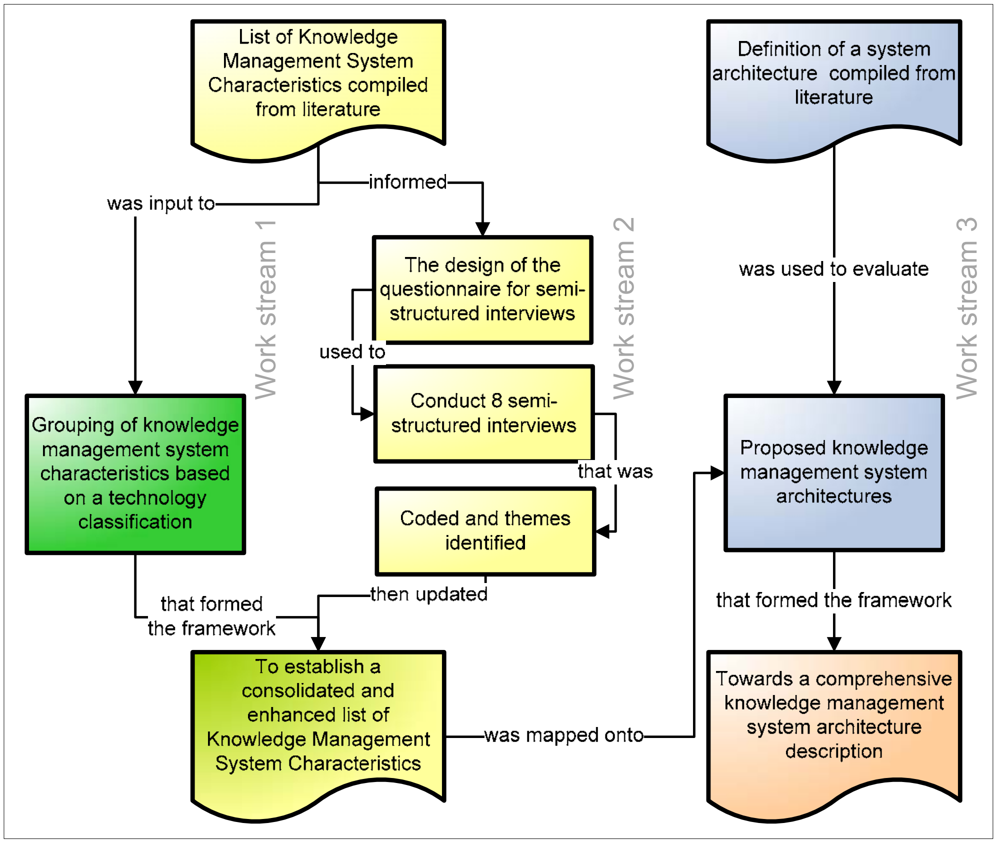

Figure 22: Research approach

A study of the published literature was conducted to investigate and establish a theoretical framework for the research study with two objectives: to compile a list of typical knowledge management system characteristics and to establish a definition for a typical system architecture.

The first work stream grouped the list of characteristics based on technology classification (Antonova, Gourova and Nikolov, 2006) described in Section 3.4.2, to form a knowledge management system characteristic framework.

The purpose of work stream 2 was mainly the verification and enhancement of the knowledge management system characteristics framework defined in work stream 1 and consisted of eight semi-structured interviews that were coded, after which themes were identified and knowledge management system characteristics extracted. An enhanced list of knowledge management system characteristics was the output of work stream 2.

Work stream 3 used the system architecture definition obtained to evaluate proposed knowledge management system architectures after which the characteristics framework was mapped to the architectures towards a comprehensive knowledge management system architecture.

5.4.4 Data collection

Each of the research methods discussed in Section 5.2.2, uses techniques for collecting empirical data. Tustin (2006) distinguishes between primary and secondary sources of data. *Primary* data is data that is unpublished and has been collected directly from people, research participants or the organisation, and *secondary* data refers to any materials that have previously been published, e.g. books, journals, and articles. The researcher used primary and secondary sources of data collection for this study.

- **Literature survey (secondary data):** The purpose of the literature survey was to identify existing key characteristics and conceptual models of knowledge management systems, as well as potential architectures for knowledge management systems.
- **One-on-one semi-structured interviews (primary data):** The main objective of the field interviews was to establish personal perspectives and facts about knowledge management system characteristics in their respective contexts. The interviews were conducted using a semi-structured interview guide that steered and guided the interviews. Research participants were expected to answer questions relevant to their respective roles, although they were given the opportunity to share their views on all the questions. Answers were clarified to ensure that the correct interpretation of the response is noted and probed where further information and perspectives were required. The last open-ended question was included at the end of the interview to allow the research participants to add any facts or comments that they might consider relevant.

5.4.4.1 Research participant selection

Potential research participants were selected based on their area of expertise and the knowledge work that they perform, by utilising both theoretical and convenient sampling (Whitman and Woszcynski, 2004).

The criteria and rationale used to identify the research participants are summarised in Table 16 and both these components informed the typical profile of the research participants. The main criteria that informed the participant profile were environments where knowledge and knowledge sharing are key priorities, behaviours regarding knowledge sharing and some knowledge on human resource aspects in order to obtain input on the human-computer interface and related issues. Furthermore, research participants with a technical background, who understand systems with broad business process knowledge, as well as a systems and business architecture background, informed the profile. These criteria were then applied across different management (job grade) levels and leadership styles in the organisation to obtain different perspectives from an MTN Group as well as an MTN SA context.

Table 21: Identification of research participants

	Criteria	Rationale	Typical participant profile
1	Technical / technology / systems background	Utilise their understanding of systems and systems architecture	Information Systems and Network Group (engineering) participants
2	Human resources / behavioural background	Obtain input in the human computer interface and any issues regarding this interface; capturing of implicit knowledge	Organisational Development (Human Resources) participants
3	Environments where knowledge and knowledge sharing are key for success; environments where these key assets leave the organisation's premises every day	Determine issues regarding knowledge sharing within the MTN Group and regarding key specialist skills and knowledge	System specialists, business architecture and system architecture specialists in MTN
4	Job grade in MTN Group and MTN SA	Obtain input from different levels of work and different operational levels; obtain input from different management and leadership styles	Different levels of participants with regards to job grades e.g. executives, general managers, senior managers, etc.
5	Broad business, people, process and system knowledge	Obtain input on "big picture" issues / requirements regarding business, people and knowledge management	Generalists in MTN, participants required to integrate all management aspects in order to deal with their respective departments

By applying the criteria as defined in Table 21, research participants (referred to as RP) with different profiles were selected, as depicted in Table 22. In order to ensure that all research participant profile criteria were addressed, as well as different combinations of criteria, eight participants were identified. This selection ensured that different perspectives on the research questions were obtained in order to contribute to the richness of interview data.

Table 22: Research participant profile

	Criteria (refer Table 21)	RP1	RP2	RP3	RP4	RP5	RP6	RP7	RP8
1	Technical / technology / systems background	☑	☑		☑	☑	☑	☑	
2	Human resources / behavioural background			☑			☑		
3	Environments where knowledge and knowledge sharing are key for success	☑	☑	☑	☑	☑	☑	☑	☑
4	Job grade (5 = executive; 4 = general manager; 3 = senior manager, 2 = team leader) in MTN Group (G) and in MTN SA operation (O)	G5	O3	G4	O3	O4	O2	O4	O5
5	Broad business, people, process and system knowledge	☑		☑		☑		☑	☑

5.4.4.2 Interview process

Knowledge management, knowledge management processes and knowledge management systems, as described in Chapter 2, are broad concepts and are interpreted differently based on the research participant's context. In order to establish a baseline for the particular interview, the first three questions asked in the interviews explored the research participant's current understanding of and frame of reference regarding the knowledge management topics in order to set the scene for the rest of the questions that dealt with the characteristic and architecture specific components.

Some key words were included in the interview guide related to each question to guide the interview in terms of exploring deeper context. The questions were not necessarily asked in sequential order – all relevant facts were rather collected throughout the flow of the interview in the order in which the research participant felt comfortable to share views and perspectives.

Each research participant signed a letter of consent describing the purpose of the study, that they are willing to participate in the interview and that they are aware that the interview is being recorded. The interviews were recorded using a Speed-Link Digital Voice Recorder Model PDR3 with voice activated recording (VOX) and PC-link via USB port functionality. Although the interviews were recorded, the researcher made notes on the interview guide and indicated where further detail must be explored in the interview.

All interviews were conducted in English, lasted for approximately one hour each and were concluded on-site at the offices of MTN SA in Johannesburg. Table 23 reflects the interview schedule and relevant details regarding the interviews, such as the transcription code for the interviews, the date of the interviews, the start time and the first language of the research participant.

Table 23: Research participant interview schedule

Research participant	Interview transcription code	Date of interview	Start time of interview	Research participant's first language
RP1	MTN01	8 January 2008	14:30	Afrikaans
RP2	MTN02	26 November 2007	08:00	Afrikaans
RP3	MTN03	7 January 2008	12:00	Afrikaans
RP4	MTN04	7 January 2008	13:30	English
RP5	MTN05	7 January 2008	15:00	English
RP6	MTN06	8 January 2008	10:15	Afrikaans
RP7	MTN07	10 January 2008	12:30	Afrikaans
RP8	MTN08	11 January 2008	16:00	English

The researcher captured field notes within one day after each interview in which personal observations and perceptions were noted. The contents of the field notes contain information regarding the interaction with the research participants and include both descriptive[13] and reflective[14] forms - some information on why the particular research participant was selected, as well as notes on the flow of the interview – from a participant and personal perspective. The notes also include the researcher's observations on the participants' role relevant to knowledge management in the organisation, personal notes on how the researcher experienced the interview, some issues highlighted about the venue of the interview and the technology used to record the interview.

An on-line folder was created on a laptop for the proper management and filing of electronic interview files, as well as a paper-based file containing the signed letter of consent, the interview notes, the interview field notes and any interview-relevant paper-based documentation separated into different folders per research participant.

[13] Represents descriptions of the research participants, reconstructions of dialogue, descriptions of the physical setting, accounts of particular events etc.
[14] Reflects a more personal account in a subjective manner from the researcher of the course of the research.

The electronic file folder containing the interview transcriptions have been included on the CD accompanying this study and marked as Annexure A.

5.4.4.3 Interview questions

The interview questions consisted of three parts: the first three questions established the research participant's perspectives on relevant definitions of knowledge, knowledge management and knowledge management processes. The following questions explored knowledge management system characteristics specifically and the last questions referred to knowledge management system architecture. All interview questions were open-ended. Table 24 depicts the questions indicating the objective and the specific questions related to the objective.

Table 24: Interview questions

Interview question number	Objective	Question
#1	• Establish current understanding, frame of reference • Set scene for characteristic discussion • Move towards technology and systems	How would you define knowledge?
#2		How would you describe knowledge management?
#3		What do you regard as the main components of a knowledge management process?
#4	• Set scene for system requirements discussion	Is there a role and how would you describe the role of technology in knowledge management?
#5	• Establish characteristics of a KMS • Establish thinking around application of KM	When you buy a PC game, you look at the specification on the package before you decide to purchase it. If you had to buy a knowledge management system off the shelf, what characteristics would you look for on the package?
#6		What is the role of software tools currently installed in the organisation for knowledge management?
#7	• Move to architecture	**[Not all participants might be able to answer this question]** If you had to design a typical architecture for your knowledge management system, what would it be?
#8		**[Not all participants might be able to answer this question]** Does this [typical architecture] apply to current software tools [in the organisation] as well as an "of f-the-shelf" application?

A topic guide is a list of key words or phrases that serves as a prompt to the researcher (Mitchell and Branigan, 2000). It aids the systematic and uniform coverage of relevant issues, while still allowing the flexibility to pursue the detail that is relevant to each individual research participant (Ritchie and Lewis, 2003).

Topics and key words were defined based on the interview question objectives, interview question themes and interview questions, as depicted in Table 25. The topic guide was used for some indication of issues for follow-up questions and probing to ensure full exploration of the interview question topics under investigation.

Table 25: Interview questions topic guide

Q	Theme	Interview question	Topic guide
1	Definition	How would you define knowledge?	• Fluid mix of framed experiences, values, contextual information and expert insight • Provides a framework for evaluating and incorporating new experiences and information. • Dimensions of knowledge o Implicit (know-how) o Explicit (articulated body of knowledge) o Tacit • Data, information, knowledge, insight / wisdom • Comes with insights, framed experiences, intuition, judgement and values • Body of understanding and skills that is mentally constructed by people • Value is increased through analytical thought processes as data and information are processed, understood and connotation added
2	Definition	How would you describe knowledge management?	• The art of creating value by leveraging intangible assets • The management of corporate processes designed to create, disseminate and protect knowledge in support of sound decisions leading to profit • The capacity to transform knowledge into competencies and replicate know-how • The practice of transforming the intellectual assets of an organisation into business value • Framework for designing an organisation's goals, structures and processes so that the organisation can use what it knows to learn and to create value for its customers and community
3	Definition	What do you regard as the main components of a knowledge management process?	• Key enabler • Creating, storing, retrieving, sharing (e.g. geographic remote locations) • Reliable and secure access from various locations • Collaboration between people who are not geographically collocated • Helping with user assimilation of information • Providing access to sources of knowledge rather than knowledge itself • Gathering, storing and transferring knowledge • Providing link among sources of knowledge to create wider breadth and depth of knowledge flows • Providing effective search and retrieval mechanisms for locating relevant information • Enhancing intellectual capital by supporting development of individual and organisational competencies
4	Technology	Is there a role and how would you describe the role of technology in knowledge management?	• Key enabler • Creation, storage, retrieval, sharing (e.g. geographic remote locations) • Reliable and secure access from various locations • Collaboration between people who are not geographically collocated • Helping in user assimilation of information • Provide access to sources of knowledge rather than knowledge itself.

Q	Theme	Interview question	Topic guide
			• Gathering, storing and transferring knowledge. • Provide link among sources of knowledge to create wider breadth and depth of knowledge flows. • Provide effective search and retrieval mechanisms for locating relevant information. • Enhance intellectual capital by supporting development of individual and organisational competencies.
5	Technology	When you buy a PC game, you look at the specification on the package before you decide to purchase it. If you had to buy a knowledge management system off the shelf, what characteristics would you look for on the package?	• Access to information • Archiving • Authoring • Classifying • Cognition • Collaboration • Content delivery • Content evolution • Context sensitive • Externalisation • Flexible • Heuristic • Indexing • Intermediation • Internalisation • Knowledge harvesting • Object • Process • Search and retrieval • Security • Storing • Suggestive • User sensitive
6	Technology	What is the role of software tools currently installed in the organisation for knowledge management?	• Document and content management • Competence management • Collaboration tools • Customer support • Data and knowledge discovery • Intellectual property capture • Expert networks • E-learning management systems • Portals
7	Architecture	If you had to design a typical architecture for your knowledge management system, what would it be?	• Information and knowledge sources • Low level IT infrastructure • Document and content management • Organisational taxonomy • Knowledge management services • Personalised knowledge gateway • Business application layer
8	Architecture	Does this [typical architecture] apply to current software tools [in the organisation] as well as an “off- the-shelf” application?	• Plethora of software tools available labelled as “knowledge management solutions” by software vendors in an attempt to make it more attractive to organisations, a complete and comprehensive knowledge management system is not purchased off the shelf as a single technology or software tool. • Knowledge management software tools have the advantage of using the organisation’s existing IT infrastructure

5.4.4.4 Interview transcription

Each interview was recorded as a separate .S16-file and transferred to a laptop hard disk before converted to individual .WAV-files using the Voicemanager software that was made available with the recorder. Each file was renamed based on the transcription code and the name of the research participant and arranged in a separate folder.

