ELECTRONIC MEASUREMENT OF COLLABORATION HEALTH WITHIN A CENTRAL ELECTRONIC KNOWLEDGE PLATFORM

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A dissertation submitted to the School of Electrical and Information Engineering, University of the Witwatersrand, in fulfilment of the requirements of the degree of Master of Science in Engineering.

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DECLARATION

I declare that this dissertation is my own unaided work. It is being submitted for the Degree of Masters of Science in Engineering to the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

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19th day of August 2008.

ABSTRACT

In the keynote of Executive Workshop on the Aging Workforce in the Utility Industry held in April 2006 at Carnegie Mellon University in Pittsburgh, Erroll Davis highlighted the following fact:

"The U.S. Bureau of Labour reports that the U.S. will face a shortage of 12 million qualified skilled workers by 2010." (George, 2006).

According to Krishna (2006) as many as 300,000 power utility workers within the U.S. are expected to retire over the next 15 years. Capturing and disseminating industry experience will be essential combined with effective communities of practice.

These statement alone indicate why the virtual access to knowledgeable people will become a very important feature of any electronic knowledge platform (eKP). No longer is it practical to have a ratio of 1:1 in terms of students to mentors. Mentors are also not able to attend to the needs of apprentices entering the power industry. There has to be a balance between sharing the knowledge of a mentor in an explicit way (i.e. documents, decision support trees, questions and answers) and enabling knowledge workers seeking advice to contact the specialist when the available literature and tools are not self explanatory or doesn't cover the particular problem.

The challenge of today's knowledge economy is the skills shortage and lack of sufficient people to mentor and train others on the job. The proof-of-concept (POC) presented in this dissertation is focussed on an electrical utility company in South Africa. Knowledge management is a multi-disciplinary field and touches on human and the technology aspects to address the problems experienced by knowledge management practitioners and managers.

This dissertation focuses on how information technology (IT) could be used to assist in determining an electronic knowledge collaboration indicator that will give managers a tool to objectively measure and control retention of knowledge gained by individuals throughout their careers within an organisation. A central platform, namely Hyperwave, a commercially available software environment, combined with an effective search and indexing engine called "Autonomy" is used for the proof-of-concept (POC).

This dissertation is dedicated to my loving wife
Mariska Lok,
my children and God almighty

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1. Introduction

Virtual access to knowledgeable people will become a very important feature of any electronic knowledge platform (eKP). It is no longer practical to have a ratio of 1:1 student and mentor ratio. A mentor would also not be able to attend to all the apprentices. There has to be a balance of sharing the knowledge of a mentor in an explicit way (i.e. documents, decision support trees, questions and answers etc.) and also to enable the knowledge workers seeking advise to be able to contact the specialist in the case where the literature and tools is not self explanatory or doesn't cover the particular problem.

The challenges of today's knowledge economy are skills shortages and lack of enough experienced people to provide mentoring on the job. This proof-of-concept (POC) is focussed on an electricity utility company in South Africa utilising electronic collaboration to partially solve the problem. The dissertation focuses on measuring the electronic collaboration to ensure that subject matter experts share their knowledge.

Eskom realised its vulnerabilities similar to the rest of the global economy in that knowledge of an aging work force are to be retained. The eKP was identified as one mechanism to achieve this goal. The behaviour to change people to ensure that the eKP is used became a challenge. The need to monitor the collaboration behaviour within the organisation became an important aspect to ensure that knowledge of Eskom people are continuously harvested during their careers. The need to monitor collaboration behaviour required the research into effectively behavioural data out of the eKP and determining effective performance indicators. The identification of the technology as well as the performance indicators form a key part of this research.

The problem in specific which outlines this research dissertation is the challenge to measure the collaboration behaviour on a continuous basis and also to enable management to monitor and control electronic knowledge collaboration behaviour to ensure that the knowledge is shared and document throughout a person's career.

1.1. Objective

This dissertation focus on how information technology (IT) could be used to assist in determining an electronic knowledge collaboration indicator and give managers a tool to objectively measure and control retention of knowledge gained by individuals throughout their careers within an organisation. A central platform called Hyperwave with an effective search and indexing engine called Autonomy were used for the proof-of-concept (POC).

Measuring collaboration could be a tedious task and will only be possible of quantitative results could be obtained to determine peoples behaviour. Electronic collaboration measurement is the focus of the dissertation to ensure quantitative measurement of the collaboration behaviour.

1.2. Research questions

The research presented in this dissertation involved the development and testing of a Proof of Concept (POC). The objective was to answer the following research questions:

1. What measurements are required to monitor the knowledge contribution on an electronic knowledge platform (eKP)?
2. What architecture could be used to establish an electronic knowledge platform (eKP) to harvest knowledge and to measure the key indicators of knowledge contribution?
3. How could these indicators be used as a proactive tool for managers to determine knowledge sharing risks?

1.3. Research approach

- **Literature Review.** A complete literature review on the relevant work was done to ensure that previous work is taken into consideration.
- **Field Experience.** Industry experience in the appropriate fields was applied to the literature and to the research questions to ensure that the research is relevant and could be practically utilised within a business.
- **Experiment.** An experiment was done with a group of technical people within a specific organisation to enable collaboration via the eKP.

    - **Quantitative measurement.** The eKP was utilised to extract usage data to determine the nature of collaborative behaviour on the eKP. The extraction of this data is the quantitative measurement aspect of the experiment.
    - **Qualitative measurement.** A survey was done with the managers within a specific section in the organisation to assess whether the experiment was a success and whether it had the desired effect with regards to the collaboration behaviour.

The study was conducted in the following chronological order of steps:

1. **Literature review**. A complete literature review was performed, searching various information sources to gain background and support information for work that has previously been carried out on this topic. Related literature to enable the design of the POC was identified and used as building blocks towards the implementation of the POC.
2. **Apply industry experience**. Industry experience was applied to determine how these existing models and approaches could be used as a unit to answer the research questions. The research questions and the POC were based on real problems experienced within a specific section within an organisation and care had to be taken as to which models and approaches would be used to answer these questions.
3. **Design and implement experiment**. An experiment was designed utilising the eKP, human resources models and the SECI model (Nonaka *et al*, 2000). The utilisation of the POC by participants within a specific organisational section was monitored, and data was extracted to enable the measurement of the "collaboration health".
4. **Confirm the validity of the research.** The managers utilising these "collaboration health" indicators were requested to complete a questionnaire to determine the utilisation and relevance of the indicators used. The qualitative research of the dissertation concluded the research and ensured that relevant results were obtained from the experiment.

2. Literature Review

2.1. The Knowledge Context

Kane (2003) added an interesting perspective from the Greek philosophers in how they perceived knowledge. According to Kane (2003), it is clear from the early philosophers that they understood that knowledge is complex. Currently the most complex of the knowledge groups is tacit knowledge, which will be described and defined at a later stage for the purpose of this dissertation.

The following basic commonly used definitions of the word "knowledge" are available :

"*Understanding of or information about a subject which has been obtained by experience or study, and which is either in a person's mind or possessed by people generally*" (Cambridge Advanced Learner's Dictionary, 2008).

"Awareness" (Cambridge Advanced Learner's Dictionary, 2008).

Knowledge could be brought into context with the evolution from perceived facts to the ultimate state of knowledge. For the purpose of this dissertation, these states would be defined as "data", "information" and "knowledge".

- **Data** is gathered by perceiving facts and could be collected via various mechanisms depending on the medium. A human being for example would gather facts by using senses: sight, smell, taste, hearing and touch. Each of these senses produces different pulses to the brain to gather facts about the environment. Just as a human being gathers facts, so too can an electronic system make use of certain sensors to produce electronic pulses to a central system. All that is being done at this stage is the gathering of the perceived facts.
- **Information** would be the transformation of the data into a useable form for interpretation purposes. For example, a set of colour pigments needs to be interpreted by the brain to produce a picture in one's mind. Without the picture being formed within the brain, one would not be able to see at all. The same is true with any electronic data gathered by a system. Some transformation is required to display a graph, picture or report.
- **Knowledge.** As human beings become more familiar with different information sets and experience different behaviours within their environment, they are able to learn scenarios. An important aspect of the human mind is its ability to create relationships between different concepts. This enables a human being to create new concepts out of the existing experience. Therefore "knowledge" is experience within various environments that enables a person to understand and be aware of the behaviour of the environment and to enable a person to make decisions based on events within a particular environment. The experience gained by reacting to information becomes part of a person's knowledge.

Kane (2003) indicates that the early philosophers chose rather to conceptualise knowledge than defining it in detail. The danger is that many companies still try to manage knowledge in a conventional way, based on information management principles. However this leaves the human being out of the technology equation. "Knowledge management" focusses around managing the people in the organisation together with their business-related knowledge. Technology and processes can play a very important role, but people are still the focal point of knowledge.

It is critical that the following terms are understood before commencing any work within the domain of knowledge management (Nonaka *et al*, 1995).

- **Tacit knowledge**. Tacit knowledge is the component of knowledge that would still be within the human mind.
- **Explicit knowledge**. Explicit knowledge is the knowledge gained that is external to the human mind and captured in some medium.

Explicit knowledge can further be expanded to “structured” and “unstructured”.

- **Structured knowledge**. This knowledge would be within a database structure that could be interpreted easier
- **Unstructured knowledge**. This type of knowledge would be the knowledge that is contained within documents, e-mails, video clips and pictures. It is not easy to analyse and deduce conclusions from it, but it usually contains valuable knowledge.

In addition the following has been defined by Nonaka and Takeuchi (1995):

“Tacit knowledge is personal, context-specific and therefore hard to formalise and communicate. Explicit or “codified” knowledge on the other hand, refers to knowledge that is transmittable in the formal, systematic language.”

The assumption of this dissertation is that some tacit knowledge could be made explicit by collaborating on an eKP, therefore enabling organisations to harvest parts of their tacit knowledge. There will always be tacit knowledge that is very difficult to harvest such as explaining certain smells and the interpretation thereof. People write e-mails, documents, build spreadsheets and very often answer questions in specific domains. Therefore the experiences of these individuals are captured to a certain extent as well as the reference information used for their decisions.

2.2. Knowledge models

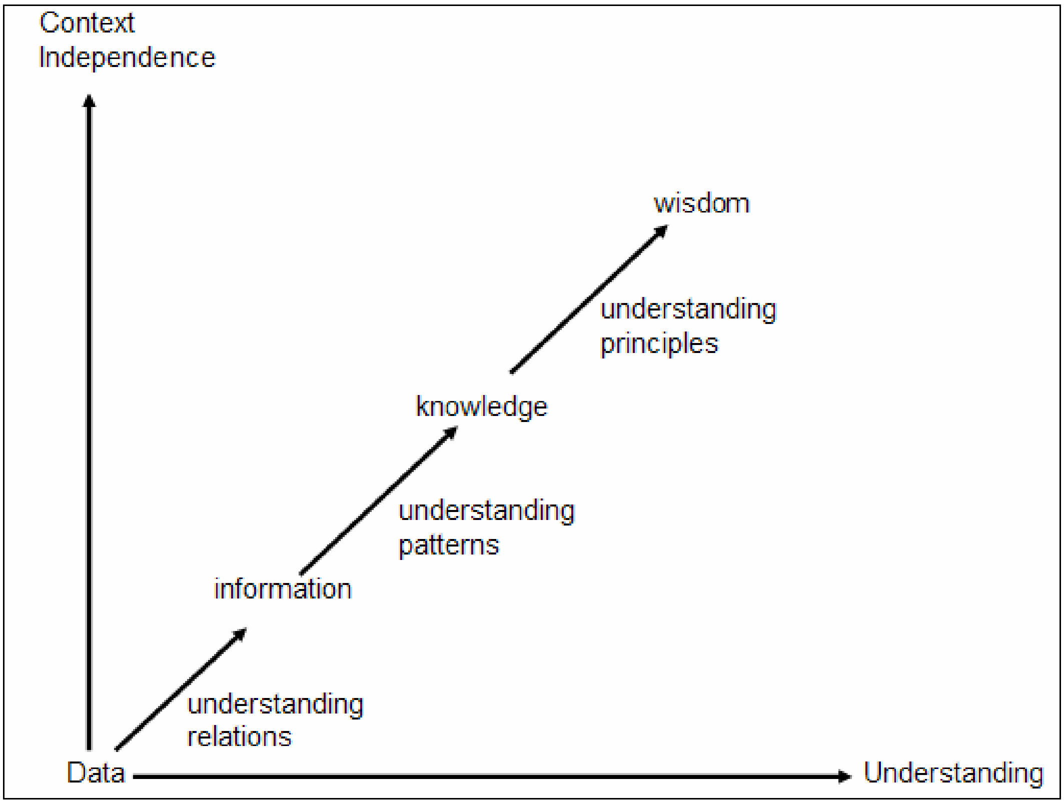


Figure 1 DIKW Model (Bellinger, 2004)

One of the emerging models by Bellinger (2004) is the DIKW model (**D**ata, **I**nformation, **K**nowledge and **W**isdom).This model conceptualises where knowledge fits into the value chain of wisdom. Collection of data cannot be seen as information. It is important to understand that each part of this model has an important role and is a building block of what Bellinger (2004) believes is ultimately converted to wisdom.

Based on the Bellinger (2004) model the collection of data is not information, but is still an important building block of knowledge. Without data collection (whichever format or media may be used), information, knowledge and wisdom is not possible. The basis of the article (Bellinger, 2004) indicates that each state of the model, is built on top of each other, but requires some kind of transformation.

- Data becomes information after understanding relationships between the data sets.
- Information becomes knowledge after the patterns are known for the relationships in data.
- Knowledge becomes wisdom if the knowledge patterns are understood and principles are formed based on these patterns.

In the model of Bellinger (2004) [see Figure 1] the Y-axis refers to the different state of each part of the model. Data collected is out of context in the beginning and usually not easy to understand. Once it is analysed and rationalised, the relationships should become clearer. This increases the understanding of the data and progresses to information. In the same way information progresses to knowledge and knowledge to wisdom. The X-axis is the level of understanding gained until wisdom is achieved.

SECI (Socialisation, Externalisation, Combination and Internalisation) (Nonaka *et al*, 2000) is one of the most well known models in the discipline of knowledge management (Nonaka *et al*, 2000).

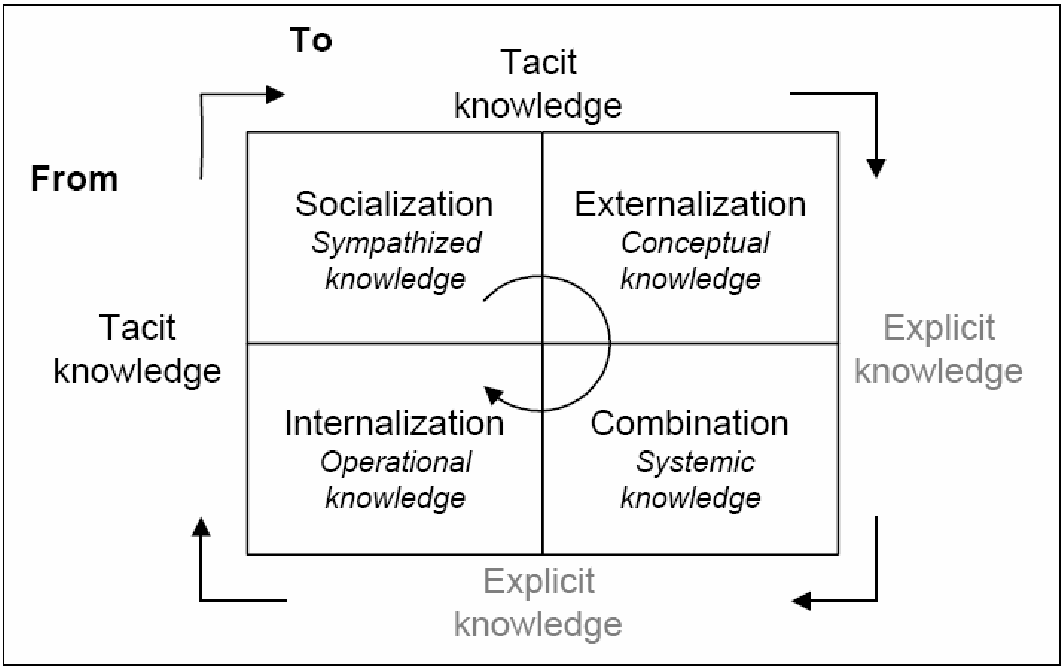


Figure 2 SECI Model (Source: Nonaka et al, 2000)

The following briefly explains the model in Figure 2 (Nonaka *et al*, 2000):

- **Socialisation (Sympathised knowledge)**. Socialisation is the process of discovering new knowledge via discussions. The typical on-job training is referred to here instead of normal text scripts or books. It is also mostly the start of any knowledge creation cycle. People discuss concepts before it is formalised. Therefore it is also classified as tacit knowledge.
- **Externalisation (Conceptual knowledge)**. Once the socialisation process has successfully conceptualised the concept, it is written into an explicit form. The tacit knowledge becomes explicit in some kind of document.
- **Combination (Systemic knowledge)**. Relationships are determined between several explicit knowledge resources. Therefore it is combined into new concepts. This knowledge is still explicit.
- **Internalisation (Operational knowledge)**. Internalisation is the process where the explicit knowledge is retrieved, based on concepts required from the knowledge worker and it becomes new tacit knowledge to some other knowledge workers. Socialisation around new ideas start again and the spiral continues.

EXPERIENTIAL KNOWLEDGE ASSETS	CONCEPTUAL KNOWLEDGE ASSETS
Tacit knowledge shared through common experiences	Explicit knowledge articulated through images, symbols and language
•Skills and know-how of individuals •Care, love, trust and security •Energy, passion and tension	•Product concepts •Design •Brand Equity
ROUTINE KNOWLEDGE ASSETS	**SYSTEMATIC KNOWLEDGE ASSETS**
Tacit knowledge in routines and embedded in actions and practices	Systemised and packaged explicit knowledge
•Know-how in daily operations •Organisational routines •Organisational culture	•Documents, specifications and manuals •Databases •Patents and licenses

Figure 3 Four categories of knowledge assets (Nonaka *et al*, 2000)

Figure 3 highlight the examples of the different knowledge asset categories (Nonaka *et al*, 2000):

- **Experiential knowledge assets.** Tacit knowledge shared though common experiences.
- **Conceptual knowledge assets.** Explicit knowledge articulated through images, symbols and language.
- **Routine knowledge assets.** Tacit knowledge in routines and embedded in actions and practices.
- **Systematic knowledge assets.** Systemised and packaged explicit knowledge.

2.3. Intellectual Capital Models

This model explains employee capital in some detail and the context of employee capital for the purpose of this research.

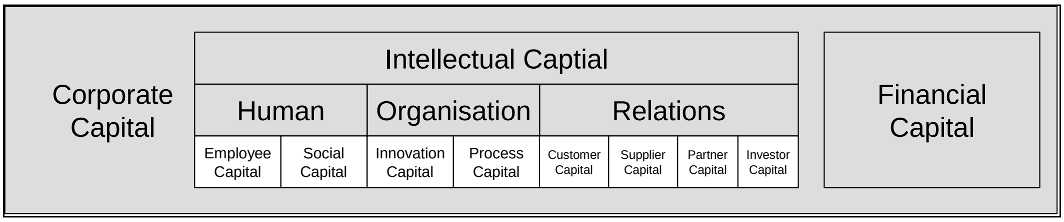


Figure 4 Corporate Capital Model (Davenport *et al*, 2002)

The Corporate Capital Model is briefly explained (Davenport *et al*, 2002) as follows:

- **Human Capital**. The human capital consists of employee capital (competence) and social capital (the knowledge network's potential to generate knowledge).
- **Organisational Capital**. This consists of the knowledge with regards to innovation capital (innovation from organisational knowledge – patents etc) and process capital (process knowledge of how the organisation operated).
- **Relational Capital**. The relational capital refers to the knowledge that the company does not have a direct influence in, but could make a major difference to the business (customer knowledge, supplier knowledge, partner knowledge and investor's knowledge).

Siemens (Davenport *et al*, 2002) identified that quality management, competence management, innovation management, information management and knowledge management have to combine forces in order to reach the individual and common goals. All of these goals have to be defined within the strategy and controlled within the Balanced Score Card (BSC). (Davenport *et al*, 2002). Siemens identified three stages in their Knowledge Network (KN) enabling process: analysis, measurement and control.

Snell *et al* (1999) describes employee capital in four quadrants:

- **Idiosyncratic human capital (low value, high uniqueness)**. Quadrant 1 is specific unique skills to the organisation, but does not create particular customer value. This capital is difficult to replace and therefore this intellectual capital must be captured.
- **Ancillary human capital (low value, low uniqueness)**. Quadrant 2 defines employee knowledge that does not create customer value, nor does it perform a unique, specific function within the organisation. It is a basic task that could be sourced from the market with ease.
- **Core human capital (high value, high uniqueness)**. Quadrant 3 is the employee capital that provides a high customer value and a high uniqueness. This capital is of strategic importance for the organisation and losing this intellectual capital costs the organisation the most in intellectual capital.
- **Compulsory human capital (high value, low uniqueness)**. Quadrant 4 provides a high customer value, but this type of resource could be found in the generic job market. Although the skill is generic, the intellectual capital is still important as it also generates high value to the organisation.

