APPLICATION OF A KNOWLEDGE MANAGEMENT SYSTEM FOR TACIT KNOWLEDGE IN THE RAILWAY SECTOR IN SOUTH AFRICA

by

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DECLARATION

I, Mluleki Justice Majavu, declare that the contents of this thesis represent my own unaided work, and that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

11/05/2016

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ABSTRACT

This research reports on a study conducted in the railway industry in South Africa, the purpose being to help the railway industry by showing how a knowledge management system can be used in the task of extracting tacit knowledge. In the light of the fact that railways in many countries throughout the world function as an effective mass transportation system for passengers, this study aims to design and propose a model that will help the railway industry in South Africa in the task of implementing a knowledge management system to facilitate the process of extracting tacit knowledge from experienced employees and making it explicit knowledge in order to sustain railway system operations. This study looked at the process of designing a model that is presented as a recommendation to be used for a knowledge management system in the railway sector in South Africa. The aim of this study is not to provide a technical solution but to give a viable and workable reply to the main research question of this study: How can a knowledge management system be implemented or deployed to the railway sector? This study used an inductive approach as the question is descriptive but the results of this study have explanatory implications regarding the process needed. The methodology used is a case study with a qualitative method. The primary data was collected by using interviews as the instrument and analysed using thematic analysis that was developed through coding.

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DEDICATION

This thesis dedicated to my mother Nozibhozo Caroline Majavu and my grandmother who passed away , Mapholane Jolinkomo Majavu and especially to my wife Thenjiwe Princess for your continued support through my studies while you keep our family together, my daughter, Asithandile; my twins Buhle and Okuhle may God keep on Blessing you.

GLOSSARY

Terms/Acronyms/Abbreviations	Definition/Explanation
BPMN	Business Process Model Notation
DSS	Decision Support Systems
EPC	Event-driven Process Chain
ERP	Enterprise Resource Planning
IS	Information System
IT	Information Technology
KBS	Knowledge-Based System
KM	Knowledge Management
KMS	Knowledge Management System
K-Map	Knowledge Map
SECI Model	Socialization, Externalization, Combination, Internalization Model

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CHAPTER ONE
INTRODUCTION

1.1 Introduction

The South African Railway industry faces a major problem with regards to skills retention in the signalling maintenance. Signal engineers are an important part of the railway system in that they maintain essential systems that ensure the safety of goods and passengers. Most signal engineers have also doubled up as lecturers at railway training centres teaching new employees, signal engineers and artisans how to use various techniques. In many organizations the use of tacit knowledge is an important way of improving new recruits. Training is often done online as compared to the old system of classroom training. It is impossible for any one person to attain the breadth of knowledge needed in this field. It is important, therefore, for the experienced signal engineers to make explicit and codify their tacit knowledge base to new staff if services are to be maintained efficiently and effectively. In addition to the current demands of the railway system by passengers and the need for engineers, there is among the present employees a high level of retirement. South Africa does not have a specific institution where a person can learn about signalling. The only way a person can gain such knowledge in the railway sector is through innovative training methods and job shadowing. This does not mean, however, that all the expertise within the railway sector is immediately captured by a trainee or artisan. In order to become a signalling expert one needs to work in the railway sector for many years because it is the only way to gain the know-how in dealing with signalling faults.

The above illustrates showed that there is tacit knowledge in the railway system and it is of vital importance that those who will soon retire transfer their knowledge to others so that the railway system can benefit from it. It is obvious that a signal engineer is an important component in the railway system, as their key business is to transport passengers safely using reliable signalling systems. Stover (2004) specifies that there must a systematic articulation of that knowledge in order to prevent the loss of knowledge from those signal engineers. Jain et al (2008) states that the railway is still doing things the old traditional way, but at the same time the old signal engineers are retiring or leaving the organisation. This alone should be a warning signal to the railways industry that if something is not done to address this issue; it could lead to the collapse of the railway.

The effective use of Knowledge Management (KM) is an important means of achieving competiveness as its application and use is a relatively new approach. The usefulness of KM and its application has been identified by different pioneers and academics as an important area in organisations(Chang et al., 2011). Chang et al. (2011) point to studeies by Drucker and Strassman in the 1980's, and observed that information in general and knowledge information are an in organisations (Benedictetal.,2005; Ward and Peppard,2007; Davenport,2013). KM has become a critical issue in organisations as the major competitive advantage for a corporation lies in its corporate knowledge, i.e. information in the context in which it is used (Adeleke and Alegbeleye, 2013). The implementation of Knowledge Management System (KMS) processes has long been overlooked in the KMS literature.

A well designed and functional KMS can help an organisation to ''know what they know and what they do not know''(Li et al., 2011), and assist an organisation in the need to share, retain and re-use knowledge. KMS are pervasive, resulting in that the amount of money spent on KM services is growing steadily (Xu and Quaddus, 2012). This is particularly true for tacit knowledge possessed by individuals – knowledge that is vital for a company to compete in a highly competitive environment (Nevo and Chan, 2007). Important knowledge that resides in a company is often not noticed, stored or utilised. It is usually when staff members leave or resign from a company that the awareness of the loss of knowledge becomes apparent. This represents a substantial loss of valuable intellectual assets in a company (Wong and Aspinwall, 2004). One aspect of a KM programme is to foster the emergence of sharing and diffusion of knowledge among staff members so that each member can take advantage of the learning and expertise of another in daily work (Nevo and Chan, 2007).

Knowledge adds value to an organisation through its contribution to products, processes and people, while a KMS transforms information, data and intellectual assets into enduring value by identifying useful knowledge for management actions (Vandergrift and Goh, 2006). KM consists of processes that facilitate the application and development of organisational knowledge, in order to create value and to increase and sustain competitive advantage (Cheng et al., 2008; Patil and Kant, 2014).

Corporate attention and spending have been paralleled by rising academic interest, which has produced numerous investigations, ranging from the ontology (Köhler et al., 2006) of organisational knowledge and its transfer to a KMS as well as the

effectiveness of KM within organisations. As Galunic et al.(2014) note, studies of the effectiveness of a KMS are important because the risks of inflated expectations are high, given the volume of knowledge-based work, and the allure of technology to help eager managers craft higher performing organisations. However, while studies of general knowledge transfer, consequences and performance have appeared (Hendriks and Vriens,1999), studies of the benefits of a KMS are under-explored (Galunic et al.,2014). Luban and Hîncu (2009) pointed out that although KM is primarily process-oriented with strategies determined by the organisational culture, motivation and policies, KM needs the right methods, technologies and tools for successful implementation (Luban and Hîncu, 2009). In particular, the focus area of this research is "how can knowledge be extracted and transferred from employees in the railway organisation so that it becomes explicit knowledge?"

Although operationalised in many different forms, knowledge management systems are generally information technology-supported processes (Xu and Quaddus, 2012) which collect, categorise, and disseminate organisational knowledge (Wilson, 2005) for the purpose of quality, efficiency (reuse), and learning or development (Abdul-Munaim and Lutfi Hussain, 2014). These are tools that help connect workers to knowledge and to other people, regardless of physical distance (He, Qiao and Wei, 2009), and that can be used whenever a knowledge worker chooses. Additionally, they constitute knowledge governance in firms' attempt to use them as formal structures which influence human capital development and progression. A KMS can help because it will work as a baseline that can be utilised to access previous knowledge (Wong and Aspinwall, 2004). This research then focuses on the development of a KMS for the railway industry in South Africa.

1.2 Background to the Study

In South Africa, the knowledge which is relevant to the job description of a signalling system in the railway sector, is related to theory and practice, signalling components, assessment and competency and refresher course administration (Haywood, 1994). The problem is to capture organisational knowledge systematically and to store manuals, best practice experience, guidelines for practical and theory-training and know-how. This is done in order to make knowledge accessible to more than one individual. Liao (2003) mentions that as it stands today, informal methods of creating and managing knowledge are currently being utilised by signalling, but this is done more on an individual, fragmented basis. When older signalling technicians retire, they leave the railway sector with the knowledge that they have accumulated over

their many working years. This knowledge base has then to be re-built or re-constructed by every new staff member who takes up employment in the industry.

Other than a process of a KMS of organisational knowledge (Rubenstein-montano et al.,2001), access to relevant knowledge, and finding key stakeholders and knowledge experts to assist, is often not an easy task (Kulon et al., 2006). Furthermore, the theoretical concepts of KM should be the basis for the process of designing a KMS and the appropriate ways of representing knowledge (Karadsheh, 2009). There are unstructured ways to build organisational knowledge, but this will take time as it will entail searching for and accessing relevant knowledge, which in turn impacts on the speed and quality of decision-making because of the absence of the knowledge base, which is technology based (Moradi et al.,2013). Floyde et al.,(2013) looked at technologies that have been implemented to ensure the speed at which knowledge is accessed, but knowledge representation techniques have made computational methods of processing knowledge possible.

1.2.1 Context of the Study

A railway signalling system requires a high level of safety to maintain the safe operations of trains. Therefore, in order to ensure the safety of passengers, safety-related regulations for railway signalling systems are internationally standardised. A safe, reliable and efficient railway system is dependent on many different factors, but it is signalling which is the most essential element, as without a signalling system trains cannot run both safely and efficiently. Therefore, it is crucial for rail organisations to look at the process of managing their current knowledge base so that it can be transferred to new and upcoming technical staff.

When employees leave an organisation they take with them the organisational knowledge that they have built up over many years of service in the organisation (Ooi,2014). This highlights the need for railway organisations to extract tacit knowledge from their employees before they leave or retire from the organisation.

An organisational entity, such as the railway sector in South Africa, does not have a specific institution or curriculum for the training of people in signalling systems, rail engineering and other rail-related courses. The only knowledge that the organisation possesses has been gained through experience, i.e. tacit knowledge. When the sector loses its experienced employees, it not only loses the employees but also the knowledge that these people have. These experienced engineers e with tacit

knowledge are in high demand, and therefore the costs involved in rehiring them are substantial.

Without this valuable asset, rail infrastructure and rail operations would collapse. The results would be devastating both for those people who are dependent on the railway for transport, and also for employees who would lose their jobs as a result of a collapse in this industry. The damage done to the economy at large would also be severe. At the present time it is not clear how the railway industry in South Africa can retain the knowledge held by its experienced employees when they leave the organisation.

1.3 The Research Problem

When employees leave the railway industry, they leave with substantial organisational knowledge (Maruta, 2014). This results in a negative impact on the operation of the entire railway network in South Africa, specifically on the signalling system, which is the key to its operation (Jain et al.,2008). The research problem for this study was therefore:

> "How can knowledge be extracted and transferred from employees in the railway organisation so that it becomes explicit knowledge?"

This research focused on the investigation of how knowledge is currently captured as well as how the railway sector in South Africa can design and implement the process of transferring tacit knowledge that employees have, before they retire, so that the tacit knowledge they have can be passed on to others in order for the railway sector to continue working smoothly.

1.4 Research Objectives

The overall objective of this study was to explore a model that would assist the railway industry in South Africa to implement a KMS that facilitates the process of extracting tacit knowledge from experienced employees and to make that knowledge explicit in order to sustain organisational capacity. In order to achieve the sub-objectives are therefore to:

1. Investigate the current practices of capturing tacit knowledge in the railway industry in South Africa.
2. Investigate the need for tacit knowledge to become explicit knowledge.
3. Examine mechanisms required to extract tacit knowledge from older and experienced employees.

4. Propose on how the railway industry can design a system to capture tacit knowledge.

1.5 Research Questions

Based on the problem statement and the objectives of the study, the following research questions are also posed to amplify the research topic:

1. What are the current practices of capturing tacit knowledge in the railway industry in South Africa?
2. Why is there a need for tacit knowledge to become explicit knowledge?
3. What mechanisms are required to extract tacit knowledge from older and experienced employees?
4. How can the railway industry design a system to capture tacit knowledge?
5. How can a KMS for tacit knowledge be designed and implemented for better service delivery?

1.6 Scope of the Study

The study was carried at Metrorail a division of Passenger Rail Agency of South Africa (PRASA) in the Western Cape region of South Africa. There participants were selected from three departments; human resources, signalling, information and communication technology and business performance. The scope of the study was to explore a process on how to design and implement a KMS for the railway industry in South Africa. The study did cover the technical design of a KMS, as this would have necessitated more time, and going beyond the scope of a masters' degree.

1.7 Significance of the study and limitations

The assumption was that railway organisation in South Africa had the tacit knowledge within human capital. There was a need for extractive tacit knowledge to make it explicit. The study excluded other regional signaling engineers, artisans; top management, human resource and infrastructure were not being part of the study. There focus was on the Western Cape region the whole cape metropolitan areas.

This study contributed to the railway sector in South Africa by proposing a model that will assist in the extracting of tacit knowledge and put to the system, the knowledge will be available for the new technical staff. It will also contribute in South Africa railways, by saving lot of money they used to rehire the employees with the knowledge of signaling system. Since the research in the railway sector is not much, this contributed to research for the new knowledge in the railway sector worldwide.

1.8 Definition of Terms

Information and Communication Technologies is the use of systems (especially computers and telecommunications) for storing, retrieving, and sending information (Wu et al., 2010).

Knowledge is defined as doing what is needed to get the most out of knowledge resources (Wu et al.,2010).There are two knowledge classifications: tacit and explicit knowledge.

Explicit knowledge is the knowledge that is the more visible knowledge found in manuals, documentation, files and other accessible sources (Nonaka, 1994). Explicit knowledge may pose a particular challenge related to an assumption of legitimacy by virtue of being recorded (Botha et al 2008).

Tacit knowledge is the knowledge that is highly personal and is difficult to formalise, making it difficult to capture, communicate, or share. Subjective insights, intuitions, and hunches fall into this category of knowledge (Novak, 2009; Mishra and Bhaskar, 2011). It is deeply rooted in an individual's actions and experience as well as in the ideals, values, or emotions they embrace, which makes it difficult if not impossible to formalise and communicate(Novak, 2009).

Data are any form of information available for the purpose of making decisions (Al-Jamimi and Ahmed, 2013).

Information is external knowledge that has been gathered from different sources for the purpose of assisting others in their various tasks. By using this information a person's life can be changed as they learn from the experiences of others (Altaher, 2010).

Knowledge Management is the process of capturing, developing, sharing, and effectively using organisational knowledge (Baskerville and Dulipovici, 2006).

Knowledge Acquisition is the process of extracting, structuring and organising knowledge from one source, usually human experts, so it can be used in software such as an Expert System (Soo et al., 2002).

Knowledge Transfer is the practical problem of *transferring knowledge* from one part of the organisation to another (Stephens & Fulé, 2005).

Knowledge Management System (KMS) refers to a class of information systems applied to managing organisational knowledge and is defined as "an application system that combines and integrates functions for the contextualised handling of both explicit and tacit knowledge, throughout the organisation or that part of the organisation that is targeted by a KM initiative." (Dorasamy et al.,2013).

Knowledge Management Process is the process of capturing, developing, sharing, and effectively using organisational knowledge. It refers to a multi-disciplined

approach to achieving organisational objectives by making the best use of knowledge (Karadsheh, 2009).

1.9 Conclusion

The focus of this study was on “how can knowledge be extracted and transferred from employees in the railway organisation so that it becomes explicit knowledge?” This study considered the nature of knowledge in terms of the progression from data to knowledge, the various types of knowledge (namely tacit and explicit knowledge), and knowledge structures that exist within the railway industry in South Africa, in order to evaluate suitable knowledge-sharing tools and representation techniques for effective knowledge transfer. Recommendations are made for a suitable combination of tools and techniques suited to the railway sector in South Africa. The study was focused specifically on knowledge pertinent to the work of signalling for staff members of the railway industry in South Africa, revealing how this important issue is usually omitted by technicians and their managers who are working to alleviate the problems involved in signalling on railways.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

The literature in KM provides a valuable insight into the research on the development of tacit KMS. This chapter explores literature relating to KM; the nature and attributes of KM; knowledge types and their characteristics; ICTs as an enabler in KM; KM in railway organisations; the process of attaining a KMS; different knowledge management systems; kinds of knowledge and its codification.

2.2 Knowledge and Knowledge Management

It is no surprise then to find that studies on KM allude to the fact that by effectively connecting the wealth of inherent and integral knowledge contained within an organisation through various KM techniques, the right knowledge can be supplied to the right people at the right time (Georgiev,2013). This enables the implementation of this knowledge into concrete actions and so enhancing organisational efficiency and effectiveness (Bush and Tiwana, 2005).

It is posited that KM facilitates improved organisational performance (Zhen et al.,2013), improved decision making (Holsapple and Joshi, 2001; Holsapple and Joshi,2000; Durcikova et al.,2011; Bush and Tiwana, 2005:71;Watson and Hewett,2006), creation of core competences (Liao, 2003), gaining a competitive advantage (Luban and Hîncu, 2009) and becoming a promoter of improved problem solving (Hung et al.,2011; Bush and Tiwana,2005:p.67-71; Watson and Hewett, 2006). As Zieba (2013) puts it, “[t]hat knowledge is of fundamental importance for organisations of any size and industry is no longer a question”.KM is also an enabler of organisational learning as it facilitates the continuous sharing and exchange of knowledge that perpetuates the learning process within the organisation (Zhen et al., 2013). There are three types of learning that occur within an organisation as a result of KM: individual learning, learning through direct communication, and learning using a knowledge repository (Yun, 2013).

A knowledge repository is typically associated with the systematic storing of explicit knowledge. Direct communication is often necessary for experiential learning, whereas tacit knowledge is acquired through consultation with experienced persons (Hall and Andriani, 2002;Hall and Andriani, 2003;Gourlay, 2006).