The full interviews were transcribed in MS-Word, indicating both the researcher and research participant dialogue. The MS-Word files were renamed aligned to the naming convention used for the .WAV-files and arranged in a separate folder per research participant. A printout of the transcribed interviews for each research participant was filed in the paper-based file.

5.4.4.5 Interview data analysis

According to Leedy and Ormrod (1989 : 142), content analysis is "the detailed and systematic examination of the contents of a particular body of material for the purpose of identifying patterns, themes or biases". Myers and Avison (2002) describe a form of content analysis where the data is categorised into concepts that are implied by the data known as open coding (Leedy and Ormrod, 1989, Welman, Kruger and Mitchell, 1994, Whitman and Woszcynski, 2004). Once categories and themes are established, interconnections or relations are made among these categories and sub-categories based on the context thereof by using axial coding (Leedy and Ormrod, 1989, Whitman and Woszcynski, 2004). Categories, themes and their interconnections are continually refined through a process of open and axial coding as additional data is collected (Welman, Kruger and Mitchell, 1994)

A combination of open coding and axial coding was used as a method of analysing the research interview data. A topic guide for each interview question was defined that directed the initial coding of categories and concepts (Lowe, 1995, Whitman and Woszcynski, 2004). Open coding was facilitated by creating a template in MS-Word consisting of the transcribed interview and by using the highlighter tool in MS-Word, text from the interview was highlighted that represented a specific and relevant concept informed by the topic guide. A second column was inserted to capture the concept identified next to the particular phrase highlighted. This analysis was completed for each interview, stored in a separate MS-Word document with the naming convention aligned to the same principles used for naming the other data files and stored in the folder per research participant. A printout of the open coded interviews for each research participant was filed in the paper-based file.

The concepts and related text were then transferred to MS-Excel where the origin of each line were indicated with the research participant and transcription codes. Themes were defined by using axial coding and by inserting the particular theme in a column next to each concept and text combination. The MS-Excel file was sorted using the theme as primary sort criteria and the result was reviewed in the context of the original interviews. This file provided the basis for Part IV, Chapter 6 of this thesis in which that findings are discussed.

5.4.5 Ethics and anonymity

It is acknowledged that personal opinions and views of the research participants might have been shared with the researcher during the interviews. The ethical considerations of importance is informed consent by research participants and the research participants' right to privacy and protection from harm (Leedy and Ormrod, 1989, Welman, Kruger and Mitchell, 1994). Welman, Kruger et al (1994) also emphasises that researchers should guard against manipulating research participants or treating research participants as numbers rather than human beings. Some disciplines have professional codes of ethical standards governing research that involves human subjects.

Although no hard-and-fast rules exist to guide qualitative researchers as far as ethics are concerned, the researcher attempted to identify all possible violations of ethical standards to ensure that taking part in the study will not harm any of the research participants (Olivier, 1997, Myers and Avison, 2002).

Written consent was obtained from each participant to conduct the interviews and to use the data collected for this study. In order to ensure anonymity of the research participants, identification codes RP1 to RP8 and MTN01 to MTN08 were used for reflecting and reporting on interview data collected.

5.5 Summary

The research methodology and design were the main focus of this chapter. Information systems research was considered first and it was established that most IS research today is concerned with the ongoing relations among IT, individuals, organisations and human computer interaction. Philosophical perspectives and research paradigms were discussed and the underling perspectives of qualitative research were explored. Qualitative research methods and in particular action research, case studies, ethnographic research and grounded theory as approaches most commonly used in information systems research were depicted. An example of each of these approaches was given.

The research methodology and design that was used for this study was described as an interpretive case study and the approach described by Van der Merwe was used to confirm the research methodology by matching the research strategies and data-collection methods to each of the research questions.

Data collection was described by considering the criteria for research participant selection, as well as the interview process, questions, transcription and data analysis. Eight semi-structured interviews formed the primary data-collection technique and the literature survey the secondary method. Research participants were identified based on their area of expertise and the knowledge work that they perform by utilising theoretical and convenient sampling. An interview guide and a topic guide containing keywords and phrases were designed to guide the interview and to ensure that information on all aspects of the interview questions were obtained. Complete interviews were transcribed reflecting both the researcher and research participant dialogue and content analysis consisting of open and axial coding was used to obtain primary and emerging themes from the interview data.

The last section in this chapter described principles regarding ethics and anonymity, as well as the handling of research participants by the researcher.

Part IV Evidence and Discussion

Part IV (figure 23) of this thesis consists of Chapter 6 and discusses the evidence and the data analysis based on the research strategy described in the previous chapter.

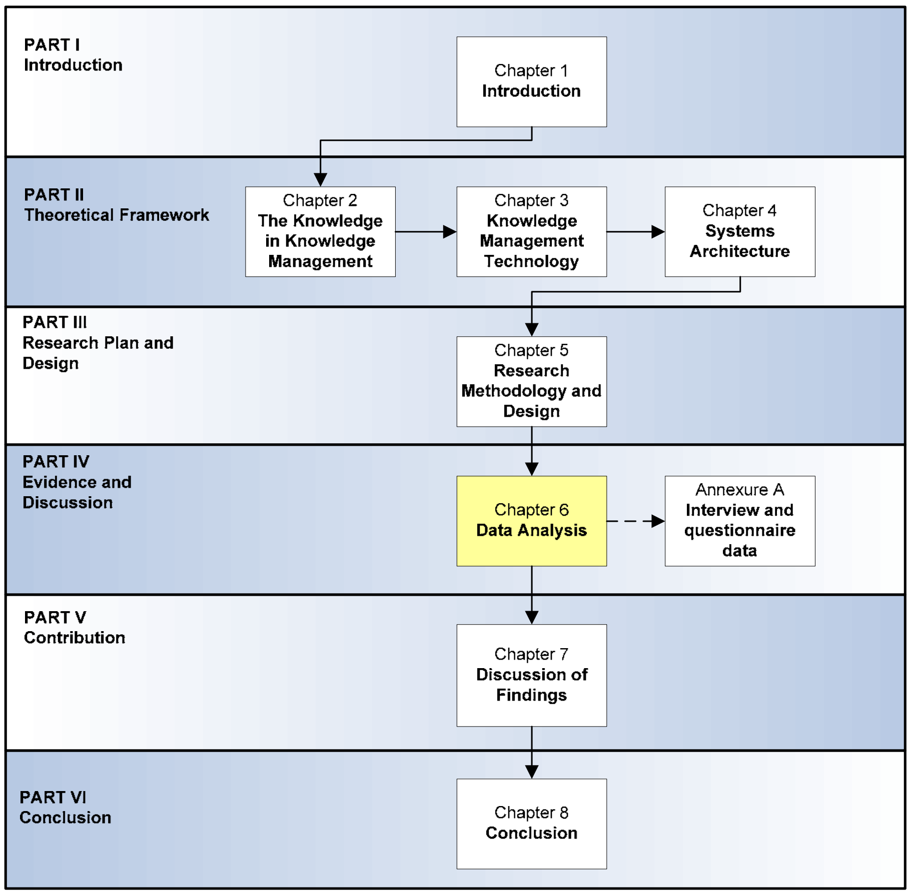

Figure 23: Part IV outline

Chapter 6 Data Analysis

6.1 Introduction

This chapter focuses on the data analysis of knowledge management system characteristics extracted from literature, as well as from the transcripts of the field interviews with specific reference to the themes identified during the coding process. The themes are reflected in two main categories, namely the primary themes identified in relation to the interview questions and topic guide, as well as the emergent themes. The emergent themes are themes that evolved during the data-analysis process.

Observations and findings in this section are illustrated by using quotes from interview participants where applicable and appropriate.

The contents of this chapter are outlined in Table 26:

Table 26: Chapter 6 outline

Outline of Chapter 6			
Section	**Description**	**Sub-section**	**Sub-section description**
6.1	Introduction		
6.2	Knowledge management characteristics from the literature		
6.3	Research and interview questions	6.3.1	Set of questions and themes
		6.3.2	Topic guide
6.4	Presentation of findings	6.4.1	Definitions
		6.4.2	Technology
		6.4.3	Architecture
6.5	Summary of findings	6.5.1	Theme 1: Definition
		6.5.2	Theme 2: Technology
		6.5.3	Theme 3: Architecture
6.6	Context for analysis of findings		
6.7	Summary		

6.2 Knowledge management characteristics from the literature

Various new and existing technologies can be used to create a knowledge management system (Offsey, 1997) and information systems have been developed to support the knowledge management cycle in organisations (Salisbury, 2003). Holm, Olla et al (2006) indicated that a set of guiding principles must be recognised to ensure that there are consistencies in such a knowledge management programme. Such guiding principles inform key features and characteristics (Offsey, 1997) that establish what technologies must be complied with to support knowledge management in an organisation with alignment to the organisational need and drivers (Holm et al., 2006).

Merriam-Webster's on-line dictionary (characteristic, 2007) defines characteristic as "a distinguishing trait, quality or property" and this broad definition guided the collation of characteristics from literature of a knowledge management system, as depicted in Table 27. Each characteristic is listed showing the distinguishing feature of a knowledge management system, a description of the distinguishing characteristic, an example clarifying the characteristic and the reference in the literature from which the specific feature was extracted. The characteristics from the literature are listed in alphabetical order for ease of reference.

Table 27: Knowledge management system characteristics from literature

KM Solution Characteristics			
Characteristic	**Description**	**Example**	**Reference**
Accessibility	Knowledge is a condition of access to information via different mechanisms (e.g. web based) and locations.	Role of IT is to provide effective search and retrieval mechanisms for locating relevant information.	(Offsey, 1997, Alavi and Leidner, 2001, Holm et al., 2006)
Application	Timeous availability of organisational and individual memory, just in time learning. Inter-group knowledge access	Expert systems, rapid application of new knowledge through workflow systems	(Barclay and Murray, 1997, Katz, 1998, Alavi and Leidner, 2001, Lindvall et al., 2001, Antonova, Gourova and Nikolov, 2006, Holm et al., 2006)
Archiving	Refers to archiving ability based on certain criteria specified by knowledge base administrators	Archiving of project specific information	(Bergeron, 2003, Holm et al., 2006)
Authoring	Encompasses knowledge objects i.e. sources of explicit (e.g. documents, manuals, proposals, email messages) or implicit knowledge (e.g. people)	Supported by standard authoring tools like word processors and database management systems (DBMS)	(Grey, 1999, Lindvall et al., 2001, Reinhardt et al., 2001, Antonova, Gourova and Nikolov, 2006)
Capability	Knowledge is the potential to influence action, processing, decision-making, application.	Role of IT is to enhance intellectual capital by supporting development of individual and organisational competencies.	(Alavi and Leidner, 2001, Preece et al., 2001, Antonova, Gourova and Nikolov, 2006)
Classification	Handles content management according to context of organisation	Corporate taxonomy as knowledge map supported by classifying and indexing tools	(Offsey, 1997, Davenport and Prusak, 1998, Lindvall et al., 2001, Marwick, 2001, Greenwood, June 1998)
Cognition	Refers to connection of knowledge to process	Functions of systems to make decisions based on available knowledge	(Barclay and Murray, 1997, Wind and Main, 1998, Hinkelman, 2006, Frappaolo and Capshaw, July 1999)
Collaboration	Support the knowledge sharing process through a social network analysis and collaborative tools; collective insights across operations and different geographical locations; multi-dimensional collaboration	Facilitate communication between users, collaboration among users and workflow management	(Lindvall et al., 2001, Chua, 2004, Antonova, Gourova and Nikolov, 2006, Holm et al., 2006, Vequist and Teachout, 2006, Xie, Zhang and Xu, 2006)
Content delivery	Personalisation involves gathering of user-information and delivering appropriate content to meet specific user needs aligned to user profile	Electronic bulletin boards, through portals is knowledge distributed as needed by different applications	(Clarke and Rollo, 2001, Lindvall et al., 2001, Finneran, 2007)
Content evolution	Knowledge creation, combining new sources of knowledge, optimise	Data mining and learning tools	(Nonaka and Takeuchi, 1995, Offsey, 1997, Lindvall et al., 2001, Beesley and Cooper,

KM Solution Characteristics			
Characteristic	**Description**	**Example**	**Reference**
	feedback loops and re-apply, re-create		2008)
Context sensitivity	Solution should be able to understand the context of the knowledge requirement and tailor response accordingly	Should be able to understand and respond differently between *animal reproduction* and *document reproduction*	(Godbout, 1999, Frappaolo and Capshaw, July 1999)
Creation	Refers to generation of new knowledge through thinking or reasoning	Brainstorming	(Nonaka and Takeuchi, 1995, Hoffmann et al., 1999, Lee, Kim and Yu, 2001, Beesley and Cooper, 2008)
Externalisation	Refers to the connection of information source to information source and creating interrelationships; integration of organisational interdependencies	Focuses on explicit knowledge and provides a means to capture and organise this knowledge into a knowledge repository	(Wilson and Snyder, 1999, Preece et al., 2001, Frappaolo and Capshaw, July 1999)
Flexibility	Solution should be able to handle knowledge of any form as well as different subjects, structures, taxonomies and media	If knowledge seeker wants to learn about gramophone records, it should supply knowledge on the technology as well as purchasing trends and examples of famous recordings	(Asgarkhani, 2004, Antonova, Gourova and Nikolov, 2006, Frappaolo and Capshaw, July 1999)
Heuristic	Solution should constantly learn about its users and the knowledge it possesses as it is used i.e. continually refine itself as a user's pattern of research is tracked by the system. Its ability to provide a knowledge seeker with relevant knowledge should therefore improve over time	If the solution responds to many requests on a particular subject, it should learn how to assist multiple users in more depth on that subject	(Marwick, 2001, Frappaolo and Capshaw, July 1999)
Indexing	Handles content management according to context of organisation, corporate taxonomy	Corporate taxonomy as knowledge map supported by classifying and indexing tools	(Alavi and Leidner, 2001, Lindvall et al., 2001, Antonova, Gourova and Nikolov, 2006)
Intermediation	Refers to the connection of people to people i.e. bring together those who are looking for a certain piece of knowledge and those who are able to provide this piece of knowledge	Primarily positioned in the area of tacit knowledge based on its interpersonal focus	(O'Leary, 1998, Frappaolo and Capshaw, July 1999)
Internalisation	Refers to the connection of explicit knowledge to people or knowledge seekers	Involves extraction of knowledge from the external repository and subsequent filtering ensuring greater relevance to knowledge seeker	(Katz, 1998, Antonova, Gourova and Nikolov, 2006, Frappaolo and Capshaw, July 1999)
Knowledge harvesting	Pro-active facilitation of harvesting and capturing of ideas, knowledge, expertise	Knowledge harvesting workshops and focus groups, defining tangible knowledge and capturing it	(Dix, Wilkinson and Ramduny, 1998, McManus, Snyder and Wilson, 2003, Holm et al., 2006, Kothuri,