This dissertation will not focus on the total Balanced Score Card, but will only focus on monitoring and changing the behaviour of the employee capital. In addition to the employee capital model, it is important to understand possible human resources staff levels to ensure that valuable employee capital could be monitored within the existing organisational human resources framework (Employment Equity Act 55 of 1998).

Semantic Scale	Patterson		Peromnes	Hay	Castellion
Top Management	F	F	1++ 1+		14
Senior Management	E	E Upper E Lower	1 2 3	1 2	 13
Professionally qualified, experienced specialists and mid-management	D / MPS	D Upper D Lower	4 5 6	3 4	12 11 13
Skilled technical and academically qualified workers, junior management, supervisors, foreman and superintendents	C	C Upper C Lower	7 8 9 10 11 12	5 6 6A 7 8	 9 8
Semi-skilled and discretionary decision making	B	B Upper	13 14 15 16	9 10 11	7 6 5 4
Unskilled and defined decision making	A	A	17 18 19	12 13	3 2 1

Table 1 Management Grades (Employment Equity Act 55 of 1998)

2.4. Change Management

Change has sequential, but iterative steps referred to by Randall (2006) in the "ADKAR" model. These steps are critical to manage throughout the project as well as the continuous change required in collaboration:

- **Awareness.** The first step to change is to make a person aware of the change.
- **Desire.** A person that is aware of the change needs to be convinced that the change is necessary. Features, attributes and benefits (FABs) need to be marketed to create the desire within the person to change.
- **Knowledge.** The desire is supported by giving more information and training on what needs to happen to change.
- **Ability.** The skills need to be learned by the person to affect the change.
- **Reinforcement.** Change requires the need to follow-up and ensures that the change is sustained.

People-process-technology (PPT) is a well known approach towards implementing technology. As part of the change process these aspects have been taken into account.

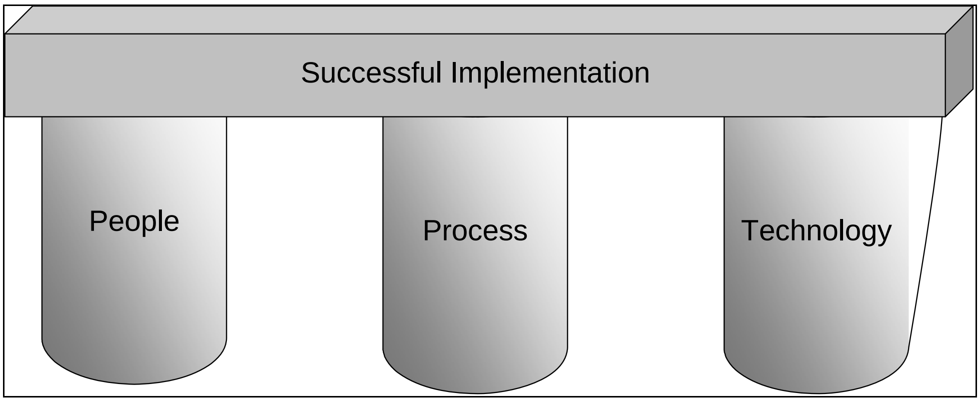


Figure 5 People-process-technology (PPT) pillars

People-process-technology (PPT) is important to take all the relevant important factors into consideration. All three pillars carry the same weight and no particular distinction has been made between the pillars' importance. People are the centre of any KM implementation and therefore if the people are unhappy and their expectations are not managed, it could have a detrimental effect on any project.

Technology that is well written, solution focussed and intuitive makes a difference. User-friendly interfaces enable technology acceptance as real benefits could be demonstrated and achieved. Marketing the technology within the organisation in terms of the features, attributes and benefits (FABs) is vital to gain buy-in from executives and from the users.

Process is the glue to ensure that the organisation's process (value chains) is strongly imbedded within the people and technology pillars. All three pillars are dependant on each other and the success of the project relies upon these three pillars.

2.5. Information technology

2.5.1. History of the Internet

The basis of the Internet as we know it today is due to the evolution of the communication networks in the world. Between 1950 and 1960's there were very limited protocols for proprietary networks to communicate with each other. Licklider (1960) had the idea of the Internet formed in 1962. Licklider established the idea of ARPANET and in 1968 a thorough description of the concept was published (Licklider *et al*, 1968). After this research various network systems such as ARPANET and X.25 were built and became the fundamental research platforms for the Internet.

The protocols to talk on the different networks required some research, but in 1981 the ARPANET protocol standardised to accept only TCP/IP traffic. (Postly, 1981). In the early1990s the Internet and e-mail had grown to be a very useful tool to share information. Browser technologies also evolved such as Mosaic (Andreessen, 1993) to allow Internet users to view the information published on the Internet.

The Internet sharing mechanism was well established in 1990, but finding the information is very important. It is of no use publishing information if other users are not able to find the information. There were many indexing engines before the World Wide Web (WWW), but the first full text web search engine was WebCrawler in 1994. Prior to WebCrawler only web page title searches were available. It would have been very difficult to find documents with similar concepts using title only searches.

2.5.2. Derek Binney

Binney (2001) identified the possible knowledge management applications and the underlying technologies for these applications and provides a basic framework to conceptualise the technologies required for the different knowledge applications.

	Transactional	Analytical	Asset Management	Process	Developmental	Innovation and Creation
Knowledge Management Applications	▪ Case-Based Reasoning (CBR) ▪ Help Desk Applications ▪ Customer Service Applications ▪ Order Entry Applications ▪ Service Agent Support Applications	▪ Data Warehousing ▪ Data Mining ▪ Business Intelligence ▪ Management Information Systems ▪ Decision Support Systems ▪ Customer Relationship Management (CRM) ▪ *Competitive Intelligence*	▪ Intellectual Property ▪ Document Management ▪ Knowledge Valuation ▪ Knowledge Repositories ▪ *Content Management*	▪ TQM ▪ Benchmarking ▪ Best practices ▪ Quality Management ▪ Business Process (Re)Engineering ▪ Process Improvement ▪ Process Automation ▪ Lessons Learned ▪ Methodology ▪ *SEI/CMM, ISO9XXX, Six Sigma*	▪ Skills Development ▪ Staff Competencies ▪ Learning ▪ Teaching ▪ Training	▪ Communities ▪ Collaboration ▪ Discussion Forums ▪ Networking ▪ Virtual teams ▪ Research and Development ▪ *Multi-disciplined Teams*
Enabling Technologies	▪ Expert Systems ▪ Cognitive Technologies ▪ Semantic Networks ▪ Rule-based Expert Systems ▪ Probability Networks ▪ Rule Induction, Decision Trees ▪ *Geospatial Information Systems*	▪ Intelligent Agents ▪ Web Crawlers ▪ Relational and Object DBMS ▪ Neural Computing ▪ Push Technologies ▪ Data Analysis and Reporting Tools	▪ Document Management Tools ▪ Search Engines ▪ Knowledge Maps ▪ Library Systems	▪ Workflow Management ▪ Process Modeling Tools	▪ Computer-based Training ▪ Online Training	▪ Groupware ▪ e-Mail ▪ Chat Rooms ▪ Video Conferencing ▪ Search Engines ▪ Voice Mail ▪ Bulletin Boards ▪ Push Technologies ▪ Simulation Technologies
	▪ Portals, Internet, Intranets, Extranets					

Table 2 Knowledge Management Technology Landscape (Binney, 2001)

Binney (2001) makes a distinction between five categories of electronic knowledge assets:

- **Transactional.** This electronic asset refers to actual transactions and rules applied to assist in decision making. Models and algorithms could be applied to assist in analysing data based on rules and permutations.
- **Analytical.** Once data is available from any system, technologies could be applied on structured and unstructured knowledge to assist with decision making by mining the data with different view points or by analysing unstructured data by using conceptualised algorithms.
- **Asset management.** The technologies that have the most unstructured knowledge are document management systems. Documents need to be controlled, but must also be easy to find and retrieve.
- **Process.** Process mapping and automation of electronic processes contains valuable business knowledge on how to best execute a process.
- **Developmental.** Knowledge management also implies that people's knowledge must grow and therefore there must be a learning component within the organisation.
- **Innovation and creation.** Knowledge capital cannot grow unless there is some component of innovation. Innovation's heart is in the process of collaboration or as the SECI model (Nonaka *et al*, 2000) indicated socialisation.

The *Asset Management* and *Innovation and Creation* categories of the Binney (2001) framework will be used in this study as the components of the system to enable collaboration. The other pillars are equally important, but for collaboration the focus would be only on the two abovementioned categories.

Data warehousing and data analytics are very important and is still important to any complete organisational knowledge systems architecture. The structured part of knowledge is encapsulated within structured databases, while the two categories this study will focus on relates more to unstructured knowledge. The process category is also fundamental as this encapsulates organisational process knowledge on how and when things should be done.

In the asset management category of Binney (2001), the following enabling technologies are mentioned:

- Document Management
- Search Engines

These components are very important and fundamental to any eKP that would capture unstructured knowledge utilising tools to share knowledge and to collaborate.

2.5.3. Document Management

Document management is a very important function of any business. The utilisation of document management involves the following:

- **Formal document management**. Formal documents such as directives, policies and procedures need to be managed and reviewed continuously and becomes a very important part of explicit knowledge within the organisation. These are controlled and trusted sources of explicit knowledge within an organisation. Version control, document life cycle management, meta tagging, classification, access control, workflow and accessibility are very important features for formal documents.
- **Records management**. Records management is content produced usually once-off such as minutes, e-mails and presentations. These content types should also have version control, meta-tagging, access control, retention periods and accessibility.

- **Content management**. Content to be published to formal information areas within the organisation needs to be version controlled, processed according to workflow, accessible, subjected to access control, meta-tagging, and easy to publish.
- **Collaboration content**. These are content types that are important to ensure discussion groups, polls, electronic chatting and conferencing tools could function.

The following summarises the functionality of document management and is not particular to a specific vendor, but rather very important functionality to have available.

- **Version Control.** The ability to check-in, check-out, view previous versions of the document, revert to a specific version and have draft versions available for an author to write a document not yet ready for publishing.
- **Meta-tagging.** Meta-tagging refers to the ability to add more keywords, description and custom meta information on a document to enable better search results, custom search results, better classification of documents, contextualise documents on higher level agreed categories within the organisation and to filter documents based on the additional meta information.
- **View of document history.** It is always important to view the history of a document. These could include the history of the content of a previous version or some meta information on a document. This is very important for audit trails and could become very relevant in pursuing legal action.
- **Access control.** Access control is important to protect information that is sensitive to the organisation. Access control is also a very useful feature when a group doesn't want everyone to have access to their discussions, such as board members or technical teams working on a "secret" level of security classification.
- **Record management.** The ability to define record types with applicable retention periods.

2.5.4. Search Engines

In the Eskom implementation the heart of an electronic knowledge platform (eKP) was to be the search and indexing engine. It is important to have a very good indexing and search engine if success is expected from the eKP. Utilisation would not be achieved if the search engine does not provide correct results. A combination of search, indexing and taxonomy are important to achieve a good search experience. In addition to just indexing the content and meta- information, it is also important to know the author or user that published the content.

All the other components are functionality, but the search engine provides the core layer required to profile people and find relevant content. The following topics will be discussed when looking at search and indexing engines ensuring a good eKP:

- Classification (taxonomy)
- Search technologies and algorithms
- People profiling
- Access control

Search technologies are much more than just adding keywords to a document. The amount of information generated in a large organisation such as Eskom makes it impossible to tag every piece of content. In the Eskom implementation at most the title of the document is known and keywords are seldom added. Hence the need for an effective search technology that would be able to interrogate the content of the document in addition to meta information.

A good search engine would be an engine that has:

- Scalability
- Quality search results
- Relevant search results
- Proper ranking mechanism
- Effective indexing technology that supports many mime types
- Authorisation and authentication, where required.

There are three main technologies involved in a web searching engine:

- **Web crawling**. Web crawling is the technology where the content of other web content could be fetched from the source and placed on the web search server.
- **Indexing.** The content on the web search server must be indexed to allow the retrieval engine to find information effectively.
- **Searching**. The search engine allows the querying of the search index built.

WEB CRAWLING

In enterprise search, web crawling could be used. If a central repository for documentation management and enterprise content management do exist, then it may reduce the need to crawl. Web crawling has a negative impact on the corporate network if too much crawling is required. Intelligent crawlers could "spy" the whole corporate network for web content and spider these pages. This could easily cause serious traffic and should be allowed only on specific instances. The attributes of a good web crawler has been highlighted by Shkapenyuk (2001) and the policies to be implemented is suggested by Edwards *et al* (2001).

Edwards *et al* (2001) suggests basic policies to keep in mind when utilising crawlers for an enterprise search. Another challenge usually in enterprise crawling is permission levels. If documents are access controlled, it should remain so. The crawlers would necessarily have access if access is not granted. However, if the crawler is allowed access, the same security model should apply to the source where it is indexed. Usually in this case, some sort of integration is more appropriate, rather than utilising web crawling techniques to make information available to all.

A good crawler should have the following characteristics (Shkapenyuk, 2001):

- **Flexibility.** The tool should be easy to change and should be highly configurable.
- **Low Cost and High Performance.** The tool should be effective in utilising resources and should be low in capital and maintenance costs.
- **Robustness.** The tool must be trustworthy and adaptable to exceptions such as unplanned high loads, high network congestions or communication failures.
- **Performance.** The tool must be effective enough to deal with the business demands.

Edwards *et al* (2001) stressed the following policies when crawlers are implemented:

- **Selection policy.** Clearly define which pages to crawl.
- **Re-visit policy.** Deciding when to revisit the web page for updates is also important to ensure efficiency and to reduce unnecessary network traffic.
- **Politeness policy.** This policy is used to ensure that web sites are not overloaded by the crawler's interference.
- **Parallelisation policy.** This policy specifies how crawlers would run in parallel processes.

Shkapenyuk (2001) defined a high-level architecture for distributed web crawlers. The World Wide Web (WWW) could be the corporate network and the crawlers would be able to interrogate all available web sites for information, based on the policy selections defined.

The crawler could be divided into functional modules: crawling system and the crawling application.

- The **crawling application** decides what page to request next, given the current state, and the previously crawled pages and issues a stream of requests (URLs) to the crawling system.
- The **crawling system** downloads the pages and the crawling application subsequently analyses and stores the downloaded pages.

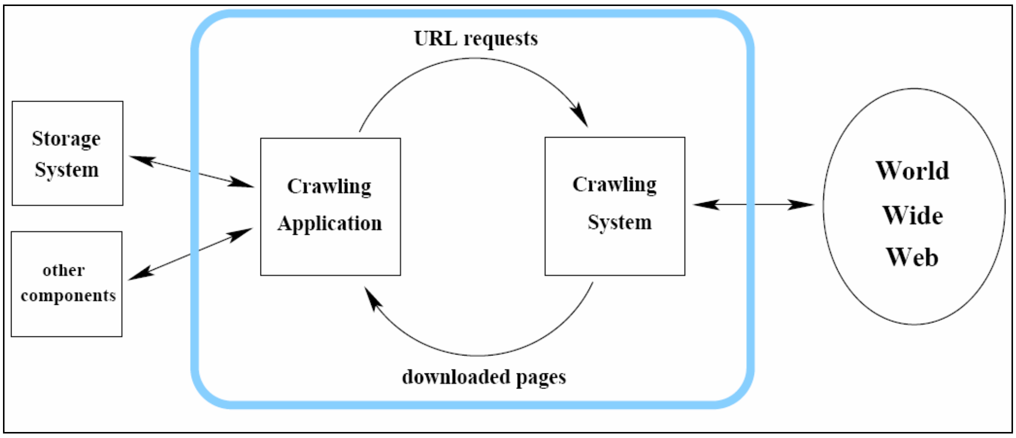


Figure 6 Basic architecture of distributed web crawlers (Shkapenyuk, 2001)

INDEXING

Content of pages could not be searchable if it is not indexed. The indexer plays a very important role in organising information into a high performance search index to retrieve results. This is critical to any eKP implementation. The main purpose of an effective index is to enable the search engine to find documents related to the search content quickly. Search technologies have also enhanced this to have some statistics also available to do conceptual matching, categorisation and taxonomy creation.

The basic functions of an indexing engine would be to collect the content, and then parse and store the content in a relevant data structure based on the storage strategy of the indexing engine. Gusfield (1999), Wood (1993) and Zobal *et al* (2006) highlighted the following three functions to be incorporated within the indexing engine:

- **Collect content.** This part of the indexing engine could usually be assisted by crawlers or an integrated application.
- **Parse content.** This is usually the more complex part of an indexing engine and a powerful indexing engine must be able to handle the most relevant file formats and usually has to cater for specific content formats as well.
- **Store index content.** The parsed content has to be organised into a data structure that would assist the search engine in effectively finding the concepts in the indexing engine.

Gusfield (1999), Wood (1993) and Zobal *et al* (2006) cover different indexing storage structures. There are many more structure types and approaches that could be used to store the indexing data. The detail of each structure is very interesting, but it is important that the technology used implements these algorithms effectively. With large organisations, terabytes of data must be indexed and retrieved. This should be effective to store and retrieve. It should be scalable and must be able to handle these large volumes.

The following are examples of storage structures that are used in structuring index data:

- **Suffix tree.** This is a data structure that presents the suffixes of a given string in a way that allows for a particularly fast implementation of many important string operations (Gusfield,1999).
- **Tree.** A tree, also known as *trie*, supports using extendible hashing techniques which is required for quick access of the index (Wood, 1993).
- **Inverted index.** An inverted index builds on trees and stores each unique occurrence of the criterion into the tree. (Zobal *et al*, 2006).
- **Citation index.** A citation index stores citations or hyperlinks between documents to support citation analysis. Hash or tree type structures could be used.

SEARCHING

An eKP requires not just effective searching and indexing, but also statistical analysis on these indices. Statistical analysis could allow for auto taxonomy creation, auto categorisation and also allow for the finding of similar documents. Most of the mathematical and statistical methods are being used in the searching space. Depending on the size of the information, the complexity of dealing with the large amount of information becomes important to the search engine.

Searching algorithms could be very simplistic, but in implementing these algorithms on a large amount of data could be inefficient and could result in having difficulty finding the correct information. There are various components to searching:

- **Navigation.** Navigation could be used to navigate to the most relevant part in the taxonomy. This reduces search scope and only returns more relevant information, instead of causing an overload. Usually a good search engine is able to handle a search scope based on navigation. This is an essential feature to ensure that knowledge workers do not get overloaded with information. Various methods of navigation exist:
    - **Breadcrumbing.** This method of navigation allows users to navigate throughout the site using a one-line approach. This method reduces the space of the navigation method leaving more space to the user for content. It is usually used in connection with a browseable structure within the web environment.

Figure 7 Example of breadcrumbing navigation (Source: Hyperwave IS6 Platform)

-
    - **Treeview navigation.** Treeview navigation gives the user a more complete picture of the content categories (site map type concept), but usually takes more space in the content of the web environment.

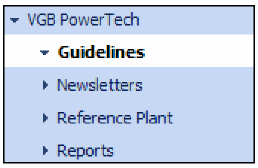


Figure 8 Example of treeview navigation (Source: Hyperwave IS6 Platform)

-
    - **Site map or spider navigation.** Site map or spider type navigation gives a complete picture either at different levels or at least the first two levels of navigation. This could still work, but the main problem with the site map approach is that it does not usually work very well with large taxonomies.

- **Search theories.** The search algorithm based on the search theories is the part where the concepts used in searching is matched against the content of the index.

  The search algorithm based on the search theories is the part where the concepts used in searching is matched against the content of the index. The search theories used in algorithms determines the effectiveness of finding information.

  Bayesian search theory. The algorithm is the application of Bayesian statistics to the search for lost documents (Stone, 1975).The basic principles of this theory is to implement probabilities of which concept is more accurate. Some search engines could use the concepts together with user profile and user feedback depending on how complex it is to implement the search algorithm to determine probabilistic concept matching. It is very effective and more appropriate to the knowledge worker doing the search. Scoring is possible as ranking could be applied based on the probability. Similar documents could be identified by utilising this search theory.

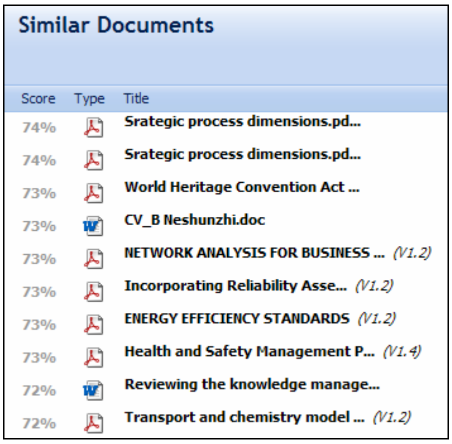


Figure 9 Example of a similar document search result (Source: Hyperwave IS6 Platform)

Boolean search algorithms. This search algorithm is very restrictive as it only focuses on exact matches. It is more accurate in terms of the term used, but usually is not effective on large volumes of information as context, applicability and similar concepts are not taken into consideration.

Clustering search algorithms. Clustering searches could be used to bring documents with similar concepts together in a search result, organised under applicable categories. It is not based on the predefined classification, but rather based on the statistical analysis of the concept matches, displayed in the same category. Usually the classification is generated on the search action and is not a predefined taxonomy.