Knowledge is considered to be a high-value form of information. What makes it so valuable is added experience, context, interpretation and reflection (Davenport, (2013: p.43), i.e. personalised information (Alavi and Leidner, 2001).Tacit knowledge is the knowledge that people have in their minds, whereas explicit knowledge is the kind of knowledge that is captured or written down (Gourlay, 2006). An example of tacit knowledge would be an academic's know-how of approaching the task of teaching mathematics in an effective manner. An example of explicit knowledge would be a framework for assessing knowledge on different cognitive levels (Jung et al.,2005). The main difference between the two is that tacit knowledge cannot be accessed as easily as explicit knowledge. According to Jennex et al. (2007) embedded knowledge within an organisation, found in repositories, documents, processes, manuals etc., is made more valuable with the context, experience and interpretation that a living person can add to it, i.e. tacit knowledge. Jung et al.(2005) insinuated that knowledge can come from a wide range of sources, such as projects, tasks and processes, as well as from the people who make and use those processes.

KM consists of a collection of methods, techniques and tools (Liao and Wu, 2010) that facilitates four activities: capturing, storing, sharing and using knowledge (Sher and Lee, 2004). These four processes are performed sequentially. However, knowledge-sharing is considered to be the main process of KM (Nonaka at el., 2008).

Knowledge-sharing is the process of making an individual's knowledge available to others. This is possible by converting knowledge into a form that is easily accessible and easily understood by others (Nonaka and Takeuchi, 199). By sharing knowledge about expertise, skills and other relevant knowledge based on context, experience etc., particularly from various domains, a level of organisational learning and knowledge is created which is more valuable than the knowledge that is possessed by a single individual (Noruzy et al., 2012), enabling the organisation to innovate (Nieto, 2003; Herschel at el.,2001).

In some studies conducted in the field of KM, it is noticeable that knowledge-sharing in particular has become an area of concern (Nomura, 2002). This is due to the fact that KM can only be sustained through the continuous process of sharing, which is dependent upon people. Therefore the efforts involved in, and the aim of preserving KM, is to create a culture of sharing in an organisation (Nomura, 2002).

In a study conducted by (Voelpe, 2005),they reported that motivations for knowledge-sharing from the receiver's point of view include: time saving and productivity

enhancement, access to approved solutions and answers to problems, and finding capable people who can provide assistance based on their experience. This reveals the invaluable benefits of knowledge-sharing, even if this is not always evident to the knowledge sharer. That is why, according to Wiltshier and Edwards (2014), the process of providing feedback on how one's knowledge-sharing efforts have benefited the work of others is essential for developing a positive attitude towards knowledge-sharing.

The literature shows the importance of both tacit and explicit knowledge in an organization. While explicit knowledge is more formal and easily accessible tacit knowledge resides in the heads of people and this study sought to find how this particular knowledge can be captured and stored for the benefit of the railway sector in South Africa.

2.3 The Nature and Attributes of Knowledge

Understanding and highlighting the various levels of KM, and differentiating between the terms used in KM is important for this study. The key terms are data, information and knowledge (Altaher, 2011). These terms, often used interchangeably within decision making processes, are however, different in essence and function (Alavi Maryam & Leidner, 2001). The right understanding of this difference is a vital basis for a successful design, establishment and functioning of any KMS, as well as for the design process for the particular system used.

2.3.1 Data

Data is a raw fact, not related to any other data. Indeed, on its own, raw data is insignificant. Information, however, is a collection of related facts (or data), for which a context has been established through a relationship. The added context provides meaning to this collection of data (Liebowitz, 2011).The context, established through the relationship of the collection of data, makes it useful. It has also has been shown that the tools used in the process of converting data, as mentioned above, must be distinct from the tools used when converting data in general. Examples of data would be experiments, calculations, observations derived from attributes or numerical quantities (like quantitative data which are capacity, cost, time and velocity and capacity), and qualitative data interviews and structure questionnaires (Maxwell, 2012). Maxwell speaks about how data can be collected, however this data needs to be converted and processed in order for this data to become information. This is shown by Liebowitz (2011) who states that knowledge is the application of information.

2.3.2 Information

Information is associated with explanations and data collection, interpretations, and other textual material concerning a concerned process or event and object (Kairu-Wanyoike et al.,2014). The question that relates to data and information is when, where, what and who (Wellman, 2009). This implies that through the application of information in a particular process, the how and why ensues and knowledge is created. It is only by answering when, where, what and who on the level of information, as identified by Wellman (2009) that we can enter the level of knowledge. Therefore, knowledge is the use of information to increase awareness, organise, teach and understand all the information within an organisation in order to synthesise all of the various components into a cohesive whole. Knowledge and its potential is found in groups, people or organisations. It is knowledge that must be utilised in the processes of decision making. When there is an ethos of a learning process, decisions can be made that will help to attain proper understanding and appropriate action (Singh and Kant, 2008).

It has already been stated that Liebowitz (2011), links wisdom to the experience of anything that a person has done. It is impossible to transfer personal experience to another person, but an experienced person can teach others so that they can learn from that person's experience and so be opened up to that person's wisdom (Liebowitz, 2003; Bellinger et al., 2004). This can lead people to maturity, to the ability of identifying truth and making correct judgements based on the knowledge, experience and insight of others (Altaher, 2011). The intellectual capital within organisations like railways etc., needs the application of KM in order to attain collective organisational wisdom. In simple words, the progression from data to knowledge occurs as understanding increases, so that wisdom and experience occur simultaneously (Liebowitz, 2011). Bellinger, Castro and Mills (2004) concur with this progression from data to knowledge, but include understanding and wisdom as additional classifications of the content of the human mind (even though their focus for this "content" relates more to the realm of IT than to KM).

2.3.3 Knowledge

Knowledge is one of the most important concepts used in engineering, building on the great contribution of Greek philosophers for centuries (Mary et al.,2013). It is vital to understand that knowledge originates with people. According to Malavasi et al.

(2014), the knowledge that someone has about anything is a good asset. When this principle is applied to the context of railways, we find that the knowledge a person has is vital in the task of knowing how to identify and fix signal faults – something that is not an easy task for an ordinary person to do (Sutton and Mcilwain,2008). Through the use of reason, the way engineers fix signals can be turned in to knowledge. The Greek philosopher Aristotle states that the reason we have understanding is to provide us with the means to solve problems. He called this "knowledge" (Qipeng et al.,2011). Knowledge is considered as rational, abstract, impartial and universal in Western Philosophy. When knowledge is used to solve a particular problem, it is important to store that knowledge using some form of technology so that it can be used by others (Rodrigue et al., 2013).

The very first KM tools were developed in the early 90's (Nonaka,1994) because people became more aware of knowledge understanding. KM models and tools that were used within the context of social interactions in general and in human behaviour (Koh and Gunasekaran,2005; Pridmore et al.,2007; Chen et al.,2012), were the same models and tools that were used in the context of the railway industry (Pridmore et al., 2007;Pezzillo et al.,2012;Schiuma, 2012). However, these tools and models did not focus on or capture human knowledge in a suitable way to fulfil the objectives of railway organisations (Pezzillo et al.,2012). Knowledge demands an active contribution of managing knowledge systems, something which is of a far more complex nature than just simply having data and information (Mostert,2007). Therefore, for the implementation of a KMS, it is essential, already at an early stage, to clarify the vast differences that exist between the terms "data" and "information" (Nevo and Chan, 2007).

Many researchers have tried to clarify and discuss what constitutes data, information and knowledge, and lastly wisdom (Bermell-Garcia et al., 2012;Collins, 2010; Costa et al., 2010;König et al.,2013;Marras & Hancock, 2014), where the basic terminology used is dependent on the researcher's objective and the lessons learnt from the area of the research involved. This also contributes to the body of knowledge in regard to KM in general. There is relationship between data, information and knowledge that can be likened to the form of a pyramid (Liebowitz ,2011). Liebowitz and Megbolugbe (2003) illustrated that in this context the pyramid has data as its base, followed in hierarchy by information and knowledge, with wisdom connecting directly with experience at the apex, as is shown in figure 1.1.

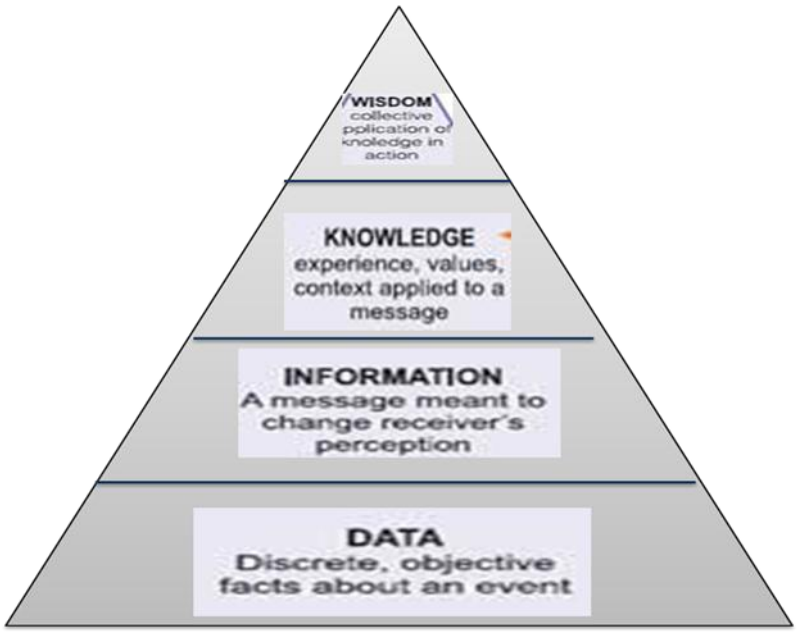

Figure 1.1: Knowledge Pyramid (Liebowitz, 2011)

The DIKW hierarchy was first mentioned within the field of KM by Zeleny in 1987 and subsequently by Ackoff in 1989, but an earlier reference is made by Cleveland in 1982 within the Information Science domain Hey and Nielsen (2004); Sharma et al. (2012). Up to this point only data, information and knowledge have been considered for the purpose of this study, but Clarke & Bailey (2000) considers four classifications, with the progression from data to wisdom. Ackoff (1989) includes understanding, making it five categories in total for classification. However, Milton et al.(2006) does not include understanding as a classification or category, but depicts understanding as the support for the transition from one category to the next. Ackoff's (1989) definitions of data, information and knowledge concur with what has already been explained that data means symbols or raw facts, information means data that is processed into a usable form, knowledge being what is created through the application of data and information (Bellinger et al., 2004).

Ackoff's (1989) view is that knowledge addresses the "how" while understanding addresses the "why". His differentiation between knowledge and understanding is that knowledge is deterministic, while understanding is cognitive and analytical (Martin, 2009). In other words, knowledge is being able to collect relevant information for the purpose of its application, while understanding is being able to reason about knowledge, usually based on perception and judgement. Based on this differentiation between knowledge and understanding, Ackoff (1989) considers knowledge to

involve an assimilation of information and understanding as the synthesis of new knowledge from existing knowledge.

2.4 Knowledge Types and the Characteristics

Knowledge types and characteristics are explained in the form knowledge elements, tacit and explicit knowledge. Figure 1.2 shows both knowledge elements separated (tacit and explicit), and their differences are categorised. The human elements of knowledge that are implicit in and part of tacit knowledge need to be captured and stored so that these tacit elements become integrated into explicit knowledge. The proposed purpose of this research was to look at "how can knowledge be extracted and transferred from employees in the railway organisation so that it becomes explicit knowledge?"

Figure 1.2: Knowledge Elements (Polanyi, 1969)

Polanyi (1969:p.18), posited in scientific theory generation, that it was the application of tacit knowledge in any industry that leads (Nonaka et al.,1995) scientists to generate new theories. Using this as a premise, the study showed a proposed model of a KMS that can be specifically used in the railway industry. The knowledge that is needed here can be gained from understanding the value, strength and power of tacit knowledge.

Nonaka (1995) argue that the awareness and importance of tacit knowledge has been generally accepted in the literature of KM as a powerful element. Because tacit knowledge resides in an individual's mind, it has been identified as a more personal element in knowledge, as it is built on individual experience, values, personal beliefs and perspectives (Hendriks and Vriens, 1999).

There is a wide range of studies in the field of KM regarding tacit knowledge and its concepts, for example, in the field of engineering, mathematics, non-academic industries etc. The importance of tacit knowledge has been emphasised in many different areas, for example, knowledge auditing, knowledge innovation, knowledge-sharing, knowledge acquisition, artificial intelligence, data mining, information systems and others (Wyatt, 2001;Stover,(2004);Gharehbiglo et al.,2012;Warkentin et al., 2012;Larsen and Olaisen, 2013). Tacit knowledge is the concept that was first introduced in KM by Nonaka and his colleagues, however, many other authors use this work as a kind of reference point (Collins, 2010; Gourlay (2006), discussed tacit knowledge as a form of knowledge that is without linguistic and numerical elements, something that is highly personal and context specific and deeply rooted in an individual's emotions, values, ideas and experiences.

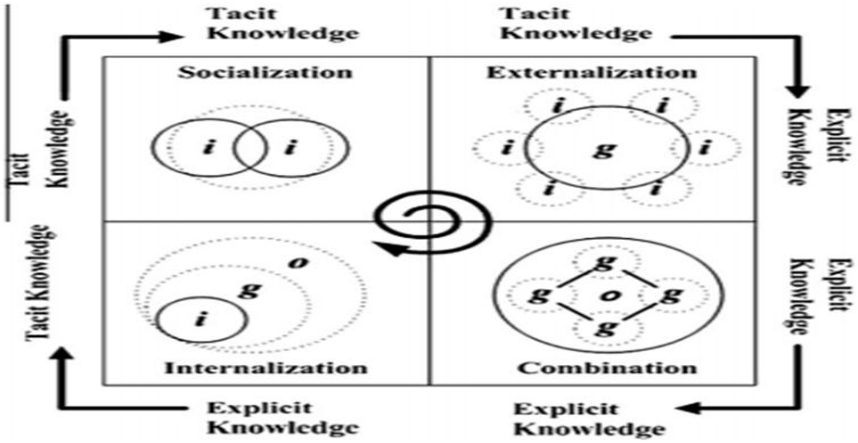

Figure 1.3: SECI Model (Nonaka & Takeuchi, 1995)

Polanyi (1969), differentiates the various types of tacit knowledge and their meanings, as technical tacit knowledge (meaning skills or concrete "know-how"), and cognitive tacit knowledge which refers to ingrained dispositions, beliefs and mental models that are taken for granted (Gourlay, 2006). By direct experience, and through the actions of individuals, technical tacit knowledge is created. Through learnerships or job shadowing (Nonaka and Takeuchi 1995:p.10-60), technical tacit knowledge can be acquired through practical learnings (apprenticeships) (Nonaka and Konno, 1995: p.62-63; Nonaka et.al.,1994: p.314). Cognitive tacit knowledge, however, is not transmitted through formal academic channels but, for example, through informal discussions regarding problems at work or through the medium of social activity (Nonaka and Takeuchi, 1995: p.63; Dirección, 2013). "Internalisation" input needs to be based not just on tacit knowledge, i.e. personal experience etc., but also needs to be balanced by using explicit knowledge. This necessarily involves changing mental models, (Nonaka, 1994; p.64-69).

Gourlay (2006) identifies that the know-how is more concrete in technical tacit knowledge than in cognitive tacit knowledge. This argument shows that tacit knowledge and tacit knowing are aligned to technical tacit knowledge more clearly. Today, as in the past, people use face to face and hands-on methods to convey tacit knowledge or 'know how' to other people (Gourlay, 2006). This is shown in technical tacit where most people are able to show others the type of experience they have gained, not necessarily in writing, as most of the signal engineers in the railway industry do not like to write down what they know.

If one needs to use both tacit and explicit knowledge, there are a number of activities and frameworks that are available in a number of studies done by different authors. (Nonaka and Konno, 2000) came up with the proposed model SECI figure 1.3. This model is well-known in KM. As well as indicating that tacit and explicit knowledge is a type of KM, he also describes how tacit and explicit knowledge were described and recreated, transferred and generated, in most enterprises. More specifically, if one talks about the SECI model figure 1.3, the model has four knowledge conversion modes: (tacit to tacit) socialisation, (tacit to explicit) externalisation, (explicit to explicit) combination, and (explicit to tacit) internalisation (Nonaka & Takeuchi, 1995)

The process of tacit knowledge-sharing can be done by practice, formal participation in technical issues, through informal contacts and also through observations. This process is called "Socialisation". A building field of socialisation normally starts with social interaction. The key to the creation of knowledge is "Externalisation", i.e. when tacit knowledge becomes explicit knowledge through articulation. The process of integrating concepts into knowledge is called "Combination". Lastly, Nonaka et al., (2000) discuss "internalisation" as a process of transferring tacit knowledge into explicit knowledge (Yu at el., 2013). They also argue that in the production of a product unique to a particular individual, the SECI model can be used effectively (Yip at el., 2012).

The SECI model is very important in teaching institutions, but can also be of great benefit to complex organisations like the railway industry. In railway signalling, KM should look at how a KMS can help in identifying, designing, keeping, sharing, distributing, (Krogh, 2009) and implementing a system for tacit knowledge within the railway sector for the smooth operations of railway services when people who have that knowledge retire. The SECI model would be the most suitable approach (Krogh, 2009) for the railway sector that will help in the process of designing the tacit

knowledge system. Nanaka and Takeuchi's (1995) SECI model is seen by most researchers as the best and most suitable framework in KM, even though there are other models and frameworks available. As tacit knowledge is the form of knowledge that is most prevalent in organisations like the railway system, it is vital for groups and individuals to interact in a ''knowledge spiral'' (Nonaka and Takeuchi, 1995) which will result in the creation of knowledge.

Pawlowski and Bick (2012), states that there are 160 reviews of KM frameworks worldwide. Most of the activities regarding knowledge are: acquiring (Sher and Lee, 2004), auditing, engineering (Studer et al., 1998), capturing, storing, transferring (Simperl, 2009), creating, applying and identifying. Although the knowledge activities are described separately (Curado and Bontis, 2011), the integration of the activities is seen as more beneficial to the organisation than each separate activity (Kraaijebrink, 2012).