KM Solution Characteristics			
Characteristic	**Description**	**Example**	**Reference**
			May 2002)
Knowledge objects	Data is facts, raw numbers. Information is processed / interpreted data. Knowledge is personalised information. Knowledge is an object of structured information, un-structured information, insight, facts, practical and theoretical experience, as well as best practice to be stored and manipulated.	KMS will not appear radically different from existing IS, but will be extended toward helping in user assimilation of information. Role of IT involves gathering, storing and transferring knowledge.	(Davenport and Prusak, 1998, Alavi and Leidner, 2001, Clarke and Rollo, 2001, Holm et al., 2006)
Process	Knowledge is a process of applying expertise.	Role of IT is to provide link among sources of knowledge to create wider breadth and depth of knowledge flows.	(Alavi and Leidner, 2001, Salisbury, 2003, Antonova, Gourova and Nikolov, 2006, Holm et al., 2006)
Search and Retrieval	Primarily concerned with enhancing the interface between the user and information / knowledge sources, user-friendliness and learning agility	Help users better understand the information and knowledge available by providing subject-based browsing and easy navigation	(Offsey, 1997, Clarke and Rollo, 2001, Lindvall et al., 2001, Bergeron, 2003, Finneran, 2007)
Security	Have to address physical and logical security since knowledge is such a valuable asset	Implemented using inherent mechanisms in each tool or by using specific tools in addition to the existing system	(Offsey, 1997, Lindvall et al., 2001, Asgarkhani, 2004, Holm et al., 2006)
Storing	Support knowledge creation through exploitation, exploration and codification	Technology enabled store or knowledge repository that can support less structured information	(Katz, 1998, Clarke and Rollo, 2001, Lindvall et al., 2001, Preece et al., 2001, Bergeron, 2003, Chua, 2004, Antonova, Gourova and Nikolov, 2006)
Suggestive	Solution should be able to deduce what the knowledge seeker's knowledge needs are	Suggest knowledge associations the user is not able to do	(Frappaolo and Capshaw, July 1999)
Timeliness	Knowledge is available whenever it is needed.	Eliminates time-wasting distribution of information just in case it might be required	(Offsey, 1997, Chua, 2004)
User-sensitive	Solution should be able to organise the knowledge in the way most useful to the specific knowledge seeker	Should give knowledge relevant to knowledge seeker's current knowledge level, facilitating easier understanding	(Frappaolo and Capshaw, July 1999)

According to Offsey (1997), knowledge management systems share many basic features although a specific knowledge management system would be informed by the specific organisation. The list of characteristics depicted in Table 27 is such a list of common, basic features that knowledge management solutions share. This will be discussed further in Chapter 7 of this study.

6.3 Research and interview questions

The research questions and interview questions were described in Section 5.4.4.3. Questions for the interview were designed in order to obtain research participant feedback on the research questions. Interview questions were designed according to three themes: definition, technology and architecture.

Definition refers to the research participant's view or description of the definition of knowledge, knowledge management and knowledge management processes while technology indicates the research participant's opinion of knowledge management systems, characteristics and software tool application. Architecture refers to the research participant's view of a typical knowledge management system architecture.

6.3.1 Set of questions and themes

Knowledge and knowledge management are defined in several ways as described in Part II of this study. It was important to establish the research participants' individual definitions of knowledge and knowledge management in order to explore characteristics of knowledge management systems in their particular contexts and software applications.

The set of questions for the interviews were designed with this in mind, as depicted in Table 28 where the questions related to each research question are indicated. The interview question theme and sub-theme are also listed.

Table 28: Research and Interview questions

Research question 1: How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?		
Interview Question #	**Interview question theme and sub-theme**	**Interview question**
1	*Definition*: knowledge	How would you define knowledge?
2	*Definition*: knowledge management	How would you describe knowledge management?
3	*Definition*: knowledge management process	What do you regard as the main components of a knowledge management process?
Research question 2: What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?		

Interview Question #	Interview Question Theme and Sub-theme	Interview Question
4	*Technology*: knowledge management systems	Is there a role and how would you describe the role of technology in knowledge management?
5	*Technology*: knowledge management system characteristics	When you buy a PC game, you look at the specification on the package before you decide to purchase. If you had to buy a knowledge management system off the shelf, what characteristics would you look for on the package?
6	*Technology*: knowledge management system application	What is the role of software tools currently installed in the organisation for knowledge management?
Research question 3: How do knowledge management system characteristics contribute to a knowledge management system architecture description?		
Interview Question #	**Interview question theme**	**Interview question**
7	*Architecture*: typical knowledge management system architecture	If you had to design a typical architecture for your knowledge management system, what would it be?
8	*Architecture*: typical knowledge management system architecture	Does this [typical architecture] apply to current software tools [in the organisation] as well as an “off- the-shelf” application?

6.3.2 Topic guide

The topic guide described in Section 5.4.4.3 was used in the research participant interviews for identification of issues for follow-up to ensure full examination of the interview question topics under investigation.

6.4 Presentation of findings

The interview questions were divided into three main themes, namely definition, technology and architecture - all related to knowledge, knowledge management and knowledge management systems. The three main themes comprise of sub-themes, as shown in Figure 24. Each sub-theme, in turn, is divided into topic guide keywords that constitute primary themes and emergent themes are also reflected based on the interview feedback.

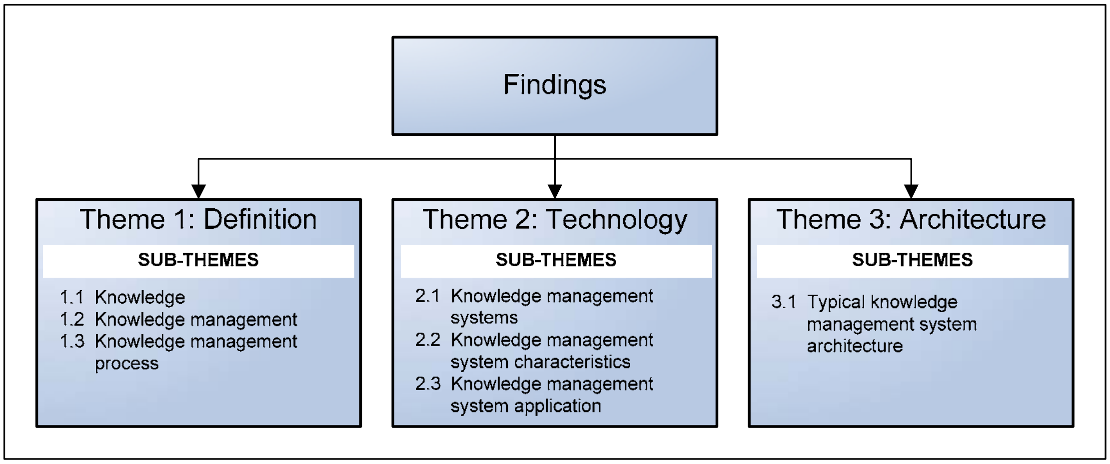

Figure 24: Themes and sub-themes of findings

The next sections contain the findings based on the theme and sub-theme breakdown.

6.4.1 Definitions

Three questions were introduced in order to establish the research participants' understanding and frame of reference regarding concepts discussed in this study, namely knowledge, knowledge management and knowledge management process. These three questions introduced and set the scene for the question regarding knowledge management systems and knowledge management system characteristics, as well as a typical architecture for a knowledge management system.

6.4.1.1 Knowledge

To determine the research participants' perception of knowledge, the question asked was:

Q1: How would you define knowledge?

In terms of primary themes, all eight research participants reflected that knowledge is data or information with meaning and experience added, while five of the eight also referred to insight and judgement.

RP1: "…not just information or facts, it's insight, it's instinct …"

RP2: "... experience we've gained in terms of type of work we do or type of activities that we perform ..."

RP5: "…specific usable information in the sense of decision making …"

RP6: "…you internalise that information and then you extend that information - that's knowledge …"

RP7: "... in an organisational context, it's the things an organisation knows ..."
RP8: "… contextualised every scenario that could have taken place be it a policy, procedure, process or system …"

Two themes emerged from the data as one research participant emphasised that education contributes to knowledge and six research participants indicated that learning is a component of knowledge whether it is experiential learning or transfer of knowledge.

RP3: "…result of knowledge management is increased learning …"
RP4: "... experiences that taught us certain things ..."
RP8: "so learning could be the transferring of an event or an experience to someone who doesn't have the direct experience themselves ..."
RP8: "… learning creates knowledge …"

Twelve primary themes based on the topic guide keywords and two new themes emerged from the interviews. A summary of the primary and emerging themes for knowledge is shown in Table 29.

Table 29: Primary and emerging themes for knowledge

Q1: How would you define knowledge?	
Primary themes	**Emerging themes**
1. Analytical thought processes	1. Education
2. Body of understanding	2. Learning
3. Connotation	
4. Contextual information	
5. Expert insight	
6. Framed experiences	
7. Increased value	
8. Information processing	
9. Intuition	
10. Judgement	
11. Skills	
12. Values	

The primary themes include topics on the definition of knowledge used in this study and consist of a mix of *framed experiences*, *values*, *contextual information*, *expert insight, intuition* and *judgement*, as well as providing a framework for evaluating and incorporating new experiences and *information*. *Increased value* refers to value that is enhanced through *analytical thought processes* as data and information are processed, understood and *connotation* and meaning added that creates a *body of understanding* and *skills*.

The two emerging themes are *education* and *learning,* and research participants indicated that knowledge is a combination of literature-based experience, education and skills, as well as different forms of learning.

6.4.1.2 Knowledge management

To establish the research participants' perception of knowledge management, the question asked was:

Q2: How would you describe knowledge management?

All eight research participants related knowledge management to the replication of know-how and seven of the eight to the generation of business value in terms of primary themes.

> RP3: "…managing knowledge from entry level right to decision making or interpretation or application …"
> RP6: "... strategic information management ..."
> RP7: "…management of it [knowledge] is making sure that it becomes an asset in the organisation …"
> RP7: "…to capture it and to capture it correctly which is easier with formal stuff and very difficult with the others, the informal and unstructured stuff …"
> RP8: "…knowledge management is about capturing the event, its outcome, so that other people can reference it so that they can learn and they can therefore predict the circumstances …"

Several new themes emerged as research participant, RP6, indicated that proper knowledge management leads to innovation, while research participant RP1 highlighted that knowledge management should consider sensitivities regarding multi-cultural contexts. This theme is emphasised by research participant RP1, who indicated that personal context refers to "business science as well as life science" at an individual level.

Ten primary themes based on the topic guide keywords and three new themes emerged from the interviews. A summary of the primary and emerging themes for knowledge management is shown in Table 30.

Table 30: Primary and emerging themes for knowledge management

Q2: How would you describe knowledge management?	
Primary themes	**Emerging themes**
1. Generate business value	1. Knowledge innovation
2. Capacity to transform knowledge	2. Multi-cultural context
3. Create knowledge	3. Personal context
4. Disseminate knowledge	
5. Leverage intangible assets	
6. Organisation uses what it knows	
7. Protect knowledge	
8. Replicate know-how	
9. Support of sound decisions	
10. Transform knowledge	

6.4.1.3 Knowledge management process

In order to ascertain the research participants' perception of the knowledge management process, the question asked was:

Q3: What would you say are the main components of a knowledge management process?

Research participants provided comprehensive feedback on this question and 11 primary themes based on the topic guide keywords and 14 new themes, some of which are enhancements of the topic guide keywords, emerged from the interviews. Knowledge application, capture, identification and sharing, as reflected in the topic guide were highlighted by most of the research participants.

> RP1: "...well defined process as well, it's documented, it is broadly communicated and all insights are there ..."
> RP2: "...process is to make people aware of the information ..."
> RP4: "...formal process trying to capture informal information, knowledge ..."
> RP4: "... some sort of process to put my knowledge down in some sort of system ..."
> RP7: "...before you capture I guess you need to identify ..."
> RP8: "...the approach in analysing and considering all of the information, the corroborating information and the information you can gain, the information you have, information the person shares with you for desired outcomes ..."

A number of new themes were collated from the interviews, as most research participants highlighted knowledge interdependency, knowledge interpretation and knowledge validation as key components of a knowledge management process. A summary of the primary and emerging themes for knowledge management processes is shown in Table 31.

Table 31: Primary and emerging themes for knowledge management processes

Q3: What would you say are the main components of a knowledge management process?	
Primary themes	**Emerging themes**
1. Knowledge application	1. Knowledge awareness
2. Knowledge capture	2. Knowledge context recording
3. Knowledge creation	3. Knowledge creation through innovation
4. Knowledge distribution	4. Knowledge filtering
5. Knowledge elicitation	5. Knowledge interdependency
6. Knowledge identification	6. Knowledge interpretation
7. Knowledge organisation	7. Knowledge maintenance
8. Knowledge sharing	8. Knowledge management objectives
9. Knowledge storing	9. Knowledge presentation
10. Knowledge transfer	10. Knowledge quality
11. Knowledge translation	11. Knowledge summarisation
	12. Knowledge tagging
	13. Knowledge user
	14. Knowledge validation

Several knowledge management processes, as well as the knowledge harvesting process, have been described in Chapter 2 of this study. A generic knowledge management process consists of *identification* or *creation* of knowledge, *elicitation*, *capture* and *recording* of knowledge, *organisation* and *storage* of knowledge, knowledge *application* and *translation*, knowledge *distribution*, *transfer* and *sharing* of knowledge – all of which were highlighted in the research interviews.

Research participants highlighted several additional components of a knowledge management process. One research participant, RP2, emphasised knowledge management *objectives* and indicated that there are "so much knowledge and data in the world we must be specific on what we are trying to achieve" and that we should "understand the objectives of why you are trying to retain knowledge". Knowledge *awareness* refer specifically to making employees aware of the knowledge, where it is held and communicating about it. Knowledge *user* points to the human factor in the knowledge management process and the human-computer interface, as well as how this interface is reflected. Knowledge *filtering* refers to the fact that there are so much knowledge and information available that the knowledge management process must facilitate filtering of the volume, while knowledge *summarisation* allows for high volume of knowledge to be summarised before it is captured into the knowledge repository. Knowledge *tagging* supported the allocation of a usefulness indicator for ease of search. Knowledge *quality* refers to understanding the quality of information that you have not generated yourself and knowledge *validation* to the auditing of knowledge and information prior to submitting it to the knowledge repository. Six of the eight research participants emphasised the importance of knowledge *maintenance* and the requirement of a process to ensure that knowledge stays recent, valid and relevant. According to one research participant, RP3, an organisation is a "system of interdependencies", and three research participants highlighted that this is reflected in the *interrelationships* of data, information and knowledge. Two research participants emphasised the importance of knowledge *interpretation* and one research participant, RP5, indicated specifically "how it [knowledge] gets interpreted once you have applied the business rules make it into valuable information". One research participant indicated that people must be cognisant of how knowledge, once extracted, is *presented* to management and the organisation.