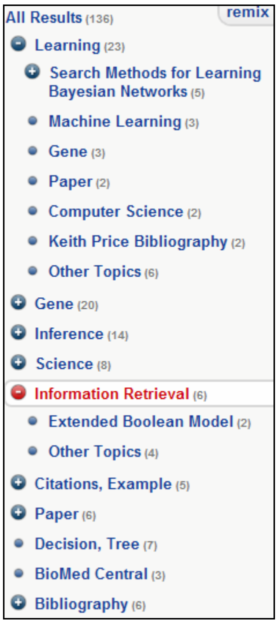


Figure 10 Example of clustered search results (Source: Vivisimo)

Shannon's information theory. The Shannon (1948) theory is used in more fields than just searches. The basis of the theory is again probabilistic statistical methods. In the search context it means that the search results will be ranked based on the probability of the concept matched in the search index.

- **Agent technologies.** A knowledge worker does not always want to actively search for information, but is interested in new happenings in a domain of interest on a regular basis. Agent technologies could be used to push search results of certain concepts to the knowledge workers.

PEOPLE PROFILING

Tacit knowledge applicable in a business process is very important in making the correct decisions. It is not always about finding the explicit knowledge in a decision support system or a search engine, but also to know where one could find the person that knows about these particular concepts. Indexing engines usually add the knowledge worker as meta-information to enable anyone to search on a concept and find the knowledge worker working with similar concepts.

Managing knowledge is not just about externalising tacit knowledge applicable to a business process, but also to manage people with the knowledge. Why is it so important to know who is a knowledgeable person in a specific field? Companies find it more challenging with the aging workforce and wish to share more knowledge with limited knowledgeable resource available (George, 2006).

ACCESS CONTROL

Access control is very important for information security. It is the aim of knowledge sharing that all knowledge being shared should be publicly available to the organisation, but certain knowledge cannot be shared. Therefore it is important to have access control to specific areas and pieces of information.

CLASSIFICATION (TAXONOMY)

The Cambridge Advanced Learner's Dictionary (2008) defines taxonomy as follows:

"A system for naming and organizing things, especially plants and animals, into groups which share similar qualities"

The taxonomy is therefore a systematic way of classifying knowledge (Wyllie, 2005). A corporate taxonomy is a way to organise and classify things or concepts, and is essential to categorise the corporate knowledge base. It may lead to different ways of classification, but it is important to have some classification and rules around classification. If the classification does not incorporate all the required views, an effective search engine would assist to find the correct information.

The taxonomy assists in filtering out certain information not considered as relevant categories to the knowledge worker for a specific search. Navigation through the taxonomy is the first point of a "*search*" activity. Once the highest level of the relevant taxonomy is reached, the knowledge worker would be able to search the indexing engine. This reduces the amount of search results to browse through as it is more relevant.

Basic principles could be used in building the taxonomy: generalised information versus specific information. In a corporate taxonomy it is also important to have an organisational classification (sections, departments, divisions) and a discipline classification (electrical engineering, plant maintenance etc.). Wyllie (2005) highlighted standards and technologies when designing these taxonomies that could be used to design and maintain these taxonomies.

A basic taxonomy could be classified by humans, but when a bulk upload is done to these systems, it could become impossible to manually classify these documents. Training by example is a very important part of taxonomy classification. The taxonomy software and tools must be closely integrated with the search and indexing software as this reduces the effort to find information (Wyllie, 2005).

Taxonomies are important to provide structure to information stored and to reduce the effort of finding information. Several reasons have been established by Wyllie (2005) as to why taxonomies are important:

- Coping with the information overload.
- Content tagging necessary for customising information
- The business-to-business (B2b) utilising web services, which requires agreed information architectures.
- The need to be more innovative by making connections between related concepts across different disciplines.

Wyllie (2005) highlights some expert advice when designing these taxonomies as follows:

- Involve the users when designing the taxonomy.
- Have a common higher-level taxonomy, but the rest of the taxonomy should be fit for purpose. Do not dictate the taxonomy to the lowest level, but rather look at the generalisation/specialisation type of methods for classification.
- The two most useful resources for building the taxonomy are user feedback and "*don't knows*".
- Taxonomy must be constantly updated.
- Automated systems could advise on the taxonomy, but human interaction is still critical.
- Keep it simple so that the users can use it and not get frustrated.

The technology used for taxonomy creation and maintenance is also highlighted by Wyllie (2005):

- **Training by example**. Technologies exist that could learn the concepts from a training set of documents that should be in the specific taxonomy.
- **Rule-based**. Documents are classified based on predefined rules.
- **Statistical methods**. Based on the words used, documents could be classified.
- **Natural languages processing**. Classification could rely on an extensive dictionary and thesaurus for identifying concepts.

Standards could be used to design and maintain taxonomies and relationships. The two commonly used are (Wyllie, 2005):

- **RDF (Resource Description Framework)**. Meta-data description framework.
- **OIL (Ontology Inference Layer)**. Specifying relationships between entities.

2.5.5. Innovation and creation components

Collaboration is essential to innovation. A very good example is where people collaborate to determine a solution to a specific challenge. Brainstorming sessions, scenario planning and story telling techniques are used to collaborate. Utilising an eKP to collaborate could achieve some innovation and create ideas for the business. This could lead to new products or processes, enhancing existing products and processes or to increase market share.

Electronic collaboration could have the following advantages:

- Collaboration with people geographically separated.
- Reusing existing ideas or solutions already discussed on the eKP.
- Building on existing ideas to form new ideas and solutions out of the pieces of ideas already available.
- Sharing best practices. Templates, drawings, designs and models could be shared across the organisation no matter what the geographical challenges.
- Reduction of travelling costs and reduction in the carbon foot print associated with various travelling mediums.

There are many more advantages that could be linked to electronic collaboration. The components according to Binney (2001) that fits into the innovation and creation category are as follows (reduced to the technologies used in this dissertation):

- E-mail
- Groupware (discussion forums, Wikis and Blogs)
- Chat rooms
- Search engines
- Push technologies

Video conferencing and voice-over-IP (VoIP) will become technologies that will be very beneficial especially when voice could be converted to text and indexed (Willis, 2007). The reason why it is excluded in this dissertation is that the adoptions of these technologies are slow as the cost of enabling such infrastructure and technologies is high. The adoption of these technologies according to Gartner will be between 5-10 years (Willis, 2007).

The fundamental issue when implementing any of these technologies is that it should be available to the search engine. The information should be classified in the common taxonomy and indexed so that the concepts between the different sources of unstructured knowledge could be matched. The importance of a very good indexing engine and search algorithms can not be stressed enough.

E-MAIL

E-mail systems are well known to many people today. The growth of e-mail was more widespread and rapid than the Internet. Collaboration on e-mail is well known and widely used. E-mail results in an enormous amount of tacit knowledge being made explicit through this medium. People discuss topics, share information and share answers to questions. E-mail systems must be linked to the corporate searching engine. There are various ways to integrate e-mail systems, but it is important that the e-mail content is available to the search engine so that concept matching could be done to the other information sources.

The more popular form of collaboration, which should reduce e-mail communication in future, are discussion forums, blogs or Wikis. However, e-mail is embedded in many peoples' way of working. The user should be allowed to save manually an e-mail to the eKP or have the corporate taxonomy available within the e-mail client so that the knowledge worker could easily drag-and-drop the e-mail in the applicable taxonomy.

Advantages of an e-mail system are as follows:

- **High availability.** Most e-mail systems usually allow the user to work on the system even when there is no network available.
- **Known technology.** E-mail is widely known to the most basic computer user. It is an easy technology to collaborate on.
- **Notification system.** E-mail is to some extent most users' information portal as many notifications are sent to the e-mail system for the user to action or to be informed.
- **Available for non-company users.** E-mail is a well formed standard and therefore many mail systems of different vendors will be able to accept e-mails in their system. No firewall configuration on any side is required and therefore is a very easy technology to use when collaborating outside of the company boundaries.

E-mail has its disadvantages as well. The following disadvantages of e-mail should be considered in relation to its use as a method of collaboration:

- **High redundancy.** Usually an e-mail message is sent to a few people and each individual in his/her own capacity could decide to save the e-mail and attachments to a storage location or the eKP. This increases storage requirements and increases the number of duplicate versions users have to consider.
- **No single thread of discussion.** E-mails can be very cumbersome when a lengthy discussion takes place. . Users could reply late on discussions already wrapped up because there is not single view of the discussion. Discussion forums allow for discussions to be more organised and for there to be a single view of the discussion thread.
- **Many version of the "truth".** Attachments on e-mails are the worst kind of documents to manage. There are too many versions of the document that each individual needs to manage. A better approach would be to rather have the documents shared in a common workspace on the eKP for anyone (with appropriate access) to collaborate on the document.
- **"Junk Mail".** With e-mail some spam can be filtered out, but in some cases many people are sent e-mails within the organisation to discuss topics irrelevant to other users. It is not contextualised and causes a user to end up spending a lot of time to get to business related e-mails.
- **Large e-mails.** E-mails may become very large with attachments. These e-mails are sometimes difficult to share within the corporate firewall due to size restrictions.

There are many functions that an e-mail should have:

- **Send and retrieve e-mails.** The basic functionality to send and retrieve e-mails is required.
- **Retracting of e-mails.** Sometimes e-mails are incorrectly sent and retracting an e-mail allows the knowledge worker to revoke the message from all mailboxes. This usually only works within the corporate firewall though.
- **Supporting various e-mail formats.** Usually plain text and HTML e-mails should be supported.
- **Group Calendars.** Recent e-mail systems contain groupware functionality such as sharing calendars, which allows users to share their calendars. Users are allowed to determine availability of other users to schedule appointments.
- **Offline capability.** It is critical for most knowledge workers to have an e-mail tool that could work on and offline. This allows the knowledge worker to be productive when access to the network is not possible.

GROUPWARE (DISCUSSION FORUMS, BLOGS OR WIKIS)

Groupware is a better way of communication. Groupware could be used to create a team workspace with associate document management, discussion forums and calendars. These functions in groupware allow “communities of practice” (COPs) to collaborate with proper document control, one view of a discussion and a common view on the project or topic at hand.

Discussion forums, blogs or Wikis (in what follows these will be referred to collectively as *discussion forums*) are more or less the same functionality. It gives the ability to have a common discussion with one view of the threads of a discussion. The advantages of discussion forums are as follows:

- **Single view of a discussion.** A single view of a discussion is essential. Users could view the discussion and determine to what extent the discussion has matured, without going through numerous e-mails to gain a trail of thought.
- **Sharing of documents.** Most discussion forums will allow some links to documents and therefore ensure that there is one document discussed. Any version changes are easy to disseminate as it is dependent on the user to download the latest version.
- **No redundancy.** Discussion forums allow for no redundancy in discussion, reducing complexity of large discussions.
- **Large file sharing.** E-mail systems usually have file size limits for internal and external communication. This makes it very cumbersome to share information. Discussion forums with document management or just a file share function will be able to overcome this problem, providing that the discussion forum is available to external people.
- **Context based.** Discussion forums are usually done within a given context and the common view is shared within the community. This makes it more acceptable for communities to contextualise discussion within the discussion forum’s context. This becomes very relevant when reading discussion history. E-mails sometimes don’t make sense when looking at a history, because the context has been forgotten and therefore could be problematic in interpreting e-mail history.

The disadvantages of discussion forums are:

- **No offline capability.** Usually discussions are online and therefore the high availability for offline users is not always available. E-mail could be used in conjunction with the discussion forum to overcome this problem. Many discussion forums do allow for e-mail integration.
- **Culture change.** Discussion forums are not as widely used as e-mail. This makes it difficult to change a culture to use discussion forums instead of e-mails. People are used to using e-mails. By integrating e-mails systems this could be overcome, but this does not allow for the culture change. E-mails should notify and the users should still go into the discussion forum.

Discussion forums have many advantages over the conventional e-mail and should be part of the collaboration infrastructure. In the eKP, it could be any discussion forum (software) as long as it is integrated with the powerful indexing and searching engine.

CHAT ROOMS

The adoption of online chats is seen to be less than two years away according to Gartner (Johnson, 2007). It is a very effective way of communication as it is more interactive than e-mails and discussion forums. Chat rooms could also be integrated with technology to collaborate using white boarding, application sharing and web sharing. These technologies are not too expensive to implement and could be used effective to save time and reduce travel. Text of chat rooms is searchable and should be closely integrated with the eKP search engine.

The advantages of a chat room are:

- **Interactive communication.** Chat rooms provide an interactive mechanism to discuss a topic. This makes it more intuitive to the user as there is no delay in answers as with e-mail and discussion forums.
- **Quicker resolution of discussion.** Interactively solving a problem on the fly could reduce a lot of delays or further problems.
- **Relatively device independent.** Chat rooms could easily be integrated with hand-held tools or cell phones. Therefore making the conversation more accessible than e-mail or discussion forums.

The disadvantages of a chat room are:

- **Collaboration is online.** All the parties in question need to be online to enable a chat session. If the user is not available, the discussion is not possible.

INNOVATION VIA SEARCH ENGINES

In the Eskom study, the effective search engine was identified by the project team to be used for innovation for the following reasons:

- **Making ideas easily available.** Search engines that indexes content would enable ideas to be more accessible and available to others. This will stimulate ideas of the knowledge worker internalising all the content around a specific topic.
- **Conceptualised matching.** Matching concepts will allow the engine to highlight similar content types of interest to the knowledge worker. Therefore the knowledge worker could get an idea of what has been done and possibly identify gaps that could be investigated.
- **Auto taxonomy creation.** An interesting feature of auto taxonomy creation is that it builds on concepts found in the contents. The search engine that extends the feature to auto taxonomy creation could highlight specific concepts being dealt with. The knowledge worker could deduce from this any new concepts or innovations that may come to light.

PUSH TECHNOLOGIES

Push technologies allow relevant information to be pushed to the knowledge worker. Knowledge workers may watch several different topics and it is not always practical for one person to manually search and find information on a daily or weekly basis. Search agents that can push relevant information to the knowledge worker would reduce the amount of time spent to find information in a specific contextual area.

Within an organisation push technologies could be used to supply information to a knowledge worker dealing with:

- New and changed documents pertaining to specific concepts.
- New and changed tasks
- New and changed discussions
- New and changed calendars

Users that collaborate on the eKP could receive notifications of changed content without a user having to spend time to send information to the team about changed content.

HARVESTING TACIT KNOWLEDGE USING FREQUENTLY ASKED QUESTIONS (FAQS)

People can gain and share knowledge in many ways. A human being has many sensors and abilities to gain and share knowledge. One method that is constantly used in every-day life by virtually every person, is the process of asking and answering questions. Most of the time it is easier to ask a specialist a question and to get an answer then to search for information to try and find a fit for the question.

In the eKP used in this study, frequently asked questions (FAQs) are used as a mechanism to tap valuable tacit experience from knowledgeable people. Any user can ask the question with regards to the defined knowledge areas. The questions are then answered first with statistical reasoning by the search engine, based on the concept and also the user feedback of the relevance of the answer. This method ensures that specialists are not continuously occupied by answering similar questions, but rather make use of the engine's capability to first try and find the best possible match.

The implication of having the specialist answering the questions is that the specialist could share the tacit experience with other interested parties. This way the tacit knowledge pertaining to the question at hand is made explicit. The following pictures illustrate how such an engine appears to the user and what the behaviour is.

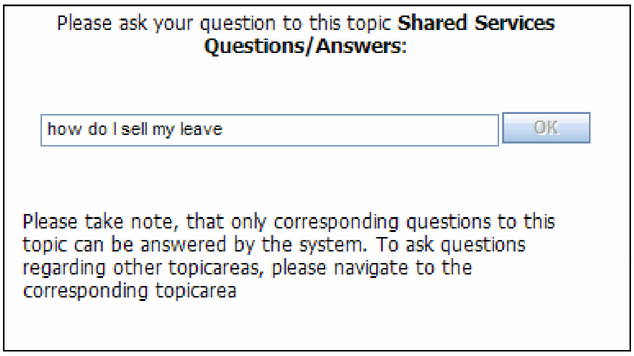


Figure 11 Asking a question to a conceptual matching search engine (FAQs)

The user would ask a question to the engine such as "how do I sell my leave". This question is asked to the domain of human resources. The engine then does conceptual matching and ranks the answers already available based on user feedback and content. The system will then return the most probable answers (ranked) to the questions (*see* Figure 12).

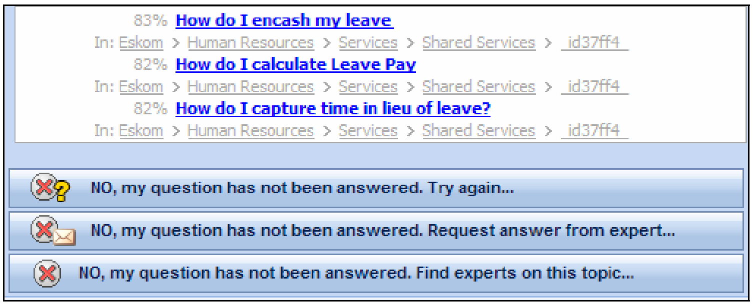


Figure 12 Probable answers returned by the conceptual matching search engine (FAQs) (Source: Hyperwave IS6 Platform)

The user will select an answer for more detail and in this case the answer is linked to a previously answered question with the title *"How do I encash my leave?"*. It is important to note that the engine trains itself on words used that is not in the content. In this case it is the word *"sell"*. The user is then given the options (*see* Figure 13) to choose if the answer is correct or choose that an expert answers the question (content of the answer omitted to protect confidentiality).

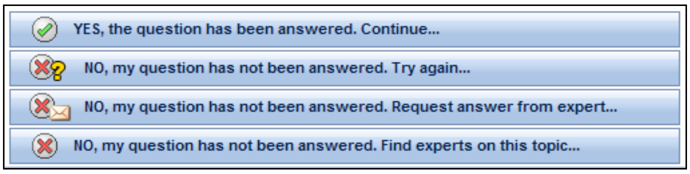
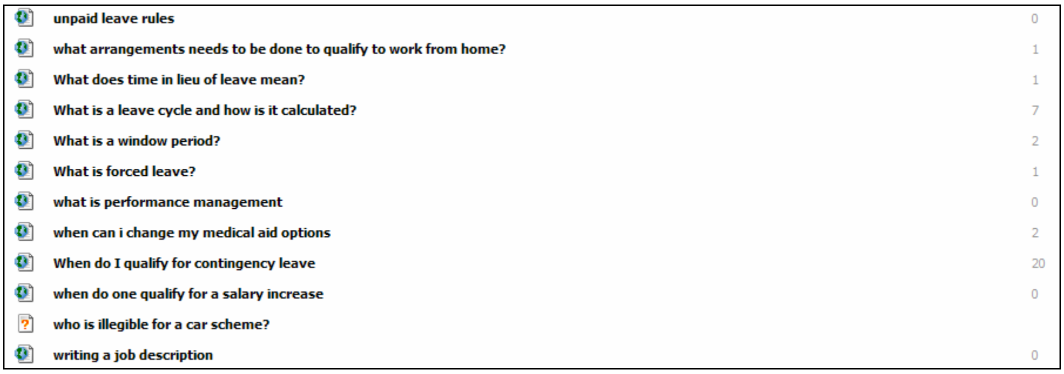


Figure 13 User options for the answer given (FAQs) (Source: Hyperwave IS6 Platform)

This mechanism allows the user then to get direct answers from a trusted source without having to contact the specialist directly or having to wait for an e-mail answer. The administrator (expert) also benefits from this as the statistics are available for users answering "YES" where the answer was sufficient (*see* Figure 14).



unpaid leave rules	0
what arrangements needs to be done to qualify to work from home?	1
What does time in lieu of leave mean?	1
What is a leave cycle and how is it calculated?	7
What is a window period?	2
What is forced leave?	1
what is performance management	0
when can i change my medical aid options	2
When do I qualify for contingency leave	20
when do one qualify for a salary increase	0
who is illegible for a car scheme?	
writing a job description	0

Figure 14 Answer statistics available to the expert (FAQs) (Source: Hyperwave IS6 Platform)

Many processes and procedures do not contain all the necessary tacit knowledge from the specialists. In this way the relevance of policies and procedures could be facilitated to be clearer to the users of this information by aligning it with the typical questions in the business and also any future questions that may arise. This mechanism has a few subtle advantages as it could highlight areas to rework in formal documentation as well as identifying new research ideas where answers are not known.

3. The Conceptual Research Framework

The conceptual research framework of this dissertation combines three models. Two of these models were adopted from existing literature (Nonaka, *et al.* 2000) and the human resources model (Employment Equity Act 55 of 1998). The IT architecture model is designed to support the collaboration principles of SECI (Nonaka, *et al.* 2000) and extract the data from the platform aligned with the human resources model.