Nonaka and Takeuchi (1995) mention that internalisation is a way of making explicit knowledge tacit. The concepts of tacit and explicit knowledge are discussed further in the next section in order to gain a greater understanding of the various types of knowledge. Rowley (2007) not only touches on internalisation, but also on other processes for transforming information into knowledge, including information combined with synthesis, study, experience, skills, training, perception and understanding. Reed et al.(2013) rightly pointed out that "Knowledge is power", independent of being tacit or explicit. Knowledge begins with an individual who passes it on to others, eventually becoming organisational knowledge.

2.5 Information and Communication Technologies as an enabler in Knowledge Management

ICTs have contributed significantly to the speed at which knowledge can be accessed and processed. This applies even to the railway sector (Liao, 2003:158). Knowledge transfer today relies on ICTs for the creation and dissemination of knowledge within the railway industry (Liao, 2003:p.158, 159). There are many studies that have evaluated suitable KM technologies, including the studies conducted by Liao (2010) and more recently (Wu et al., 2013), which identifies several KM technologies and knowledge-based systems (Ward and Peppard, 2007). Other studies consider KM technologies as one of a number of barriers to knowledge-sharing in the railway

sector (Schalekamp & Behrens, 2010) as much of the literature focuses only on the technical issues at its inception (Alavi and Leidner, 2001:p.193).

According to Wu et al. (2013), the technologies that have been deployed in the railway sector in order to enhance knowledge processing capabilities, include ICTs applications such as enterprise resource planning, portals, data warehouses and KM tools (Saxena, 2013). However, most of these technologies, particularly signalling systems, have not applied the full potential of KM. Most signalling systems, for example, are used for operational or fault finding activities, such as signal points. These technologies, therefore, cannot be considered as knowledge-processing tools if we consider the true definition of knowledge (Wiltshier and Edwards, 2014). There is a real need to differentiate between information and knowledge (Simperl, 2009). What are considered to be knowledge-sharing tools are in fact information-sharing tools, if we are to apply Pohs' (2000:p.2) definition of KM, which emphasises the need for tacit knowledge to be used together with explicit knowledge. According to Renzl (2008), both explicit and tacit forms of knowledge must be captured and shared for information to become knowledge.

Some examples of knowledge include: knowledge of a particular job (Kruger and Johnson, 2005), such as how to elicit and specify user requirements, or how to teach computer programming; knowledge of a good way(Kuby et al., 2001). If not the best way, to do a particular task; knowledge of how to solve a particular problem; knowledge of who knows what in an organisation (Mahboob, Zahid, et al., 2012). Knowledge of how to put together a team that can achieve a particular task (Mahboob, Schone, et al., 2012) knowledge of how to get things done in an organisation; knowledge of a particular customer account; knowledge of a country and its business customs(Kuznetsov et al., 2014). König et al.(2013)Knowledge is often unique to a particular organisation or domain. The kind of knowledge that would be created and transferred would therefore influence the kind of IT tools that facilitate KM.

The basic knowledge life cycle involves knowledge creation, knowledge transfer and knowledge use (Bakshi, 2005). In relation to the four KM activities identified previously, i.e. capturing, storing, sharing and using knowledge (Lee, 2001:p.324), knowledge creation encompasses capturing and storing, while knowledge transfer relates to sharing. The process of transferring knowledge involves codification and personalisation (Babur and Ali, 2006). Where codification incurs, more explicit processes of documenting knowledge such as writing down an experience are

required, so that any employee who has the same experience, will be able to use that knowledge. Personalisation involves tacit forms of knowledge which is better shared through personal sharing, where context and meaning are added (Bartol and Srivastava, 2002). Technology can facilitate both processes of codification and personalisation (Armistead and Meakins, 2002). An example of knowledge codification would be employees referring to a knowledge base containing codified knowledge. An example of knowledge personalisation would be knowledge that is transferred from person to person. The role that IT could play in codification would be to connect people across the enterprise with codified knowledge. The role of ICTs could play in the personalisation process that would be connected to people through communication tools and expert directories (Bjørnson & Dingsøyr, 2008).

Knowledge that is accessed by using ICTs must be stored in a systematic and structured manner. Knowledge representation techniques are utilised for this purpose. Therefore, ICTs and information systems rely on knowledge representation techniques in order to retrieve relevant knowledge when it is needed. Knowledge representation is the encoding of human knowledge. Knowledge-based systems, expert systems and database technologies, all make use of knowledge representation. Jeong et al. (2006) stated that different types of knowledge require different kinds of representation and reasoning. This study will consider the knowledge needs within a railway context, differentiating explicit and tacit knowledge within this context and making recommendations for representation techniques suitable for the respective knowledge types to be utilised by a KMS and ICTs.

2.6 Knowledge Management in Railway Organisations

In most theories of tacit knowledge, the context of KM is presented (Alavi & Tiwana, 2002; Sabel and Egura, 2012b). Even though the railway environment practiced KM in a more traditional way (Hong et al., 2011), there are still many similarities between how the knowledge management systems in the business world work and the ways (Floyde et al., 2013) that signal engineers have traditionally taken care of information. Many people have always passed their accumulated knowledge and wisdom on to future generations by telling them about their stories, work and experiences.

It is both valuable and difficult for tacit knowledge to pass on to others, as it is practice-based and intuitive (Griffith et al., 2013). Stover (2004), called this “knowing in practice.” Someone with knowledge has a great deal of knowing about something.

Experience gives a person the advantage of intuitively being capable to find answers to a problem more speedily than someone who does not have that experience or whose expertise is in a different area. Wyatt (2001) argues that knowledge is found in individuals who work in the same field. This knowledge is called “Tacit”. Knowledge is often possessed by groups, usually through the insights, contexts of individuals and collective experience and expertise; in a different and better way that one individual can have (Collins, 2010). Although most railway signal engineers are not aware of KM theory, it is vital that the process of a KMS should become an important part of the railway sector. According to Swan et al.(2007) information should be shared to make more accessible.

There are many reasons why tacit knowledge (making it explicit) and codifying it is crucial to the success of any organisation. The problems encountered will already have a reference-point where even a new technician or engineer without the benefit of many years of experience, will be able to refer to it, thus enabling any signalling engineer to solve the issue with the knowledge of how to do it (Gourlay, 2006). The organisation does not need the “owner” of a particular piece of tacit knowledge to be present or even rehired in order to share this information. Once tacit knowledge is converted to explicit knowledge, the organisation is less prone to losing its “asset (knowledge capital)” when employees leave the organisation (Stover, 2004).

The important role that tacit knowledge has to play in signalling can be shown by the various aspects involved in signalling, i.e. train traffic, perway and sleeper maintenance, coach maintenance and railway safety regulatory services (Quaglietta, 2013). Signal engineers have tacit knowledge, experience and expertise which are undocumented, but this broad spectrum of knowledge is both crucial and important for the daily running of the railway system (Quaglietta, 2013). Even though the codes and troubleshooting procedures are not written down, the engineers can resolve issues based on their experience and passion for learning. They have the know-how in their minds, not on paper, knowing how all the signalling components within the railway system work. There are many different elements involved in the railway sector that enable trains to function properly, that is why one needs to know if the problem that is encountered is related to signalling or not (Alves et al.,2012). Stover (2004) states that they also have the know-how to articulate and analyse the information that is required, evaluate the components needed, select and use the right tools and quantify the cost and time for solving specific problems. There are people who do not have explicit knowledge or training and adequate education, (Louwerse and

Huisman, 2011) who are struggling to keep the records updated on how to solve signal faults or technical problems.

Tacit knowledge and common sense are two elements that depend on each other in order to troubleshoot most of the problems that occur in most situations, especially in railway signalling. Many companies use tacit knowledge to augment a person's academic learning and experience. Louwerse and Huisman (2011), argue that most managerial success depends on the ability to acquire and manage tacit knowledge. The main factors in maintaining and attracting a productive workforce are loyalty and talent among the workers, giving them the opportunity to use and gain tacit knowledge (Nonaka and Takeuchi,1995; Collins, 2010).

Sharing the knowledge that has been gained in various forms of transportation is vital to the optimisation of its economic benefits to South African nation (Mentzas et al., 2001). Transportation information and knowledge are spread across numerous transportation-related organisations and libraries. Capturing knowledge, sharing knowledge, and the ability to quickly find knowledge would greatly benefit the transportation industry, especially because at the present time there is a decentralisation in the knowledge network between the different modes of transport within the transport sector

In KM tacit knowledge that may be written down in words, still retains its tacitness, for three main reasons: firstly, the concern with power and secrecy (Yu et al., 2013); secondly, people do not always recognise the importance of exploring the potential of knowledge (Chang, 2013) ; thirdly, all people have assumptions which are subjective (sensuous) rather than objective (Lindner and Wald, 2011).There are, however, no major barriers to making tacit knowledge explicit.

We "know" what the purpose of a railway is, how a signalling system works, but this kind of "knowledge" cannot be fully expressed in words or other explicit communicable form, but must be gained through experiencing the sensations (Chou et al., 2014). These authors, Chou et al. (2014) express the idea there are things that cannot be wholly expressed in words, and they emphasise the need of personal experience for an individual to see how things work and how they operate rather than just giving an explanation in words.

KM is the study of strategy, process and technology to acquire, select, organise, share and leverage business-critical information (Zhao et al., 2014). KM needs to be regarded differently from simple information gathering in order to take advantage of its competitive potential (Zhao et al., 2014). These authors, explains, that KM consists of management activities which help to develop and utilise an organisation's knowledge resources efficiently and therefore improve a firm's creative ability. KM has helped organisations identify, select, organise, disseminate, reuse and transfer important information and expertise. These are necessary for problem-solving, dynamic learning, strategic planning, and decision making (Ölçer, 2007).

This demonstrates that KM has been around for a long period of time, it is not new. However, for a long time research about this topic was not developing so rapidly. In order for the railway industry to become better, a KMS is essential in all the areas of the industry in order to help it to grow, to make decisions, to produce new ideas, to modernise its infrastructure and increase the efficiency of the whole transport system.

2.7 Process of Attaining a Knowledge Management System

Many organisations need a detailed process view for attaining a knowledge management system that focused on which information technology will in that particular process (Alavi and Leidner, 2001). According Alavi Maryam & Leidner (2001) articulated that by looking on the literature and knowledge management system processes analysis, there were several issues discussed around the vital role of IT and KMS in organisational processes. Alavi and Tiwana (2002) highlighted that knowledge management system had some tacit knowledge on practical work that were embedded in them. The most important organisation is the one that understands the value of knowledge that those individuals had.

Organisational knowledge is the most distinctive and valuable and the must be a process to attain it (Curado and Bontis, 2011). Some of the benefits of this form of knowledge are survival and growth, service quality improvement, continued advantage in competition and performance effectiveness. However, in order to gain these benefits the utilisation of knowledge is necessary and is the key to service delivery that may bring, power, and advancement (Brandt et al., 2008). Demonstration of KM by the use of benefits is a critical function for organisations (Pezzillo Iacono et al., 2012). Though the process of a KMS is fully developed by engaging all relevant people in decision making, there still remains, however, a managerial and theoretical issue. There is no consensus at the present time in KM as

to a general framework or model that can be used to utilise knowledge (Coombs et al.,1998). This may be challenging for the railway organisation when engaging in a KMS and its processes.

Within the transport industry in South Africa, there is little or no literature that highlights the use of a KMS process. Therefore, it could be the reason why railway did have KMS as they are also part of the transport system in South Africa context. The process of a KMS should help to mitigate all potential problems and help service delivery in transport system like railway (Maruta, 2012). The literature outlined that any process should influence by business strategy (Maruta, 2014).The railway sector became the world leader in passenger transportation(Alves et al., 2012). However, railway signalling (train traffic control) is the most important component in the safe and reliable functioning of trains on railway lines. Even though Nonaka and Takeuchi, (2008) introduced the KMS concept in organisations in general, railway industry is still left behind in terms of understanding the KMS process (Bititci et al., 2011). The lack of literature in transport created the gap of KMS processes in KM in the field of information system context in South Africa.

2.8 Knowledge Management Systems

It is evident that through an effective transfer of knowledge, an organisation would be able to gain competitive advantage and superior performance. Therefore, modern organisations strive towards managing their knowledge in order to facilitate an adequate and fruitful sharing of this knowledge. This is due to the fact that knowledge is now regarded as an asset capable of giving many untold benefits that make a difference between a successful and less successful organisation (Ismail and Yusof, 2010). Industries are taking this asset “knowledge” as the most important one to keep the organisation on the same par as others. A KMS could be defined as a technology system that uses IT to create, organise and disseminate knowledge throughout an organisation (Hu et al.,2014).

In many industries, sustainable competitive advantage comes increasingly from knowledge (Floyde at el.,2013), and core competencies need to change in order to adapt to environmental changes. This places the emphasis on strategic management of the knowledge capital of an organisation. Especially hard to capture is the tacit knowledge of individuals and groups, which is the knowledge based on experience, not easy to codify and reproduce (Estrada et al., 2011).KM is about collecting, disseminating, using and developing knowledge in an organisation. It involves the use of people, technology and processes (Basden and Klein, 2008).

There are several ways of categorising the knowledge that can be managed by a firm. The literature on KM distinguishes types of knowledge based upon the extent to which it can be transferred. A fundamental distinction is between tacit and explicit knowledge (Elgort and Warren, 2014). While describing a KM concept, the processes must involve storing, collecting, structuring, sharing, controlling, creating, disseminating, codifying, using and exploiting knowledge.

In the KM literature these processes, which are based on managing knowledge, have been evaluated in a non-hierarchical order and describe part of the KM definition (San, 2006). Basden & Klein, (2008) illustrated that when someone looks at tacit knowledge there are two dimensions involved: technical, such as informal skills; cognitive, such as beliefs, ideals etc. Basden and Klein (2008) not only looks at tacit knowledge generally, they looked deeply into it in order to gain the best possible result. Unlike other authors, who just identify the two types of knowledge, Nonaka (1994) also looked at the human and personal dimension of tacit knowledge.

It has been argued that the effectiveness of KM depends on how the generation of new knowledge is organised and how existing knowledge is transferred throughout the organisation. Practitioners of KM understand that this is a valuable asset as it leads to desirable organisational benefits. Fundamentally KM is enabled by an effective information communication technology (ICT) solution (Dorasamy et al., 2013). KM from an Information System perspective refers to the effective tool needed in order to enable the KM processes. In this context, a KMS is the key enabler of KM and should be applied as a natural step. Many researches define KMS as an ICT-based system, developed in order to support and enhance knowledge creation, the storage or retrieval, the transfer and application of knowledge. KMS includes knowledge-based systems, document management systems, semantic networks, object oriented and relational databases, decision support systems (DSS), expert systems and simulation tools. Any one of, or combination of these tools, can be designed as an effective KMS (Dorasamy et al., 2013). The objective of KMS is to support the creation, transfer, and application of knowledge in organisations. Knowledge and KM are complex and multi-faceted concepts, thus, the effective development and implementation of KMS requires a foundation in ICT based infrastructure and applications.

2.9 Kinds of Knowledge and its Codification

Wu et al.(2013) stated that knowledge is created when information is further processed, through which patterns emerge and when these patterns are understood as well as their implications for future predictability. These emerging patterns are often dynamic, which is not the case with information that is static. Smith et al.(2002) points out that humans or even data-mining (by machines) can spot these patterns by extracting meaning from information that emerges as knowledge.

Wu et al.(2013) distinguishes between three types of knowledge, namely: tacit, coded and theoretical. These are knowledge types that are differentiated in terms of their representation, or semiotics, i.e. the signs or symbols that are used to represent that knowledge. These knowledge types are not differentiated based on knowledge con tent. Tacit knowledge is personal knowledge, usually acquired through experience which according to some, cannot be coded (Wu et al., 2013). This implies that tacit knowledge, knowledge which is kept in one's mind, cannot be systematically stored and coded for retrieval and usage. Coded knowledge is knowledge that relates to procedure, rules and guidelines that are stored in a systematic, structured and usually categorised form. Theoretical knowledge often uses logical methods to provide explanations and answers to "why" questions, for example. These three types of knowledge often can work hand-in-hand, as according to Wu et al. (2013) , these three types of knowledge build upon each other.

According to Smith et al.(2002) there is a difference between tacit and explicit knowledge. They also point out that tacit knowledge is difficult to communicate via symbols, i.e. codification, making it difficult to transfer this kind of knowledge systematically. Furthermore, Smith et al.(2002) argue that tacit knowledge can be codified into explicit knowledge.

There are varying arguments regarding the articulation of explicit and tacit knowledge. Some authors argue that only that kind of knowledge that can be articulated in an explicit form can be codified through knowledge creation; however, tacit knowledge is best communicated through direct interaction. Others posit that tacit knowledge can be articulated and shared explicitly through codification using narratives, embedding tacit knowledge into systems (through rules and relations with a computer-based expert system), and knowledge models (knowledge maps), for example (Baskerville and Dulipovici, 2006).This implies that both explicit and tacit knowledge can be codified.

In order to transfer knowledge for it to be used, it must be codified. This process of codification can occur in many different formats, including formulae, expert systems, codes, written documents like reports or policies, budgets, databases, knowledge repositories, patents, assessments, drawings, memos, business plans, methodologies or similar (Lamont, 2006). Knowledge codification can also be differentiated in terms of different levels of abstraction. The least abstract form of codification is numbers and codes. The second least abstract is text, such as a policy document. The most abstract is tacit knowledge (Kairu-Wanyoike and Kiara, 2014). These levels of abstraction, however, depend on the context or environment.

The authors (Frenkel et al., 2014) posed that a focused KM strategy is one that is able to determine exactly which kinds of codification are suitable for different kinds of knowledge, concurs with this argument, stating that "the challenge in knowledge management is to determine how each knowledge type can be codified and transferred in an organisation." The decisions are often motivated by the speed and accuracy for transferring a particular kind of knowledge (Kebede, 2010), and reducing the risk of involuntary transfer of knowledge which poses risks to organisations where their competitors are concerned. In this particular context, kinds of knowledge refer to, for example, marketing knowledge versus technological knowledge. However, the knowledge types also have an influence on the kind of transfer and codification chosen. Gold et al. (2001) suggests that tacit knowledge is more suitably transferred via interpersonal methods which often require face-to-face interaction. IT, however, has made interpersonal communication possible, through the use of personal intranets. On the other hand, explicit knowledge can be recorded in structured formats and is facilitated by information systems and knowledge bases. Essentially, the transfer of both forms of knowledge is now facilitated by IT that enables sharing beyond geographical boundaries. Even though the most effective way of sharing tacit knowledge is face-to-face (Wu et al., 2013) , such as via workshops or training, IT has extended tacit knowledge-sharing platforms to include e-mail, groupware etc.