Lastly, knowledge *context recording* and knowledge *creation through innovation* emerged as new themes as an extension of knowledge capture and knowledge creation respectively. Context *recording* refers to the fact that the knowledge management process must also allow for the capture of context and background to the knowledge. Research participants indicated that new knowledge is created specifically through a process of *innovation* based on the usage and application of existing knowledge and information.

6.4.2 Technology

The technology theme followed the definitions theme, and three questions were introduced in order to obtain the research participants' input on the role of technology in knowledge management, as well as to obtain characteristics of a typical knowledge management system. The third question in the technology theme related to the application of knowledge management and specific software application examples that were utilised by the research participants were discussed.

6.4.2.1 Knowledge management systems

To determine the research participants' perception of knowledge management systems, the question asked was:

Q4: Is there a role and how would you describe the role of technology in knowledge management?

Several primary themes aligned to the topic guide keywords were obtained in the interviews and all participants indicated that the role of technology is a key enabler. Seven of the eight participants referred to creation and storage, as well as providing a repository, as key roles of technology.

> RP1: "... technology in a broader sense has a huge enabler role to play ..."
> RP1: "...system is an enabler and it's a very nice element to maintain the discipline ..."
> RP2: "... feed that back into your knowledge system ..."
> RP3: "... facilitates the connectivity of learning and experiences and information, skills, documentation imperative to decision making ..."
> RP5: "... repository or in a digital format ..."
> RP7: "... technology enables you […] previously there was sort of one view now there are 30 different views ..."
> RP7: "... capture intangible knowledge by building a systemised process, something tangible that other people can actually use ..."
> RP8: "... capture so much to the extent that you've captured the emotion and the circumstance at the same time so the predictability is greater ..."

Several new themes emerged from the interview data, which research participants identified as part of the key role that technology plays in knowledge management. Measurement and reporting, as well as real-timeness, were identified as key components and all research participants felt that technology facilitated the usage of various media for knowledge management.

> RP1: "... to capture the discipline of the doing because people forget ..."
> RP3: "... the workflow within the system ..."
> RP4: "... have to create a need for it [knowledge management system] , a sponsor for it, usage of it, otherwise it will die ..."
> RP7: "... all sorts of media so you can capture almost anything today ..."

A summary of the primary and emerging themes for knowledge management technology is shown in Table 32.

Table 32: Primary and emerging themes for knowledge management technology

Q4: Is there a role and how would you describe the role of technology in knowledge management?	
Primary themes	**Emerging themes**
1. Collaboration	1. Artificial intelligence
2. Creation and storage	2. Consistent application
3. Develop organisational competence	3. Context sensitive search

Q4: Is there a role and how would you describe the role of technology in knowledge management?	
Primary themes	**Emerging themes**
4. Facilitate sharing 5. Key enabler 6. Link among knowledge sources 7. Repository 8. Search and retrieval 9. User assimilation	4. Creation and storage validation 5. Knowledge operationalisation 6. Measurement and reporting 7. Real-timeness 8. Refresh data and information 9. Refresh repository 10. Usage training 11. User buy-in and commitment 12. User-friendly user interface 13. Various media 14. Workflow enablement

Nine primary themes and fourteen emerging themes were identified based on the input given by research participants. Technology is a *key enabler* of enhancing intellectual capital by supporting the *development* of individual and organisational *competencies* as it assists with *user assimilation* of information. Technology also provides effective *creation*, *storage*, *search* and *retrieval* mechanisms for locating relevant information. It also offers access to *sources of knowledge* rather than knowledge itself and creates wider breadth and depth of knowledge flows. *Collaboration* between people who are not geographically collocated is made possible through technology as it provides reliable and secure access from various locations.

Research participants identified some new themes and enhanced some of the primary themes based on specific topics. *Consistent application* is facilitated by technology as it applies business rules and follows *workflow* built into the system consistently. As technology and software applications provide a documented source of information, it assists with the *operationalisation* of knowledge as it makes it easy to use through a *user-friendly user interface* and *usage training*. Technology enables the storing and retrieval of *various media*, as well as *validation* of information before it is committed to the knowledge repository and retrieved through *context sensitive search* mechanisms and *reported* on. Systems allow data, information and the repository to be *refreshed* by the click of a button, *real-timeness* and access to the knowledge repository as and when required[15] and from multiple locations.

One research participant, RP1, referred to smart and *artificial intelligence* systems specifically regarding the processing of millions and millions of data entities and

[15] RP4 referred to after office hours and RP7 used the analogy of a library

providing insight into it.[16] Lastly, one research participant, RP4, referred to the importance of user buy-in and commitment as no knowledge management system can be utilised successfully if employees do not commit their knowledge to it, buy into the knowledge management process and utilise it.

6.4.2.2 Knowledge management system characteristics

In order to obtain the research participants' view of knowledge management system characteristics, the question asked was:

Q5: When you buy a PC game, you look at the specification on the package before you decide to purchase it. If you had to buy a knowledge management system off the shelf, what characteristics would you look for on the package?

Research participants provided comprehensive feedback and answers to this question and 44 themes were identified of which 20 are aligned to the topic guide keywords as primary themes while 24 new themes emerged.

All research participants indicated the importance of storing, search and retrieval and ease of use. Two research participants indicated that knowledge harvesting characteristics are an important feature while three research participants highlighted intermediation - the connection of people to people – as a key characteristic.

> RP1: "... how best to harvest the ideas ..."
> RP2: "... how to find information inside of this application ..."
> RP3: "... people to collaborate with each other using technology ..."
> RP6: "... retrieval capabilities ..."
> RP7: "... the value is in the retrieval, to get what you are looking for very very quickly, but relevant ..."
> RP8: "... the links between all of these things ..."

Research participants indicated that characteristics also relate to the role of technology in knowledge management, as discussed in the previous question, and some overlap in answers to Question 4 is observed. Several new themes emerged from the interview data based on requirements specified by research participants.

[16] RP1 referred to the processing and analysis of cell phone call data records where millions of such records are generated daily.

RP1: "... if your insight on your IT systems and defining the processes is such that you can see real-time when this is happening and respond very quickly you will save millions and millions ..."
RP2: "... to distribute to a number of locations ..."
RP2: "... relevance of data is also important in terms of date and time stamps around the data, how old it is, if information gets too old the relevance of it also decreases over time ..."
RP2: "... whenever it gets updated, notify me ..."
RP3: "... features would be things like speed, complexity, user-friendliness, taxonomy, in what language can the system support and flexibility in that it has compatibility with other interfaces within the scope of application ..."
RP3: "... learning agility of the system, how easy it is to transfer the skill of using the system from the system itself to the people, the users ..."
RP4: "... easy for a person to put their knowledge and skills into the system ..."
RP5: "... in terms of running on different types of platforms ..."
RP5: "... different types of media perspective, visual, graphic representation ..."
RP6: "... design and customise it according to my needs because what you put in is what you're going to get out ..."
RP7: "... so, the way you capture things must also be quite simple ..."
RP8: "... the ease of use, when we talk about the human interface ..."

A summary of the primary and emerging themes for knowledge management system characteristics is shown in Table 33.

Table 33: Primary and emerging themes for knowledge management system characteristics

Q5: When you buy a PC game, you look at the specification on the package before you decide to purchase it. If you had to buy a knowledge management system off the shelf, what characteristics would you look for on the package?	
Primary themes	**Emerging themes**
1. Authoring	1. Access to information
2. Classifying	2. Application scalability
3. Cognition	3. Appropriateness
4. Collaboration	4. Archiving
5. Content delivery	5. Back up and housekeeping
6. Content evolution	6. Content capture
7. Context sensitive	7. Content upload
8. Externalisation	8. Content validation
9. Flexible (various media)	9. Customisation
10. Heuristic	10. Date and time stamp
11. Indexing	11. Distributed architecture
12. Intermediation	12. Hardware platform independent
13. Internalisation	13. Knowledge gap identification
14. Knowledge harvesting capability	14. Maintenance and update
15. Process	15. Multi-language support

Q5: When you buy a PC game, you look at the specification on the package before you decide to purchase it. If you had to buy a knowledge management system off the shelf, what characteristics would you look for on the package?	
Primary themes	**Emerging themes**
16. Search and retrieval 17. Security 18. Storing 19. Suggestive 20. User sensitive	16. Real-timeness 17. Refresh data and information 18. Relevance 19. Responsiveness 20. System learning agility 21. Taxonomy 22. User-friendly user interface 23. Various distribution bearers 24. Workflow enabled

Some themes point to basic characteristics of a knowledge management system and in general to characteristics of any standard software application. *Access to information* refers to the *process* and the ease of *authoring*, *classifying*, capturing, *storing*, *searching, retrieving* and *delivery* of content and information from the knowledge management system. *Flexible* indicates the ability of the solution to handle knowledge of any form as well as different subjects, structures and media, while *indexing* handles content management according to the context of the organisation. Application, user, role and remote access *security* are implemented using inherent mechanisms in each tool or by using specific tools in addition to the existing system to manage access and retrieval levels.

The other themes either expand on the basic characteristics or have a very specific application in terms of a knowledge management system. *Knowledge harvesting* capability is specific requirements regarding the focused elicitation, collection and capture of knowledge in order to break down barriers to knowledge management and facilitate the *evolution* of knowledge base content. *Context-sensitive* refers to the capability of the solution to understand the context of the knowledge requirement and tailor responses accordingly, *suggestive* points to the ability to deduce what the knowledge seeker's knowledge needs are and *user-sensitive* represents the ability to organise the knowledge in the way most useful to the specific knowledge seeker. *Heuristic* means that the solution should constantly learn about its users and the knowledge it possesses as it is used, i.e. continually refine itself as a user's pattern of research is tracked by the system. Its ability to provide a knowledge seeker with relevant knowledge should therefore improve over time. *Externalisation* refers to the connection of information source to information source and creating interrelationships, while *internalisation* refers to the connection of explicit knowledge to people or knowledge seekers. *Intermediation* points to the connection of people to people, i.e.

bringing together those who are looking for a certain piece of knowledge and those who are able to provide this piece of knowledge. *Collaboration* supports the knowledge sharing process through a social network analysis and collaborative tools.

The interview participants highlighted several new themes. These new themes pointed to the data, information and knowledge captured in a typical knowledge management system. *Relevance* refers to all information entities that is valid to the organisation and that have a business impact on the organisation as opposed to information that provides the required background and context, but does not have a direct impact on the organisation. *Content capture*, *content upload* and *content validation* refer to characteristics that are required to either capture information directly, or to upload documents in various formats into the knowledge repository once they are validated. *Date and time stamp* indicate when the information was uploaded or captured into the knowledge base as it might have to be *updated*, *maintained* or *refreshed* over time as new and more relevant information becomes available. In knowledge areas where new information and knowledge are generated in short cycles,[17] archiving is required to store outdated information, but still allow access to it as and when required. All research participants emphasised the use of an approved and well-defined *taxonomy,* as it is crucial to organise your knowledge repository in a defined way in order to retrieve *appropriate* and relevant information aligned to the knowledge user's requirements.

Research participants also mentioned some features required for the user interface of a typical knowledge management system. *Real-timeness* and *responsive* feedback out of the system via a *user-friendly user interface* with *multi-language* support were highlighted. *Customisation* and the *configuration* of the system aligned to organisational requirements in order to support ease of use and the human interface were noted, as well as the *system learning agility,* which refers to how easy it is to transfer the skill of using the system to the users. Another useful feature according to the research participants is *workflow enablement,* which will notify users when any changes were made to the knowledge repository component that they are interested in.

Three research participants referred specifically to the *scalability* of the application depending on the organisation's requirement that support a *distributed architecture* that

[17] Research participants referred to the mobile industry specifically as the evolution of technology during the past 14 years is "visible" in the devices (handsets) that are used today.

is *hardware platform independent* with *various distribution bearers*. As with standard software applications, *back-up and housekeeping* processes and procedures must be in place.

Lastly, according to research participant, RP4, an outcome is the *identification of knowledge gaps* where it is clear that you have components in the system where no data, information or knowledge are captured and reflected or requested.

6.4.2.3 Knowledge management system application

To attain the research participants' outlook of knowledge management applications utilised in the organisation, the question asked was:

Q6: What is the role of software tools currently installed in the organisation for knowledge management?

Research participants listed several examples of knowledge management solutions that are currently used in the MTN Group and MTN SA further to the interview questions asked and feedback provided. These examples are included in Table 34.

Table 34: Examples of knowledge management system solutions and applications

Q6: What is the role of software tools currently installed in the organisation for knowledge management?	
Topic guide keywords	**Some KM software application examples specific to the MTN Group and MTN SA**
Document and content management	• eGain Knowledge • Sequel • ORACLE • E-TOMS
Competence management	• Requisite Pro, a rational toolset application, databases where business rules and other parameters are stored • Workshops, face-to-face engagement
Collaboration tools	• Conferences • Tele-conferencing, videoconferencing, web-based meetings and interfaces • ARIS, visual modelling
Customer support	• Siebel • SmartWizard • Remedy • MTN Active (web-based self service)
Data and knowledge discovery	• ORACLE Discoverer • Internet
Intellectual property capture	• FACTS system • MTN Group Business Intelligence (BI) system
Expert networks	
E-learning management systems	• Audio Books • ORACLE Learner Management • Itutha • Computer-based training tools
Portals	• SharePoint, portals and presentation tools

The topic guide keywords were used to classify the application examples quoted by research participants as discussed in Section 3.4.2 in this study (Wessels, Grobbelaar and McGee, 2003).

6.4.3 Architecture

The last theme addressed in the interviews was a typical architecture for a knowledge management system. Two questions were originally introduced to obtain research participants' input on architecture, but only one question – Question 7 – was used in the interview, as the two questions potentially overlapped and all required information was obtained by discussing only the one question.

The question asked was:

Q7: If you had to design a typical architecture for your knowledge management system, what would it be?

The knowledge management system architecture (Lindvall, Rus and Sinha, 2003) as described in Section 4.3 and evaluated in Section 4.4 of this study, consists of seven layers namely information and knowledge sources, low-level IT infrastructure, document and content management, organisational taxonomy, knowledge management services, personalised knowledge gateway and the business application layer. This seven-layer structure was used in the topic guide and to structure the data obtained in the research participant interviews.

As pointed out in sections 5.4.3.2 and 5.4.3.4, not all research participants chose to answer this question regarding a typical architecture for a knowledge management system and only four participants, RP2, RP4, RP5 and RP6, contributed.

> RP2: "... portal environment must be integrated into your customer care environment ..."
> RP2: "... other applications to insert information into your database...."
> RP2: "... inside the application where versioning is crucial, you need data quality tools and the ability to scrap data and merge data ..."
> RP4: "... use the system outside of business hours ..."
> RP5: "... system go down we have the ability to retrieve the information within six hours or a day later, or whatever is acceptable ..."