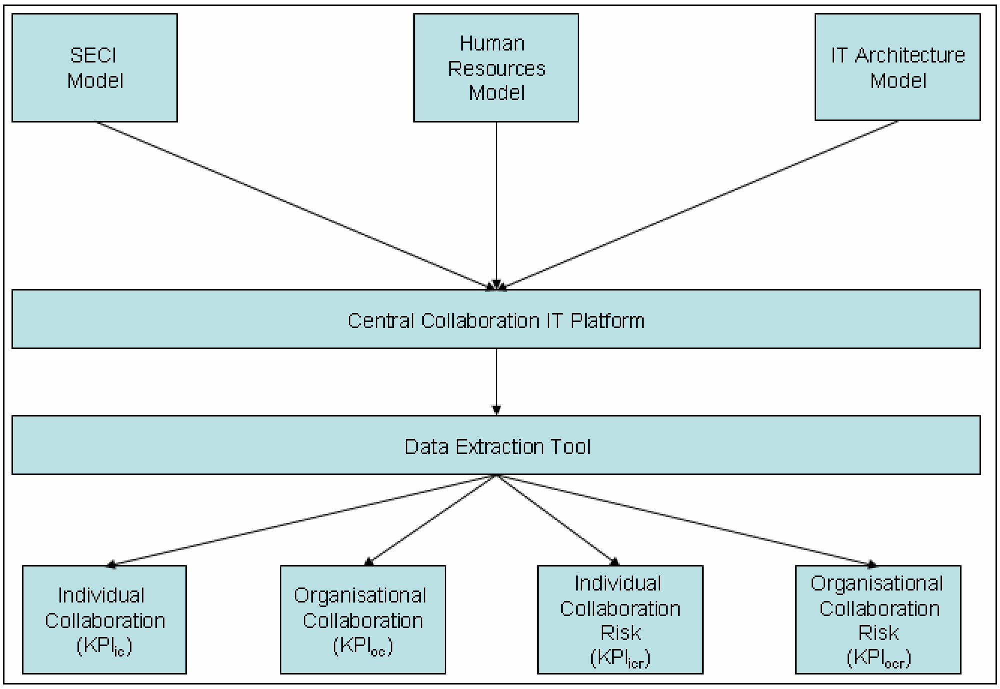


Figure 15 Conceptual Research Framework

Knowledge management is a wide field and could be covered in several research projects. To focus and streamline this project it is critical to define the boundaries and the assumptions for this research. The following issues are within the scope of research presented in this dissertation:

- Management and control of the collaboration health on an eKP.
- The approach is a technological approach rather than a psychological approach.
- The SECI model (Nonaka, *et al.* 2000) is used as the knowledge sharing process.
- The primary content type in the research is unstructured knowledge.

The following is the basic approach that was adopted to conduct the research:

- Define the technology platform and components that would support unstructured knowledge capturing. The SECI model (Nonaka, et al.,1995) was to be mapped onto the technology components to illustrate how the technology would support the SECI model (Nonaka et al,1995) for knowledge collaboration and knowledge sharing.
- Identify the electronic knowledge collaboration indicators to be measured based on the data available within the technology platform.
- Determine where the sources of the data exist and what is required to extract the data to measure these indicators.
- Measure the indicators using the eKP.
- Confirm if the indicators are useful

4. Knowledge Behaviour Indicators

Within the knowledge sharing domain, it is important to measure the stages of the SECI model (Nonaka *et al*, 2000) as suggested by Davenport *et al* (2002). The SECI model (Nonaka *et al.*, 2000) is an important process to measure, and the indicators of the knowledge behaviour that were developed as part of this research focussed around the following SECI (Nonaka *et al*, 2000) pillars:

- Socialisation
- Externalisation
- Internalisation
- Combination

This dissertation focuses only on employee capital and excludes the other forms of intellectual capital. Customer, supplier, partner and investor capital could also be included, but these are not internal to the organisation. The scope of this research project only considered internal human capital. (Davenport *et al*, 2002).

Given the challenges and difficulty being experienced by managers in the organisation studied in this proof-of-concept (POC), it was also important to monitor and determine some risk indicators. These risk indicators were used to enable these managers to manage and control knowledge sharing and collaboration more effectively.

4.1. Employee Capital

Employee capital should be explained before focussing on monitoring knowledge sharing behaviour for this type of capital (Davenport *et al*., 2002). It is envisaged if the employee sharing of knowledge is focussed and sound, then it would be easier to establish better organisational capital and relational capital knowledge sharing. These employees are also management and executives who would ultimately establish organisation capital and relational capital.

The focus and context of this dissertation is purely focussed on the employee capital, which is a subset of the human capital. It is assumed by Daveport *et al* (2002) that the social capital is individualised and does not belong to the company. Social capital could benefit the organisation, but could not be made explicit.

4.2. Defining indicators based on the SECI model

The SECI model (Nonaka *et al.*, 2000) is an important starting point to monitor the behaviour of people. Although the SECI model (Nonaka *et al.*, 2000) is more far-reaching in vision than just an IT platform it could be applied as a basis for measuring the behaviour of people in sharing knowledge on an eKP. The SECI model (Nonaka *et al*, 2000) in the context of the eKP and measurement of indicators on this platform should be expanded in this context to consider the following aspects (Nonaka *et al*, 2000):

1. **Socialisation.** Socialisation is required to enable collaboration using chat facilities, discussion forums, e-mail systems etc. Socialisation should be measured on the participating behaviour of the individuals. Therefore, it should not measure volume of content, but rather how many days in a month or year a person contributes (chat, publish or discuss).
2. **Externalisation.** In the process of collaboration utilising an eKP existing ideas within a certain concept have been externalised. Externalisation will then be done implicitly by socialising on the eKP. In addition, sharing documents, minutes, policies, procedures, work instructions, forms etc. would also be considered as externalising valuable knowledge from employee capital, which becomes part of the organisational capital. Externalisation would have to be measured to

determine if there is a healthy contribution volume within the organisation and for the individuals.

3. **Combination.** Within the context of an eKP, combining all the concepts and relationships could be facilitated by a very good indexing and search engine. This is not monitored as it is part of the technology architecture.
4. **Internalisation.** Internalisation should be monitored to determine if the content is being used within the organisation. It could be measured on a higher level within the organisation or on individual level. It is not always practical to measure this on individual level, but it would be discussed within this dissertation to determine the applicability and feasibility of both approaches.

The individual indicators highlighted in considering the SECI model (Nonaka *et al*, 2000) should therefore be as follows:

- **Monitoring individual volume contribution (year-to-date) (I_1):** This indicator is the sum of all the document contributions per annum per individual.
- **Monitoring individual days of contribution (year-to-date) (I_2):** This indicator is the sum of all the days contributed per annum per individual.
- **Monitoring the ratio of volume/day per individual (year-to-date) ($I_3=I_1/I_2$):** This indicator measures the ratio of contributions per day..

The assumptions are:

- A document uploaded or changed is classified as a contribution.
- The user is authenticated to the system to enable the system to identify the individual linked to the contribution.

The following indicate the actual formulas for each indicator to be calculated:

I_1 = Sum of all document contributions per annum per individual

$$I_1 = \sum_{i=1}^{n} x_i$$

Where:

I_1 = The total of all the accumulated contributed documents per annum for an individual

n = The number of the data values in the population or sample

x_i = The i^{th} document contributed to the eKP

$\sum_{i=1}^{n} x_i$ = Sum of all document contributions per annum per individual

Equation 1 Individual Volume Contribution (Indicator I_1)

$$I_2 = \sum_{i=1}^{n} x_i$$

Where:

I_2 = The total of all the days contributed per annum for an individual

n = The number of the data values in the population or sample

x_i = i^{th} day contributed to the eKP

$\sum_{i=1}^{n} x_i$ = Sum of all the days contributed per annum per individual

Equation 2 Individual Days Contributed (Indicator I_2)

$$I_3 = I_1 / I_2$$

Where:

I_3 = The ratio between I_1 and I_2. The measurement would be in contributions

	per day.
I_1 =	Sum of all document contributions per annum per individual
I_2 =	Sum of all the days contributed per annum per individual

Equation 3 Individual Contribution per Day (Indicator I_3)

After determining the values of the collaboration indicators on individual level (I_1, I_2 and I_3), the values should be factored into a ratio between actual and a benchmark target. One should not expect the same collaboration behaviour from senior management compared to middle management. It is important that an individual operating at a middle management level is measured against the limits set within the middle management class.

The classifications as suggested by Snell *et al* (1999) on employee capital should be mapped to the applicable human resources models (Employment Equity Act 55 of 1998) to determine which level in the organisation is considered to be contributing valuable tacit knowledge.

There are many other models that could be applied, but these are the models that are mapped according to the Employment Equity Act 55 of 1998. The more important part to map the management grades to the Snell *et al* (1999) categories are the semantic scale. All other human resources grading systems could be mapped against the semantic scale and should then be applied against the following table:

Semantic Scale	**Employee Capital Quadrants**	**Management Classification**
Top Management	Quadrant 3	Senior Management
Senior Management	Quadrant 3	
Professionally qualified, experienced specialists and mid-management	Quadrant 3 and 4	Middle Management
Skilled technical and academically qualified workers, junior management, supervisors, foreman and superintendents	Quadrant 1 and 2	Supervisor
Semi-skilled and discretionary decision making	Quadrant 1	Staff
Unskilled and defined decision making	Quadrant 2	Staff

Table 3 Equivalent employee capital quadrant and semantic scale management grading (Adopted from Snell *et al* (1999) and Employment Equity Act 55 of 1998)

The content published by the knowledge workers in quadrant 3 and 4 are assumed to be of a good quality based on their seniority level and therefore the content is trusted. The supervisor level is included into the knowledge worker pool and it is assumed that most work of a supervisor will be revised by a knowledge worker in quadrant 3 and 4. As a precaution, the SECI model (Nonaka, *et al.* 2000) by nature does cater for the elimination of faulty content by having the community reading and internalising the information. If most people in a discipline dispute a piece of content, then it has to be changed or discarded.

The important key focuses of these indicators are to change behaviour and to improve collaboration to ensure a certain extent of tacit knowledge capturing. The indicators are determined per management class and therefore the target for individuals per management class would be the same for an organisational unit and an individual. The targets are also not intended to be a moving target and the calculated target could be the fixed target for the next year. The following statistical principles would be applied to determine the targets of each indicator:

- **Median as target for an indicator**. The reason why the median is chosen rather than the average is because the knowledge workers could do bulk upload of information which could affect the targeted figure. If the average is the target and there is a bulk upload, the target would be too high and would discourage the knowledge workers from increasing their collaboration. Therefore indicators such as I_1 and I_3 should rather use the median instead of the average.
- **Average as target for an indicator**. The average could be used as the target where the results are fairly representative and accurate to describe the behaviour. I_2 is the days contributed. It would be very difficult to have incorrect days contributed and therefore an average would be a more accurate target than the median.

INDICATOR TARGET	STATISTICAL METHOD
Target for volume contribution (T_1)	Median
Target individual days of contribution (T_2)	Average
Target for the ratio of volume/day (T_3)	Ratio

Table 4 Individual Target Statistical Methods

The following formulas should be applied to determine the targets based on the statistical methods to be applied on the sample or population.

T_1 = Median of the sample set of document contributions for all individuals in a particular management class (senior, middle management or supervisor). The median would be determined on the sample set of I_1.

Equation 4 Median of contributions per annum for the individuals in a particular management class (T_1)

$$T_2 = \frac{\sum_{i=1}^{n} (I_2)_i}{n}$$

Where:

T_2 = Average of the sample set of days contributed for all individuals in a particular management class (senior, middle management or supervisor).

n = The number of data values for the particular management level class.

$\frac{\sum_{i=1}^{n} (I_2)_i}{n}$ = Average of the sample set of days contributed for all individuals in a particular management class (senior, middle management or supervisor).

Equation 5 Average of days contributed per annum for the individuals in a particular management class (T_2)

$$T_3 = T_1/T_2$$

Where:

T_3 = Ratio of the document contributions per average days contributed.

T_2 = Average of the sample set of days contributed per individual

T_1 = Median of the sample set of document contributions per day per individual

Equation 6 Ratio of median document contributions per annum (T_1) and the average of days contributed (T_2) for a particular management class (T_3).

The next step is to convert the indicators to key performance indicator (KPIs) and this would be intended to be a ratio of the indicator over the target. The KPIs need to affect the correct behaviour. It is important that the performance measurement on I_2 should have a higher weight than the other factors. The behaviour that is required is a higher amount of days accessing and contributing to the knowledge platform to ensure a culture of collaboration and knowledge sharing is cultivated.

Therefore, the indicators to determine the performance of both individuals and at any level of the organisation should be as follows:

KPI_{I1} =	Key performance indicator for individual documents contributed expressed in percentage.
The limit of KPI_{I1} would be restricted to 100%	

Equation 7 Individual Volume Contribution KPI (KPI_{I1})

KPI_{I2} =	$(I_2 / T_2) \times 100$
Where:	
I_2 =	Sum of all days contributed per annum per individual
T_2 =	Target for days contributed
KPI_{I2} =	Key performance indicator for individual days contributed expressed in percentage
The limit of KPI_{I2} would be restricted to 100%.	

Equation 8 Individual Days Contributed KPI (KPI_{I2})

KPI_{I3} =	$(I_3 / T_3) \times 100$
Where:	
I_3 =	Ratio of individual contributions per day per annum
T_3 =	Target for contributions per day
KPI_{I3} =	Key performance indicator for individual contributions per day expressed in percentage
The limit of KPI_{I3} would be restricted to 100.	

Equation 9 Individual Days Contributed Per Day KPI (KPI_{I3})

This study will use a weighting on the KPIs as follows:

- KPI_{I1} = 10%
- KPI_{I2} = 80%
- KPI_{I3} = 10%

The reason for the weighting is based on the 80/20 principle where the assumption is made that 80% of the contribution behaviour should be achieved by measuring and controlling the days contributed. The other 20% is split equally between the volume contributed and the contributions per day.

This will ensure that the correct behaviour to access the sharing platform more frequently is achieved. The KPI_{ic} equation should be calculated with these weights on each indicator.

KPI_{ic} =	$(KPI_{I1} \times 0.1) + (KPI_{I2} \times 0.8) + (KPI_{I3} \times 0.1)$
Where:	
KPI_{ic} =	Key indicator for individual collaboration expressed in percentage
KPI_{I1} =	Key performance indicator for individual documents contributed expressed in percentage.
KPI_{I2} =	Key performance indicator for individual days contributed expressed in percentage.
KPI_{I3} =	Key performance indicator for individual documents contributed per day expressed in percentage.

Equation 10 Key Performance Indicator for Individual Collaboration (KPI_{ic})

Similar to the individual KPI_{ic} an organisational level collaboration KPI_{oc} must be calculated. The organisational KPI_{oc} of the organisational unit in questions should be the average of the individual KPI_{ic}. The individual KPIs has taken the management level into account and is already normalised to percentage.

$$KPI_{oc} = \frac{\sum_{i=1}^{n}(KPI_{ic})_i}{n}$$

Where:

KPI_{oc} = Average of the KPI_{ic} for the sample set expressed as percentage

n = The number of the data points which values are within the sample set.

KPI_{ic} = The individual collaboration key indicator expressed as percentage.

Equation 11 Organisation Collaboration KPI (KPI_{oc})

4.3. Monitoring Electronic Employee Capital Risk

Risk identification in terms of knowledge health on individual and organisational level is also very relevant. The collaboration indicator should not only measure the KPI_{ic}, but also have some warning indicator if someone that is considered as delivering Quadrant 3 and 4 of the Snell *et al* (1999) classification. There are various factors that could have a risk to a manager with regards to an individual in these quadrants:

- Age
- Health
- Resignation
- Death
- Availability (shortage of skilled people)

A comprehensive model of these risk factors could be built, but is beyond the scope of this dissertation. The principle is that if any of these factors realise today, what is the risk in not having electronic knowledge of the person available and what is the worth of the person's knowledge. If a person is not utilising the platform to share information and to collaborate electronically, the risk is very high. If this person is part of quadrant 3 and 4, then the risk is higher. The correlation between the Snell *et al* (1999) quadrants and the levels of management has been defined (see Table 3), which will be used in the remainder of this dissertation.

The risk indicator is combined in looking at two factors:

- Active utilisation (contribution) of the platform (Nonaka *et al*, 2000).
- Level of management (supervisor, middle management and senior management). The risk is inherent in management level and a target is set for each level.

There is a difference between the indicators defined for changing of behaviour and determining of risk. If the indicator of behaviour is used for the risk calculation, then the risk would not be highlighted that well. If the risks are highlighted in the behaviour part, then the community would be discouraged to participate as initially the targets would be too high too achieve. Changing the culture to collaborate on an eKP could take a few years.

Two to three individuals in each of the management levels that are known for collaborating well on the platform should be used to determine the target averages for risk indicators. There were not many available on the platform that were considered to be collaborating well, since the culture of collaboration is still being established within the organisation. The same indicators as with the KPI_{ic} will be used, but with different target sets. The targets should then be determined as set within the organisation as modifiers to the risk calculator.

Based on quantitative analysis done with the actual data, the following modifiers for this study were defined as follows:

Management Level	**Contribution Target (median) (RT_1)**	**Days Contributed Target (average) (RT_2)**	**Contribution per day Target (Ratio) (RT_3)**
Supervisor	1246	47	27
Middle Management	1756	79	27
Senior Management	2579	114	26

Table 5 Risk Target Modifiers

The following method was used to determine the targets in Table 5:

- Identify individuals who adopted the technology and work on the eKP.
- Contribution Target (RT_1) was calculated for each management level by extracting the documents contributed in the system for 2007 by the individuals and calculating the median of these values.
- Days Contributed Target (RT_2) was calculated for each management level by determining the total days documents were contributed in the system for 2007 by the individuals and calculating the average of these values.
- Contribution per Day Target (RT_3) was calculated for each management level by dividing RT_1 by RT_2.

These target values were based on actual median and averages of individuals that accepted the culture change and actively collaborate on the platform. The utilisation statistics of these individuals were extracted utilising a Java program to query the indexing engine and updating an Oracle database with the statistical results. These results are reflected in Table 5. An interesting observation in terms of the actual data is the fact that the senior management has a higher contribution target and days contributed than the other management level. The same observation holds true for the middle management compared to the supervisor level. This proves to be an important point: the higher the level of management, the more knowledge is available, which coincides with Snell *et al* (1999).

Comparing this with a larger group of 63 people where there were some active and some new users, the same pattern was recognised between middle management and supervisor level. In the case of senior management, there was only one person who has currently not yet adapted to the technology, and therefore the contribution was less.

KPI_{IR1} = $100 - ((I_1 / RT_1) X 100)$
Where:
I_1 = Sum of all document contributions per annum per individual
RT_1 = Predefined risk targets for documents contributed as determined in Table 5.
KPI_{IR1} = The individual collaboration risk indicator expressed as a percentage for documents contributed.
The limit of KPI_{IR1} would be restricted to 100%.

Equation 12 Individual Volume Contribution Risk KPI (KPI_{IR1})

KPI_{IR2} = $100 - ((I_2 / RT_2) X 100)$
Where:
I_2 = Sum of all days contributed per annum per individual
RT_2 = Predefined risk targets for days contributed as determined in Table 5.
KPI_{IR2} = The individual collaboration risk indicator expressed as a percentage for days contributed.

The limit of KPI_{IR2} would be restricted to 100.

Equation 13 Individual Days Contributed Risk KPI (KPI_{IR2})

KPI_{RI3} = 100 - ((I_3 / RT_3) X 100)

Where:

I_3 = Ratio of individual contributions per day per annum

RT_3 = Predefined risk targets for contributions per day as determined in Table 5.

KPI_{IR3} = The individual collaboration risk indicator expressed as a percentage for contributions per day.

The limit of KPI_{IR3} would be restricted to 100%.

Equation 14 Individual Days Contributed Risk KPI (KPI_{IR3})

This study used a weighting for the collaboration risk KPIs as follows:

- KPI_{IR1} = 10%
- KPI_{IR2} = 80%
- KPI_{IR3} = 10%

The reason for the weighting is based on the 80/20 principle where the assumption is made that 80% of the contribution behaviour should be achieved by measuring and controlling the days contributed. The other 20% is split equally between the volume contributed and the contributions per day.

This ensured that the correct behavioural risk was determined to share and collaborate frequently and to aid the manager to act on high risk areas. The KPI_{icr} equation was calculated with these weights on each indicator.

KPI_{icr} = ((KPI_{IR1} X 0.1) + (KPI_{IR2} X 0.8) + (KPI_{IR3} X 0.1))

Where:

KPI_{IR1} = Key performance indicator for individual documents contributed risk expressed as percentage.

KPI_{IR2} = Key performance indicator for individual days contributed risk expressed as percentage.

KPI_{IR2} = Key performance indicator for individual documents contributed per day risk expressed as percentage.

KPI_{icr} = Key performance indicator for individual collaboration risk

In terms of the KPI_{icr} the risk classification in terms of low, medium and high is assumed to be the following:

- <20% - Low Risk
- 80%<*x*<20% - Medium Risk
- >80% - High Risk

Equation 15 Individual Collaboration Risk (KPI_{icr})

Similar to the individual KPI_{icr} an organisational level KPI_{ocr} must be calculated. The organisational KPI_{ocr} of the organisational unit in question is the average of the individual KPI_{icr}. The individual KPIs took the management level into account and was normalised to percentage.

$$KPI_{ocr} = \frac{\sum_{i=1}^{n} (KPI_{icr})_i}{n}$$

Where:

KPI_{ocr} = Average of the KPI_{icr} for the sample set expressed as percentage

n = The number of the data points which values are within the sample set.

KPI_{icr} = The individual collaboration risk expressed as percentage.

Equation 16 Organisation Collaboration Risk KPI (KPI_{ocr})

The following table summarises the calculations required for this study in monitoring individual and organisation collaboration behaviour and risk.