The study done by Goh (2002:p.24) indicates that learning from the knowledge of others does not take place by merely supplying a knowledge repository. The transfer of knowledge depends on the success of the recipient's understanding of what has been supplied. Goh (2002) argues that unless the intended users of knowledge are aware of their need for it, no learning will take place. Walsham (2001:p.600), on the other hand, argues that it is tacit knowledge that created explicit knowledge in the first place and that explicit knowledge is only useful to a user if it appeals to their tacit

knowledge. This means that the creators of explicit knowledge must anticipate the "sense-reading" activity of the user to understand their "sense-giving" activity (Walsham, 2001:p.602). In doing so, knowledge is not simply treated as a commodity. In his paper, Walsham (2001), differentiates between three categories of KM initiatives: the creation of knowledge repositories in the form of presentations, written documents and data warehouses, which he deems a knowledge commodity because of its "top-down, data driven" nature, which is meaningless to its users; the codification of raw data into meaningful "information" which is ready to be used by its intended users, such as decision-making tools; and personal interaction, including special interest groups or e-mail interaction. The codification process of raw data into a usable format should consider the anticipated users and their level of understanding. Personal interaction, according to Walsham (2001:p.603), is the most successful form of knowledge transfer due to the ability to dynamically respond to the needs of the user.

It is often difficult to understand what knowledge is, as many authors use the terms knowledge and information interchangeably. As a result, the methods for codifying explicit knowledge are often confused with methods for disseminating information. If we are to consider a database as an information-sharing tool, then we cannot also consider it as a knowledge-sharing tool unless there is added processing of information into usable knowledge. As explained by (Parent et al.,2014)), information must be further processed to create knowledge. The added processing of information will generate new patterns that are dynamic. The dynamic nature of knowledge is due to the continuous interaction between tacit and explicit knowledge. As Davenport, (2013) put it, "the challenge is to codify knowledge and still leave its distinctive attributes intact, putting in place codification structures that can change as rapidly and flexibly as the knowledge itself." Dell et al.,(2007) relays the practices of some companies in her paper, including companies like Business Connection and Xerox Corporation, emphasising their efforts to transform information in databases into usable formats that are ready to be used by those who need this form of knowledge to perform their jobs. Sandidzadeh and Dehghani (2013) also indicates that a process of transformation must occur for information to become usable knowledge, specifying that the KM process involves steps to capture, evaluate, cleanse, store, provide and use knowledge(Dell et al., 2007).

According to Stover (2004:p.164), tacit knowledge must be converted into explicit knowledge so that it can be codified. This is because explicit knowledge can be

expressed in a structured format which is required for codification. Tacit knowledge can be made explicit, but without the nuances that are implicit in tacit knowledge. Therefore, in order to retain the distinctive attributes of tacit knowledge, there needs to be some form of socialisation in place in order to convey the nuances inherent in tacit knowledge. According to Stover (2004:p.165), the process of codifying tacit knowledge should be for the purpose of reuse, so that new knowledge is generated and that a continuous process of refinement is encouraged. This is necessary to prevent codified knowledge from becoming old (Johnson et al.,2014).The role of tacit and explicit knowledge in the work place is much important because most of the organisations needs both knowledge types available (Pollalis and Dimitriou, 1996), also emphasises the need to maintain knowledge repositories because “outdated or inaccurate databases used to create and access knowledge have little value”. In order to generate new knowledge, people have to share what they know so that others can internalise it and then apply it (Liu et al., 2011)

The study done by the researchers Bjørnson & Dingsøyr (2008) emphasised the divergent opinions regarding the codification of tacit knowledge within academia, does however indicate that tacit knowledge is essential in order to use explicit, coded knowledge. Furthermore, he mentions that both tacit and explicit knowledge are shared when people interact (Bjørnson and Dingsøyr, 2008). Even though the general consensus is that tacit knowledge is difficult to share, he does not necessarily decide in favour of any of the two views on sharing tacit knowledge. The author, however, tends to agree that tacit knowledge can be converted into explicit knowledge to a certain extent (without retaining its nuances), and, that with the added facet of tacit knowledge, this explicit knowledge can become useful. (Correa et al.,2005) considers the practices of a few companies in order to determine whether tacit knowledge can be converted into explicit knowledge for codification. For instance, (Wallace et al., 2011) points out that a common practice at IBM is for field service reps to document their tacit knowledge about how to diagnose and fix machines by creating and maintaining a tacit knowledge base by consistently maintaining “tips” pertaining to their jobs (Elliot et al., 1995).

Elliot et al.,(1995) further points out that it is typical for organisations to lean more towards sharing explicit knowledge because it is easier to codify, but that tacit knowledge can be shared when employees document their insights, experiences and personal stories via methods such as drawings, diagrams, photographs etc. to show how to solve a problem. In fact, Cheung et al.(2007) identify strategies for acquiring

and teaching tacit knowledge, involving several forms of encoding that filter out the most relevant information to create usable knowledge, including selective encoding. However, which requires filtering out only the relevant information for a given context from that which is irrelevant for the given purpose (Abdul-jalal et al., 2013).

Tyugu (2006) refer to different knowledge artefacts which are created based on the different degrees of knowledge articulation, i.e. explicit, implicit and tacit knowledge. These varying degrees of articulated knowledge not only differ in terms of their codification, but also in their degree of abstraction and the degree to which it can enable decision-making or an action to be taken. They further explain that knowledge artefacts can be a combination of more than one knowledge component. An explicit artefact is fully coded and readily transferable. All required knowledge has been articulated to affect a process or decision. The codification of an implicit knowledge artefact is incomplete, as it requires a certain degree of existing knowledge in order to interpret it. This ties up with (Wallace et al.,2011) argument about anticipating the sense-reading capabilities of the user of codified knowledge. Erden et al.(2008), argued that tacit knowledge artefacts "defy expression and codification", which concurs with the argument that tacit knowledge that cannot be codified. Different forms of knowledge artefacts include not only written forms of knowledge, but also conversations and thoughts (Krogh, 2009).

Curado and Bontis (2011) explains that tacit knowledge and explicit knowledge go hand-in-hand and that a user of explicit knowledge requires tacit knowledge in order to understand it. This argument ties in with the fact that there are various forms of explicit knowledge that not everyone can understand unless they have the pre-existing tacit knowledge that is required to understand it, such a complex specifications or scientific formulae. Although explicit knowledge is readily available in various forms, the transfer of that knowledge is dependent on tacit knowledge.

Curado and Bontis (2011) contended that the degree to which knowledge is tacit or explicit is dependent on the extent to which an individual has absorbed or comprehended the "codes" which determine the degree to which they will interpret that knowledge. (Collins,2010) provide an example of this, as is clear in the following statement by Chou et al.(2014) "until the system of bass and treble clef notation was devised the knowledge of music could only be acquired by direct experience". In making this point, they are asserting that music which was once tacit has moved to explicit on the knowledge continuum. They further point out that for those who cannot

read musical notation, musical knowledge is still fairly tacit in comparison to those who do understand it, thereby illustrating the degree of tacitness versus explicitness. It can therefore be asserted that knowledge that is used within an organisation is made more explicit due to the sense-reading ability of its users in comparison to those who exist outside of the organisation.

The following statement by (Herschel et al., 2001) resonates with this view: “Understanding is said to be able to occur if the information presented is relevant and somewhat familiar to the listener”. Herschel et al. (2001) are of the opinion that tacit knowledge can be made explicit, but with a certain amount of effort. Their study on knowledge exchange protocols looks at a means for sharing tacit knowledge by making use of structured narratives. Knowledge exchange protocols structure knowledge that must be shared by systematically presenting the knowledge in such a way that the provider of knowledge is able to document their thought processes related to sense-making, knowledge creation and decision-making (Herschel et al., 2001:p.108). They, however, caution against including too much knowledge, advising to present knowledge in a way which is “interpretable” and “accessible”. Access to knowledge can be compared to asking for advice from a knowledge expert. They are able to provide the response that is needed to make a decision or to perform a certain task.

Knowledge management systems should provide access to similar knowledge, but in such a way that it is more accessible to the broader organisation. IT has made access across geographical boundaries possible, but in order to access the right knowledge, a system that is able to retrieve relevant knowledge based on similar questions that one might ask of a human knowledge expert is required. At the same time, this system is able to capture the knowledge of human knowledge experts and retain the knowledge capital of an organisation. Even though explicit knowledge is shared through platforms such as e-mails and documents, unless there is a way to harness this knowledge in a systematic manner, and to generate a structured format from this knowledge so that future use might be possible, this does not constitute KM tools. Essentially, the different forms of knowledge discussed here must be used together to generate the answers, not only related to know-what, but also know-how. Even though the nuances of tacit knowledge are lost through conversion and codification, it is useful for conducting “processing” of information into usable knowledge through various forms of encoding.

2.10 Conclusion

This chapter has explored: the literature related to the nature and attributes of knowledge; knowledge types and characteristics; IT as the enabler of KM; KM in transport and railways; the process of a KMS; knowledge management systems in general; the various kinds of knowledge and its codification. It showed that KM has been around since the 1980's, Peter Drum being its advocate. KMS has the shortage of literature in South African context, around transportation industry as most of the organisation had an old way or doing the business. IT enables KM so that knowledge can be shared and stored systematically through technology. In the railway sector there is very little literature available that relates to KM. South African railway sector had a massive role in transporting people. The population of South Africa depended most in railway for transportation; however there is little literature relating to KM in transport and less in the KMS in the railway industry. There more research needed in the sector to analyse many issues regarding railway safety, reliability and etc. The South African institutions do not provide railway related courses as most of the knowledge is in the form of tacit. The railway sector in South had their staff members since 1970s, especially in the signalling department that means there is lot of tacit knowledge which is not recognized in the sector. Information Management is one of the most important elements that the literature emphasized in the form of KM. the availability of academic studies in the KM context around railway could benefit even the new technical people that the sector will employ in future. Proper KMS process could assist in attaining the tacit knowledge that most employees have in the sector.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

The topic of this study is the application of knowledge management systems for tacit knowledge in the railway sector in South Africa. The case study research methodology was used within a specific railway company. According to Yin (2003) case study research addresses the “How” and the “Why” type of research questions. Lovett et al. (2000) points out that case study research involves answering selections or options like “which is the best out of the others” type of questions.

The main research question for this study is: How can one extract or transfer knowledge of employees in an organisation into explicit knowledge? It deals only with the process involved, not with any technical part of the system.

This chapter describes the case study research methodology used in this study; it explains the steps for the specific methods of data collection and provides an explanation of how the methods were used to address the research questions.

3.2 Research Approach

This study used the case study methodology to investigate the application of tacit knowledge of a knowledge management system for railway sector in South Africa. Research approaches can be distinguished in many ways. One such feature used to distinguish research is by classifying it as either quantitative or qualitative (Myers, 2007). This study employed a qualitative research approach. The main reason why this study was based on a case study using interviews was the fact that the researcher wanted to interact with the participants and allow them to elaborate on their opinions, rather than using questionnaires. Interviews are useful as the researcher can ask detailed questions and can be rephrased if a person does not easily understand the question asked but also enabling follow-up questions in order to get more information on the topic with participants (Wohlin and Aurum, 2014). This study is based more on the signalling department because of its importance to the railway sector.

3.2.1 Case Study

The qualitative case study methodology provided tools like interview guide for the researcher to study the complex phenomena (within the railway context in South Africa) (Yin, 2003). After a case study approach is applied correctly in the KM context, it becomes a valuable method for any railway sector worldwide to be used for teaching cases, transfer and sharing, storing and reuse of knowledge. Since this study is to explain the phenomenon of KMS process within the railway sector in South Africa.

In December 2004 the government of South Africa decided to consolidate passenger rail entities, Metrorail and Shosholoza Meyl into a single entity reporting to the Minister of Transport (Passenger Rail Agency of South Africa, p. 18-21, 2012). This new entity focused on providing reliable, safe, and efficient passenger services to the people of South African. This system transports more than 2.2 million people annually within the Western Cape. When dealing with issues of safety, reliability and efficiency in railway operations, it is clear that these issues are vital elements in the signalling system of any railway operating organisation, both locally, like the Passenger Rail Agency of South Africa, and internationally (Liu, Mao, Wang, Du and Ding, 2011; Quaglietta, 2013).

3.2.1.1 Advantages of a case study

In case study research, the advantages are to get the real information of what is happening in the organisation to assist the researcher to answer the research questions posed. The case study research approach is often able to provide suitable solutions for the relevant problem. It uses inductive approach and makes it easy for management to interpret information from the study. If the study is on two cases, it helps to identify problems through organisation operations and provide proper solutions. The other advantage is that case study research in any organisation like railway uses emphatically evidence in order to study the KM in the context. The case can be interpretive, as is aligned with the study the researcher is doing.

3.2.1.2 Disadvantages of a case study

The disadvantages of a case study are: General, theoretical (context-independent) knowledge is more valuable than concrete, practical (context-dependent) knowledge. The analysis sometimes is relevant to the specific case study which is not relevant to other case. The researcher is not getting information that relevant to the study only, but about the issues in the organisation. Any one or researcher cannot generalize on the basis of an individual case; therefore the case study cannot contribute to scientific

development. The method maintains a bias towards verification, understood as a tendency to confirm the researcher's preconceived notions, so that the study therefore becomes of doubtful scientific value. Experience, however, shows that even in a single qualitative case study, the conscientious social scientist often finds no explanation that seems satisfactory and has to revise researcher's hypotheses, preconceived views, assumptions or concepts (Flyvbjerg, 2006).

Flyvbjerg (2006) emphasis the misunderstanding is that, the case study is most useful for generating hypotheses; that is, in the first stage of a total research process, whereas other methods are more suitable for hypotheses testing and theory building, he continued saying that, the case study contains a bias toward verification, that is, a tendency to confirm the researcher's preconceived notions and, lastly it is often difficult to summarize and develop general propositions and theories on the basis of specific case studies.

3.2.2 Research Population

The research population for the study were employees of the Metrorail section of Passenger Rail Agency of South Africa and were selected from three departments (signalling, Information and communication technology, infrastructure as well as signalling, human resources and business development) in the Western Cape region. The population consisted of a total of fifteen participants and twelve successfully participated in the scheduled interviews.

3.2.2.1 Characteristics of the research population

The research participants were selected on the basis of their roles in the sector. The participation in the study was voluntary. .

3.2.2.1.1 Senior Management

In the senior management category, the senior manager for infrastructure which consists of sub-departments like perway, signalling, electrical, telecoms and maintenance planning for railway tracks participated in the study. The senior manager heads the department and is also part of the Western Cape regional executive reporting to the regional manager. The senior manger's role is to make sure all the maintenance of railway infrastructure like perway, signals and electrical components for the organisation are in place. The movement of trains depends mostly on this role without which the trains cannot move.

3.2.2.1.2 Middle Management

The role of middle management in signalling is to make sure the staff is available for fixing and maintaining signals. He middle manager position reports to the senior manager of infrastructure for the entire signal related this in the organisation. This level is accountable to all supervisory related roles in the signalling department at Western Cape region.

3.2.2.1.3 Signalling Staff

The signalling staff consists of senior engineering technicians, engineering technicians, and process workers (artisans). The senior engineering technicians are the ones in charge in the training centre to train all new staff members in the department and also work as tutors. These staff members have worth 130 experiences in the Railway organisation. Engineering technicians have a mixture of experience staff members and new engineers. These are members that make sure all the signals are running for trains to operate. They work in section as supervisors to process workers. Process workers reports to them and they are the ones in charge for managing their time.

The staff members were the most important participants in the study, and most of them have served the organization for twenty and more years. Also included in the category were new artisans with about two years' experience.

3.2.3 Sampling procedures

Sampling is the process of choosing a group of people who can give a clear representation of the different levels within a population (Johnson and Christensen, 2004:197). The participants were selected in order to gain the information that was necessary to address the research objectives of the study. Fifteen participants were chosen, and 12 % participated in the interviews. The final list of the participants consisted of the following as illustrated in table 2.1:

Table 2.1: Interview Participants

Numbe	Title of the Interviewee and the Designation
1	Senior manager infrastructure
2	Senior manager, human resources and business performance
3	Middle manager signalling

4	Senior engineering technician (lecturer) Koeberg
5	Senior engineering technician (lecturer) Koeberg
6	Senior engineering technician (lecturer) Elsies
7	Engineering technician Salt River
8	Engineering technician Bellville
9	Engineering technician Langa
10	Engineering technician Wynberg
11	Process worker Salt River
12	Process worker signalling Langa

This study focussed on the signalling department in the railway sector of South Africa. However, the human resources department and the ICT department were involved as part of the study, since they are the key supporting departments to this process.

The study excluded other regional signal engineers, process workers and top management as the responses from the Western Cape region would be adequate to cover the study.

3.4 Reliability and Validity in case studies

This study is an interpretative study that will be of benefit to the railway sector in South Africa through a proposition of a model that can assist in extracting tacit knowledge and putting it into a KMS so that this knowledge will be easily available for new technical staff. Interpretive case studies attempt to understand the phenomena in a given situation. . According to Yin (2009), interpretive case studies focus on the social construction of reality. The study will contribute to South African railways, by saving a huge amount of money that would have been spent rehiring employees who have knowledge of signalling. This study will contribute to the body of knowledge by introducing a model of KM that and the study will benefit the railway sector worldwide to have a model that will assist tacit knowledge extraction.

3.5 Data Collection

In case studies data can be collected from interviewees by means of semi-structured questions (Maxwell, 2012). Since the purpose of the interviews was to narrow down the level of knowledge in order to obtain the real information from each respondent, the focus was the identification and determination of detailed information

about tacit knowledge within the railway sector, specifically related to signalling. The data collection method depends on the research questions posed (Bryman, 2004).