RP5: "... if it's not administered properly and becomes a free for all and people just dump data it becomes unmanageable and it grows exponentially in terms of storage and space utilisation is depleted at a very rapid rate ..."
RP5: "... your typical type blogs information ..."
RP6: "... flexibility of changing the database so that I can add my own meta data ..."

A summary of the themes that emerged for a typical knowledge management system architecture is shown in Table 35.

Table 35: Themes for knowledge management system architecture

Q7: If you had to design a typical architecture for your knowledge management system, what would it be?		
KM architecture model	**Emerging themes**	
• Business application layer	• customer care • data reporting • ease of capture • integrated services • multiple access points • rating system, trust information • real time accessibility • search, retrieval and integrated access services	• security levels and services • simple reporting • single sign on • software application management • structure access privileges, rights, roles • time independent access
• Document and content management	• repository storage	• various file format content management
• Information and knowledge sources	• administration tools • data segregation • high and low usage knowledge areas • increase knowledge areas • inputs and outputs • integrated services	• knowledge control mechanism • knowledge rating mechanism • proper knowledge base administration • publish information • publishing quality assurance
• Knowledge management services	• archiving data based on specific rules • collaboration services • data retrieval and data tools • information blogs	• public disseminated type of information • repository search, various media search facility • workflow management
• Low-level IT infrastructure	• database, database features and flexibility • development and test environment • disaster environment, disaster recovery • exponential growth of storage and space utilisation, space management • firewall	• off-line capabilities • physical infrastructure • redundancy for real-timeness • sophisticated database and scalable database • thin client web based
• Organisational taxonomy	• environment administrator	• grant access privileges, rights, roles
• Personalised knowledge gateway	• ease of retrieval • ease of search • ease of use • front-end capture	• multi language user interface • portal, portlet • search engine • visual modeling

The data obtained from the research participant interviews contributes to the second research question regarding the relation of the knowledge management system characteristics to defining a conceptual framework for a knowledge management system architecture. Some of the themes that emerged from the interview data are to facilitate *searching and extracting* information that is *relevant* and to make relevant *task support tools easily available* to users, according to the task being performed whether it is *visual modelling*, *front-end capture*, *reporting* or general user *administration*. The personalised knowledge gateway should further allow for smart *navigation* via a *customised, semantically-connected portal* with knowledge management services like *workflow enablement* for notification as well as posting of questions and comments. This allows users *individual access* to the *right information* available from *multi-media information sources* in *context* of the work to be performed, as well as *collaborative* work. *Archiving* must be performed as and when required based on specified business rules.

Three of the four research participants indicated that such a knowledge management system architecture should support a *flexible, scalable and sophisticated database,* including *development and test environments* over and above the production environment. One research participant, RP5, emphasised that *redundancy* as well as a *disaster recovery* process for a knowledge environment, are key requirements.

6.5 Summary of findings

According to Braunstein (June 2004), a knowledge management process entails all the processes or operations that are related to knowledge assets, and it can be divided into several parts, as summarised by Alavi (2004) (as shown in Figure 25).

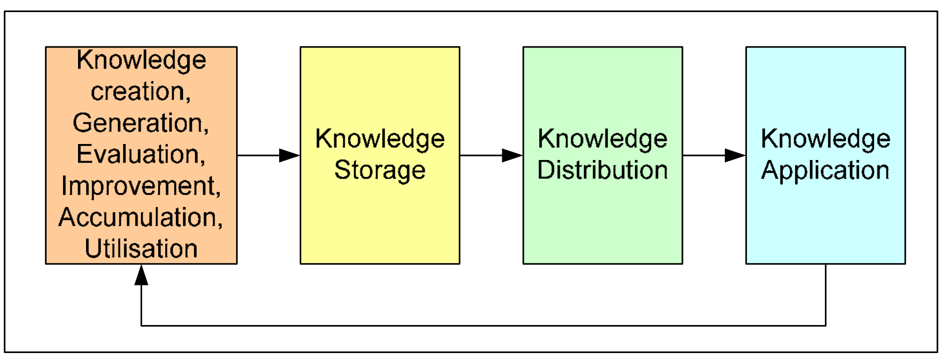

Figure 25: Knowledge management process components (Alavi, 2004)

This outline is utilised to summarise the data obtained from the research participant interviews.

6.5.1 Theme 1: Definition

Theme 1 consisted of the definitions theme with sub-themes on the definition of knowledge, knowledge management and knowledge management process.

By comparing the knowledge management process themes obtained from research participants for Question 3, as discussed in the previous section, to the knowledge management process defined by Alavi (2004) and discussed in Section 6.4, the following summary has been compiled (see Figure 26):

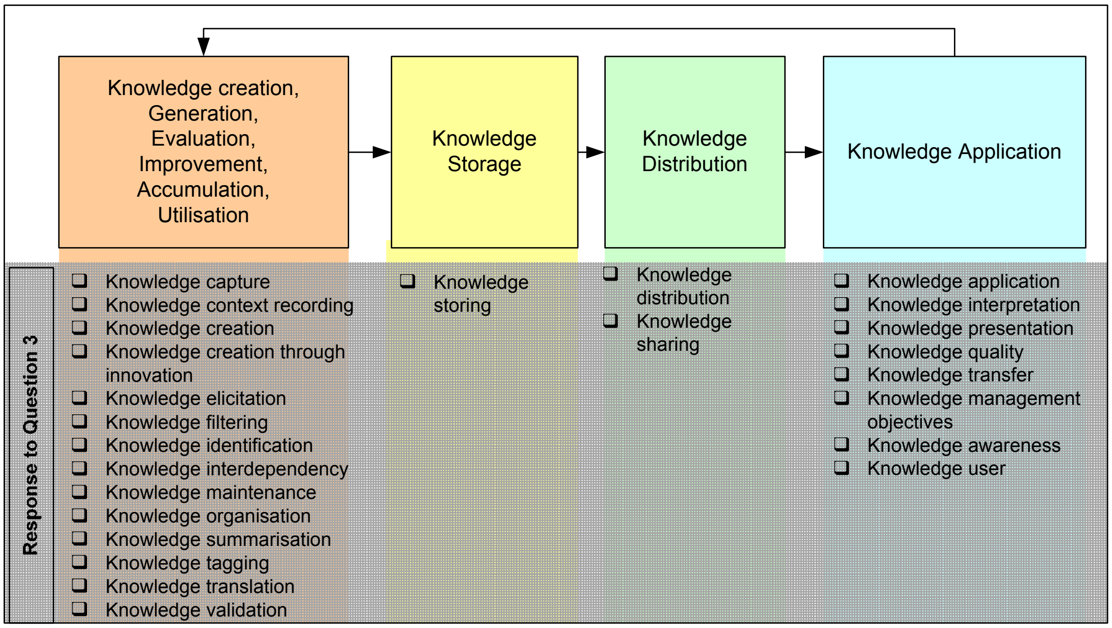

Figure 26: Knowledge management process theme mapped

According to Alavi (2004), there are four main components to the knowledge management process, namely firstly, a knowledge set-up activity (consisting of knowledge creation, generation, evaluation, improvement, accumulation, utilisation); secondly, knowledge storage; thirdly, knowledge distribution; and lastly, a knowledge application activity. The primary and emerging themes obtained from research participants when they responded to the interview question "*What do you regard as the main components of a knowledge management process?*" and discussed in Section 6.3.1.3 are categorised using the four-step process defined above.

By using the summarised knowledge management process for the interview data obtained for Question 3 regarding the knowledge management process, Question 1 with responses to the definition of knowledge and Question 2 with the input regarding knowledge management can be summarised as shown in Figure 27 to provide an overview of the definition theme and its sub-themes of findings.

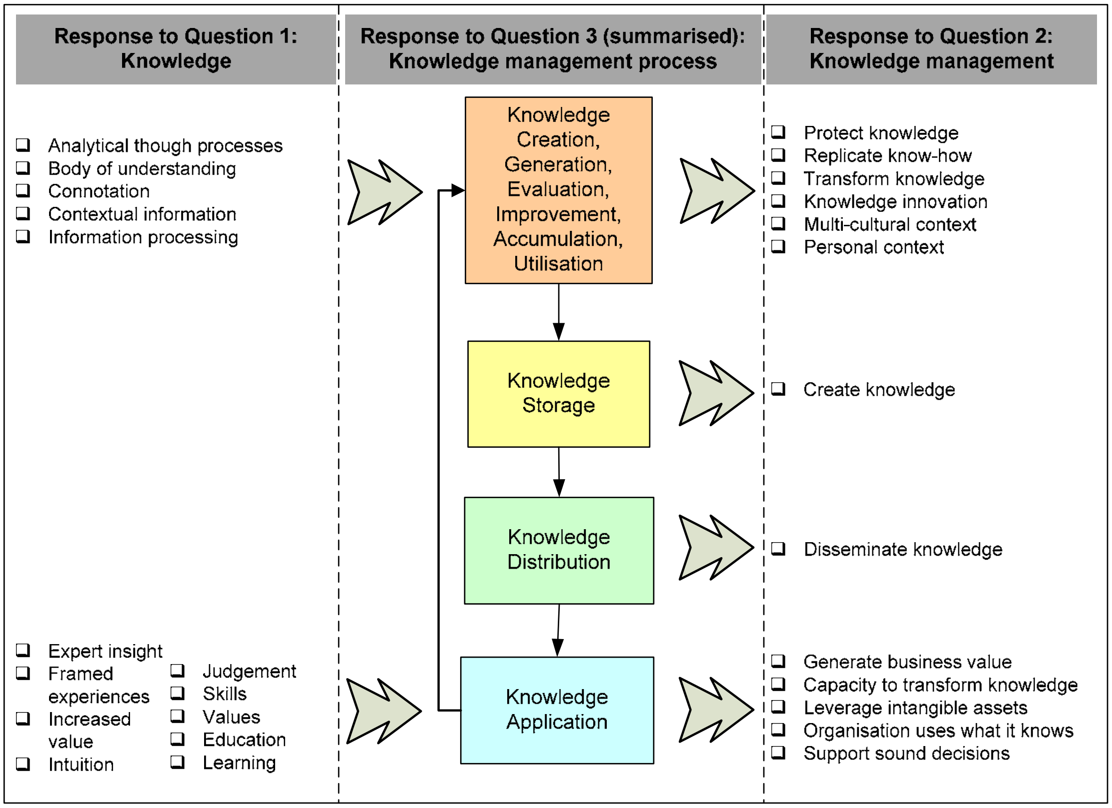

Figure 27: Summary of findings for *definition* theme (theme one) and sub-themes

Knowledge themes (responses to Question 1, as discussed in Section 6.3.1.1) are related to the knowledge management process through which knowledge management (responses to Question 2, as discussed in Section 6.3.1.2) and knowledge management objectives are achieved. The knowledge management themes are also categorised using the knowledge management process defined by Alavi (2004) as basis.

6.5.2 Theme 2: Technology

Theme 2 is the technology theme consisting of the knowledge management system, knowledge management system characteristics and knowledge management system application sub-themes.

In Section 2.4.1, different knowledge management processes models were described and Bergeron (2003, as quoted by Antonova, 2006) proposes the description of knowledge management processes related to the technologies. This model has been used to summarise the research participant interview responses to the technology questions, questions 4 and 5, regarding the role of technology in knowledge management and knowledge management system characteristics.

Figure 28 depicts the research participant interview responses mapped to the knowledge management process model (section 2.4.1) as proposed by Bergeron (2003, as quoted by Antonova, 2006). The role of technology responses are depicted in black and the knowledge management system characteristics in red. If *modification* as a process step is considered, then the relevant technology roles are *artificial intelligence* and *knowledge operationalisation* and the knowledge management characteristics that are important in this instance are *maintenance and update*, *knowledge gap identification* and *customisation*.

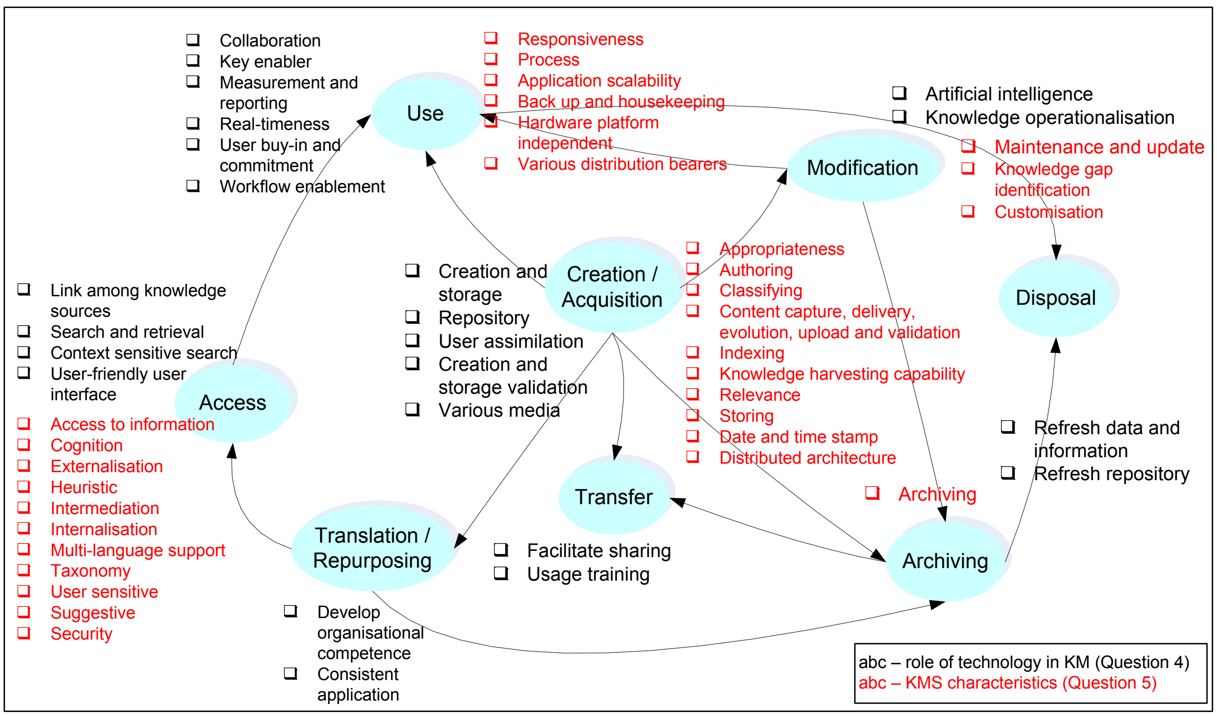

Figure 28: Summary of findings for *technology* theme (theme two) and sub-themes

6.5.2 Theme 3: Architecture

Theme 3 is the architecture theme, which is reflected and summarised in Section 6.3.3. It will be discussed further in Chapter 7 of this study.

6.6 Context for analysis of findings

As the research questions for this study focused on knowledge management system characteristics and architecture, only questions 4 and 5 will be considered further. As indicated in Section 6.3.1, it was necessary to discuss more questions in the interviews to establish the research participant's understanding and personal context of the nature of knowledge, knowledge management and knowledge management systems.

It must also be noted that the list of characteristics collated from literature and the research participant interviews, is a comprehensive list, but might not necessarily include all features. As new knowledge requirements and technologies evolve, this list might need to be expanded.