Equation Description	Equation
Equation 1 Individual Volume Contribution (Indicator I_1)	$I_1 = \sum_{i=1}^{n} x_i$
Equation 2 Individual Days Contributed (Indicator I_2)	$I_2 = \sum_{i=1}^{n} x_i$
Equation 3 Individual Contribution per Day (Indicator I_3)	$I_3 = I_1 / I_2$
Equation 4 Median of contributions per annum for the individuals in a particular management class (T_1)	Median of I_1
Equation 5 Average of days contributed per annum for the individuals in a particular management class (T_2)	$T_2 = \frac{\sum_{i=1}^{n} (I_2)_i}{n}$
Equation 6 Ratio of median document contributions per annum (T_1) and the average of days contributed (T_2) for a particular management class (T_3)	$T_3 = T_1/T_2$
Equation 7 Individual Volume Contribution KPI (KPI_{I1})	$KPI_{I1} = (I_1 / T_1) \text{ X } 100$
Equation 8 Individual Days Contributed KPI (KPI_{I2})	$KPI_{I2} = (I_2 / T_2) \text{ X } 100$
Equation 9 Individual Days Contributed Per Day KPI (KPI_{I3})	$KPI_{I3} = (I_3 / T_3) \text{ X } 100$
Equation 10 Key Performance Indicator for Individual Collaboration (KPIic)	$KPI_{ic} = (KPI_{I1} \text{ X } 0.1) + (KPI_{I2} \text{ X } 0.8) + (KPI_{I3} \text{ X } 0.1)$
Equation 11 Organisation Collaboration KPI (KPI_{oc})	$KPI_{oc} = \frac{\sum_{i=1}^{n} (KPI_{ic})_i}{n}$
Equation 12 Individual Volume Contribution Risk KPI (KPI_{IR1})	$KPI_{IR1} = 100 - ((I_1 / RT_1) \text{ X } 100)$
Equation 13 Individual Days Contributed Risk KPI (KPI_{IR2})	$KPI_{IR2} = 100 - ((I_2 / RT_2) \text{ X } 100)$
Equation 14 Individual Days Contributed Risk KPI (KPI_{IR3})	$KPI_{IR3} = 100 - ((I_3 / RT_3) \text{ X } 100)$
Equation 15 Individual Collaboration Risk (KPIicr)	$KPI_{icr} = (KPI_{IR1} \text{ X } 0.1) + (KPI_{IR2} \text{ X } 0.8) + (KPI_{IR3} \text{ X } 0.1)$
Equation 16 Organisation Collaboration Risk KPI (KPI_{ocr})	$KPI_{ocr} = \frac{\sum_{i=1}^{n} (KPI_{icr})_i}{n}$

Table 6 Individual and Organisational Behaviour and Risk Equations

5. The Electronic Knowledge Platform (eKP) Architecture

5.1. Introduction to the eKP (eKnowledge Platform)

The data required for measuring the indicators is dependant on functionality in an eKP (eKP). The equations required to perform the calculation were defined in Table 6. These calculations required data, and to gather this data, functionality was required by the eKP to enable this to be achieved. In addition to this functionality, there was specific functionality required. The approach was to identify important functionality required in a knowledge sharing platform and analyse how it supported fundamental models such as SECI (Nonaka *et al*, 2000).

The concept of an eKP has a lot of history. It is important to understand some of this history and the problems experienced with it to gain knowledge on how a knowledge platform should operate today within the organisation (see 2.5.1 History of the Internet). The products used for this dissertation are Hyperwave with Autonomy.

The knowledge platform for this dissertation was defined as a platform with a central full text indexing engine that provided the following high-level functionality:

- Collaboration
- Search and retrieval
- People profiling
- Document Management
- Workflow

5.2. Selecting the electronic eKP architecture

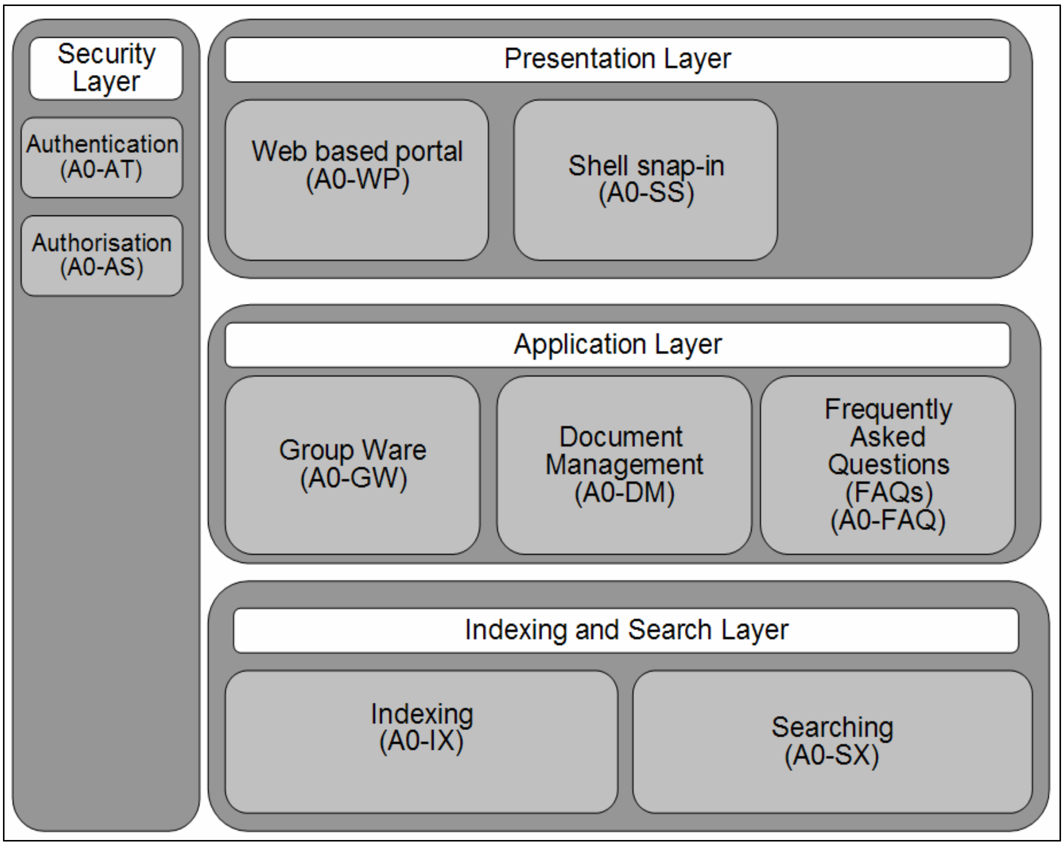


Figure 16 Conceptual Application Architecture (A0)

The conceptual application architecture (A0) have been categorised in the following sub system categories:

- Presentation Layer
  - Web based portal (A0-WP)
  - Shell snap-in (A0-SS)
- Application Layer
  - GroupWare (A0-GW)
  - Document Management (A0-DM)
  - Frequently Asked Questions (A0-FAQ)
- Indexing and Search Layer
  - Indexing (A0-IX)
  - Searching (A0-SX)
- Security Layer
  - Authentication (A0-AS)
  - Authorisation (A0-AT)

5.2.1. Presentation Layer

The presentation layer is seen as a flexible web portal (A0-WP) with some level of configurability by the user. This allows the user to easily create views to various parts of the taxonomy to enable the user to navigate with ease and have an overall view of the knowledge sources.

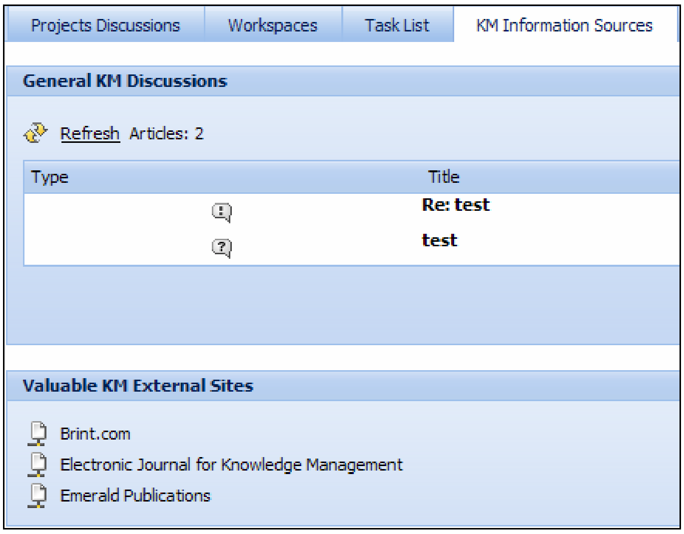


Figure 17 Example of a Personal Web Portal (A0-WP)

The personal portal concept (A0-WP) will allow users to have their own *"home"* page to configure to allow the knowledge worker to effectively view knowledge sources and navigate. This is not always the detail view, but the overall view the knowledge worker require to view various knowledge sources. The user should also be able to share public portals with other users.

All of the other functionality will be within the web application as well, except for the explorer type snap-in (A0-SS). This snap-in allows users to upload and update documents the way that most users use their exploring type filing system.

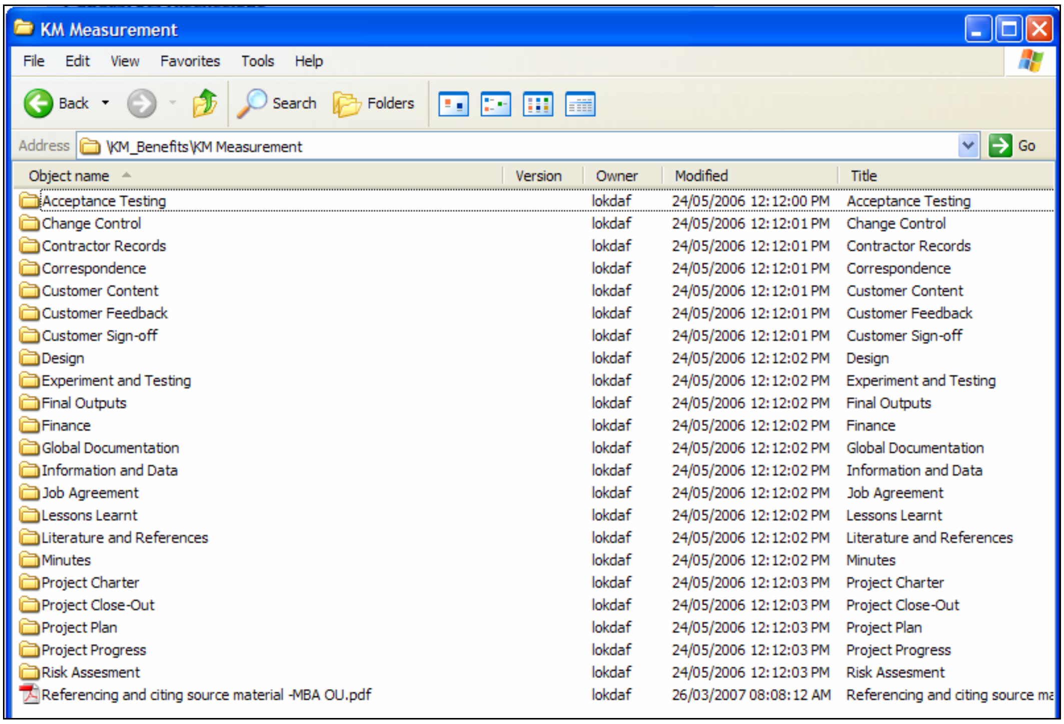


Figure 18 Explorer type snap-in (A0-SS)

This functionality is required to make it easy for knowledge workers to upload and update documents with the least amount of effort. The web user interface would also allow the user to upload and update, but the snap-in would allow multiple document upload and intuitive updating of documents.

5.2.2. Application Layer

The application layer consists of all the components with functionality to allow collaboration and tacit knowledge sharing within the context of this study. It must be stressed that these are not the only components to be utilised, but the subset necessary to collect the data for electronic knowledge health measurement (eKHM).

The groupware is the first application sub-system identified (A0-GW). The functionality required is highlighted in this document in the following sections:

- E-mail (see 2.5.5 Innovation and creation components)
- Groupware (discussion forums, blogs or Wikis) (see 2.5.5 Innovation and creation components)
- Chat Rooms (see 2.5.5 Innovation and creation components)

GROUPWARE (A0-GW)

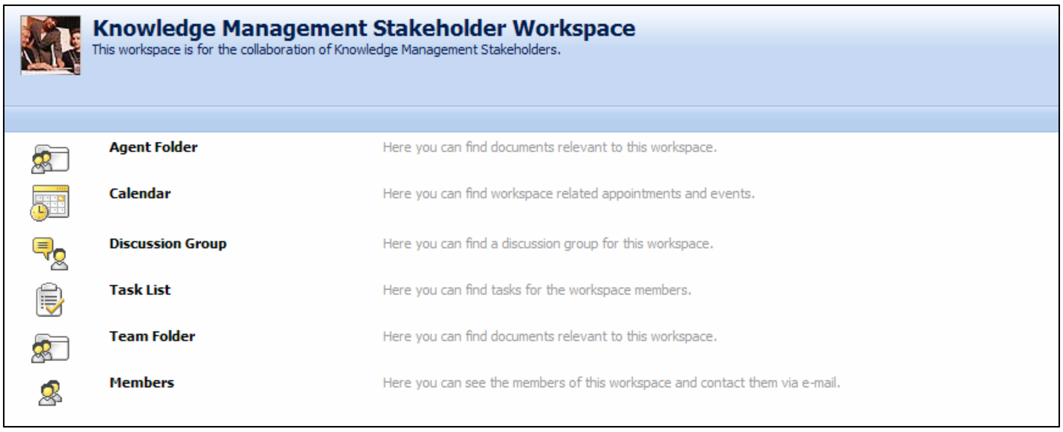


Figure 19 Example of the groupware portal (A0-GW)

The following explains the headings of the groupware utilised in the POC:

- **Agent folder.** All the push agent technologies used for the COP will reside in the "agent folder". These agents will inform the working group members of any changes to calendar events, discussions, tasks and documents.

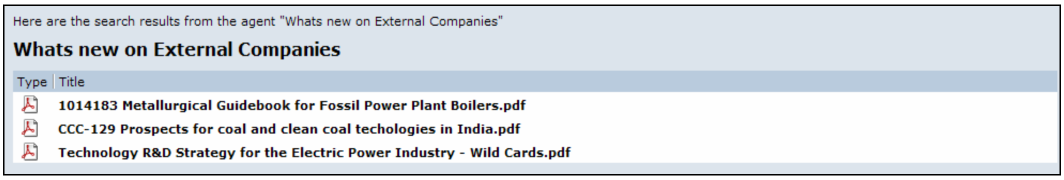


Figure 20 Example of a push agent

- **Calendar.** Shared calendar for the group to have a common view of the COP calendar.
- **Discussion group.** The discussions of the group will be handled with this component.
- **Task List.** The task list will be used to allow team members to receive tasks, note progress and share this with the rest of the COP in a common view.
- **Team Folder.** The documents of the team will be shared in this folder. It could have sub folders. The documents would not be attached for discussions via e-mail, but would reside in the team folder accessible to the COP.

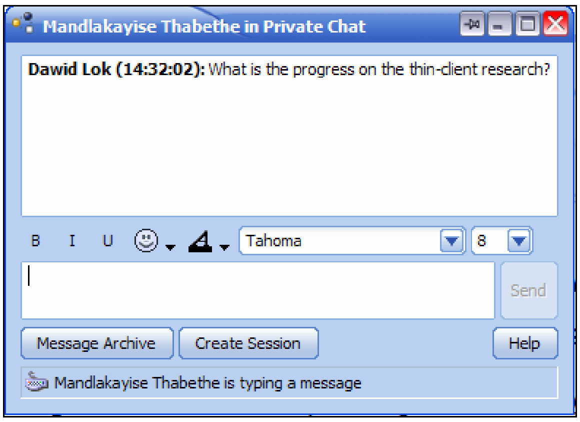


Figure 21 Example of chat session (including busy-typing indicator)

The keyboard indicator at the bottom of the screen (*see* Figure 21), intuitively indicates to the user that the other user is currently typing a message. This is very important with chats as the user need to know if there is any activity and whether he/she is awaiting a message. The chat session would enable a discussion between two or more people in a chronological order (*see* Figure 22). All previous discussions are searchable and available in the archive for further reference.

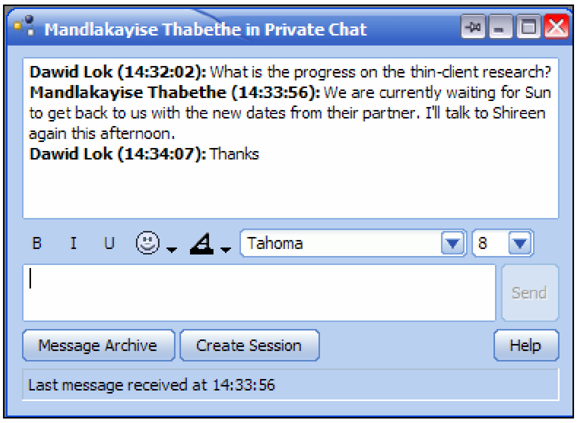


Figure 22 Example of completed chat session

DOCUMENT MANAGEMENT (A0-DM)

Document management is the second sub-system identified in the application architecture (A0, see Figure 16). All of the features discussed were included in the application layer of this architecture to enable basic document management functionality.

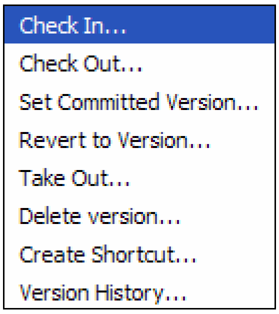


Figure 23 Example version control menus

The following document functionality was available:

- **Check-in**. Once a document is uploaded to the system, the document could be placed under version control. If it is an existing document, the document could be checked out, replaced and checked in.
- **Check-out**. A document under version control cannot be edited without checking out the document. Once a document is checked out, only the version owner could work on the document until it is checked in again.
- **Set Committed Version**. This allows the author(s) to work on a later document version without making it available to the community. The committed version is the official version despite newer versions available on the system.
- **Revert to Version**. The version history could be set a particular version, removing all subsequent versions of the document.
- **Take Out**. This feature removes the document out of version control and stored the document as a non-version controlled document.
- **Delete Version**. This menu item allows the user to remove a specific version.

- **Create Shortcut**. This feature allows the user to link to a document without creating a duplicate in another part of the classification structure (taxonomy).
- **Version History**. The full version history (content and meta information) is kept in the version history.

FREQUENTLY ASKED QUESTIONS (A0-FAQ)

The frequently asked questions provide functionality for users to ask a question to a particular FAQ domain. The system determined answer based on probability given to the user asking the question and enabling the administrator (expert) of the FAQ domain to react to unanswered questions (*see* 2.5.5 Innovation and creation components – "Harvesting tacit knowledge using frequently asked questions (FAQs)"). Figure 11, Figure 12, Figure 13 and Figure 14 indicate how the FAQ functionality was presented to the user. The search algorithms are the most important player in this functionality to allow determining probabilities when the user requests the best possible answer for the question.

5.2.3. Indexing and Search Layer

The central point to all the technologies that enables unstructured knowledge mining is the indexing and search engine (*see* 2.5.4 Search Engines). The algorithms applied in the search engine are important and includes Bayesian inference and Shannon's information theory.

The algorithms are handled by the platform. There are however important meta-tags that are required to be indexed in addition to the content to ensure that many of the information retrieval will be quick and enabling people profiling.

- Title
- Keyword
- Description
- Object Name
- Owner (allows people profiling)
- Author
- Trained Questions

5.2.4. Security Layer

The security layer required authentication (A0-AT) and authorisation (A0-AS). The authentication was based on a directory authentication utilising Light-weight Directory Access Protocol (LDAP). The authorisation was group and role based depending on the requirement of the taxonomy owner. All the layers of the authorisation were restricted by the authorisation module. This is indicated by the vertical layer next to all the horizontal layers (*see* Figure 16).

6. The Implementation Approach

The technology is important, but the balance between people and process is just as important to ensure a successful rollout of an eKP. People, process and technology are important and change management across all three of these pillars is required.

Siemens followed a Knowledge Strategy Process (KSP) to implement knowledge management into the whole of the organisation (Davenport *et al*, 2002). The process is very comprehensive and could not be applied to its fullest in the POC. The POC's implementation however has striking similarities with KSP.

POC Approach	KSP (Davenport *et al*, 2002)
A high-level strategy defined the need for KM	**Step 1:** Determine business context, strategy and ambitions
The area of the POC has been identified as an important business entity with people willing to participate	**Step 2:** Identify Knowledge areas relevant for the business case
The business KPIs exist. However, the KPIs for better collaboration are the focus of this study.	**Step 3:** Identify critical performance indicators
This is not in the scope of this dissertation as this requires extensive resources to conduct a full current versus future benefit realisation.	**Step 4:** Analyse knowledge areas (current and future impact on KPI)
The KM ambition identified is the need for better collaboration and knowledge sharing. The more frequent the contribution the better	**Step 5:** Analyse selected knowledge areas in terms of proficiency (P), codification (C) and diffusion (D) and determine KM ambitions.
The action plan is to better collaboration. Items such as training and workshops have been implemented to support this action plan.	**Step 6:** Formulate knowledge management action plan

Table 7 Comparison of the POC approach versus the KSP (Davenport *et al*, 2002) approach

The KSP proposed by Davenport *et al*, (2002) is a good process to follow from strategy through to the reinforcement part of the process, but is too comprehensive for this study. Table 7 indicates how this POC is similar to the KSP (Davenport *et al*, 2002) process without having an extensive process from strategy to reinforcement. A framework for implementing the tools and processes was defined to get a quicker implementation but without losing focus on the fundamental important factors.