3.5.1 Data Collection Instruments

The data collection is categorised into primary section, which are interviews, and secondary section, which includes reports, books and articles that contain information generated for other purposes other than the original one (Cohen et al.,2013). Primary data was data collected for the first time by the researcher for the purpose of finding answers to the research objectives (Creswell, 2013) as per chapter three of the study. As such, this study collected primary data through interviews only.

3.5.1.1 Interview guide

The interview guide covered the key areas of the research objectives and that was;
An interview guide was created to guide the researcher for the information that was needed (Kane et al., 2006). Wohlin and Aurum (2014) argued that data collection methods may involve qualitative or quantitative data. Some commonly used qualitative data collection methods in KM research are interviews, or group discussions and observation (Creswell, 2013). Qualitative data commonly used as data collection methods are interviews, group discussions and others like meetings, observations etc. (Maxwell, 2012). More information regarding data collection methods in KM can also be obtained from Shull et al. (2008), Runeson et al. (2012), Wohlin et al. (2012), Munyua and Stilwell (2010), Rubin and Rubin (2012), Silverman, (2013), Wallace et al., (2010) and Lethbridge et al. (2005). In this study the researcher provided a brief summary of the interview guide as one of the data collection methods that the researcher believes is most relevant to the application of a KMS process for tacit knowledge research**.**

3.5.2 Data Collection process

The data collection was conducted over a period of two months followed by the analysis. Various Metrorail depots were visited and interviews were conducted for 20 to 30 minutes. The researcher transcribed collected data using Microsoft Word. After transcription, the thematic analysis of the transcribed data followed without using software's like Nvivo for data analysis. (Barry ,1998; Jones, 2007).

3.5.2.1 Interviews

Interviews are a data collection method which provides and insight into the participant's or individual's viewpoint on a specific topic. It involves a series of questions that are directly asked by the researcher to the participant at a face to face meeting. This method is useful as the researcher can ask detailed questions that can be rephrased if there is no understanding about the question asked, using follow-up questions to get more information on the topic with participants. Other than face-to-face interviews, phone interviews and interviews through network connectivity like video conferencing, and the Internet are other ways of interviewing participants.

3.6 Data Processing and Analysis

The data was analysed manually and that was transcription from recordings to word processing. Bryne (2001) informs that "qualitative data analysis consists of identifying, coding, and categorising patterns found in the data". According to Renner (2003), the analysis process involves the steps below:

- need to know your data;
- analyse it;
- put themes in your information;
- Interpretation using your themes, as per chapter four of this study.

There is no way the raw data can be interpreted without first transcribing the audio records to a word processing programme, and then coding the information in order to identify themes from the study so that the primary data collected would make sense for interpretation.

3.6.1 Thematic Analysis

Thematic analysis is widely used as a qualitative data analysis technique in many researches in KM, as it provides deeper understanding about the data content. The authors Braun and Clarke (2006) described thematic analysis as a method for identifying, analysing and reporting themes within data. They identified phases of thematic analysis, i.e. familiarising yourself with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing a report. Codes in the thematic method are used to organise themes and also involve open coding. Braun and Clarke (2006), classify thematic analysis as having "semantic" or "latent" themes. Semantic themes are identified based on explicit meaning contained in the data. The researcher searched for patterns using semantic themes.

On the other hand, in latent themes the researcher searched for underlying ideas within the data that was theorised. Braun and Clarke (2006), suggest that semantic themes tend to be used in a positivist research approach paradigm, whereas latent themes tend to be used in an interpretivist research approach. The researcher identified themes and assigned codes to themes manually. A guideline for thematic analysis can be found in Braun and Clarke (2006). Ideally, the thematic analysis involves several studies, with themes being developed using interview subjects or the researcher capturing many ideas from various participants. Since this study is specific to the railway sector, there are many railway-specific themes, but the main focus of the study was on the development of KMS in the railway industry.

3.7 Ethical Considerations

The researcher was required to maintain the highest ethical and safety standards in conducting the research, particularly when human subject are involved. It remains the responsibility of the researcher to comply with all relevant regulations in this regard, including those of the institution at which the research is carried out. An ethical clearance certificate (where applicable) must be submitted to the institution in respect data collection and the letter of consent, request for data collection, approval letter and confidentiality agreement were requested and granted by the researcher to the organisation as per appendixes A,B and C.

It is important for researcher to maintain ethical standards. This involves:
Permissions for obtaining ethics approval from the appropriate ethics committees; obtaining permission from interviewees (and if appropriate, their manager).
Respect for treating people with respect (before, during, and after the interview), respecting their time, respecting their position within the organization, respecting their knowledge. Fulfilling commitments to individuals and organisations as this may involve keeping confidences, keeping transcripts or records or and the technology confidential and secure. Lastly, presenting findings and results, as this may be advisable sometimes to provide early feedback to subjects and organisations and to check with them about factual matters if needed.

3.8 Conclusion

This chapter has extensively discussed the research design strategy, which includes: the methodology, data collection techniques and processes, and ethical considerations. First, it discussed extant relevant methodologies and selected one with justification for its choice. Second, a data collection method was identified and justified. Subsequently a discussion of the instrument development was presented, and validity and reliability measures of the instrument design were presented. Thirdly, Sampling techniques were discussed, involving: selection of sampling population, frame, techniques, and size. Fourthly, research instrument administration was discussed, which entailed; data collection techniques and sites. Last, ethical considerations of the study were discussed.

CHAPTER FOUR
PRESENTATION AND ANALYSIS OF FINDINGS

4.1 Introduction

This chapter presents an analysis of the data that was collected from the employees of Passenger Rail Agency of South Africa (PRASA) in the Western Cape Region of South Africa. In addressing the research: How can knowledge be extracted and transferred from employees in the railway organisation so that it becomes explicit knowledge? Twelve participants were participated in this study). The participants were selected by the researcher in order to gain the information that was necessary to complete this study. Fifteen participants were chosen however only twelve were available throughout the scope of this study.

- 1 x senior manager from the Infrastructure department.
- 1 x middle manager in the signalling department.
- 1x senior manager from human resources and business performance (since training and development are part of human resources, and he is also an accounting officer in terms of business performance).
- 1 x information, communication and technology infrastructure manager, as ICT in an enabler of knowledge management systems.
- 3 x senior engineering technicians, as they are the people who lecture staff about signalling both in the training centre and in practice (they are the most crucial people in the department but due to old age they are about to leave the organisation).
- 6 x engineering technicians, 4 of them are also about to retire within 3 years, and the others are young staff members from the technikon with diplomas in electrical engineering.
- 2 x process workers who have little theoretical or practical knowledge regarding signal components.

4.2 Status of Tacit Knowledge

The first part of the study was to find out if employees were aware of the importance of tacit knowledge in the organisation.

Forty-two percent (42%) responses came from engineering technicians. These technicians consist of old and experienced engineers, as well as young inexperienced engineers in the organisation. Young staff members join the field with a national diploma in electrical engineering, mostly dealing with heavy current. They

mention that knowledge is available in the organization, but the level of knowledge management is not in the way it should be.

Senior engineering technicians followed engineering technicians with twenty-five percent (25%) praising that knowledge sis managed in at least in the right way in the organisation. Senior engineering technicians were lecturers at Koeberg training centre they have 130 years' worth of experience; they were the ones with tacit knowledge and lot of experience in the signalling field. Process workers do not have any clue about what is happening in terms of managing knowledge.

The young employees were aware that there was a need for tacit knowledge to be shared. One participant stated that there were not many experienced people left in the industry, and that it takes quite a while to train a new person. However, to alleviate eventual problems, the organisation always tries to have a specialist, who was competent in working with signals, in standby within each area in case one staff member was not competent in a section. There are different kinds of signals in the whole of the Western Cape.

The staff member still needs to go for practical assessment in sections or areas where he will be assessed by an immediate supervisor or line manager. This concern with the importance of receiving training and becoming competent in one specific field in signalling, even if it is interlocking or outside signalling maintenance, shows the desperate need for a KMS. All of the engineering technicians responded to the status of KM.

The employees were not aware of knowledge management in the railway industry especially tacit. It shows clear that, there was a need for tacit knowledge to be shared with young engineers in the signalling department. Since there are not many employees with tacit knowledge still left in the industry, thus creating a huge gap as it takes quite a while to educate a person to gain this knowledge.

The railway industry followed standard percentage 80% pass mark when they assessed their signalling employees during theory exams in the training canter, the exams are based on the manuals written by senior engineering technicians (tutors). Even though there was an in-house training but the employees are concerned about getting proper training from these experienced engineers and becoming competent in working with signalling by looking at the time the training is scheduled.

The experienced staff members were also very concerned about the status of knowledge management, however at the present time no one was being mentored to take over from them. Most of them had passed their retirement age but due to the value of the tacit knowledge they possess, the organisation at large was not willing to let them retire. Those experienced staff members were very much aware of the tacit knowledge that was being lost if it not managed. They emphasize that this tacit knowledge cannot be theoretical but only something that can be picked up after many years of experience.

4.3 Captured and stored of knowledge

Senior engineering technicians provided most detailed and precise responses on knowledge capturing and storing knowledge, as they were the ones who worked with signalling system for a long period of time. They captured and stored knowledge in manuals, but when teaching they always add certain aspects that may not be contained in the manuals. They informed the employees if they had found something really important, like the way a staff member can fixed certain faults, maybe not according to the book, but also by their own personal experience. Together these employees have over 130 years of knowledge in signalling as of the date of data collection. They write training manuals for the training centre, compile the course structure, provide the theoretical and practical training, and of course pass on the knowledge to trainers through mentorship. They also indicated that most of their knowledge was still in their minds, not in manuals. This fact was clearly stated by one of the respondents who also indicated the difficulties involved in transferring this knowledge to others. Only 6% of the knowledge they have in their minds can be found on the computers and in the archives.

The engineering technicians and process workers also confirmed the findings from other groups, that there was very limited captured and storaged of knowledge within the organisation. This was making the job more challenging as it was not always possible to act according to the book when fixing faults in the field.

Senior management who made up 25% of the respondents, consisting of infrastructure and human resources and business performance together with middle managers (17%) agreed with the engineering technicians that the way of captured and stored knowledge was limited. They also believe that there must be a succession plan in place, so that a person can be assigned to a senior engineering technician who will be able to impart information that was useful for the future or for the current job situation. This system is used to store documents which contain information about

processes and systems. They emphasized that capturing knowledge was not happening the way it should. The intention was to capture and stored knowledge; however, the organisation does not systematically capture the processes used when fixing signals. This was not done step by step, but that they just stored whatever information is available, not necessarily what is relevant to signalling.

Senior management stated the importance of capturing and storing knowledge, as this knowledge was not readily available, even from the manufacturers of each specific component that was used in signalling.

The findings showed that knowledge was captured and stored in manuals by senior engineering technicians. They were the ones writing training manuals for the training centre were written by senior engineering technicians. When it comes to course structures, they compile them by senior engineering technicians.

Theoretical and practical training are provided by senior engineering technicians. And the knowledge was passed on to staff members through mentorship.

The organisation does not had systematic plan in place for storing information, however, whatever information is available is stored, not just information relevant to signalling. The reason could be there was a lack of support from management regarding the importance of a knowledge storage system.

It was a necessary to capture and stored knowledge as this knowledge was not easily available, not even from the manufacturers of each specific component used in the industry.

4.4 Process of extracting tacit knowledge

Eleven percent (11%) responses came from senior engineering technicians. They expressed that there was a manual system they were using at the Koeberg training centre, then anyone in ICT can come up with a KMS this can improve theirs. One senior technician indicated that senior engineers who had left the organisation were asked to come back as there was a big void in knowledge to run the system smoothly. Another senior engineer emphasised the lack of management support in knowledge storage systems. Management felt that it was not an easy process as most knowledge was stored in the minds of people. These technicians had over 130 years of knowledge and experience (both in practical work and in the training centre). It is not possible to teach a new person within a year all this experience and knowledge that these technicians have about signalling. These engineers are aware

of the knowledge they had in their minds and the importance it had for the organisation, but they can also visualise the tacit information that is being lost.

Regarding the process of extracting knowledge, the senior engineering technicians mentioned that someone will have to take all the tacit information available and compile it into book form. This will take a while because that person must know inputs of signalling, must have knowledge in the different areas of signalling and the ability to archive that knowledge in a systematic way in order to assist those who were looking for specific information to find it in the wealth of the archive. Engineers mentioned that in order to achieve this they will need more resources because at present there were only three people working in the training centre. These engineers have created workshops for practical teaching about points and signals. Engineers have tried to construct some points that were smaller in size and house them in the training centre in order to show technicians the way signals behave and work. This is the system they are using at the present moment.

The technicians do not see any stakeholder they can involve in this process, because there was a lack of support from the management, and that even human resources were not aware of what they were doing. Furthermore these technicians do not know who they can get involved in assuring that the tacit knowledge they have remains in the organisation when they leave. It was also mentioned that they use things like what they themselves called “monkey puzzle” where it shows where you can go to fix a fault, using technicians and all their knowledge as part of the process.

Eleven percent (11%) responses came from middle management. These responses reveal that before the organisation loses even more knowledge, there was a vital need for more people to work with these staff members on a daily basis as part of the succession plan, so that they can be mentored and grow in knowledge about what they are doing. This group consists of individuals who are not close to retiring. They still had about twenty or more years left in the organisation and also have attained a good level of knowledge about signalling. However, the challenge was that these resources were not enough. These members of staff, who were involved in training, they themselves gained their knowledge of signalling through the same process of going in-house training for three years. However, they pointed out that most of the people (about 90%) who trained with them have already left the organisation. The process of training was lengthy according to them. They said that a person goes for theoretical studies after being employed for two years with one year practical training.

However, competency was not fully achieved after this period. A period of working in this section for at least ten years was necessary before becoming fully competent.

Twenty-three percent (23%) responses came from engineering technicians. They mentioned that the company gave bursaries to students to study electrical engineering at technikon, but that these students did not receive any knowledge relating to signalling. Most of them study heavy current instead of light current or electronics. So after their period of study they still have to go to the in-house training centre for three years theory and one year practical.

The way that knowledge is extracted now from the technicians was through the teaching given in the training centre. Under supervision, the employees are deployed in sections to do fault finding and maintenance (mentorship). However, before going into the various sections, the employees still need to pass with 80% or above in order to continue with the practical side of their training. In the case of engineering technicians the story is slightly different. Since there was a shortage in the field, as most of the old staff members are retiring, employees have not always finished three years of training. People have been deployed to sections after just two years of training. These employees are sometimes battling with some of the issues they are faced with in the field.

In order to cover the resource shortage, the engineering technicians came with a proposal. They suggested that the company should employ about 30 or 40 people at once, giving them the theory they need. When this was done they should be sent to work in Elsies River, as this will provide them with the concrete issues the railway has to deal with, i.e. vandalism etc. By doing so the company will see if these employees can handle the job, the stress levels and all the complex issues involved. As many of them who have diplomas do not want to get their hands dirty doing practical things, it would be a good way for the company to sieve through their employees in order to arrive at a good team of dedicated staff members. One of the engineers argued that there was no university or institution that provides proper training for signalling. Only in-house-training can provide that. Therefore a person needs to go for the entire three years of training and one year practical, calling this a diploma in railway signalling.

Thirty-three percent (33%) of the senior management was involved in this study. The responses they gave provide the same view, more or less, as the engineering technicians – that bursary students do not get the proper training and therefore need

to attend in-house-training. They must be inclined to do this and have the willingness and enthusiasm to do so.

Another issue the management raised was that when a person who has received a bursary from the company is qualified and begin working in the organisation, the management must decide if that person will do civil engineering, mechanical engineering or electrical engineering, or be sent to the signalling department as a signal engineer or telecom engineer. The bursary holder must be aware of this, that the management decides where a person is to be allocated. This was the process that needs to be followed.

All those who finish their diploma must go to the training centre for the required period of time if they were to work in the signalling department. Even though universities or technikon at present do not have a curriculum which was a railway-specific course, there was nothing, in theory at least, preventing an institution providing such courses. The stumbling block here was that institutions in universities and technikon provide training based on market conditions. Since there were only two railway organisations in the country, railway-specific courses might be deemed as not being marketable.

Twenty-two percent (22%) responses came from senior management (human resources and business performance). They outlined the importance of knowledge because that knowledge is developed from trial and error, where people had tried different processes in order to reach solutions to concrete problems. This information was not gained from manuals but through knowledge gained by working directly with issues related to signalling.

They also mentioned something about the succession plan. They motivated that the contracts of staff members must be extended so that the signalling department will had the opportunity to see how the knowledge that these people had will remain within the organisation when they retire. One way was to achieve this was to get young staff members to work with older staff members on a daily basis and have the department monitor their progress. This could be done on a quarterly basis, and as the younger staff members gain more knowledge the company would benefit from the transfer of this knowledge.

The signalling department must also understand that the knowledge people have in their field had been gained when they are being paid salaries by the company for

their labour. Therefore, the knowledge and information they had belong not to them personally but to the company as a whole. If the department does not retain this information then the company had wasted a large portion of the money they had paid to employees in salaries. They also stated that this task not only belongs to the signalling department but to all departments within the organisation, i.e. business performance, human resources etc.

Twenty-two percent (22%) responses came from process workers. They stated that they must work with people like leaders, maintainers, process workers and engineers. They do not want to work alone. At present the task of a process worker was to carry tools and do some cleaning on the outside of signalling equipment. However, they would like to learn from senior engineers and after training in the training centre, be deployed in section signalling jobs with qualified engineers. There is no explicit attempt to extract knowledge in signalling in order to outline the process of fixing faults was available within the organisation. Nothing regarding the step by step process was available at the present time. The management felt that KM is not an easy process as most knowledge was stored in the mind. There signalling department require more resources were needed because only three people were working in the training centre at present. There lot of knowledge in senior engineering technicians, they tried to house some points that were smaller in size to show technicians the way outside signals look and work in reality. There was need for employment of people who will work with experienced staff members are needed on a daily basis as part of the succession plan. The process requires all departments to be involved in the process of extracting knowledge. Engineers have a knowledge that was gained and developed from trial and error where people try different processes to fix faults.