6.7 Summary

The purpose of this chapter was to discuss the evidence and the data analysis from the research participant interviews based on the research strategy described in the previous chapter.

The first section in the chapter described knowledge management system characteristics collated from literature where a description and an example were included for each characteristic. The results from the research participant interviews were presented as findings based on three themes namely definition, technology and architecture - each containing sub-themes as well.

The first theme, definitions, is portrayed in terms of the knowledge, knowledge management and knowledge management process and primary and emerging themes of each were discussed. The second theme, technology, was described in terms of knowledge management systems, knowledge management system characteristics and knowledge management system application. The last theme, architecture, included information regarding knowledge management system architecture specifically. Each theme was illustrated using direct quotes from research participants and primary and emerging themes were identified and listed.

The findings were then summarised according to each of the three themes. Theme one, definition, was summarised using the knowledge management process components defined by Alavi (2001), while theme two, technology, was reflected based on the technology view of knowledge management processes defined by Bergeron (2003). Theme three, architecture, was summarised according to the themes for a knowledge management system architecture defined by Lindvall, Rus et al.

The last section in the chapter provided the context for the analysis of the findings, as some interview questions were considered as background only.

Part V Contribution

Part V (Figure 29) of the study consists of Chapter 7 and details the contribution of this study.

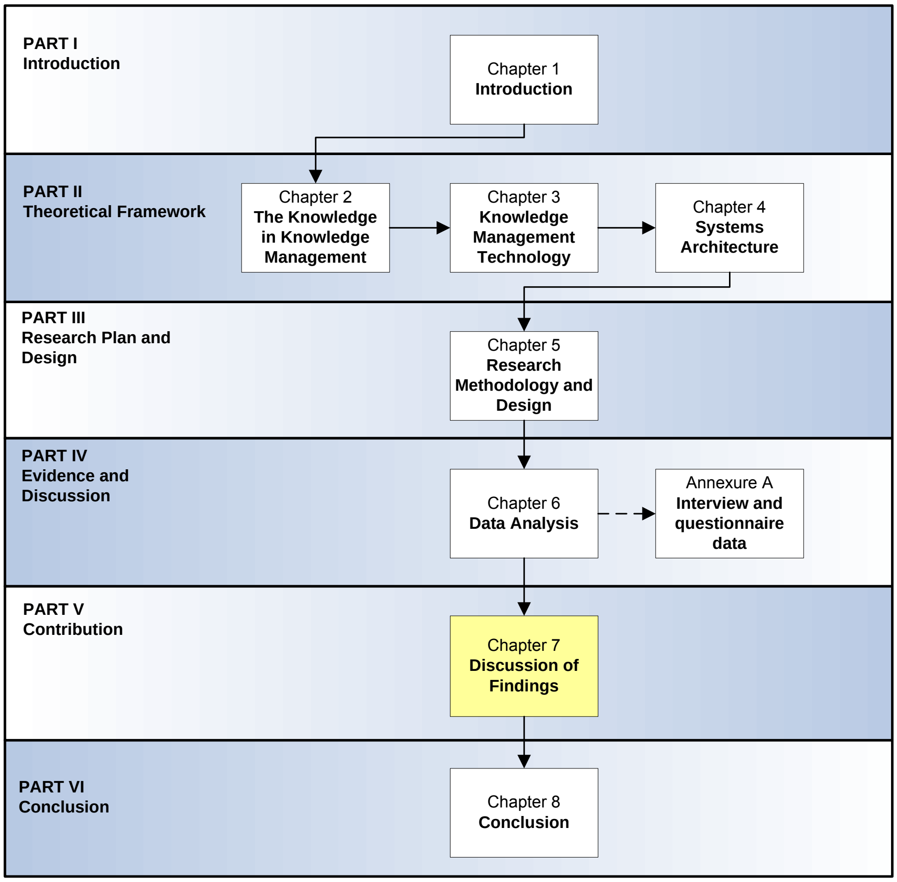

Figure 29: Part V outline

Chapter 7 Discussion of findings

7.1 Introduction

This study consisted of three work streams, as described in Section 5.4.3. The first work stream entails grouping knowledge management system characteristics based on technology classification extracted from the literature (Section 6.2). The second work stream extracts knowledge management system characteristics from the research participant interviews (Section 6.3.2.2) and the last work stream evaluates a knowledge management system architecture (Section 4.4).

This chapter focuses on the discussion of the findings for this study - consolidating the list of characteristics obtained from the literature and the research participant interviews (Section 7.2), before it is mapped to the knowledge management system architecture (Section 7.3).

Table 36 provides an outline of this chapter:

Table 36: Chapter 7 outline

Outline of Chapter 7			
Section	**Description**	**Sub-section**	**Sub-section description**
7.1	Introduction		
7.2	Knowledge management system enablers and features	7.2.1	Classification 1: Generation of knowledge
		7.2.2	Classification 2: Storing, codification and representation of knowledge
		7.2.3	Classification 3: Knowledge transformation and knowledge use
		7.2.4	Classification 4: Transfer, sharing, retrieval, access and searching of knowledge
		7.2.5	Knowledge management system characteristics summary
7.3	Knowledge management system architecture	7.3.1	Knowledge management system characteristics in relation to architecture
		7.3.2	Knowledge management system architecture summary
7.4	Towards a comprehensive KMS architecture		
7.5	Summary		

7.2 Knowledge management system enablers and features

Calabrese and Orlando (2006) described and analysed five approaches to the implementation of an effective knowledge management system, of which the four-pillar framework of the George Washington University was one. The four pillars were defined as leadership, organisation, technology and learning and consisted of an eight-step blueprint containing the following steps depicted in Table 37:

Table 37: Eight-step blueprint to implementing an effective KM solution (Calabrese and Orlando 2006)

Eight-step blueprint to implementing an effective KM solution (Calabrese and Orlando, 2006)	
Step #	**Description**
1	Locate knowledge critical functions, look at the work the organisation needs to perform and utilise a work centre analysis.

Eight-step blueprint to implementing an effective KM solution (Calabrese and Orlando, 2006)	
Step #	**Description**
2	Develop process models for candidate functions and applications.
3	Identify knowledge critical gaps, opportunities and risks.
4	Analyse the gaps, opportunities and risks, prioritise, and select goals.
5	Apply knowledge management strategically, ensure alignment with corporate strategy and orchestrate changes.
6	**Develop knowledge management requirements and *characteristics* – what, who, where, how and type e.g. tacit.**
7	**Document the *characteristics* and describe the knowledge management cycle elements involved e.g. generation, codification, validation and transfer. Select the knowledge management enablers, e.g. methods, technologies and practices.**
8	Develop reward structures and obtain management commitment, develop timeline to support benefits – quantitative and qualitative - that accrue.

The characteristic set defined as part of this study, focuses mainly on steps 6 and 7 as highlighted in Table 37.

In Section 3.5 one classification method for knowledge management technologies was discussed consisting of generation of knowledge, storing, codification and representation of knowledge, knowledge transformation and knowledge use and lastly, transfer, sharing, retrieval, access and searching of knowledge (Antonova, Gourova and Nikolov, 2006). This classification will now be utilised to group characteristics identified from the literature and to collate it with the characteristics obtained from the research participant interviews.

Some characteristics are relevant to more than one classification dimension and in such instances a primary grouping (■) and a secondary allocation (□) have been defined.

7.2.1 Classification 1: Generation of knowledge

The first classification dimension is generation of knowledge which comprises of activities for knowledge creation, acquisition and capturing as shown in Table 38.

Table 38: Characteristics for the generation of knowledge

Generation of knowledge		Source	
Dimension	**Characteristic**	**Literature**	**Research participant interview**
Knowledge content generation	Authoring	■	■
	Knowledge creation	■	
	Knowledge objects	■	
	Content validation		□
Knowledge discovery	Knowledge harvesting	■	■
	Content evolution	■	■
	Various distribution bearers		□
Data capturing tools	Externalisation	■	■
	Maintenance and update		■
	Storing	□	□
	Content capture		■
	Refresh data and information		■

■ primary grouping □ secondary grouping

With regard to *knowledge content generation*, authoring, knowledge creation, knowledge objects and content validation are important. Authoring encompasses sources of explicit knowledge line documents, manuals, proposals, e-mail messages, etc., as well as implicit knowledge. Knowledge creation refers to the generation of new knowledge through thinking or reasoning and knowledge objects encompass an object of structured information, un-structured information, insight, facts, practical and theoretical experience, as well as best practice to be stored and manipulated. Content validation points to the validation and auditing of knowledge objects when they are captured and resolves data and information conflicts.

Knowledge discovery allows the generation of knowledge through knowledge harvesting, content evolution and ensuring that this is made easily accessible and available via various distribution bearers. Knowledge harvesting is the process of pro-actively facilitating the harvesting and capturing of ideas. Knowledge, expertise and content evolution refer to the creation of knowledge by combining new sources of knowledge, optimising feedback loops and by re-applying and re-creating knowledge.

Data capturing tools enable the capture of knowledge and consists of characteristics such as externalisation, maintenance and update, storing and content capture. This toolset ensures that knowledge in the repository is maintained by providing mechanisms to refresh data and information. *Externalisation* refers to the connection of information source to information source and to creating interrelationships while *maintenance and update* ensure that knowledge objects in the knowledge management system stays valid and recent. It includes a formal change process for captured knowledge and also provides versioning of content. *Storing* supports knowledge creation through exploitation, exploration and codification and *content capture* facilitates the capture of knowledge through mechanisms such as a keyboard, optical character recognition, bar code identification and real-time location sensors.

7.2.2 Classification 2: Storing, codification and representation of knowledge

The second classification dimension is storing, codification and representation of knowledge, which comprises of activities contributing to effective storage, human-readable knowledge and the organisation of knowledge, as depicted in Table 39.

Table 39: Characteristics for storing, codification and representation of knowledge

Storing, codification and representation of knowledge		Source	
Dimension	**Characteristic**	**Literature**	**Research participant interview**
Technologies for storage	Archiving	■	■
	Capability	■	
	Customisation		□
	Flexibility	□	□
	Distributed architecture		■
	Security	■	■
	Hardware platform independent		■
	Storing	■	■
	Application scalability		□
	Back-up and housekeeping		■
Human-readable knowledge	Heuristic	■	■
	Content capture		□
	Content upload		□
	Content validation		■
Knowledge organisation	Classification	■	■

Storing, codification and representation of knowledge		Source	
Dimension	**Characteristic**	**Literature**	**Research participant interview**
	Customisation		■
	Date and time stamp		■
	Externalisation	□	□
	Flexibility	■	■
	Indexing	■	■
	Internalisation	□	□
	Application scalability		■
	Knowledge gap identification		■
	Appropriateness		□
	Content upload		■
	Taxonomy		■

■ primary grouping □ secondary grouping

The *storing, codification and representation of knowledge* classification dimension focuses on knowledge management processes and the quantity, quality, accessibility and representation of the acquired knowledge. The primary and secondary allocation of characteristics to this classification dimension are shown in Table 39.

Several *technologies for storage* consisting of several relevant characteristics have been identified in the literature and obtained from the research participant interviews. Archiving refers to archiving ability based on certain criteria and business rules specified by knowledge base administrators, while capability is the characteristics indicating the potential to influence action, processing, decision-making and application. Customisation points to the configuration and set up of the system reflecting the specific organisation or user context (personalisation). Flexibility refers to the characteristic regarding the handling of various media. Security is an important characteristic that addresses physical and logical security, since knowledge is such a valuable asset, while storing in this context refers to the commitment of knowledge to the data warehouse, knowledge warehouse, lessons learnt knowledge base or the data mart. Some characteristics like application scalability, back-up and housekeeping, hardware platform independence and distributed architecture ensure that the knowledge management application can be adapted to the size, application and hardware configuration of an organisation while ensuring accessibility and proper housekeeping of the physical infrastructure.

Human-readable knowledge consists of the characteristic set including heuristic and content capture, upload and validation. Heuristic means that the solution should constantly learn about its users and the knowledge it possesses as it is used. Its ability to provide a knowledge seeker with relevant knowledge should therefore improve over time. Content capture, upload and validation refer to the characteristics that ensure that knowledge is committed to the knowledge repository based on certain rules.

Knowledge organisation includes classification, customisation, externalisation, flexibility, indexing, internalisation, appropriateness, taxonomy and content upload. *Classification* handles content management according to the context of the organisation, while *customisation* refers to the configuration and set-up of the system reflecting the specific organisation or user context. *Externalisation* refers to the connection of information source to information source and creating interrelationships, as well as the integration of organisational interdependencies. *Flexibility* ensures that knowledge objects of any form as well as different subjects, structures, taxonomies and media can be included, while indexing means content management according to the context of organisation. Corporate *taxonomy* refers to the definition of how the knowledge is stored, where *internalisation* involves the extraction of knowledge from the external repository and subsequent filtering ensuring greater relevance and *appropriateness* to the knowledge seeker. Knowledge gap identification is a feature that allows a knowledge user to identify areas of the knowledge repository that is utilised significantly vs. underutilisation, as well as to identify areas where more *content can be uploaded* and populated in the knowledge repository. Two features, namely date and time stamp and application scalability, refer to the tagging of knowledge to track recency and the mechanism to add more knowledge areas respectively.

7.2.3 Classification 3: Knowledge transformation and knowledge use

Classification dimension three is depicted in Table 40, being knowledge transformation and knowledge use. This refers to the fact that once knowledge has been acquired it cannot be used in its raw form and must be transformed in order to become a valuable knowledge asset.

Table 40: Characteristics for knowledge transformation and knowledge use

Knowledge transformation and knowledge use		**Source**	
Dimension	**Characteristic**	**Literature**	**Research participant interview**
Knowledge transformation	Search and retrieval	□	□
	Access to information		□
Knowledge reconstruction	User sensitive	■	■
Knowledge use and retrieval	Application	■	
	Cognition	■	■
	Suggestive	□	□
	Expertise applying process	■	■
	System learning agility		■
	User-friendly user interface		□

■ primary grouping □ secondary grouping

Knowledge transformation ensures that the knowledge conforms to the format of the target repository and consists of two secondary allocated characteristics namely search and retrieval and access to information, encompassing the transformation of end-user collected data and information before it is committed to the knowledge repository.

Knowledge reconstruction ensures that knowledge is presented in the particular reasoning method that is used by the knowledge management system, e.g. editing into case formats to support case-based reasoning or a business intelligence dashboard.

Knowledge use and retrieval encompasses expert systems, decision support systems, visualisation tools and knowledge simulation. This classification dimension consists of processes of applying expertise to knowledge, the ease of learning and teaching how to utilise the knowledge management system through a user-friendly user interface, which is a secondary characteristic allocation in this dimension. Application includes the timeous availability of organisational and individual memory and just in time learning, as well as inter-group knowledge access. Cognition refers to the connection of knowledge to process and suggestive, another secondary allocation in this dimension, proposes knowledge associations that the user is not able to make through the user interface.