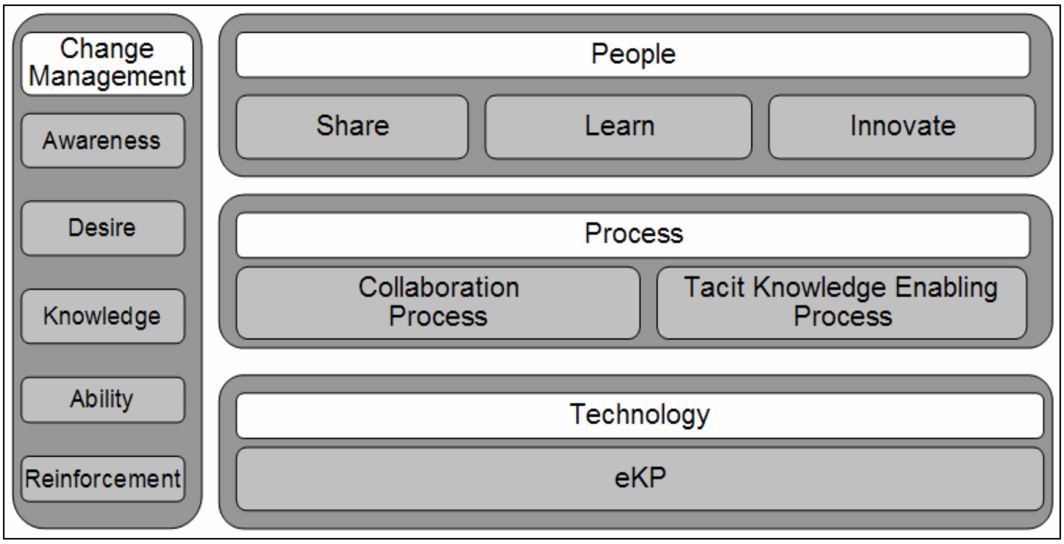


Figure 24 POC Implementation Approach (adopted from ADKAR (Randall, 2006), people-process-technology (PPT) and SECI model (Nonaka, *et al.*, 2000))

The high-level framework for implementing the technology was based on the framework in Figure 24. The framework is a combination of the ADKAR model (Randall, 2006), the popular people-process-technology triangle and the SECI model (Nonaka *et al*, 2000). The SECI model (Nonaka, *et al.*, 2000) was used as the basic principles and was not necessarily depicted in Figure 24. However, the components chosen in each of the PPT pillars were based on testing the applicability of the components against the SECI model (Nonaka *et al*, 2000) (see Table 8).

	Socialisation	**Externalisation**	**Combination**	**Internalisation**
PEOPLE				
Knowledge Sharing	X	X		
Learn				X
Innovate	X	X	X	X
PROCESS				
Collaborate	X	X	X	X
Tacit Knowledge Enabling	X	X	X	X
TECHNOLOGY				
eKP	X	X	X	X

Table 8 PPT mapping to support SECI (Nonaka *et al*, 2000) fundamentals

Sharing knowledge in this context was about the culture (willingness) to share knowledge in whichever form (verbal, written, video etc.). This was not a technology issue but rather a passion to share knowledge with others. The culture to share is not something that could be enforced easily. Sharing knowledge should be a way of life and if this was to be applied in the organisation, the culture should be stimulated through organisational processes such as collaboration and tacit knowledge enablement. Sharing knowledge could be made easier with technology and processes that support it.

Similar to knowledge sharing, learning and innovation should become a way of life and is not technology focussed. Technology and process could support this culture, but fundamentally this should be cultivated within the organisation and the individual must adopt this culture. Learning in the context of the SECI model (Nonaka *et al*, 2000) is part of internalising existing content available.

Innovation is what organisations want out of knowledge sharing and learning. Innovation cuts across all the principles of the SECI model (Nonaka *et al*, 2000) and is vital for survival for any organisation. The acceleration of innovation is a continuous challenge and should be supported by technology and processes. Innovation is ultimately stimulated by people and not technology. Processes and technology are enablers of creating an innovative platform for people.

The collaboration and tacit knowledge enabling processes are part of the process pillar and cuts across all the SECI (Nonaka *et al*, 2000) fundamentals. Collaboration requires socialisation, sharing the knowledge (externalisation), determining relationships of concepts externalised (combination) and in turn retrieving the information (internalisation). The process of collaboration is part of the drive to establish communities-of-practice (COPs). There could be a COP interested in a specific topic of a more structured COP such as a project team. A project, for example, has a critical need to share the important information and progress with the rest of the team and therefore collaboration is essential. A topical COP would discuss articles within the topic domain, stimulating innovation in the domain.

“Tacit knowledge enabling” entails a process to capture tacit knowledge (decision making knowledge) relevant to business processes and making it available to the organisation. In this study the focus was to follow a process to capture the tacit knowledge on a particular process, build decision trees and to link it to a questions and answers (FAQ) engine. The questions could then be asked to the engine and the system will in term retrieve the most probable answer to the user. If the answer is not sufficient, the question was reverted back to the specialist. The capturing process was two fold: initial capturing to gain enough information to make the FAQ useful, and then subsequently incrementally maintaining the questions and answers based on the demand from the business asking the questions.

The eKP is the technology layer to support the SECI (Nonaka *et al*, 2000) fundamentals on the people and process layer. It makes it easy to share, collaborate, learn, find information and to support specialised modules such as the FAQ engine.

The ADKAR (Randall, 2006) model is essential to ensure that all the activities that have to be done, are executed in a manner that will effect the desired change. Once the change was well known in terms of knowledge sharing, learning and innovation culture, the ADKAR (Randall, 2006) model was followed to affect the change:

- **Establish the need for knowledge management.** Collaboration and tacit knowledge sharing to support knowledge sharing, learning and innovation were identified to be the key objectives to be supported. The sample size of people supported the strategic driver and their senior management supported the project.
- **Create awareness.** Awareness was created through presentations and workshops to ensure that the people and their management were aware of the project.
- **Create desire.** The desire was required to ensure that true buy-in from the participants were established. This required understanding the business challenges of the participants through analysis and reacting to this in “selling” the features-attributes-benefits (FABs) of the project to the participants.
- **Knowledge transfer.** The training was done so that the team understood how to collaborate and how specialists would be able to perform tacit knowledge enablement.
- **Ability.** Workshops ensured that the skills were transferred based on the training with regards to collaboration in workspaces and for specialists to share tacit knowledge within the FAQ environment.
- **Reinforcement.** Continuous workshops were held to ensure that the habit of collaboration and tacit knowledge sharing were created.

7. Measuring the Knowledge Behaviour

Management required the platform to measure collaboration health and tacit knowledge sharing. Table 6 highlighted all the equations required to measure the behaviour for collaboration. The data was extracted utilising the indexing and searching engine Autonomy. A Java program was used to extract the data from the indexing engine and updating the raw data and statistical calculations into an Oracle database.

All the training on the system was completed and the users could be measured in terms of their contributions. The managers required collaboration health data from the platform which was extracted and provided to them. The section in the organisation used to test these measurements consists of 63 people

7.1. Collaboration measurement sample

The measurement of collaboration and the accuracy of the data were dependent on sufficient data collection. The search engine provided the ability to extract the activity data of the users. The following meta information on each information piece was considered as essential to determine the statistics:

- Authenticated user (owner attribute)
- Date modified
- Unique object identifier

These attributes was part of the global indexes of the search engine that allowed the extraction of the statistics.

	Population	**Sample Size**	**Sample Representation**
Number of authenticated users	240	123	51%
Supervisors	23	16	69%
Middle Management	207	106	51%
Senior Management	10	1	10%
Total documents contributed	211260	34774	16%
Total days contributed	3147	229	7%

Table 9 Summary of population and sample size

The sample representation in Table 9 indicates the users and the split between the different levels of the organisation. The sample size is considered to be representative. The statistics with regards to the documents contributed, days contributed and documents per day indicate that there were individuals in the team without a collaboration culture. This was benchmarked against good collaboration results of individuals known for actively collaborating on the platform.

CONTRIBUTIONS		
	AVERAGE	**MEDIAN**
SUPERVISOR	1246	1246
MID-MANAGEMENT	2020	1756
SENIOR MANAGEMENT	2579	2579
DAYS CONTRIBUTED		
	AVERAGE	**MEDIAN**
SUPERVISOR	47	47
MID-MANAGEMENT	79	70
SENIOR MANAGEMENT	114	114
CONTRIBUTIONS/DAY		
	AVERAGE	**MEDIAN**
SUPERVISOR	27	27
MID-MANAGEMENT	25	27
SENIOR MANAGEMENT	26	26

Table 10 Effective collaboration benchmark

This benchmark was also used in Table 5 to determine risk for a manager's responsible area as opposed to monitor to change behaviour. All the detail calculations for the summaries that follow can be referenced in Appendix 0. There are four final indicators that are important to consider:

- Equation 10 Key Performance Indicator for Individual Collaboration (KPI_{ic})
- Equation 11 Organisation Collaboration KPI (KPI_{oc})
- Equation 15 Individual Collaboration Risk (KPI_{icr})
- Equation 16 Organisation Collaboration Risk KPI (KPI_{ocr}))

KPI_{ic} and KPI_{icr} are individual indicators to monitor the behaviour of the person against each own team (KPI_{ic}) and against good collaboration targets (KPI_{icr}). KPI_{oc} and KPI_{ocr} are organisation based indicators (section, department or division) to monitor the behaviour of the organisational unit (KPI_{oc}) and against good collaboration targets (KPI_{ocr}). The results for KPI_{ic} and KPI_{icr} are respectively in Table 18 and Table 19 (see APPENDIX B DETAIL RESULTS OF COLLABORATION MEASUREMENT). The following is an extract of actual results to allow for explanation of KPI_{ic}:

	KPI_{ic}
Supervisor 1	100%
Supervisor 2	100%
Supervisor 3	55%
Supervisor 4	100%
Middle Management 1	100%
Middle Management 2	100%
Middle Management 3	100%
Middle Management 4	55%

Table 11 Extract of KPI_{ic} actual individual collaboration behaviour results

The results indicate that Supervisor 3 has a 55% individual collaboration compared to the rest of the other supervisors. Each managerial level competes on its own level. Supervisor 2 reached the limit and stretched the individual collaboration behaviour. Therefore the maximum of 100% was assigned to the individual's indicator.

The risk indicator of each individual was compared with a benchmark of effective collaboration within the same level of management. This indicator should not be used on any performance appraisal for an individual as it will discourage the individual whilst still adapting to the change. The KPI_{icr} is the indicator for each individual to indicate to a manager where an individual should be compared to the rest of the organisation.

	KPI_{icr}	Risk level
Supervisor	82%	HIGH
Supervisor	94%	HIGH
Supervisor	97%	HIGH
Supervisor	91%	HIGH
Middle Management	72%	MEDIUM
Middle Management	63%	MEDIUM
Middle Management	7%	LOW
Middle Management	94%	HIGH

Table 12 Extract of KPIic actual individual collaboration behaviour risk results

The KPI_{icr} classified the risk as low, medium or high (*see* Equation 1).

	Average KPI_{I1}	Average KPI_{I2}	Average KPI_{I2}	Average KPI_{IC}
SUPERVISOR	83%	66%	92%	70%
MID-MANAGEMENT	66%	45%	93%	52%
SENIOR MANAGEMENT	100%	100%	100%	100%

Table 13 Average Individual Collaboration Behaviour

The average of the KPI_{IC} indicates the maturity of the behaviour, with the exception of the senior manager that competes against none. Therefore, the senior management of this section should compete against the senior management of the rest of the system to be more accurate (i.e. the risk indicator should be used).

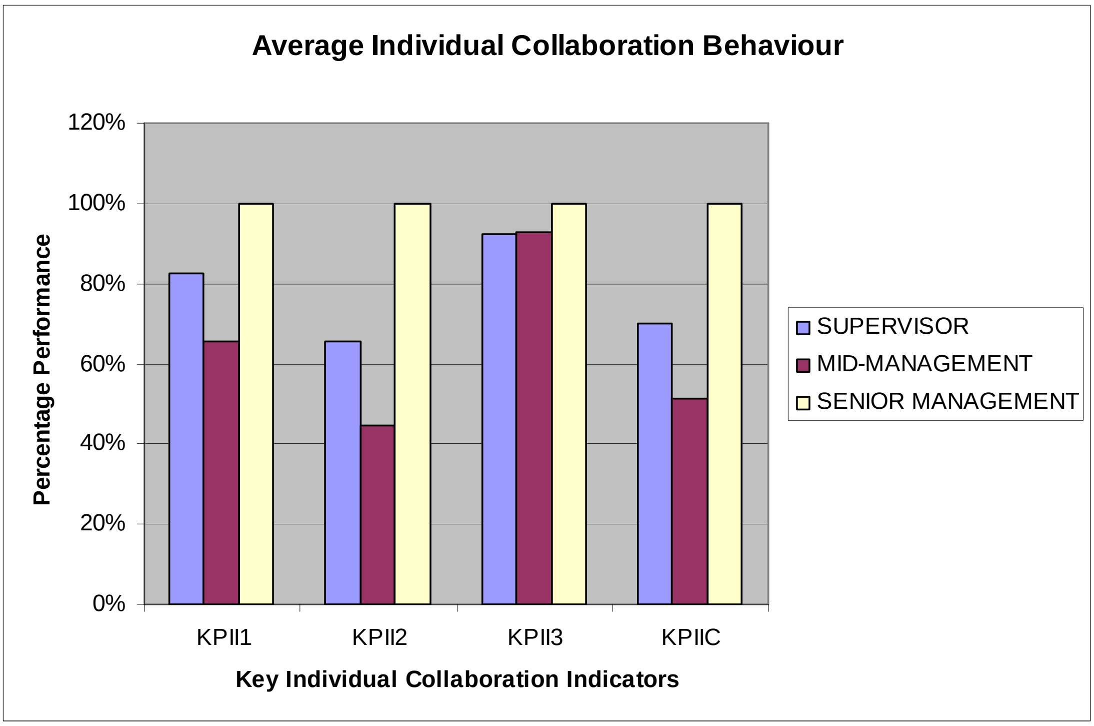


Figure 25 Average Individual Collaboration Behaviour Graph

The supervisors perform better than middle management. The senior management's result was not applicable as there were not enough people to compete in this level. The risk behaviour was more accurate in this case and was used as the measure.

	KPI_{ir1}	KPI_{ir3}	KPI_{ir3}	KPI_{icr}
SUPERVISOR	99%	95%	89%	95%
MID-MANAGEMENT	89%	95%	58%	90%
SENIOR MANAGEMENT	99%	96%	78%	95%

Table 14 Individual Collaboration Risk Indicators

The risk indicator is the indicator that adds perspective as opposed to the individual collaboration behavioural indicator. This indicator should be the target that the manager should strive to. In the cases where the individual behavioural indicator, as with the senior management in this study, is not accurate, then the risk indicator would highlight real risk.

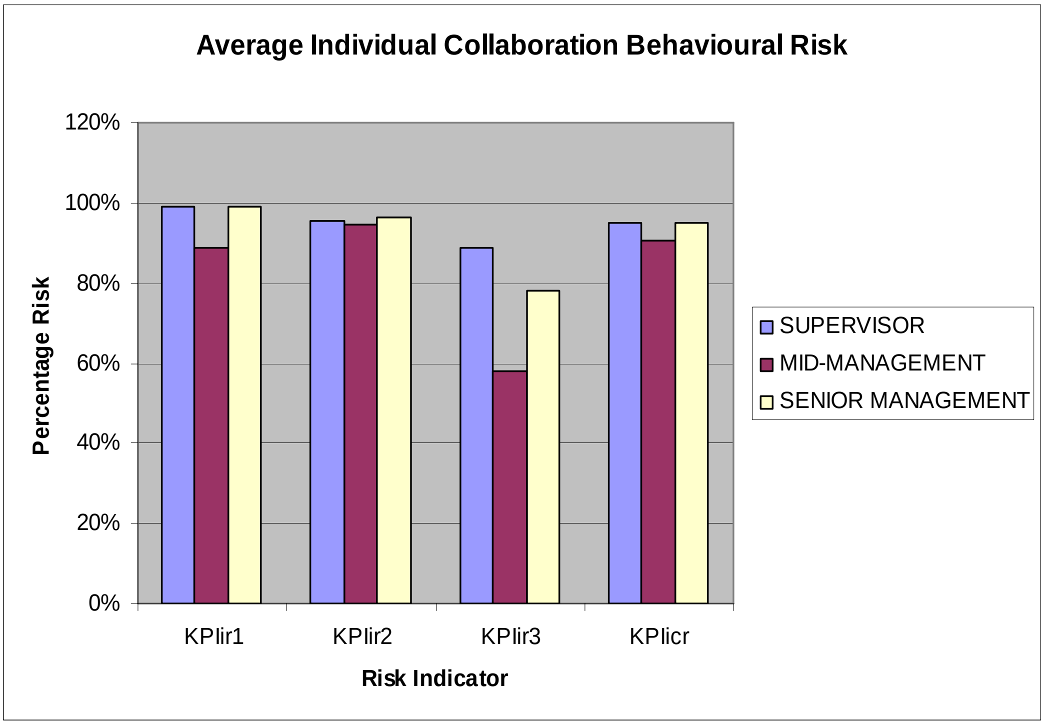


Figure 26 Average Individual Collaboration Behavioural Risk Graph

The risk and individual behaviour comparison is an important relationship to consider. Considering both values will give a manager an effective method of measuring the electronic behaviour. The correlation for the two indicators results is 0.77. This indicates that there is a significant correlation between these two factors.

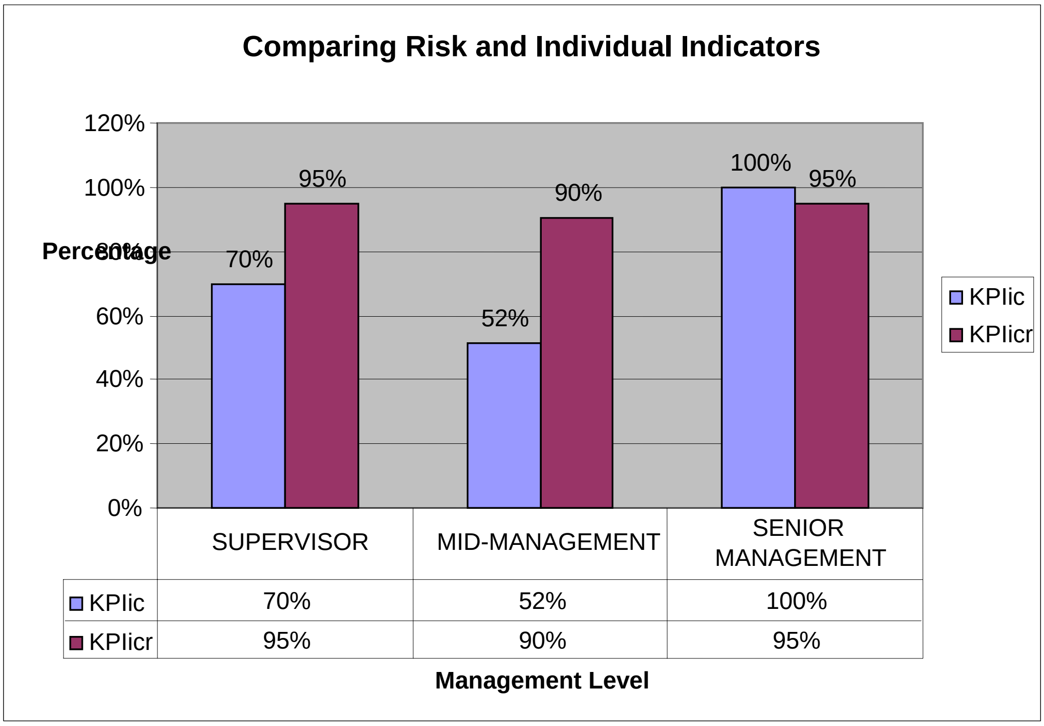


Figure 27 Summary of KPIic and KPIicr

The interpretation of these indicators compared could be summarised as follows:

Scenarios	Interpretation
Low KPI_{ic} and Low KPI_{icr}	This means that the individual was performing very well in general. The low KPI_{ic} indicated that the section or group has to improve within themselves, but compared to the rest of the good collaboration behaviour, the individuals were performing well.
Low KPI_{ic} and High KPI_{icr}	This means that the group was not performing well in general. The low KPI_{ic} indicated that the section or group need to improve within themselves. The high KPI_{icr} indicated that the behaviour of the individual was lower than good collaboration practice.
High KPI_{ic} and Low KPI_{icr}	This means that the group was performing very well and that the risk was low compared to the rest of the good collaboration practices.
High KPI_{ic} and High KPI_{icr}	This means that the group was performing very well. The high KPI_{icr} indicated that the behaviour of the individual was lower than good collaboration practice.