4.5 The importance of signalling knowledge

This form of knowledge was of vital importance because it cannot be found in books and manuals but only by experience. This point was strongly emphasised by one of the interviewees who stressed that it was only with the help of tacit knowledge, i.e. through experience gained during the years of working in the company that faults can be fixed professionally.

Twenty-three percent (23%) responses came from senior engineering technicians. They looked at railway signalling as the system that directs the safety on the railway lines in order to prevent accidents, as this was the main function of signalling. The

employee must had full knowledge of the specific interlocking systems in that specific section and he must know how that interlocking works, otherwise it was can be a grave danger. They emphasised that passenger trains transport people. If the wiring was done incorrectly then the result could be the death of many people, as it was because of this that accidents happen. As most of the experienced staff members are leaving the organisation, the supply of knowledge is being diminished.

At present there were only a limited number of people who had an adequate knowledge of railway signalling. This was due to the fact that the organisation is not looking after the staff members correctly and many were going on pension, taking their knowledge with them. They emphasised that they were running short of competent staff. Of the ten technicians trained two years ago, only one was left. Some resigned and the others retired. In the group that was trained after them, no one had resigned but they were all looking for other jobs. They also mentioned that they were about to leave as they have reached pension age.

Eight percent (8%) responses came from of middle management. They deal with the issue of interlocking. They spoke about the need to be able to understand what interlocking was and also what is the function of interlocking was. They explained that there are different types of interlocking: these are called “Mark 1 B”, “Mark 1 C”, “Mark”, and “Mark M”. This is relay based interlocking. By interlocking we mean a system for the safe running of trains that work together with signals in order to maintain the safety of passengers. For instance, if your track is down, you are not allowed to travel on that section, the section becomes locked until the signalling department gives permission for the train to continue on the track. Engineers also mentioned that there was not enough knowledge left in the company because experienced staff members were leaving the organisation.

Engineers highlighted the fact that before the organisation loses more experience and knowledge, they need experienced people who worked with younger staff members on a daily basis as part of a succession plan. These younger staff members need to be mentored and by so doing learn more about what they do on a daily basis. Trains cannot run without a safe signalling system. The staff members who had this knowledge do most of their work without had to refer to books or manuals. They had all this knowledge in their minds and at their disposal immediately. They know the scheduling of trains, and all other information about the services involved, including the technical issues involved. It was not possible to let people with this knowledge go because when they leave a huge problem arises in the scheduling of trains. The staff

that had this knowledge can schedule trains manually without needing to refer to any system. They simply know how the system works. Therefore how can the company just let these people go?

Thirty-eight (38%) responses came from engineering technicians. They stated that there was something what they called “integrity” (i.e. preventing trains moving in opposite directions while on the same tracks). These engineering technicians had the same understanding regarding safety as the senior engineering technicians had. They pointed out that signalling was very much an important element in the everyday running of trains. As signalling was essential for the safe running of trains, it is critical to had proper signalling in place. They also believe that if you take away signalling you compromise safety. The proper use of signalling enables the safe running of trains, so that they do not collide.

At present the organisation had enough knowledge about signalling. But this knowledge was being lost as knowledgeable staff members were leaving the organisation. One of those who were interviewed gave the example of a new engineering technician who was struggling to fault find an issue. He contacted a technician who had worked for 30 years as a signalling technician who showed him where the fault was and told him that this fault keeps returning on a regular basis. He showed him how to fix it and so shared his knowledge with him. This technician was willing to share his knowledge but, as he was about to retire, he had not much time left to share this knowledge. These points to a lack of management support and a viable succession plan. How can a technician with 30 years of service and experience still be working with the daily repairs of signalling rather than using his knowledge to train and mentor others? It shows that management is at fault by promoting people due to favouritism and friendship rather than by competency.

Eight percent (8%) responses came from senior management. They understand the importance of signalling. Regarding the safety movement of trains, one of the members of senior management mentioned that the safe movement of trains can be achieved in two ways, using a manual system or a computerised system. In the past everything was done manually, based on human knowledge and experience. Today it was becoming more technology based. However, at the present time the company still needs people who can run the signalling department manually. He pointed out that three things were required for the movement of trains: safe movement, which makes sure that trains cannot collide with each other; capacity of trains, the number of trains that can be run on the network; speed management of trains. If you take

these requirements, i.e. safety, capacity and speed, then the signalling system optimises these three elements. By properly designing and having adequate knowledge of signalling you can make sure that trains do not collide and by regulating and controlling the speed of trains, operate the trains at maximum capacity. Theoretical signalling skills are easily attained by study, but the main issue was the lack of practical skills in signalling which can only be attained through mentorship. As those who have the proper knowledge were involved in fault-finding, they do not have the time to mentor. This was a major issue for the railway system.

Eight percent (8%) responses came from human resources and business performance senior management. They mentioned that signalling exists for the safety of passengers and that the avoidance of accidents and fatalities must be given prime priority. They stated that there was not enough knowledge about signalling within the entire railway system. They mentioned that the only way to retain knowledge in the company is to review the processes involved and to benchmark the signalling system in SA with other companies who work internationally and globally, i.e. they must see how other companies have resolved issues with signalling.

Fifteen percent (15%) responses came from process workers. They also emphasised the importance of signalling. Trains cannot run effectively and safely without it. Regarding the level of knowledge, even though process workers have little technical knowledge, some of them pointed out that they often find faults before engineering technicians do.

The above findings emphasize that signalling knowledge is very important, however it cannot be found in books but only through experience. The main role of signalling is about safety on the railways in order to avoid accidents. It works as the most important element in running trains and without signalling trains cannot run without a proper signalling system. If signalling was not maintained properly, the safety of passengers is compromised. Lastly, there are three things are required for the movement of trains: safe movement, which makes sure that trains cannot collide with each other; capacity of trains, the number of trains that can be run on the network; speed management of trains.

4.6 Designing of a tacit knowledge management system

The aim was to see if the participants had any idea about the way a KMS must be designed and implemented, as this in the core of this study.

Senior engineering technicians said that they do not have any idea about how to design and implement a KMS. They said that it was an issue for ICT. The system that they use at present was to create manuals, and have these manuals available in the library in Salt River.

Twenty-five percent (25%) responses came from middle managers. They seem to have an idea about how a KMS should be designed and implemented. They are also aware of what kind of output was required from a KMS. They also mentioned that there was no proper system at the present time, especially since the railway company was divided into companies, one for passengers and one for freight. One of middle managers stated that when he began working for the company said that some system was needed to save the knowledge that was available in the company. He asked who came up with the idea of using DM5 as a document management system. He said that this system was not adequate for storing information relating to signalling. He said that even though the company decided to purchase this system, it was not really beneficial for them. He said that there was no need to buy something just for the sake of buying it.

The middle managers mentioned that an e-learning system should be in place to minimise the time needed to attend the training centre. They had some idea of how a KMS should work. They pointed out that the company needed to invest in such a system, but they could not say specifically how this system could be designed.

Thirteen percent (13%) responses came from the senior management infrastructure. They were also aware that everything was moving towards being technology based. They can also see the benefit of such a KMS, without having the concrete knowledge of how this system could be designed and implemented. One of the ways they did mention, however, was to have course material online, and in this way even the practical assessment could be done online through simulations of everyday problems within signalling.

Fifty percent (50%) responses came from engineering technicians. They understand the need for the use of technology so that interlocking could be computerised rather than it is now, i.e. through relay rooms. These relay rooms are manually maintained and take up lots of space. The technology to achieve this can be done through telecoms and through fibre at Windermere CTC where the routes are setup through interlocking in conjunction with track circuitry for the safe running of the tracks.

Twelve percent (12%) responses came from human resources and business management. They saw the benefit of having all the manuals and books made available in such a knowledge system at a central place. They were aware of the fact that these manuals and books must be digitised. They also spoke of the need to have off-site backups in case of disaster. They said that the responsibility for this must be given to the ICT department. IT would play an important role by providing a platform for the company to use this system in order to document and retain the knowledge that people provide before they leave the company. In would also be of great benefit in process mapping, for the efficient coordination of all departments involved. For example, succession planning would outline the necessary steps involved. This information could be documented and stored on the system. Another important issue was made, that the software used must be user friendly, accessible to everyone, was properly updated and conforms to the compatibility of any other systems used within the company. The ICT department must take on this responsibility.

No response was provided by process workers in relation to the topic of the design and implementation of a KMS.

The findings alluded that engineering technicians did not had any idea about designing a KMS. The railway sector does not have proper KMS in place at the moment in the company. In order to begin some kind of a KMS, proper computer infrastructure was required. However, in the future a KMS will be needed, using the benefits of technology rather than being manually based. The group of was aware of KMS and the senior management and infrastructure. There was a need for Off-site backups when the system was in place in case of disaster, the responsibility for this being given to the ICT department. The Koeberg training centre needs an e-learning system to minimise the time needed to attend the training centre. Hence, IT must play a role by providing a platform for the company to retain and maximise the knowledge that is available within the company, especially through exit interviews and process mapping.

CHAPTER FIVE
DISCUSION OF FINDINGS

5.1 Introduction

The main objective of this study was to explore and find a solution that can help the railway industry in South Africa to implement a KMS for tacit knowledge. At present the knowledge that most senior employees possess has been gained through experience. If the Passenger Rail Agency of South Africa (PRASA) loses these experienced employees, not only will the railway suffer, due to the loss of competent staff, but also the intellectual assets of the company will be depleted because these employees will take their knowledge with them. This results in higher costs for the organisation as they will have to rehire experienced workers on a contract basis.

In chapter five the researcher outlined all the tools and techniques that an organisation needs in order to maintain knowledge and to manage knowledge properly. The analysis presented in chapter four shows that the railway industry in South Africa does not have any KM strategies, KM road maps, clear processes of KM or even a strategy to implement KMS enabling the creation of a system to integrate tacit and explicit knowledge in order to retain knowledge within the organisation, even when experienced employees leave.

5.2 The need for KMS design

The last objective of the study was to design a KMS in order to manage tacit knowledge and make it more usable.

The literature states that the context of KM is presented in most theories of tacit knowledge (Maruta, 2012; Sabel & Egura, 2012). Within the railway environment, KM has been practised in a more traditional way (Jain, Cullinane & Cullinane, 2008). However, there are many similarities between the various knowledge management systems. The literature also states the important role that signalling has in the railway system and in the various aspects involved in signalling, e.g. trains traffic, perway maintenance, and railway safety. The literature states that all the various aspects of signalling are dependent on the tacit knowledge and experience that signal engineers possess (Quaglietta, 2013). As tacit knowledge is undocumented, and the work done by these engineers is crucial, the importance of retaining this knowledge is vital (Quaglietta, 2013).

KM, as it is practiced in the railway organisation today, is not computerised. Senior engineering technicians write manuals themselves, they develop questions for assessment, and use theory and practice as a system to manage knowledge. The literature points out; however, that manuals and cultural methods can be made more systematic by means of computer systems.

Based on the data collected from the respondents, it is clearly seen that there is no central computerised KMS that is used by all departments, in place at the present time within the organisation (see appendix G), DM5 is only used in the head office by some senior management not all of them. This reveals that there is a huge hurdle to overcome when a KMS is being developed and implemented within the organisation. A KMS is defined as a technology system that uses IT to create, organise and disseminate knowledge throughout an organisation (Florica, 2013). In the railway organisation there is no computerised system in place within signalling, or even within the other departments of the organisation. During the interviews, one middle manager mentioned that there is a system at head office called DM5. He also mentioned that in the signalling department they are looking for a configuration management system that will store all the relevant correspondence from the consultants, as this cannot be done using the DM5 system that is being used at present.

The literature also emphasises that if you are to implement a KMS, ICTs must become the key enabler. Many studies define KMS as an IT-based system for the creation, support, enhancement, storage, retrieval, transferral and application of knowledge. KMS includes knowledge-based systems, document management systems, semantic networks, object oriented and relational databases, decision support systems (DSS), expert systems and simulation tools. Any one or combination of these tools can be designed as an effective KMS (Dorasamy et al., 2013). As mentioned above, the main objective of a KMS is to support the creation, transferral, and application of knowledge in organisations; however, knowledge and KM are complex and multi-faceted issues. Therefore, an effective development and implementation of a KMS requires proficiency in an ICT based infrastructure (Alavi, Maryam & Leidner, 2001).

5.3 KMS in the Railway Sector

5.3.1 Railway process knowledge capturing

As the researcher mentioned in chapter two previously, railway sector knowledge elements are two, tacit and explicit knowledge. The explicit knowledge mainly for railway signal processes. The main focus on the tacit knowledge is on the activity of

railway signalling operation. The difficulty of building up explicit knowledge is to extract signalling knowledge data and qualify it as the factors that are categorize as main. There is also a big challenge of combining tacit knowledge to have qualified knowledge for usage in the future.

5.3.1.1 Tacit knowledge capturing

The first point to consider in the possible design of a KMS is how knowledge can be captured. As illustrated in Figure 3.1 there are five stages that need to be followed and these are: In Figure 3.1, the railway knowledge development process of tacit knowledge is categorized into fives flows, these are:

(1) **Railway signal process classification:** By the time of signalling fault finding and railway operations, the classification of railway signalling is the first to outlining the knowledge process. The next one of this is to divide the railway signalling processes into basic and key railway signal process.

(2) **Basic railway signalling process study in motion**: These will incorporate fundamental and common in fault finding procedures. The new employed technicians or engineers in signalling could learn and study the motion of railway signalling processes slow in each step.

(3) **Key railway signal process motion study**: Key railway signal process must incorporate some identified as particular or special procedures in the fault finding operations. The employees who are in the signalling department or training for the past year could just advance their learning or studies in this process.

(4) **Railway signal fault finding process study:** For the employees that were in field for some years, it will be important for them know all the faults with someone telling them like the experience engineering technicians, that alone is boosting their competency level, that will be studied in the systematic manner.

(5) **Guidance to key railway signal process:** specifically looking at the guidance to key railway signal process, the tutors at Koeberg training centre or engineering technicians who are mentoring new staff members, needs to compile at guiding manual or procedure for future references to problems.

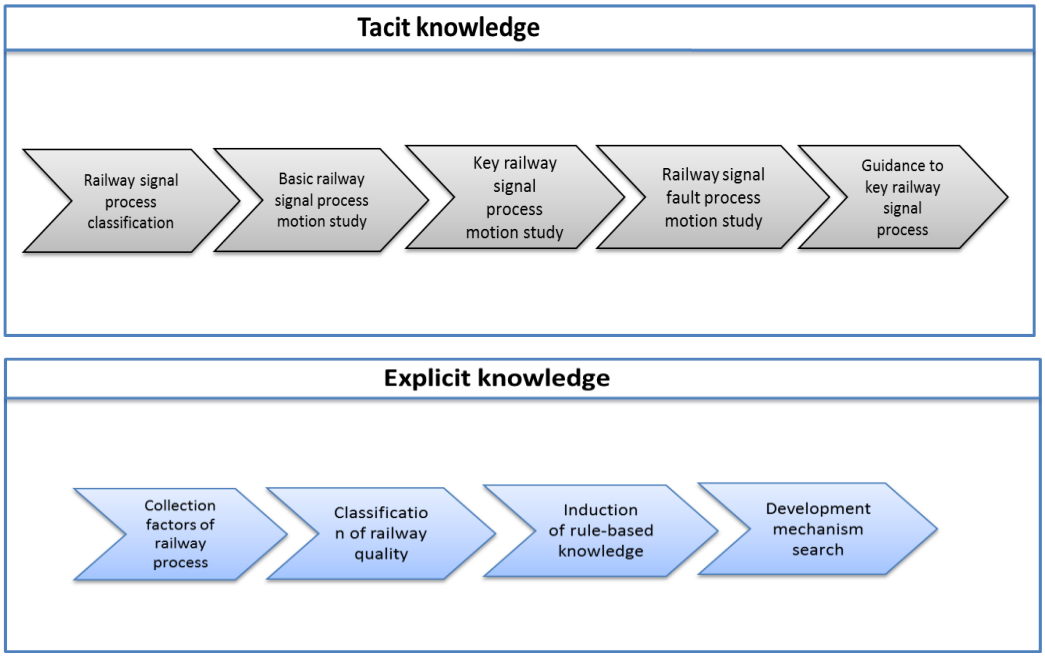

Figure 3.1: Railway build-up knowledge approach process

These systems are explained below:

- *Quality management:* Quality management considers the railway sector service the organization is providing. The knowledge of signaling process correspondences and documents or manuals that the engineers are creating in training center cab used to for quality management improvement.
- *Process KMS:* The use of the system will be based on categorize, reviewing, storing and uploading of knowledge. There are some interfaces that can work with KMS and it can be easy to align this with all other systems in the sector as interfaces by document process of railway sector and give the chance to employees to be part of it by looking at the transfer and sharing of knowledge. In this KMS there will be an allowances storing the information that was available for the experiences in the past by the recent retiring employees. All this will help in that quality management standards as standardization to improve services.
- *Educational training:* KMS can enhance new staff members to be enabled to understand fully the railway signaling process in less than the two years training that were in at the present moment. The manuals of the training have signaling equipment; devices, signaling operators, interlocking in their contents and some trouble shooting steps from trial and error and safety operations. The departments like human resources department and others that are relevant can make use of the entire KMS to come up with succession planning for the future.

- *Equipment management:* The equipment's can be managed and looked at in terms of compatibilities to the system, so that some archives and backups can be done outside that main site. Those backups and archives will have day to day information regarding the system and what equipment or machines are outdated.
- *Business management:* KMS will be used in all supporting departments in railway sector like marketing and communication, customer service, to gain the customers focus for railway services.

Moreover this system KMS will be used as the system to analyses and observe what is relevant to the customers to effective to improve the relationship with all the stakeholders that needs to be involved like government to uplift the organization profit margin.