7.2.4 Classification 4: Transfer, sharing, retrieval, access and searching of knowledge

The fourth classification dimension is transfer, sharing, retrieval, access and searching of knowledge, which comprises of knowledge access, searching, collaboration and sharing characteristics, as shown in Table 41.

Table 41: Characteristics for transfer, sharing, retrieval, access and searching of knowledge

Transfer, sharing, retrieval, access and searching of knowledge		Source	
Dimension	**Characteristic**	**Literature**	**Research participant interview**
Knowledge access and transfer	Content delivery	■	■
	Access to information		■
	Multi-language support		■
	User-friendly user interface		■
	Various distribution bearers		■
Person to person and team collaboration	Collaboration	■	■
	User sensitive	□	□
	Expertise applying process	□	□
	Refresh data and information		□
	Workflow enabled		■
Knowledge sharing	Intermediation	■	■
	Internalisation	■	■
Search and find	Accessibility	■	
	Appropriateness		■
	Context sensitivity	■	■
	Heuristic	□	□
	Multi-language support		□
	Suggestive	■	■
	Relevance		■
	Search and retrieval	■	■
	Timeliness	■	■
	Responsiveness		■

■ primary grouping □ secondary grouping

With regard to *knowledge access and transfer*, only primary allocation of characteristics and features consisting of content delivery, access to information, multi-language support, user-friendly user interface and various distribution bearers, were concluded. Access to information is facilitated via a user-friendly user interface and the delivery of content consisting of the gathering of user-information and delivering appropriate content to meet specific user needs.

Collaboration includes person to person as well as team collaboration features encompassing the support of the knowledge sharing process through a social network analysis and collaborative tools, as well as collective insights across operations and different geographical locations. Workflow enablement connects people in different ways supporting increased work performance and productivity.

Knowledge sharing includes intermediation - the connection of people to people, i.e. bring together those who are looking for a certain piece of knowledge and those who are able to provide this piece of knowledge – and internalisation, the connection of explicit knowledge to people or knowledge seekers.

For the *search and find* dimension accessibility, appropriateness, context-sensitivity, heuristic, suggestive, relevance, search and retrieval, timeliness and responsiveness are important. A multi-language user interface feature supports search and find. Accessibility provides an effective search and retrieval mechanism for locating relevant information, while appropriateness indicates the appropriateness level based on the filtering of multiple inputs for the same knowledge object. Context-sensitivity refers to the feature that the solution should be able to understand the context of the knowledge requirement and tailor responses accordingly. Heuristic indicates that as the solution responds to many requests on a particular subject, it should learn how to assist multiple users in more depth on that subject, while suggestive deduces what the knowledge seeker's knowledge needs are. Relevance indicates the significance of knowledge objects retrieved, and search and retrieval are primarily concerned with enhancing the interface between the user and information, knowledge sources, user-friendliness and learning agility. Timeliness and responsiveness refer to the feature that knowledge must be available whenever it is needed with almost immediate retrieval and presentation cycles.

7.2.5 Knowledge management system characteristics summary

The second research question defined in this study was:

What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?

A list of knowledge management system characteristics were extracted from the literature, obtained from research participant interviews and collated and discussed in sections 7.2.1, 7.2.2, 7.2.3 and 7.2.4. The characteristics were grouped using a classification mechanism for technological solutions (Antonova, Gourova and Nikolov, 2006) according to the knowledge management processes, and primary and secondary groupings were identified.

This list of grouped and defined characteristics can be used in two ways. The first is as a specification of the requirement of a knowledge management system before technology is acquired (also refer to steps six and seven of the eight-step blueprint as discussed in Section 7.2). The second way is to evaluate existing technologies for compliance to knowledge management solutions, to identify gaps in existing technologies or to assess suitability before purchasing new technology.

The set of characteristics, as defined in sections 7.2.1, 7.2.2, 7.2.3 and 7.2.4, compiled based on the nature of knowledge and knowledge management, can be used to evaluate technologies in order to establish whether it will be suitable as knowledge management applications. Such a typical checklist is depicted in Table 42, where one dimension, namely *person to person and team collaboration,* with the characteristics collaboration, user-sensitivity, expertise applying process, refreshing of data and information and workflow enablement, was used as a requirement of a knowledge management solution. Three technology solutions, namely eGain Knowledge, Sharepoint and video-conferencing, were evaluated against these characteristics to establish whether it complies with requirements for a knowledge management solution. From the result of the evaluation reflected in Table 42, a combination of eGain Knowledge and video-conferencing will comply with all the requirements listed for person to person and team collaboration, and a combination of these two technologies can then facilitate knowledge management in this example.

Table 42: Knowledge management system characteristics checklist (illustration only)

KMS characteristic checklist	Technology[18]

[18] Technologies used from example software installed at MTN based on feedback from the research participant interviews (refer section 6.4.2.3)

Dimension[19]	Characteristic	eGain Knowledge	Share-point	Video-conferencing
Person to person and team collaboration	Collaboration	✔	✔	✔
	User sensitive	✔		
	Expertise applying process			✔
	Refresh data and information	✔	✔	
	Workflow enabled	✔	✔	

7.3 Knowledge management system architecture

Holm, Olla et al (2006) suggest that a process must be followed in order to create a knowledge management system architecture. The objectives and overall strategy of the knowledge management system must be compiled first after which requirements for individual groups in the organisation must be established (Marwick, 2001, Holm et al., 2006). Individual knowledge management tasks can be derived from the requirements that need to be structured in such a way that it provides a successful course of action for the organisation (McManus, Wilson and Snyder, 2004, Holm et al., 2006). The next step is to define the services, e.g. capturing tacit expertise and expert directories required as services to integrate processes, people and systems. The final step after the services architecture has been defined is to delineate the system architecture according to a layered approach building on to already existing infrastructure and services (Holm et al., 2006).

7.3.1 KMS characteristics in relation to architecture

It has been established in Section 4.4 that the knowledge management architecture model proposed by Lindvall, Rus et al (2003) conforms to all specified criteria for an architecture in Information Systems. In order to establish how the knowledge management characteristic list compiled in the previous sections relate to the knowledge management architecture proposed by Lindval, Rus et al, the characteristics were mapped to the architecture, as depicted in Figure 30.

[19] Only one dimension of the classification has been used for illustrative purposes

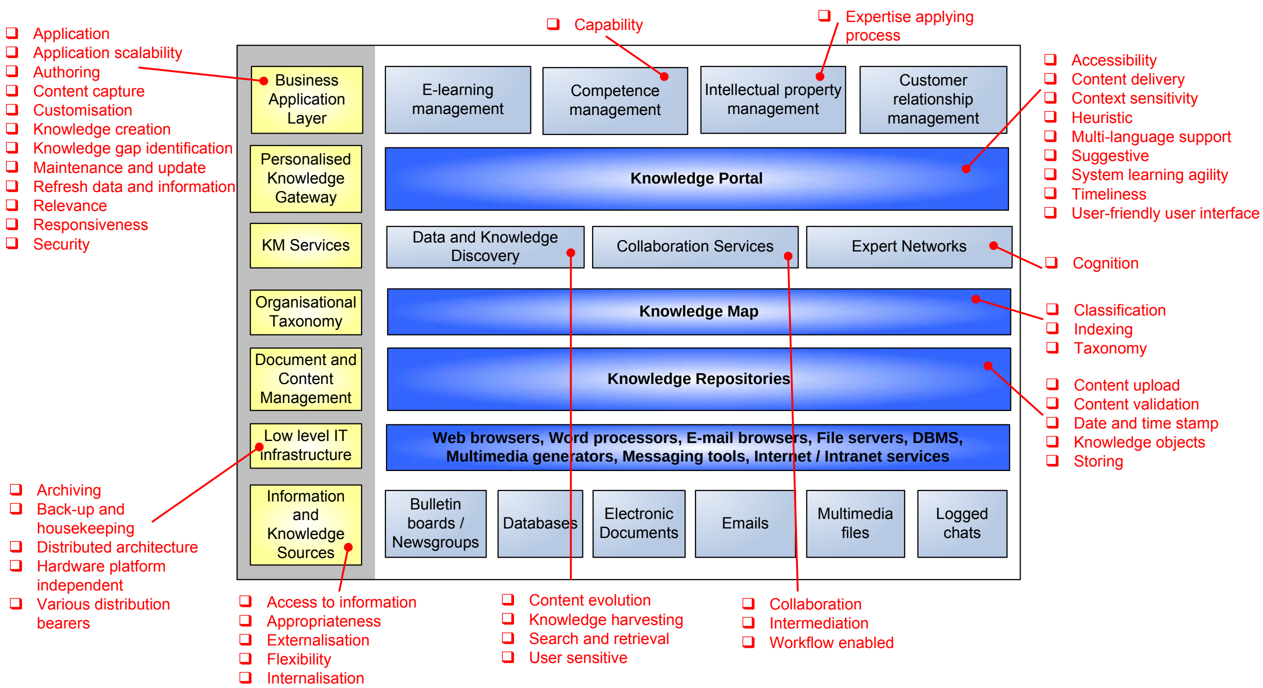

Figure 30: KMS characteristics in relation to a KMS architecture

The set of characteristics, as defined in sections 7.2.1, 7.2.2, 7.2.3 and 7.2.4, compiled based on the nature of knowledge and knowledge management has been classified and grouped based on the seven layers of a knowledge management architecture or on specific components within each layer. An example of such a grouping is the characteristics classification, indexing and taxonomy, which have been mapped to the sub-component *knowledge map* of the *organisational taxonomy* layer of the architecture.

The lower layer handles sources of explicit knowledge that resides in repositories as different types of knowledge items. Standard authoring tools such as word processors, file servers, e-mail tools, database management systems as well as internet and intranet services support this layer. Document- and content management systems handle knowledge repositories, while the organisational taxonomy layer ensures that knowledge is organised according to the context of the organisation based on the knowledge map and supported by indexing and classifying tools. Tools also support data and knowledge discovery, collaboration services and expert networks at the next layer. Through portals knowledge can be distributed as required by different users and applications such as e-learning. Figure 30 shows the characteristics mapped to all seven layers of the knowledge management system architecture, and in some instances specifically to the sub-components within a layer.

7.3.2 Knowledge management system architecture summary

The third research question identified for this study was:

How do knowledge management system characteristics contribute to a knowledge management system architecture description?

By using the set of criteria for evaluating IS architectures (Gerber, 2006), it was established in Section 4.5 that the proposed knowledge management system architecture (Lindvall, Rus and Sinha, 2003) conforms to the criteria defined. The set of characteristics collated for knowledge management systems was then mapped to the architecture to establish and show the relation between the two (Section 7.3.1). Table 43 summarises the relation between the architecture layer and the characteristics collated.

Table 43: KMS architecture and characteristic summary

KMS architecture and characteristic summary			
Layer	**Layer Description**	**Characteristics**	
1	Information and knowledge sources	• Access to information • Appropriateness • Externalisation	• Flexibility • Internalisation
2	Low level IT infrastructure	• Archiving • Back-up and housekeeping • Distributed architecture	• Hardware platform independent • Various distribution bearers
3	Document and content management	• Content upload • Content validation • Date and time stamp	• Knowledge objects • Storing
4	Organisational taxonomy	• Classification • Indexing	• Taxonomy
5	KM services	• Cognition • Collaboration • Content evolution • Intermediation	• Knowledge harvesting • Search and retrieval • User-sensitive • Workflow-enabled
6	Personalised knowledge gateway	• Accessibility • Content delivery • Context sensitivity • Heuristic • Multi-language support	• Suggestive • System learning agility • Timeliness • User-friendly user interface
7	Business application layer	• Application • Application scalability • Authoring • Capability • Content capture • Customisation • Expertise applying process • Knowledge creation	• Knowledge gap identification • Maintenance and update • Refresh data and information • Relevance • Responsiveness • Security

7.4 Towards a comprehensive KMS architecture

The problem statement for this study was summarised in Section 1.2, detailing problems and issues related to characteristics and architecture that must be considered when addressing knowledge management systems. The primary research questions addressed by this study were:

- How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?
- What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?
- How do knowledge management system characteristics contribute to a knowledge management system architecture description?

An architecture view model consisting of five viewpoints (Kruchten, 1995) and a knowledge management architecture model (Lindvall, Rus and Sinha, 2003) have been introduced in sections 4.2 and 4.3 respectively. Knowledge management system characteristics have been collected from research participants (Section 6.4.2.2) and summarised based on the knowledge management system architecture (Section 7.3.2). Research participant feedback regarding knowledge management system architecture has been collected during the interviews (Section 6.4.3).

A typical knowledge management architecture can be described by using the architecture view model (Kruchten, 1995) as architecture descriptor and by collating the knowledge management system characteristics and architecture inputs towards defining a comprehensive knowledge management architecture, as depicted in Table 44.

Table 44: Towards a comprehensive KMS architecture

Towards a comprehensive KMS architecture			
Logical view • **End-user** • **Functionality**	• Access to information • Capability development • Content capture • Content evolution • Context sensitivity • Data reporting • Ease of capture • Ease of retrieval • Ease of search • Ease of use	• Heuristic • High and low usage knowledge areas • Increase knowledge areas • Intermediation • Internalisation • Knowledge control mechanism • Knowledge creation • Knowledge gap identification	• Knowledge rating mechanism • Publishing quality assurance • Rating system, trust information • Refresh data and information • Relevance • Suggestive • System learning agility

	• Externalisation • Flexibility • Front-end capture	• Knowledge harvesting • Knowledge objects	• User sensitive
Development view • **Programmers** • **Software Management**	• Application • Application scalability • Archiving • Classification • Collaboration • Collaboration services • Customer care • Customisation • Data retrieval and data tools • Development and test environment • Disaster environment, disaster recovery • Firewall • Hardware platform	• Exponential growth of storage and space utilisation, space management • Independent • Indexing • Inputs and outputs • Multi language user interface • Multi-language support • Multiple access points • Off-line capabilities • Portal, portlet • Proper knowledge base administration	• Security • Security levels and services • Single sign on • Software application management • Structure access privileges, rights, roles • Taxonomy • Thin client web based • User-friendly user interface • Various distribution bearers • Various file format content management
Process view • **Integrators** • **Performance** • **Scalability**	• Accessibility • Administration tools • Appropriateness • Archiving data based on specific rules • Authoring • Content delivery • Content storing • Content upload • Content validation • Data segregation	• Date and time stamp • Environment administration • Grant access privileges, rights, roles • Integrated services • Maintenance and update • Real time accessibility • Repository storage • Responsiveness	• Search engine • Search, retrieval and integrated access services • Time independent access • Timeliness • Visual modeling • Workflow enabled • Workflow management
Physical view • **System engineers** • **Topology** • **Communications**	• Back-up and housekeeping • Database, database features and flexibility	• Distributed architecture • Physical infrastructure • Redundancy for real-timeness	• Sophisticated database and scalable database
Scenarios	• Expertise applying process • Information blogs • Public disseminated type of information	• Publish information • Repository search, various media search facilities	• Search and retrieval • Simple reporting

The purpose of this study was to focus on an understanding of the key characteristics of a knowledge management system architecture by exploring and describing the nature of knowledge management. With this view in mind, the architecture of a knowledge management system can be described using the components listed in Table 44.