Table 15 Interpretation of KPI_{ic} and KPI_{icr} comparisons

The last important risk evaluation to highlight is the percentage of people in each management level exposed to a high, medium and low risk. The previous risk indicator indicate the behaviour risk (see Figure 26), whilst Figure 28 indicate what percentage of people are at the risk level for each management level. Clearly there are very few people in any of the management levels that has a medium or low risk.

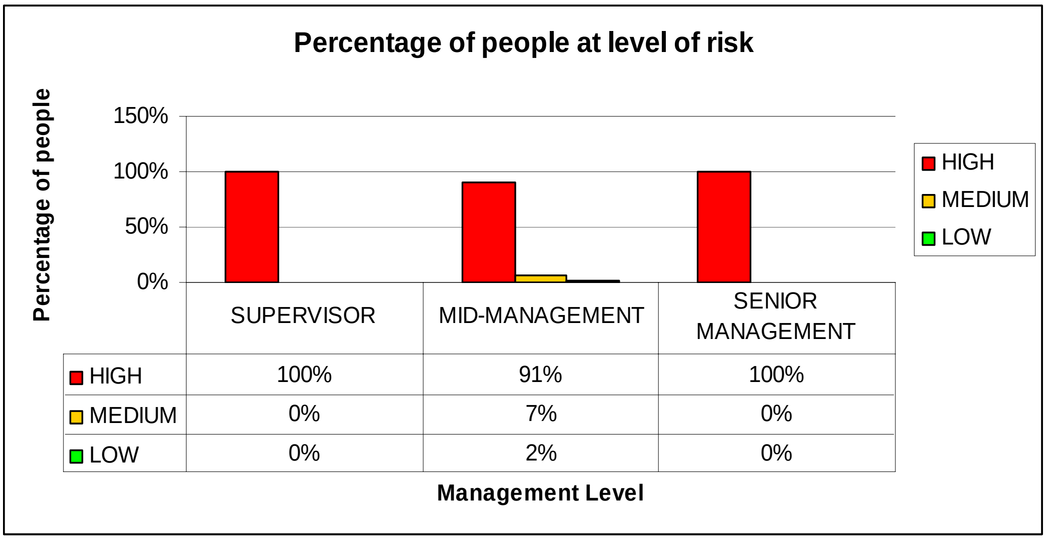


Figure 28 Percentage of people at level of risk

7.2. Qualifying the indicators

The qualification of the statistics generated was done via a questionnaire (see Appendix C) determining if it was relevant to measure the particular indicators and collectively measuring individual and organisational indicators. This section summarises the results of the questionnaires given to the managers that participated in this study. The managers in the study were a total of 12 of which all replied to the questionnaires.

The questionnaire had the following sections:

1. **Personal information**. This section gathered personal information of the manager as well has the management level.
2. **Composition of the individual indicator**. This section determined the opinion of the managers of the relevance of the components of the individual indicator as well as the relevance of comparing results to each management level.
3. **Composition of the organisational indicator**. This section determined the relevance of the organisational indicator.
4. **Usage of the indicator**. This section indicated if the individual and organisational indicators were implemented and used.

The questionnaire had a clear distinction between opinion of the relevance as well as the actual implementation of the indicators. The questionnaire did not take opinions of the risk indicator into consideration as this is an ancillary measurement and not implemented into the knowledge worker's performance compacts.

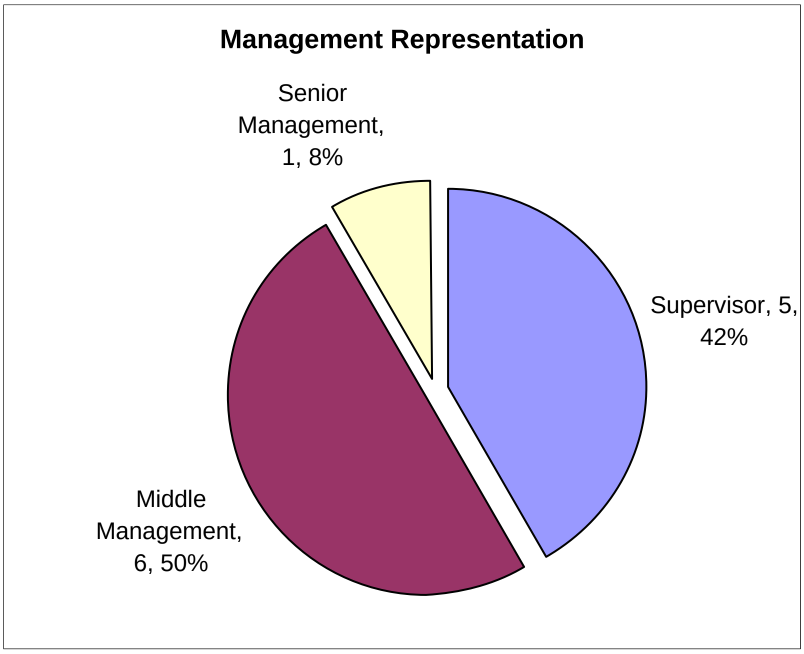


Figure 29 Management Representation

The management representation indicated the majority of the managers that participated to be middle management (50%). The results are therefore well represented from the tactical and operational level (see Figure 29).

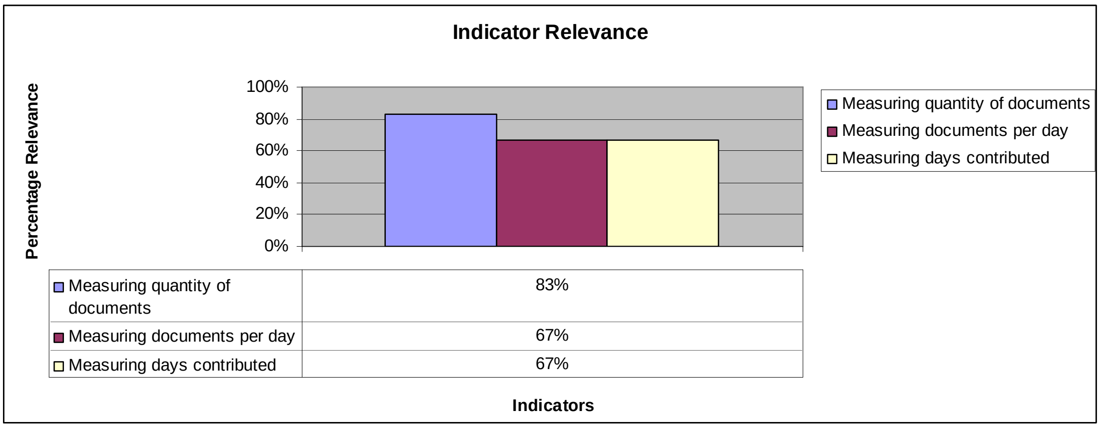


Figure 30 Indicator Relevance Results

The questionnaire indicated in Figure 30 that all three the indicators were relatively important with the highest consideration to the measurement of the quantity of the documents. The results added confidence to the relevance of all three the indicators and it could therefore be assumed that all three indicators should be measured.

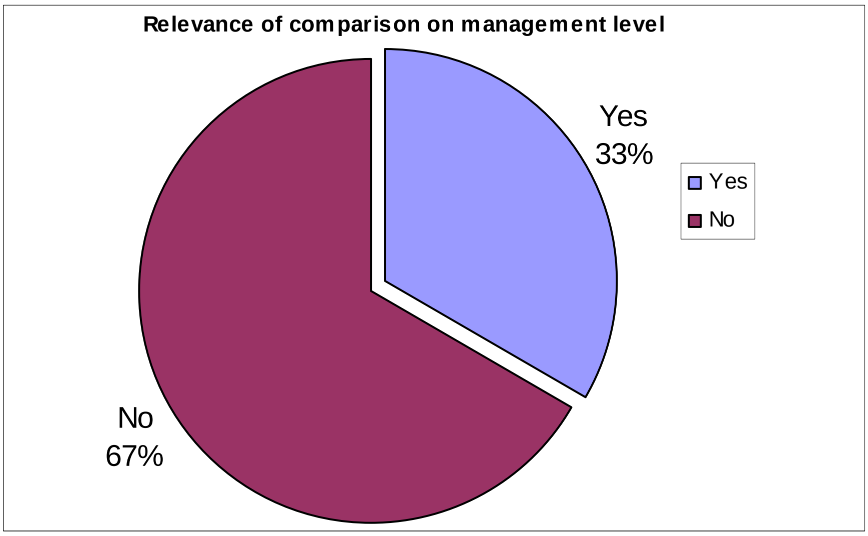


Figure 31 Relevance of comparison on management level

Most of the management considered it important to consider the aspect of the management level of the individual within the organisation. 67% of the management considered it as relevant to benchmark the individual against the relevant management group. This figure qualified the importance of considering management levels in the indicators.

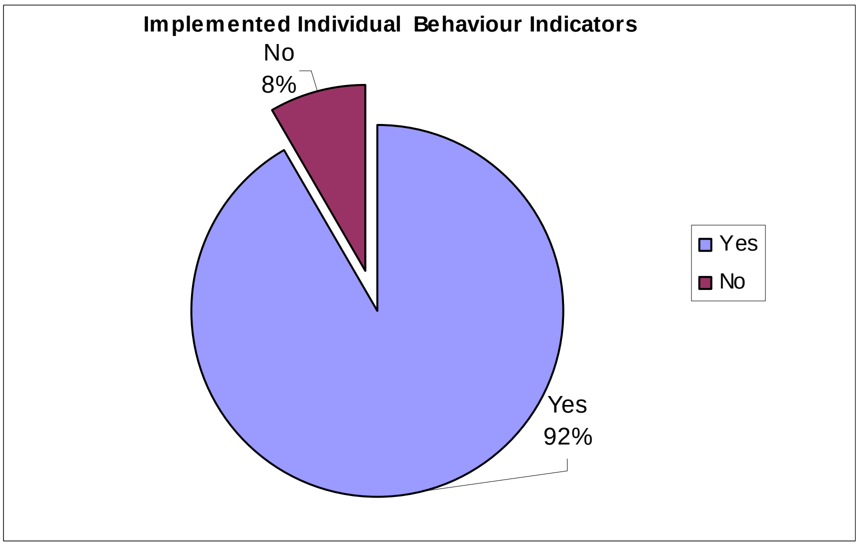


Figure 32 Implemented Individual Behaviour Indicators

Most of the managers (92%) implemented the measurement of the individual behaviour indicators on the performance compacts of the individuals (see Figure 32). Given the high relevance of the individual indicators and the actual implementation of these indicators, these indicators proved to be useful and effective.

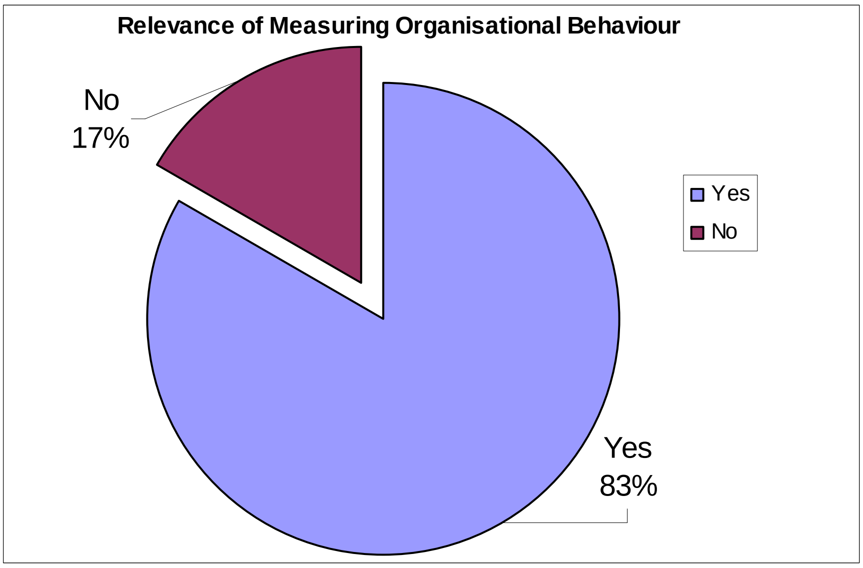


Figure 33 Relevance of Measuring Organisational Behaviour

The relevance of measuring the organisational behaviour was considered as very important (83%). Although not many of the managers implemented this indicator (see Figure 34), it is considered as important and it could be assumed that this will be implemented in future.

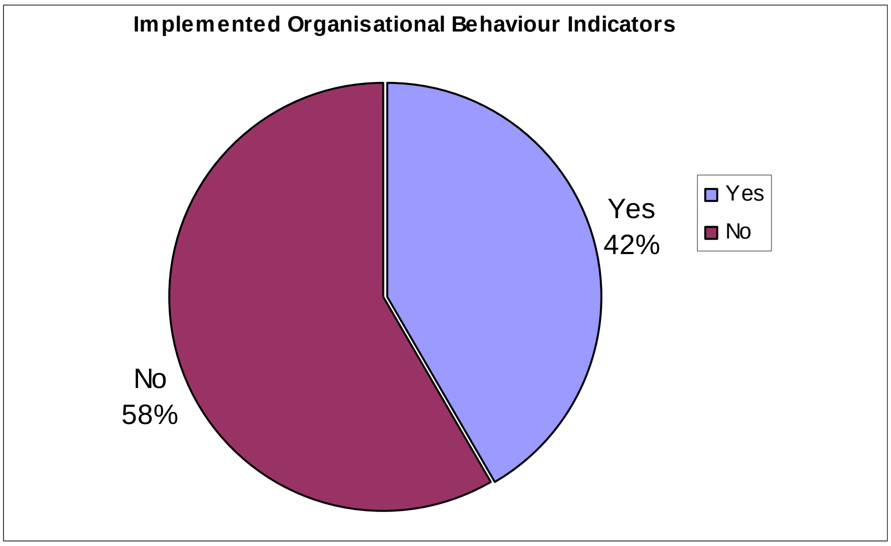
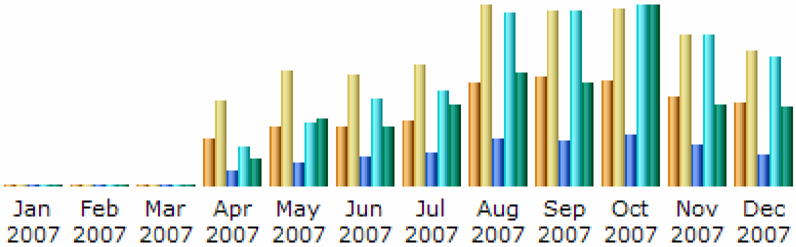


Figure 34 Implemented Organisational Behaviour Indicators

Less than half (42%) of managers implemented measurement of the organisational behaviour indicator, but given the importance of it (see Figure 33), it is likely that this indicator is useful and will be implemented.

7.3. Measurement of electronic learning culture

The measurement of electronic learning culture could be a very comprehensive study. In this study the only measurements are the utilisation of the web portal of the eKP. The web utilisation was a good indication of how many people read the information published by the knowledge workers. This indicated the need to learn and read information. These statistics were made available via the HTTP engine common log format.



Month	Unique visitors	Number of visits	Pages	Hits	Bandwidth
Jan 2007	0	0	0	0	0
Feb 2007	0	0	0	0	0
Mar 2007	0	0	0	0	0
Apr 2007	997	1792	24918	68092	4.83 GB
May 2007	1254	2423	38043	110376	12.23 GB
Jun 2007	1247	2344	50242	149142	10.87 GB
Jul 2007	1367	2538	57166	163510	15.03 GB
Aug 2007	2182	3777	80694	297114	21.08 GB
Sep 2007	2305	3683	78255	301413	19.26 GB
Oct 2007	2210	3709	88919	310670	33.36 GB
Nov 2007	1888	3174	69389	259463	14.84 GB
Dec 2007	1754	2828	52768	223001	14.63 GB
Total	15204	26268	540394	1882781	146.13 GB

Figure 35 Electronic Learning Behaviour

The average unique visitors are 1689 visitors per month. This indicated that for each contributor there were 7 visitors. The more important behaviour was the visits per visitor which amounted to 1.72. The amount of pages accessed was very important to determine if the visitor accessed more information which amounts to 20 pages per visit. The statistics clearly showed a constant interest in the information in the eKP and willingness to learn from a trusted source of knowledge workers.

8. Conclusion

Knowledge collaboration is an important part of knowledge management. Sharing knowledge and harnessing the ideas, decisions and documents that people gather through the life-long experience in organisations, enables organisations to gain a competitive edge. To ensure that knowledge is transferred and to overcome the challenge of too many students versus very few mentors, an eKP is required to disseminate the bulk of the information to other knowledge workers. The research presented in this dissertation focussed on this important aspect of knowledge management by answering these three research questions:

1. What measurements are required to monitor the knowledge contribution on an electronic knowledge platform?
2. What architecture could be used to establish an electronic knowledge platform to harvest knowledge and to measure the key indicators of knowledge contribution?
3. How could these indicators be used as a proactive tool for managers to determine knowledge sharing risks?

The measurement of the knowledge contribution health was discussed in Chapter 4 “Knowledge Behaviour Indicators”. The objective is to learn more about how many documents people contribute and how frequently they contribute to such a system. These indicators were used for both individual and organisational level measurement and could therefore be implemented into a larger organisation. The following indicators could be used to measure collaboration health on an eKP:

- Equation 10 Key Performance Indicator for Individual Collaboration (KPI_{ic})
- Equation 11 Organisation Collaboration KPI (KPI_{oc})
- Equation 15 Individual Collaboration Risk (KPI_{icr})
- Equation 16 Organisation Collaboration Risk KPI (KPI_{ocr}))

There are a number of important conclusions to take into consideration when using these indicators:

- KPI_{IC} and KPI_{OC} should be used to monitor performance of people’s collaboration in an organisation and not the KPI_{ICR} and KPI_{OCR}. Using risk indicators to the fullest extent whilst the culture is not yet establish will discourage people from changing their behaviour.
- KPI_{ICR} and KPI_{OCR} should be used to indicate the real knowledge sharing risk to the manager as a target to be achieved as part of the knowledge management strategy of the company.
- The ratings should be compared to the same management level classifications and not compare different management levels to each other. Figure 30 indicates that 67% considers the management level comparison as important.

The following observations were deduced from the management results:

- Figure 25 indicates within the KPI_{IC} indicator on the graph that the level of management does not imply a healthier contribution the higher the level of management.
- There is a significant challenge to reduce the percentage between the risk indicator and the individual indicator as indicated in Figure 27. The supervisor and middle management gap between actual and risk respectively is 25% and 38%. This may change over time as management enforces the culture into the organisation.
- It is difficult to monitor senior management behaviour without implementing the model across the organisation. Further research on this model may be required to have more exposure across senior management in the organisation.
- The need to learn from others increased over each month based on the search results indicating that the culture towards internalisation is settled and entrenched within the organisation (see Section 7.3 “Measurement of electronic learning culture”).

- There is resistance from people to be measured by their managers in terms of contributions. The opinion of 92% of the managers in this POC supported these measurements (see Figure 31). The individual behaviour should therefore be monitored according to the managers to ensure that the correct culture could be achieved.
- The organisational behaviour measurement for the section used in the POC was only implemented by 58% of the managers (see Figure 34). However, the relevance of this indicator has been highlighted to be 83% and therefore is expected to be adopted into the section.
- The risk indicator as depicted in Figure 27 measures the behavioural risk, whilst Figure 28 indicates that there are quite a number of people at each management level that is at a high risk. The management level has 7% at medium risk and 2% at low risk, whilst all the other management levels are at 100% risk.
- It is clear from the management opinion that there is a clear need to monitor the engineers in their collaboration effort (see Figure 30) whilst there is a clear challenge with regards to changing the behaviour (see Figure 27 and Figure 28).

The technology platform must have the following ability:

- The technology must be intuitive enough for people to use. Difficult technologies are not easily adopted.
- The technology must have an effective indexing and searching engine to allow ease of finding information and ease of extracting data to measure these indicators.
- The eKP must be easy to access and must be easily integrated with the day-to-day tools used for the organisation. For example, utilising office suites to perform day-to-day work for the organisation.
- In a large organisation a scalable solution should be used that could manage large volumes of data and disseminate information effectively across geographical boundaries.
- The architecture to be used has been clearly defined and substantiated in Chapter 5 “The Electronic Knowledge Platform (eKP) Architecture”. The study has shown that it is possible to extract the necessary data out of the platform to measure behaviour.

The ultimate challenge for knowledge management is to ensure that knowledge of people are shared and used by other knowledge workers. This will reduce the risk of having too few knowledgeable people to train and support a large number of junior staff. The study succeeded to ensure that there is a knowledge platform for a community to share their knowledge (see Chapter 5), monitor the behaviour of sharing knowledge (see Chapter 7) and disseminating the knowledge effectively across the organisation (see Section 7.3).

Enforcing the correct behaviour will ensure that some knowledge capital is retained for the organisation to reuse in future. Intellectual property of individuals, although created with organisational funding, remains within a human being until the individual is required to share the knowledge with others.