- *Process knowledge database:* Railway sector can have their database maintained and each every time by the database administrator so that the data can be available, shared and stored.

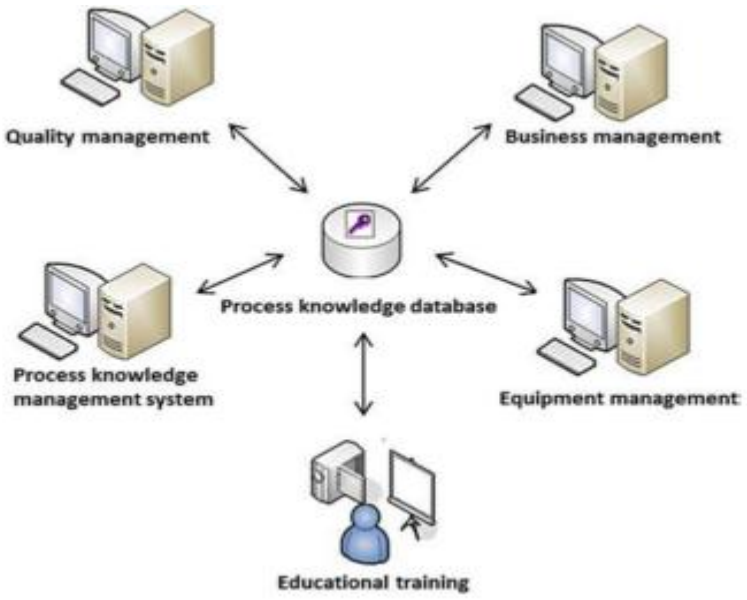

Figure 3.2 KM System architecture design

There can be a need of management centralized database to facilitate inconsistency and repetition in the database, and more on the organizational complexity information in the railway ICT space. The searches can be by this database for big data in the organization.

The main purpose the railway signaling process KMS proposed in this study is to organize knowledge of the experiences employees so that it can facilitates the process of training, mentoring, quality management, standardization and etc., to have

all the relevant knowledge in the KMS. This will improve employee satisfaction as most customers require a high level service.

5.3.2 Use case diagram of KMS

It is important to also show the use-case diagram that supports the outlined architecture in figure 3.2 before a proposed process for this study. The use-case diagram of a KMS of the railway sector process is shown in Figure 3.3. A use case is a method or methodology used in system analysis to organize, clarify, identify, and system requirements of the KMS . KMS have three categories which are, maintenance educational training and search. The maintenance knowledge is the role of database administrator who can assist in ICT or signaling department to delete, modify and add some new knowledge in the KMS, the others educational training and search of knowledge can be assessed and edited by senior engineering technicians that are in the training Centre, middle manager and training and department personnel in the human resources department.

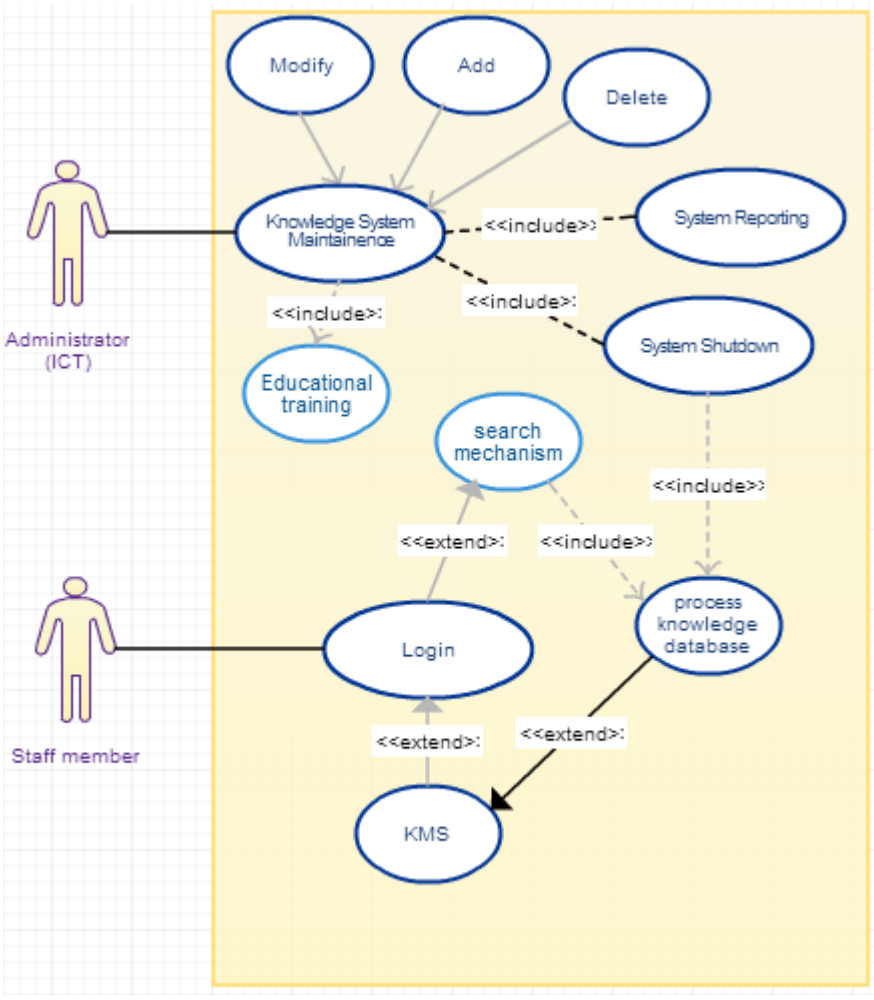

Figure 3.3: The use case diagram of KMS process

5.4 Signalling system role in railway operations

The objective was to look directly at the way the respondents understand the role of signalling in railway operations, as signalling is the key to the efficient running of the railways.

As mentioned earlier, a Signalling System is a communication system between the train and an operator, regulating the safe operation of signals, points and train detection in order to ensure the safe passage of a train on a predefined route. This definition was developed by Louis Beukes, a senior signalling manager, in an in-house workshop held in 2014 at Salt River depot. He also defines *Railway Operations* as a permanent railway line composed of parallel metal rails fixed to sleepers, for the transportation of passengers and goods in trains. Railway operation is composed of core departments like signalling, perway, rolling stock as well as supporting departments like finance, human resources, ICT and others. When speaking about railway operations, what is meant is the safe movement of trains carrying passengers from departure to destination. Senior signal engineers and middle managers emphasised that trains cannot function correctly without the availability and reliability of a signalling system that can be operated in a complex rail network like the metropolitan area of the Western Cape.

Most of the participants in this study were selected from the signalling department, as this is the core department for railway operations. The way the participants responded during the interviews clearly showed that they do not fully understand the vital role they have in transporting people by train. Even though trains have drivers, it is the signalling department that enables the movement of trains on the tracks. Without signalling, transport would be impossible.

5.5 Performance and safety of train movement

The objective was to look at the entire performance within the railway sector and to see if the employees understood the importance of signalling from a safety aspect, as well as their understanding of general performance.

Performance of trains, means looking specifically at the punctuality of trains in regard to signalling, i.e. in terms of train delays and cancellations. However, when we speak

about the safety of train movement, we mean the occurrence of accidents and fatalities within the railway network.

In chapter one of this study, we defined safety as the ability of a railway technological system to prevent injury to people (passengers, local population, operational staff, etc.). We also spoke about material damage, the threat to the ecological balance of the environment (Evans, 2010), due to the influence of objective or subjective, internal or external destabilising factors affecting the signalling system. The rate of accidents on the railways indicates if safety has been compromised. If the intensity of accident occurrence is significantly less than the intensity of train delays, then the safety aspect is being dealt with properly by the signalling system. This results in an increase in the reliability level of rail transport services (Mcleod et al., 2000).

One of the participants mentioned the need for an automatic warning system that would directly communicate with the train driver during the movement of trains. This warning system must be built into the technology used in signalling. According to McLeod, Walker and Moray (2000), the purpose of railway signalling is to ensure safety and regulate traffic. They point out that safety is ensured by maintaining sufficient headway separation between trains, given the relatively long distances required for them to slow them down. This explanation is not much different from the definition of safety by the in-house senior manager and signalling engineer Louis Beukes.

In their corporate plan 2012, the railway organisation in South Africa mentions an important point about safety regarding train movement. The current signalling system is no longer suitable for the safe movement and monitoring of traffic. It is unreliable and has been one of the major causes of accidents in the recent past (Evans, 2013). In the current system, 85% of the signalling installations have become obsolete. This causes train delays and cancellations. The signals that remain are not able to fully support the safe movement of trains. The literature shows that the current railway signalling system consists of concoction of technologies from the 1930's, 50's, 70's and 80's (Evans, 2013).

Table 2.1: Current Status of Signalling System

Region	Interlocking's	Average	Signalling elements
Gauteng	89	69	9365
Western Cape	43	30	4287

KwaZulu Natal	30	37	2928
Nationally	162	35	16 580

If the average age in years per region is analysed, it shows that the system is too old to safely and reliably transport people. Even different interlocking technologies are used in each region, as can be seen in the interlocking column above. Any expert in signalling would have difficulty understanding 162 different interlocking technologies. This shows the difficulty that the railways sector has regarding the safe transportation of 2.2 million people per day who use the railway.

Appendix G shows that the level of problems associated with performance is high. This is mainly due to the absence of a KMS. At the present time only those individuals who have been working in the railway sector for many years, have knowledge about most of the signalling used nationally in South Africa.

Senior engineering technicians also mentioned that the accumulative experience they have, is 130 years. This is a huge risk for the organisation as these technicians have already reached pension age. The middle managers also mentioned and emphasised that the railway organisation does not have any training centre in other regions within South Africa. The only one that exists is in the Western Cape and it is being run by elderly employees.

At the present time, we see only two of these types of learning at work within the railway industry, i.e. communication learning and learning through direct communication. This is due to the fact there is no specific institution in South Africa where an individual can go in order to attend a railway-specific course. Most of the knowledge is managed though in-house-training (Koeberg training centre), manuals and communication learning. Most of the time the organisation uses direct communication, since it is often necessary for experiential learning as tacit knowledge is acquired through consultation with experienced persons. Most of the knowledge within the railway industry is to be found in the minds of their employees (tacit), based on the number of years they have worked in the organisation. The literature also emphasises that tacit knowledge is created through direct experience, through the actions of technical individuals technical, and through learner ships or job shadowing (Nonaka and Takeuchi, 1998: 10-60).

KM is the biggest concern in the railway organisation in South Africa. This is illustrated by the fact that most of the responses received by the researcher highlight

this issue. It is also shown by the fact that most of the people with knowledge belong to the older generation and have been in service for the past twenty to forty years. Most of these employees with knowledge are about to retire. This means that almost eighty-five percent of the knowledge contained within the railway sector will be lost due to the absence of a proper KMS. Two senior engineering technicians and a middle manager strongly emphasised KM as their biggest concern (see results in appendix G). This simply shows that there is no proper KM tool in the railway industry. Each individual has their own way of managing their knowledge; there is no integrated way of managing knowledge. This puts the organisation at risk in terms of the knowledge that will be lost due to people leaving the industry for other kinds of employment and those who will retire within a short period of time.

5.6 Conclusion

This chapter does not deal with the technical design of a KMS. The purpose was to describe and analyse the processes involved to design and implement the system. The proposed model will help in the design and implementation of a KMS in the railway sector in South Africa. This answers the main research question that was posed for this study. This type of question is descriptive but the results of this study have explanatory implications regarding the process needed. In the absence of an integrated KMS for the railways this study showed how the ERP (SAP) that is already in place in organisation can help to integrate any system that is already being used into one consolidated KMS.

The conclusion that can be reached is there is a huge risk for the loss of tacit knowledge in the Railway organisation in South Africa. This is due to many various aspects which have been outlined above. There is also a major gap between the employees in each department and their managers. This is seen in the lack of understanding that exists among managers as to what each employee does and also in giving each employee the support that is needed

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter contains a summary of findings form the data collected in the study. By interpreting the findings in this study, the researcher will make key recommendations that should be implemented in order for the railway sector to plan for the future needs of the industry by maintaining, retaining and optimising the knowledge that the sector already possess.

The recommendations made by the researcher are specific, measurable, action oriented, realistic and time bound. By analysing the findings presented in chapter 4, the researcher will identify the procedures to be followed in order to rectify the issues raised. Last proposed model for railway organisation was addressed in this chapter

6.2 Findings

This section provides the summary of findings from the data that was collected through interviews in the railway organisation in South Africa. These findings focused on key findings on the research questions.

6.2.1 Current practices of capturing tacit knowledge in the railway industry in South Africa

The findings that are related to the posed question are that, knowledge is captured and stored in manuals by senior engineering technicians who are teaching in the in-house training centre. These are the employees who have the duty to write training manuals for the training centre. The researcher found that these three worth 130 years of knowledge. This happens before they write manuals, the must first compile course structure for the signalling department. Thereafter senior engineering technicians provide theoretical and practical training to other staff members in the department. They also help other employees by passing knowledge to the interested parties through mentorship, especially to other signalling staff members that works in sections. The researcher also found that the ways of capturing and storing knowledge are very limited, thus making the job more challenging. The pace of capturing knowledge is not happening the way it should because of the staff member's ages as they can leave at any time from now on.

6.2.2. The need for tacit knowledge to become explicit knowledge

The findings that are related to the posed question are; it is because there is a need for tacit knowledge to be shared with young engineers. The signalling department is crucial in train operations, as there are not many employees with tacit knowledge still left in the industry, thus creating a huge gap as it takes quite a while to educate a person to gain this knowledge. Even though it is in-house-training, using manuals written by older engineers, they are concerned with the standard percentage pass in signalling assessment of 80% and it was maintained.

The other employees are concerned about getting proper training from experienced engineers and becoming competent in working with signalling. However, the experienced staff members are very concerned about the tacit knowledge they, the researcher found that at the present time no one is being mentored to take over from them. Some knowledgeable staff members have passed their retirement age but due to the value of the tacit knowledge they possess, the organisation is not willing to let them retire because they are working and contracted by the company. All experienced staff members during their interviews are very much aware of the tacit knowledge that will be lost when they leave.

6.3.3 The mechanisms required to extract tacit knowledge from older and experienced employees

The research found that signalling knowledge is very important, however it cannot be found in books but only through experience. There is a need for someone to take all the tacit knowledge in the organisation and transfer it into book form. For the time being the researcher found that knowledge of archives is needed so that from the manuals can be archived in a central place. With only few resources in the department there is a need for more resources because only three people are working in the training centre at present. The people who will work with experienced staff members are needed on a daily basis as part of the succession plan in order for to at least learn. Process workers can always work with qualified people in the signalling as their job is to do work outside the signalling components.

6.3.4 The design of a KMS for tacit knowledge

The finding from the data that was collected by the researcher tells that engineering technicians do not have any idea about designing a KMS. The railways sector had no proper KMS is in place at the moment.

In order to begin some kind of a KMS, proper computer infrastructure is required. The future KMS is needed, using the benefits of technology rather than being manually based. Since middle management and senior management and infrastructure have some light about KMS the researcher found that these employees understand how the KMS should entails even though they do not how to design it. The researcher also found that there is a system to store documents that is available in the organisation, middle management mention that they need proper KMS. This KMS must capturer a step by step process on fixing faults and on fault finding in signals.

6.3 Recommendations

The study makes the following recommendations regarding the research questions posed:

1. What are the current practices of capturing tacit knowledge in the railway industry in South Africa?
   Recommendations
   a. It is recommended that all training manuals used by the company must be uploaded to the company's portal to assist young engineers in studying on their own. The few experts that are available must guide these students when issues arise.
   b. It is recommended that brainstorming as a method to see how other countries, like Australia, maintain safety standards on the railways.
   c. It is recommended that when signalling faults are discovered, young engineers must resolve the problems while the experienced engineers are available to assist them when they cannot resolve the issues themselves.
   d. It is recommended that each experienced engineer must be given twenty new engineers in order to mentor them. In each month a report on their performance must be presented to the executive management.
2. Why is there a need for tacit knowledge to become explicit knowledge?
   Recommendations

a. It is recommended that this knowledge needs to be available at all times because the same faults happen. The organisation needs to label this knowledge as an asset.
b. It is recommended that since most of the employees have only two years left before they retire, it is vital that already now in 2015 that the organisation needs to have a suitable succession plan in place.
c. It is recommended that the human resources department as well as the finance and signalling departments, must provide a combined proposal to the executive body requesting more resources. This must be done as a matter of urgency within the next 12 months.
d. It is recommended that since Koeberg training centre was established a long time ago and that no other institution provides railway-specific courses in South Africa, an application to SAQA for accrediting must be part of the organisation's strategy.

3. What mechanisms are required to extract tacit knowledge from older and experienced employees?

   Recommendations

   a. It is recommended that permanently assign younger engineers to experienced employees, in order for the younger members of staff to gain the same or equivalent experience as the older engineers.
   b. It is recommended that after the first module has been completed, young engineers must do their training under the supervision of experienced engineers in order to see if they can they manage the training. Human resources (training and development) need to be involved in this process as they are responsible for training.
   c. It is recommended that Young engineers must be involved every time the structure is amended and afterwards the course structure must be workshopped to the department of signalling.
   d. It is recommended that once a month all documents must be tested by the head of the signalling department, sometimes with the help of the authors of the documents.

4. How can a KMS for tacit knowledge be designed and implemented for better service delivery?

   Recommendations

   In addition to the model proposed in chapter 5 the following additional recommendations should also be considered:

      a. That at the meetings held within the organisation, as well as through the communication tools used in the organisation, all staff members must be

made aware of what a KMS is and therefore be encouraged to contribute to the process of designing and implementing a KMS

b. That all existing servers and databases in the organisation must be used in creating a KMS. All testing must be done when the experts are still available, before they leave the organisation. These experts must be involved at every level in the development of the KMS.
c. That access to the KMS must be made available through any internet connection and not dependent on being on-site. All staff members must be provided with the proper credentials to log into the system
d. That the responsibility for backups must be given to the ICT department. The backup process must be mirrored by two separate systems in two different places in case one system is down, the other one will work. This process must be automatic so that the chances of human error are minimised. The process of designing and implementing KMS must begin immediately. When new engineers are being trained, the management must be invited in and taken through every aspect of the training that will be provided, both theoretical and practical training, and a step by step process for every task in the organisation must be written down by experts and implemented as soon as possible.
e. It is recommended that before the experienced engineers leaving the company, all experts must have exit interviews where the process mapping is done using the system.