The character of knowledge management is about people, systems and processes in building core competencies and understanding strategic know-how through managing knowledge stocks. It involves enhancing learning and understanding through the provision of knowledge – both tacit and explicit - and focuses on facilitating assimilation of information. Knowledge management is concerned with knowledge flows and the process of creation, sharing and distributing knowledge through organised access to content. It is inherently linked to the sharing of knowledge between individuals, who are not necessarily collocated, by means of collaborative processes creating new knowledge and aiding innovation. Technology is a key enabler of knowledge management and enhances intellectual capital by supporting the development of individual and organisational competencies. It aids gathering, storing and transferring knowledge by providing access to sources of knowledge and knowledge itself through user-friendly capture and effective search and retrieval mechanisms.

The architecture description based on the nature of knowledge management and acknowledging various stakeholders of architecture can be compiled using the logical, development, process and physical views (Kruchten, 1995).

The *logical* architecture primarily supports the functional requirements of end-users. Such a view should ensure access to information by providing user-friendly mechanisms to harvest, create, capture and upload quality-assured content and knowledge. It must allow for the rating of knowledge objects in terms of relevance as well as recency and facilitate the creation of interrelationships based on context. It should be able to handle knowledge of any form and various media, as well as categorise and index it into different subject structures. Whether it is connecting people to knowledge seekers or to sources of explicit knowledge, musty it constantly learn about its users and the knowledge it possesses to continually refine itself and improve its ability to provide the knowledge seeker with relevant knowledge.

The *development* architecture focuses on the software development environment and specifically the software module organisation. The development view serves as the basis for requirement allocation, portability and security and takes internal requirements related to ease of development, software management and reuse into account. Access must be facilitated through a secure, multi-language user interface or portal that is customisable for each knowledge base user. Proper knowledge base administration must be provided and archiving and disaster recovery features must be offered. Collaboration services from multiple access points must be supplied and data retrieval tools must be provided. Applications must be scalable and platform-independent.

The *process* architecture considers non-functional requirements such as performance and availability and addresses issues of distribution, system integrity and fault tolerance. It must allow for environment administration and content upload, storing and validation and delivery features must be prevalent. Rules for archiving must be maintained and integrated services must provide search, retrieval, visual modelling, workflow management and time-independent access features.

The *physical* architecture is primarily concerned with non-functional requirements of the system such as availability, reliability and throughput, and different physical configurations e.g. for development and testing, are expected. A sophisticated and scalable database with redundancy for real-timeness and disaster recovery must be provided. Backup and general house-keeping features must be offered.

Scenarios are instances of general use cases and are a construct of the most important requirements Knowledge management processes summarise these requirements and must include features such as search, retrieval and publishing of blogs, information and knowledge, as well as the knowledge- and information-dissemination process.

This system architecture using multiple, concurrent views is the initial description of a knowledge management architecture, and such an initial architectural prototype evolves to become a real system through several iterations (Kruchten, 1995).

7.5 Summary

This chapter focused on the discussion of the findings of this study based on the classification of knowledge management technologies discussed in Section 3.5, a knowledge management architecture model (Lindvall, Rus and Sinha, 2003) introduced in Section 4.3 and an architecture view model consisting of five viewpoints (Kruchten, 1995) in describing architectures highlighted in Section 4.2. This chapter mainly focused on the second and third research questions "*What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?*" and "*How do knowledge management system characteristics contribute to a knowledge management system architecture description?*", taking cognisance of the findings of the first research question "*How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?*"

The introduction to the chapter considered two components to discussing the findings of the study. The first was an eight-step blueprint to implementing effective knowledge management solutions and the requirement of steps 6 and 7 that the knowledge management characteristics must be identified and documented, that the knowledge management cycle elements must be defined and that the knowledge management enablers must be selected. The second component was the classification of knowledge management technologies discussed in Section 3.5 based on four themes consisting firstly of the generation of knowledge, secondly of storing, codification and representation of knowledge, thirdly of knowledge transformation and knowledge use, and lastly of transfer, sharing, retrieval, access and searching of knowledge.

The characteristics of knowledge management systems obtained from the literature and from the research participant interviews were then allocated to the four themes and classified by primary and secondary allocation as some of the characteristics were relevant to more than one theme. Each theme was described in view of the characteristics allocated and an example was given of how these classified characteristics can be used to evaluate software.

The second part of the chapter focused on relating the characteristic set defined in Section 7.2 to the seven-layered knowledge management system architecture, after which it was summarised per layer in order to describe the knowledge management system architecture.

The architecture view model consisting of five viewpoints namely, logical, development, process, physical and scenarios views were used to group the characteristic set and describe each view towards defining a comprehensive knowledge management architecture.

Part VI Conclusion

Part VI (Figure 31) of the study consists of Chapter 8 and describes the conclusion to the study.

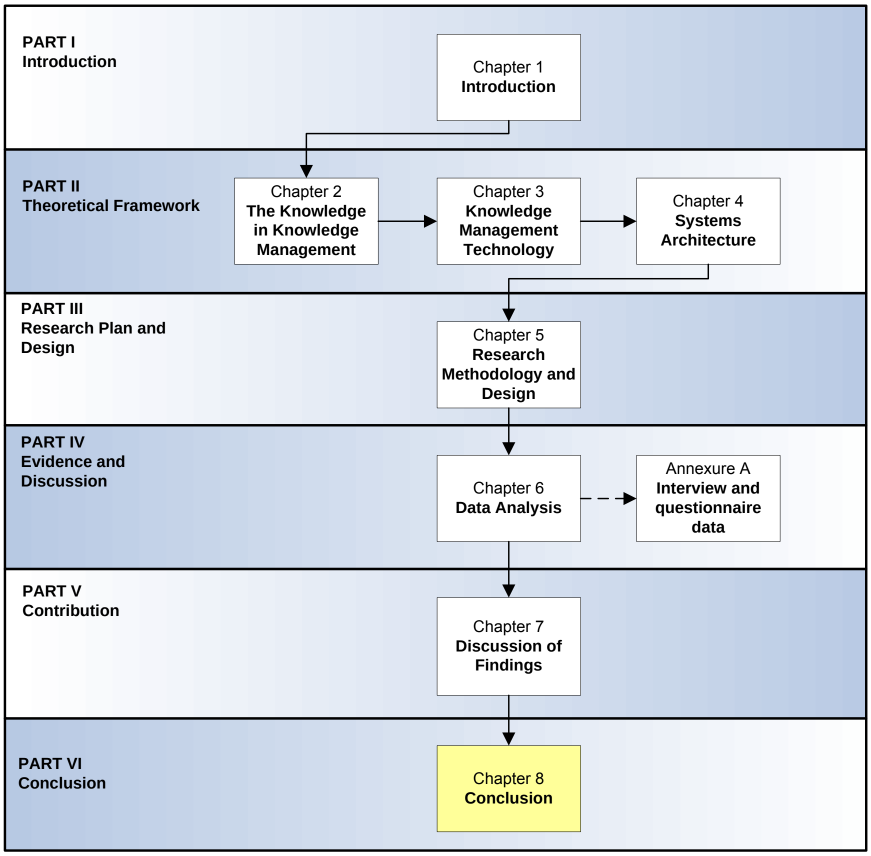

Figure 31: Part VI outline

Chapter 8 Conclusion

8.1 Introduction

The purpose of this chapter is to describe the conclusion to this study and to summarise the experiences and findings for each of the research questions. The research questions addressed by this study are:

- How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?
- What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?

- How do knowledge management system characteristics contribute to a knowledge management system architecture description?

This study consisted of six parts, eight chapters and one annexure. Chapter 1 was the introduction to the study and highlighted the background to the study and the issues identified with knowledge management solutions and provided an overview of the research strategy. Chapter 2 explored the nature of knowledge management and provided an overview of knowledge and the dimensions of knowledge management, as well as knowledge management processes and the implications in an organisational context. Chapter 3 contained an overview of knowledge management technologies, focused on systems as an enabler of knowledge management and provided a mechanism to classify knowledge management software tools. Chapter 4 provided an overview of key concepts within architecture definition and specifically for knowledge management system architectures, as well as architecture evaluation criteria that were applied in order to evaluate a model knowledge management architecture. The philosophical stances of research, an overview of qualitative research in Information Systems and the research methodology and design used for this study were described in Chapter 5. Chapter 6 focused on the data analysed for the study and a list of knowledge management system characteristics were extracted from the literature and research participant interviews. The reflection on these characteristics mapped to a typical knowledge management system architecture and the architecture description based on the five-viewpoint model were discussed in Chapter 7. The last chapter, Chapter 8, is the conclusion to the study. One annexure containing the questionnaire and interview data has been attached to the study on a CD.

Table 45 provides an outline of this chapter:

Table 45: Chapter 8 outline

Outline of Chapter 8			
Section	**Description**	**Sub-section**	**Sub-section description**
8.1	Introduction		
8.2	Summary	8.2.1	Summary: Research Question 1
		8.2.2	Summary: Research Question 2
		8.2.3	Summary: Research Question 3
8.3	Recommendations for further research		
8.4	In closing		

8.2 Summary

The purpose of this interpretive case study was to determine how a set of key characteristics relate to a knowledge management system architecture description by exploring and describing the nature of knowledge management. The study was conducted at a mobile telecommunication organisation within the South African context, in an environment with a great demand for skills and an extremely competitive industry where innovation and value proposition are key differentiators to increasing market share.

The literature study emphasised that knowledge is an organisational asset and that the shift to knowledge as the primary source of value makes the new economy being led by those who manage knowledge effectively. Organisations today are creating and leveraging knowledge, data and information at an extraordinary rate and it makes the use of technology not an option, but a necessity. However, technology aimed at knowledge management is not the only answer, as it is also about the way knowledge workers create, disseminate and manage information. The development of a comprehensive knowledge management system that supports all phases of knowledge management is both a technological and organisational solution and is not necessarily available as a single technology.

In order to ensure that the technology and software tools fulfil knowledge management requirements, organisations must consider the definition of knowledge, knowledge management principles, knowledge management processes and the organisation's particular knowledge management requirements. This informed the topic of discussion in the semi-structured research participant interviews that were conducted as part of this study.

8.2.1 Summary: Research Question 1

The first research question focused on the nature of knowledge, knowledge management and knowledge management processes and was formulated as follows:

How does the nature of knowledge management contribute to a typical architecture of a knowledge management system?

Various dimensions of knowledge, namely explicit knowledge as well as implicit and tacit knowledge exist. Information becomes knowledge when it is retained as suitable representations of the relevant knowledge and when the value can be increased through analytical thought processes and by transforming knowledge into competencies, replicating know-how in the process. In order to optimally use its know-how, organisations must gain an understanding of the source and nature of knowledge in the organisation to create a strategic knowledge solution for knowledge work. Such a strategic solution is as much about the knowledge management process, people and culture in an organisation as it is about the technology that optimally supports it.

An understanding of explicit, implicit and tacit knowledge in organisations, the modes and context of conversion of knowledge and the technologies used in this conversion are tactical approaches to knowledge creation. A strategic knowledge-creation solution encompasses all of these steps in one seamless and complete procedure for knowledge work, and these requirements must be considered in the design of a knowledge management system architecture.

8.2.2 Summary: Research Question 2

The categorisation of knowledge management systems and how they are informed by knowledge management system characteristics were the focus of the second research question:

What are the key characteristics that technology must conform to in order to be categorised as a knowledge management system?

Knowledge management tools are enhancements of existing technologies although true knowledge management technologies differ in several aspects from traditional technologies based on the nature of knowledge and knowledge management as discussed in the previous section. Some of these aspects include an understanding of the context of knowledge, organisation of knowledge in the way most useful to the knowledge seeker, capability of the solution to constantly learn about its users and the ability to deduce what the knowledge seeker’s knowledge needs are. Other aspects include access to sources of knowledge rather than the knowledge itself, support in user assimilation of information and providing effective search and retrieval mechanisms in locating relevant information. A variety of software tools are available providing support to knowledge management systems through four main functions, namely the association of people to people, the association of information source to information source, the association of explicit knowledge to knowledge seekers and the association of knowledge to process.

Knowledge management systems share many basic features although a specific knowledge management system would be informed by the specific organisation. The set of characteristics (sections 7.2.1, 7.2.2, 7.2.3 and 7.2.4) obtained from the literature and from the research participant interviews are such a list of common, basic features that knowledge management solutions share. This characteristic set can be utilised in two ways: the first is as a specification of the requirement of a knowledge management system before technology is acquired, and the second way is to evaluate existing technologies for compliance to knowledge management specific applications or to assess suitability before purchasing new technology.

8.2.3 Summary: Research Question 3

The objective of the third research question was to describe a knowledge management system architecture based on a characteristic set derived from the nature of knowledge and knowledge management. The third research question was:

How do knowledge management system characteristics contribute to a knowledge management system architecture description?

The character of knowledge management is about people, systems and processes in building core competencies through managing knowledge reserves. It supports enhanced learning and understanding through provision of explicit and implicit knowledge and aids the assimilation of information. Knowledge management is concerned with knowledge flows and the process of creation, sharing and distributing knowledge through organised access to content. It is inherently linked to the sharing of knowledge between individuals, who are not necessarily collocated, by means of collaborative processes creating new knowledge and aiding innovation. Technology is a key enabler of knowledge management and enhances intellectual capital by supporting the development of individual and organisational competencies. It aids the gathering, storing and transferring knowledge by providing access to sources of knowledge and knowledge itself through user-friendly capture and effective search and retrieval mechanisms.

These characteristics (sections 7.2.1, 7.2.2, 7.2.3 and 7.2.4) informed the description of a typical knowledge management system architecture from a knowledge management point of view (sections 7.3.1 and 7.3.2). This architecture description used multiple, concurrent views as the initial description of a knowledge management architecture, and such an initial architectural prototype evolves to become a real system through several iterations (Section 7.4).

8.3 Recommendations for further research

This study was conducted as a single case study, with the starting point being knowledge, knowledge management and knowledge management processes and resulting in a list of key characteristics of knowledge management systems. Further research is needed to generalise the list of characteristics, which will provide a platform to better understand how to best manage these activities. Beesley and Cooper (2008 : 52) highlight that "research shows that KM failures could be attributed to an over-emphasis on technologies and insufficient acknowledgement of the *humanness of knowledge*".

Another issue accentuated by this research is the evaluation of technologies suitable for knowledge management or the optimisation of an organisation's existing technologies in achieving knowledge management objectives. These ideas could be explored further and a comprehensive checklist and process can be designed to facilitate this in organisations today.

8.4 In closing

Following the practice of interpretive research, the study has shown that an organisation should define its knowledge management strategy and requirements first. By considering the nature of knowledge, knowledge management and knowledge management processes, a set of features and characteristics can be defined to inform technology selection and utilisation for knowledge management that is aligned to the organisational requirements. This set of characteristics can also be used to describe a typical architecture for such a knowledge management solution in order to optimise existing organisational technologies or to obtain best fit solutions.

Annexure A – Interview and questionnaire data (CD content)

A.1 Letters of consent
A.2 Researcher interview notes
A.3 Transcribed and coded interviews
A.4 Personal interview observation notes

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