Future research questions identified within this dissertation are as follows:

- Why is there a higher take-up of knowledge sharing on supervisor level than on middle management level and is this acceptance of knowledge sharing and the technology used related to age?
- Do senior managers share knowledge vertical (top-down) more than they share knowledge horizontal (across domains at strategic level) within the organisation?
- Is the risk indicator relevant to the organisation and does it have any value measuring it if it is not enforced on an individual's performance compact?
- What is the impact of voice and video records on the future of knowledge management? Will the collaboration behaviour change from textual information exchange to voice and video with the need to monitor these activities?
- How does one measure electronic collaboration on the other intellectual capital components as explain by Davenport *et al* (2002)?
- What process should be implemented to harvest the knowledge shared on such an eKP to make it part of the organisation's processes to continuously enhance business processes based on innovative ideas?
- Could the knowledge in this type of knowledge base be interrogated and integrated into transactional analytical databases with one search portal and does it make sense to do this?
- Should one integrate this eKP with the future Voice-over-IP (VoIP) systems to harness intellectual capital from voice communication? Could one integrate VoIP systems with the questions and answers database to ensure that a voice portal could be used to disseminate information from the knowledge portal?

REFERENCES

Andreessen, M. (1993). ‘Mosaic - The First Global Web Browser’. National Centre for Supercomputing Applications. Feb (1993).

Bellinger, G. (2004). ‘Knowledge Management—Emerging Perspectives’ [online]. Systems-thinking.org. Accessed from: <www.systems-thinking.org> [Accessed 22 March 2007].

Binney D. (2001). ‘The knowledge management spectrum - understanding the KM landscape’. Journal of Knowledge Management, 5(1): 33-42.

Cambridge University Press. (2008). Cambridge Advanced Learner's Dictionary [online]. Cambridge University Press. Accessed from: <www.cambridge.org> [Accessed February 2008]

Davenport T.H., Probst G.J.B. (2002). “Knowledge Management Case Book – Best Practices”. Second Edition. John Wiley & Sons.

Edwards J.,McCurley K. & Tromlin J. (2001). ‘An Adaptive Model for Optimizing Performance of an Incremental Web Crawler’. Tenth International World Wide Web Conference.

George, K. (2006). “Executive Workshop on the Aging Workforce in the Utility Industry”. Electric Power Research Institute.

Gusfield, D. (1999). ‘Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology’. USA: Cambridge University Press.

Johnson, G. (2007). “Hype Cycle for Enterprise Communication Applications 2007”. Gartner. ID Number: G00148589.

Kane, H.C.M. (2003). ‘Reframing the Knowledge Debate, with a little help from the Greeks’. Electronic Journal of Knowledge Management, 1(1): 33-38.

Krishna, R. (2006). “Easing the exodus”. Power Engineering. June 2006: 36-39.

Licklider, J.C.R. (1960). ‘Man-Computer Symbiosis’. IRE Transactions on Human Factors in Electronics, HFE-1(1960): 4-11.

Licklider, J.C.R. and Robert W. Taylor. (1968). ‘The Computer as a Communication Device’. Science and Technology. 61(1968): 21-41.

Nonaka, I and Takeuchi, H. (1995). “The Knowledge-Creating Company”. Oxford University Press.

Nonaka I., Toyama R. and Konno N. (2000). ‘SECI, Ba and Leadership: a United Model of Dynamic Knowledge Creation’. Long Range Planning, 33(2000): 5-34.

Postly, J. 1981. ‘NCP/TCP Transition Plan’. Internet Engineering Task Force (IETF). RFC 801.

Randall, J. A. 2006. “ADKAR: a model for change in business, government and our community”. Prosci Research.

Republic of South Africa. Employment Equity Act 55 of 1998 (EEA 9). Annexure A. “Equivalent occupational levels”. South African Government Gazette. 1998.

Shannon, C.E. 1948. "A Mathematical Theory of Communication". Bell System Technical Journal. 27: 379–423 & 623–656.
Shkapenyuk V., Suel T. 2001. ‘Design and Implementation of a High-Performance Distributed Web Crawler’. Polytechnic University.

Snell, S.A., Lepak, D.P. and Youndt, M.A. (1999), ‘‘Managing the architecture of intellectual capital: implications for strategic human resource management’’. Research in Personnel and Human Resources Management, Vol. S4, pp. 175-93.

Stone, L.D. 1975. “The Theory of Optimal Search”. Operations Research Society of America.
Willis, D. 2007. “Hype Cycle for Networking and Communications 2007”. Gartner. ID Number: G00149058.

Wood, D. 1993. “Data Structures, Algorithms, and Performance”. Addison-Wesley Publishing Company.

Wyllie J. 2005. “Taxonomies: Frameworks for Corporate Knowledge”. Second Edition. Ark Group.

Zobal, J and Moffat, A. 2006. “Inverted Files for Text Search Engines”. ACM Computing Surveys, 38(2).

BIBLIOGRAPHY

Arora, R. 2002. “Implementing KM: A balanced scorecard approach”. Journal of Knowledge Management, 6(3): 240-249.

Central Intelligence Agency (2008). “The World Fact Book 2008”. Central Intelligence Agency.

Del-Rey-Chamorro, F. M., Roy, R., Wegen, B., and Steele, A. 2003. “A framework to create key performance indicators for knowledge management solutions”. Journal of Knowledge Management, 7(2), 46-62.

Despres C and Chauvel D. 1999. “Knowledge management(s)”. Journal of Knowledge Management, 3(2).

Haggie, K. and Kingston, J. (2003). “Choosing Your Knowledge Management Strategy”. School of Informatics, University of Edinburgh, Journal of Knowledge Management Practice, June 2003.

Kakabadse N.K., Kakabadse A. and Kouzmin A. 2003. “Reviewing the knowledge management literature: towards a taxonomy”. Journal of Knowledge Management, 7(4): 75-91.

Li M. and Gao F. 2003. “Why Nonaka highlights tacit knowledge: a critical review”. Journal of Knowledge Management, 7(4): 6-14.

Malhotra Y and Galletta D.F. (2004). “Building systems that users want to use”. Communications of The ACM, 47(12): 89-94.

Malhotra Y. (2004). “Desperately seeking self-determination: Key to the new enterprise logic of customer relationship”. Proceedings of the Americas Conference of Information Systems, New York, August 2004.

Malhotra Y. 2005. “Integrating knowledge management technologies in organizational business processes: getting real time enterprises to deliver real business performance”. Journal of Knowledge Management, 9(1): 7-28.

Mooradian N. 2005. “Tacit knowledge: philosophic roots and role in KM”. Journal of Knowledge Management, 9(6): 104-113.

Perez, J.R. and Ordónez de Pablos, P. 2003.“Knowledge management and organizational competitiveness: a framework for human capital analysis”. Journal of Knowledge Management, 7(3): 82-91.

Taylor, S., & Todd, P. A. (1995). “Understanding Information Technology Usage: A Test of Competing Models”. Information Systems Research, 6(2): 144-176.

Tiwana, A. 2000. “The Knowledge Management Toolkit: Practical techniques for building a knowledge management system”. New Jersey: Prentice Hall

APPENDIX A NOMENCLATURE

TERM	DESCRIPTION
ADKAR	Awareness-Desire-Knowledge-Ability-Reinforcement
Autonomy	An existing commercial search and indexing engine (http://www.autonomy.com)
BLOG	A blog is a website where entries are made in journal style and displayed in a reverse chronological order
BSC	Balance Score Card
COP	Communities of practice
DIKW	Data, information, knowledge and wisdom
eKP	Electronic Knowledge Platform
Electronic Knowledge Platform	An electronic knowledge platform is considered a scalable IT system that could be used to collaborate and share knowledge.
FAB	Features-attributes-benefits
FAQ	Frequently asked questions
HTML	Hypertext Markup Language
Hyperwave	An existing commercial electronic knowledge platform (http://www.hyperwave.com)
Hyperwave IS 6	The server software release version of the Hyperwave platform
IP	Internet Protocol
IT	Information Technology
KN	Knowledge Network
KM	Knowledge Management
KPI	Key performance indicator
KSP	Knowledge strategy process
POC	Proof-of-concept
PPT	People, process and technology
SECI	Socialisation, externalisation, combination and internalisation
URL	Uniform Resource Locator
VoIP	Voice-over-IP
WWW	World Wide Web
Wiki	A wiki is a type of website that allows the visitors to add, remove, and sometimes edit the available content

Table 16 Nomenclature

APPENDIX B DETAIL RESULTS OF COLLABORATION MEASUREMENT

All the calculations for this appendix are based on the summary of the calculations as in Table 6. This appendix will contain the detail of these calculations. The results of the calculations are based on the sample team specified. The data was extracted using a Java program to query the search and indexing engine on the objects contributed and particular days a user contributed information into the system. The results and statistics were updated into an Oracle database for ease of extraction of statistics given to the managers.

Table 17 summarises the detail results of the individual behavioural calculations for the following equations:

- Equation 1 Individual Volume Contribution (Indicator I_1)
- Equation 2 Individual Days Contributed (Indicator I_2)
- Equation 3 Individual Contribution per Day (Indicator I_3)

Management Level	**Contributions (I_1)**	**Days (I_2)**	**Contributions / Day (I_3)**
Supervisor	77	8	10
Supervisor	5	3	2
Supervisor	4	1	4
Supervisor	21	4	5
Supervisor	10	2	5
Supervisor	5	2	3
Supervisor	5	2	3
Supervisor	1	1	1
Supervisor	0	0	0
Supervisor	0	0	0
Supervisor	22	4	6
Supervisor	4	1	4
Supervisor	60	1	60
Supervisor	5	1	5
Supervisor	7	1	7
Supervisor	1	1	1
Middle Management	1	1	1
Middle Management	3	2	2
Middle Management	5	1	5
Middle Management	1	1	1
Middle Management	5	1	5
Middle Management	282	8	35
Middle Management	3	1	3
Middle Management	27	5	5
Middle Management	2	2	1
Middle Management	0	0	0
Middle Management	399	7	57
Middle Management	5	1	5
Middle Management	67	3	22
Middle Management	12	2	6
Middle Management	4	1	4
Middle Management	2	1	2

Middle Management	6	1	6
Middle Management	9	2	5
Middle Management	219	3	73
Middle Management	0	0	0
Middle Management	0	0	0
Middle Management	1999	3	666
Middle Management	42	4	11
Middle Management	9	3	3
Middle Management	45	1	45
Middle Management	7	2	4
Middle Management	5	1	5
Middle Management	3	2	2
Middle Management	18	3	6
Middle Management	0	0	0
Middle Management	353	6	59
Middle Management	69	1	69
Middle Management	1	1	1
Middle Management	0	0	0
Middle Management	94	2	47
Middle Management	29	2	15
Middle Management	36	3	12
Middle Management	24	2	12
Middle Management	6	1	6
Middle Management	5043	1	5043
Middle Management	4	1	4
Senior Management	20	4	5
	34774	229	8253

Table 17 Individual Collaboration Behavioural Results (I_1, I_2, I_3)

The individual collaboration behaviour must be measured against a target that would stimulate a change in behaviour, instead of discouraging the participants with too high targets. Table 18 summarises the results of the following target equations:

- Equation 4 Median of contributions per annum for the individuals in a particular management class (T_1)
- Equation 5 Average of days contributed per annum for the individuals in a particular management class (T_2)
- Equation 6 Ratio of median document contributions per annum (T_1) and the average of days contributed (T_2) for a particular management class (T_3)

	Contribution Median (T_1)	Days Average (T_2)	Contributions / Day (T_3)
SUPERVISOR	5	2	2.5
MID-MANAGEMENT	16	5	3.2
SENIOR MANAGEMENT	20	4	5

Table 18 Collaboration target results (T_1, T_2, T_3)

Equation 7 Individual Volume Contribution KPI (KPI_{I1})
Equation 8 Individual Days Contributed KPI (KPI_{I2})
Equation 9 Individual Days Contributed Per Day KPI (KPI_{I3})
Equation 10 Key Performance Indicator for Individual Collaboration (KPIic)

Management Level	KPI_{I1}	KPI_{I2}	KPI_{I3}	KPI_{IC}
Supervisor	100%	100%	100%	100%
Supervisor	100%	100%	76%	100%

Supervisor	80%	44%	100%	55%
Supervisor	100%	100%	100%	100%
Supervisor	100%	88%	100%	94%
Supervisor	100%	88%	100%	91%
Supervisor	100%	88%	100%	91%
Supervisor	20%	44%	46%	42%
Supervisor	0%	0%	0%	0%
Supervisor	0%	0%	0%	0%
Supervisor	100%	100%	100%	100%
Supervisor	80%	44%	100%	55%
Supervisor	100%	44%	100%	59%
Supervisor	100%	44%	100%	57%
Supervisor	100%	44%	100%	59%
Supervisor	20%	44%	46%	42%
Middle Management	100%	100%	100%	100%
Middle Management	100%	100%	100%	100%
Middle Management	100%	100%	100%	100%
Middle Management	100%	41%	100%	55%
Middle Management	100%	20%	100%	40%
Middle Management	6%	20%	31%	20%
Middle Management	19%	41%	46%	39%
Middle Management	31%	20%	100%	31%
Middle Management	6%	20%	31%	20%
Middle Management	31%	20%	100%	31%
Middle Management	100%	100%	100%	100%
Middle Management	19%	20%	92%	27%
Middle Management	100%	100%	100%	100%
Middle Management	13%	41%	31%	37%
Middle Management	0%	0%	0%	0%
Middle Management	100%	100%	100%	100%
Middle Management	31%	20%	100%	31%
Middle Management	100%	61%	100%	73%
Middle Management	75%	41%	100%	52%
Middle Management	25%	20%	100%	31%
Middle Management	13%	20%	61%	24%
Middle Management	38%	20%	100%	32%
Middle Management	56%	41%	100%	50%
Middle Management	100%	61%	100%	73%
Middle Management	0%	0%	0%	0%
Middle Management	0%	0%	0%	0%
Middle Management	100%	61%	100%	73%
Middle Management	100%	82%	100%	89%
Middle Management	56%	61%	92%	64%
Middle Management	100%	20%	100%	40%
Middle Management	44%	41%	100%	48%
Middle Management	31%	20%	100%	31%
Middle Management	19%	41%	46%	39%
Middle Management	100%	61%	100%	72%
Middle Management	0%	0%	0%	0%
Middle Management	100%	100%	100%	100%
Middle Management	100%	20%	100%	40%
Middle Management	6%	20%	31%	20%

Middle Management	0%	0%	0%	0%
Middle Management	100%	41%	100%	57%
Middle Management	100%	41%	100%	57%
Middle Management	100%	61%	100%	73%
Middle Management	100%	41%	100%	57%
Middle Management	38%	20%	100%	32%
Senior Management	100%	100%	100%	100%

Table 19 Individual Collaboration KPI results (KPI_{I1}, KPI_{I2}, KPI_{I3}, KPI_{IC})

The particular organisation collaboration KPI (KPI_{OC}) was calculated and the result of Equation 11 is 56%. This measurement is an average of all the KPI_{IC} measurements calculated.

Equation 12 Individual Volume Contribution Risk KPI (KPI_{IR1})
Equation 13 Individual Days Contributed Risk KPI (KPI_{IR2})
Equation 14 Individual Days Contributed Risk KPI (KPI_{IR3})
Equation 15 Individual Collaboration Risk (KPIicr)

KPI_{ICR} is an indicator that amounts to 100%, which is the top end of the risk scale.

Management Level	**KPI_{IR1}**	**KPI_{IR2}**	**KPI_{IR3}**	**KPI_{ICR}**
Supervisor	94%	83%	64%	82%
Supervisor	100%	94%	94%	94%
Supervisor	100%	98%	85%	97%
Supervisor	98%	91%	80%	91%
Supervisor	99%	96%	81%	95%
Supervisor	100%	96%	91%	96%
Supervisor	100%	96%	91%	96%
Supervisor	100%	98%	96%	98%
Supervisor	100%	100%	100%	100%
Supervisor	100%	100%	100%	100%
Supervisor	98%	91%	79%	91%
Supervisor	100%	98%	85%	97%
Supervisor	95%	98%	0%	88%
Supervisor	100%	98%	81%	96%
Supervisor	99%	98%	74%	96%
Supervisor	100%	98%	96%	98%
Middle Management	93%	68%	77%	72%
Middle Management	0%	84%	0%	67%
Middle Management	0%	11%	0%	9%
Middle Management	99%	97%	64%	94%
Middle Management	98%	99%	0%	89%
Middle Management	100%	99%	96%	99%
Middle Management	100%	97%	93%	97%
Middle Management	100%	99%	78%	97%
Middle Management	100%	99%	96%	99%
Middle Management	100%	99%	78%	97%
Middle Management	84%	90%	0%	80%
Middle Management	100%	99%	87%	98%
Middle Management	98%	94%	76%	92%
Middle Management	100%	97%	96%	98%
Middle Management	100%	100%	100%	100%
Middle Management	77%	91%	0%	81%
Middle Management	100%	99%	78%	97%

Middle Management	96%	96%	0%	87%
Middle Management	99%	97%	73%	95%
Middle Management	100%	99%	82%	97%
Middle Management	100%	99%	91%	98%
Middle Management	100%	99%	73%	96%
Middle Management	99%	97%	80%	96%
Middle Management	88%	96%	0%	86%
Middle Management	100%	100%	100%	100%
Middle Management	100%	100%	100%	100%
Middle Management	0%	96%	0%	77%
Middle Management	98%	95%	53%	91%
Middle Management	99%	96%	87%	96%
Middle Management	97%	99%	0%	89%
Middle Management	100%	97%	84%	96%
Middle Management	100%	99%	78%	97%
Middle Management	100%	97%	93%	97%
Middle Management	99%	96%	73%	94%
Middle Management	100%	100%	100%	100%
Middle Management	80%	92%	0%	82%
Middle Management	96%	99%	0%	89%
Middle Management	100%	99%	96%	99%
Middle Management	100%	100%	100%	100%
Middle Management	95%	97%	0%	87%
Middle Management	98%	97%	35%	91%
Middle Management	98%	96%	46%	91%
Middle Management	99%	97%	46%	92%
Middle Management	100%	99%	73%	96%
Middle Management	93%	68%	77%	72%
Middle Management	0%	84%	0%	67%
Middle Management	0%	11%	0%	9%
Senior Management	99%	96%	78%	95%

Table 20 Individual Collaboration Behavioural Risk Results (KPI_{IR1}, KPI_{IR2}, KPI_{IR3} and KPI_{ICR})

The manager should calculate not the section behaviour as well as the actual risk to the section in term of knowledge sharing via collaboration. Equation 16 was used to calculate the average on KPI_{icr}.

KPI_{ocr} = 91%

APPENDIX C QUESTIONNAIRE FOR QUALIFYING RESULTS

<table>
<tr><td colspan="5">QUESTIONNAIRE: MEASURING COLLABORATION</td></tr>
<tr><td colspan="5">CATEGORIES:
1. PERSONAL INFORMATION
2. COMPOSITION OF THE INDIVIDUAL INDICATOR
3. COMPOSITION OF THE ORGANISATIONAL INDICATOR
4. USAGE OF THE INDICATORS</td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">1. PERSONAL INFORMATION</td></tr>
<tr><td colspan="5">This section sources personal information and to determine view points from different levels of the organization.</td></tr>
<tr><td>Name</td><td colspan="2"></td><td colspan="2">Your name</td></tr>
<tr><td>Surname</td><td colspan="2"></td><td colspan="2">Your surname</td></tr>
<tr><td>Grading Level (Mark with X)</td><td>Staff or Supervisor</td><td></td><td colspan="2">Level within the organization</td></tr>
<tr><td></td><td>Middle Management</td><td></td><td colspan="2"></td></tr>
<tr><td></td><td>Senior Management</td><td></td><td colspan="2"></td></tr>
<tr><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="5">2. COMPOSITION OF THE INDIVIDUAL INDICATOR (KPI_{ic})</td></tr>
<tr><td colspan="5">This section determines if the respondent considers the individual indicators as useful.</td></tr>
<tr><td colspan="5">Does measuring documents contributed (amount) change collaboration behaviour? (Mark with X)</td></tr>
<tr><td>Yes</td><td></td><td colspan="2">No</td><td></td></tr>
<tr><td colspan="5">Does measuring each day documents were contributed change collaboration behaviour? (Mark with X)</td></tr>
<tr><td>Yes</td><td></td><td colspan="2">No</td><td></td></tr>
<tr><td colspan="5">Does measuring documents contributed per day change collaboration behaviour? (Mark with X)</td></tr>
<tr><td>Yes</td><td></td><td colspan="2">No</td><td></td></tr>
<tr><td colspan="5">Is it valid to compare individual results against the management grading group (supervisor or staff, middle management or senior management)? (Mark with X)</td></tr>
<tr><td>Yes</td><td></td><td colspan="2">No</td><td></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">3. COMPOSITION OF THE ORGANISATIONAL INDICATOR (KPI_{io})</td></tr>
<tr><td colspan="5">This section determines if the respondent considers the organizational indicators as useful.</td></tr>
<tr><td colspan="5">Does an aggregate value of the individual indicators add value to measure a group, section, department or divisions collaboration behaviour? (Mark with X)</td></tr>
<tr><td>Yes</td><td></td><td colspan="2">No</td><td></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5">4. USAGE OF THE INDICATORS</td></tr>
<tr><td colspan="5">This section determines if the respondent actually used the indicators within the business</td></tr>
</table>

Did you measure the individual collaboration behaviour of individuals? (Mark with X)			
Yes		No	
Did you measure the organisation collaboration behaviour of individuals? (Mark with X)			
Yes		No	