6.4 Proposed Process for Knowledge Management in the Railway Sector

In order for the railway industry in South Africa to have one KMS, there is a need to have a process of designing and implementing a KMS that will be accessible by all stakeholders, i.e. by the signalling department, by the human resources department (including training and development), by senior management and by the employees and lecturers at Koeberg training centre.

Figure 4 below shows how the proposed KMS process can be accomplished.

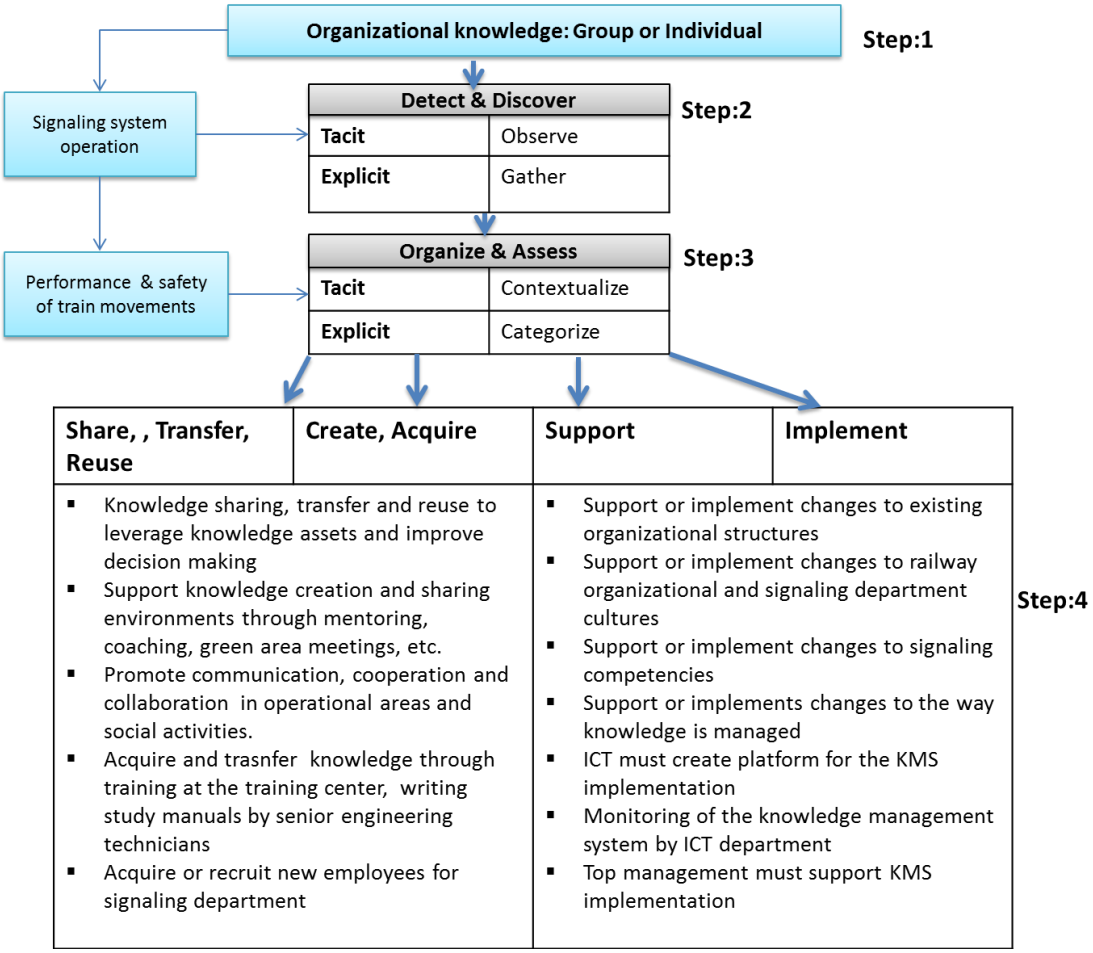

Figure 4: Proposed Process for Knowledge Management System for Railway Sector

In this proposed process KMS; outlines a series of knowledge management processes. They will be used as headings for the subsections presented here, and can be accessed through the menu on the left. These are: Knowledge Discovery & Detection, Knowledge Organization and Assessment, Knowledge Sharing, Knowledge Reuse, Knowledge Creation and Knowledge Acquisition; below is the analysis of each step in the process. They outline all aspects involved in the actual management of knowledge.

6.4.1 Knowledge Discovery and Detection

In this subsection, the study examined the knowledge management (KM) initiatives involved in knowledge discovery & detection.

This step deals with discovering the knowledge that a PRASA possesses by signaling engineers in the duration they are in the organization, and the previously hidden information that is unidentified knowledge at PRASA, this knowledge is acquired or created, which exists within the organization. However, this knowledge needs to be categorized and recognized properly by top management at PRASA even before the sharing and reusing of it.

This subsection deals with the former aspect, while the following subsection deals with the latter. It is a lot more complex to detect and discover tacit knowledge, it depends more on top management of PRASA to gain an understanding of what their company's experts actually know. Since tacit knowledge is considered as the most valuable in relation to sustained competitive advantage, this is a crucial step, a step that often simply involves observation and awareness (Bali et al 2009). There are many practices and tools that can assist in the KMS process; these are focus, individual exit interviews, troubleshooting observations, group interviews, questionnaires and analysis of the existing signaling system. PRASA can also use their ICT identify experts in the new generation that can grasp quickly using technology that is available (Botha et al,2008). The are available groupware systems and other social networks the organization is using as well as senior engineering technicians that can identify to management who considered experts in signaling, and may also give an indication of the knowledge signaling experts have.

6.4.2 Knowledge Organization & Assessment

The idea is that PRASA should categorize their knowledge assets from each sub department for each individual and aligned to company strategy. In order for them to determine the resources they have at their signaling and to identify weaknesses and strengths, top management in the organization needs to organize or arrange organizational knowledge so that it can be manageable. Organizational knowledge encompasses some activities that clearly identify, storage, signaling components, pictures, categorize knowledge for retrieval and navigation, videos and simulators (Botha et al. 2008). The knowledge intermediary for organizing, preparing and decontaminating would assign roles for this knowledge at PRASA. This could the knowledge producer or be a manager for that particular knowledge. This point clearly classify, that for knowledge to be shared or reused in PRASA or for it to be used as a tool for knowledge creation, it must be stored in a way that it can be understood ,identified and extracted by the users of that knowledge. Tacit knowledge organization in the use of individual socialization, signaling maintenance groups, engineer's expertise guides (like manuals) and available social networks, PRASA ICT communication tools and coordinators of knowledge (Liebowitz ,2011). Latter's role is to understand in which context the tacit knowledge was created. Expertise locations, such as PRASA signaling depots, operational areas, standby sites and Koeberg training center that PRASA used to categorized and locate the valuable expertise of tacit knowledge sources in the signaling department. They can be also used to give

guidance into how widespread certain tacit knowledge is, enabling PRASA to plan ahead for the retirement of key engineers or employees.

6.4.3 Knowledge Sharing and transfer

Knowledge management is fundamentally about making the right knowledge or the right knowledge sources (that is people) available to the right people at the right time. Knowledge sharing and transfer is therefore perhaps the single most important aspect in this process, since the most of KM creativities is on it.

Knowledge sharing and transfer depends on knowledge employee's willingness and habit. PRASA must provide incentives; the right culture must therefore be present.

In the rest of this section I will discuss the concepts of knowledge sharing and transfer according to the different tacit knowledge.

Some studies have considered technology as one of a number of barriers to knowledge-sharing and knowledge-transfer in most organisations like railways (Khalil, 2012). Much of the literature focuses on the technical issues that have to be overcome when a system is being developed (Alavi, Kayworth and Leidner, 2006:p.196). We have already mentioned this in chapter two. What are considered to be knowledge-sharing tools are in fact information-transfer tools if we are to apply Pohs' (2000:p.2) definition of KM, which emphasises the need for tacit knowledge to be used together with explicit knowledge. According to Chopra-Charron and Andrusky (2009), both explicit and tacit forms of knowledge must be captured and shared for information to become knowledge, as mentioned in chapter two of this study dealing with literature reviews.

Senior engineering technicians spoke more about the need for knowledge transfer and knowledge sharing. In their interviews during data collection, they emphasised the issue of knowledge transfer and knowledge sharing, as they are lecturers at the Koeberg training centre. They are the people who are responsible for knowledge transfer and knowledge sharing within the organisation. This is clearly illustrated in appendix G. Even engineering technicians emphasised the importance of knowledge sharing and knowledge transfer. This shows that when the employees who work in the training centre retire, the consequence will be catastrophic if no system in in place for KM. It also shows that knowledge of signalling is totally reliant on these teachers (Koeberg training centre). This point was also clearly made by one of the middle managers who emphasised that without the staff in the training centre, there would be no knowledge of signalling available in the organisation.

The role of IT will also be explored and discussed from a general perspective. Sharing and transferring tacit knowledge requires socialization. This can take many different forms. Davenport & Prusak (2009) outline a few relevant factors:

- Employees networking informally, which involve the day to day interaction between employees within signaling environment is important to be considered
- Unlike the formalized structure of PRASA, these networks span functions and hierarchies. They are therefore difficult to identify and monitor.
- Support of networks by management by providing communication means. PRASA will have to create more socialized areas where employees can engage in social space, discussions among themselves. Top management can allocate time after the production meeting and a location if there is a need this can also happen during departmental team buildings on a monthly bases so that employees can have more time to share and transfer expertise in the signaling space. PRASA top management must simply provide the means for employees to foster tacit knowledge and informal networks.
- Understanding the value of disorder by PRASA management. This refers to the value of unstructured work practices that encourage experimentation and social interaction. Within a more chaotic environment, individuals are given the freedom to solve problems creatively and, in so doing, must tap into and evolve their social networks. The value of less structured work environments is also well known within innovation management.

It is difficult and sometimes absolute impossible to codify tacit knowledge. There will often be a resulting knowledge loss (Davenport and Prusak 2000). Often, it is much more reasonable to simply externalize the sources of tacit knowledge rather than the knowledge itself (Davenport and Prusak 2000). This means that often it is better for experts in signaling to externalize what they know rather than how they know it. The main role of KM then becomes making sure that experts can be found so that tacit knowledge can be passed on through socialization (networking), coaching and mentoring, practice and that the PRASA supports and encourages the socialization that is necessary for these functions to occur.

To share and transfer tacit knowledge requires a culture conducive to this type of sharing and transferring. Furthermore, signaling management and senior engineering technicians from Koeberg training center whom they understand types of knowledge that exist at PRASA in signaling , their role is to translate and locate knowledge elements, thus facilitating their integration into other departments within PRASA. This

more on managing and people PRASA organizational culture change as the change management to the employees.

The role of IT for tacit knowledge sharing and transfer can thus be summarized as follows:

- Finder expert: To locate the source of the tacit knowledge through systems like corporate signaling.
- Providing limited support in the socialization of tacit knowledge: If IT systems support varied, formal and informal forms of communication then they can help tacit knowledge sharing by supporting groups in the PRASA community. Functions for example video conferencing documents creation (manuals and reports), or support other PRASA regions that are outside Western Cape region. It is important to take note that most of these employees are not used to IT systems, they will need training and it will backfire if they do not know how to use them.
- Providing limited support in the externalization of tacit knowledge: Through groupware applications that are available in the market support the discussion forums and codification process. However, not only is this aspect limited, but externalization itself is only rarely feasible.

Swan et al. (2002) pointed out that IT oriented approaches often place undue focus on externalization. This is due to the fact that much of it cannot be codified and due to the context specific nature of tacit knowledge, externalization should sometimes not be attempted. In this context, IT is perhaps best as an expertise locater.

However, in some cases IT can be of some limited use as a forum for externalization of tacit knowledge. For example, (Botha et al., 2008) illustrated that groupware systems that support brainstorming can help in the codification process. Using available discussion databases that are available online and some discussion forums can also be sources of externalized knowledge (Botha et al., 2008), although knowledge quality should be in question.

Using IT to move tacit knowledge is difficult since knowledge represents the shared and transferred understanding and the sense making that is deeply rooted in the social practice of PRASA community. The focus for the successful sharing and transferring of tacit knowledge must be on mentoring, social interaction, signaling troubleshooting, and teaching in the training center.

In PRASA employees are divided into those who take a people-oriented approach and those who take a technologically-centric view (Bali et al 2009). Increasingly however, the limitations of IT are being recognized most in this context, as well as in related disciplines such as knowledge creation.

6.4.4 Reuse of Knowledge

First, a quick overview of the knowledge reuses process, and some useful definitions. Markus (2001) identifies three roles in the reuse of knowledge:

- Knowledge producer: The original creator of the knowledge
- Knowledge intermediary: The one who packages and prepares the knowledge so that it may be stored, retrieved, and shared. This may involve any number of functions such as indexing, categorization, standardizing, publishing, mapping, etc.
- Knowledge consumer: The person who is the recipient and user of the knowledge in question.

These three functions may involve different people or they may all be done by the same person. For example knowledge reuse by new employed signaling engineer accessing the manuals or viewing the simulation (explicit) that were created by senior engineering technicians in PRASA signaling department, these are prepared by them so that they may be retrieved and understood, and that the user (new recruits) retrieved and used it. These roles are filled by senior engineering technicians at PRASA and the process included both tacit and knowledge capture and for explicit knowledge sharing across PRASA.

In tacit knowledge, the role of intermediary could be defined as the expert (senior engineering technician), since he is the one present the knowledge (through classroom, practical and socialization) in a useable way to his student and other employees. The senior engineering technician creates an expert profile for publishing on PRASA intranet or website; the knowledge manager creates an explicit account of what the expert knows rather than promoting externalization of the knowledge itself.

All in all there senior engineering technicians or any experience staff member has to have the knowledge, someone has to make this knowledge available, the database administrator at IT have administrator the databases where the knowledge is stored and also stored it, and students or newly recruits and any other employee have to search and use this knowledge. This implies not just the capability, but to the attitude of willingness to retrieve, to share, to transfer and to search.

6.4.5 Knowledge Creation

The ability to create new knowledge is often at the heart of the organization's competitive advantage. Sometimes this issue is not treated as part of knowledge management since it borders and overlaps with innovation management (Wellman

2009). The study covered the knowledge creation as the process since for tacit knowledge system application, since at knowledge creation is about innovation, that is sharing, transfer etc, and also the end knowledge must be created in the system for future purposes by PRASA as an organization in order to be competitive.

Knowledge creation according to the Nonaka's SECI model is about continuous sharing, transfer, combination, and conversion of the different types of knowledge, as users practice, interact, and learn. The shift in condition between the possession of knowledge and the act of knowing - something that comes about through practical, troubleshooting, and guidance by experience employees at PRASA; this is the driving force in the creation of new knowledge. Furthermore, in order for this to work more productively, it is important to support unstructured work environments in areas and depots where innovation and creativity are important.
Knowledge sharing, transfer and knowledge creation go hand in hand. Knowledge is created through practice, collaboration, interaction, and education, as the different knowledge types are shared and converted. Beyond this, knowledge creation is also supported by relevant information and data which can improve decisions and serve as building blocks in the creation of new knowledge.

The role of management in the knowledge creation process is thus as follows:
Knowledge sharing and transfer needs to be encouraged and unable if it’s not available at PRASA: On the tactical side, as described in the previous subsection, PRASA management must understand where and in what forms knowledge exists. They must then provide the right forums for knowledge to be shared and transfer. For tacit knowledge this implies a particular emphasis on informal communication, while for explicit knowledge this implies a focus on a variety of IT systems. On the knowledge strategic side, PRASA management needs to design or create the right working processes, environments and provide systems by making the means and willingness for that to take place.

Create PRASA environment suitable for that: This includes the notion of creating interplay between knowledge and knowing. It implies offering relevant succession planning which includes mentoring, but it is important to allow new knowledge to be created through social interaction, practice, and simulations that works as an experiment in the Koeberg training center. When dealing with tacit knowledge it is he importance share experiences in the knowledge creation process, and the need for an environment where these can be formed (Botha et al 2008). In most cases cultural norms stifle new knowledge creation and innovation at PRASA or any organization.

To provide systems that supports the work process: These can be groupware systems that facilitate communication or brainstorming. However, they must not interfere with creative processes or communities of practice, or enforce rigid organizational practices (espoused theory).

PRASA needs to provide knowledge expects with timely, relevant information and data, by implementing of IT tacit knowledge system that can present information, organize, store data in a helpful way and retrieve.

The use of IT is very much the same as it is for knowledge sharing and transfer, allowing for some degree of support in the transfer of all knowledge types. One important aspect is that it must support, and not interfere with, informal collaboration. For example, groupware systems can be used to enhance communication between communities or teams, particularly if they support varied (e.g. video conferencing, audio, text - according to the needs of PRASA), informal communication.

Apart from this, IT also has an important role through information management, by providing access to data and information, and allowing the manager to perform in-depth analyses. More than that, IT systems can also be programmed to spot trends in data and information and present that to the manager. This essentially enables the manager to make better decisions and aids knowledge creation by providing some of the building blocks for new knowledge.

IT tools can also be used in the innovation process (e.g. tools used in the actual product design), but these are outside the scope of knowledge management.

6.4.6 Knowledge Acquisitions

This aspect deserves mention, but as a general discipline it is well beyond the scope of this paper. Dealing with acquisitions is an extremely complex task that has led to numerous failures. Within the scope of knowledge acquisition, the area related to KM is how to pass on the most amount of relevant knowledge from one department or entity to another at PRASA .Very broadly speaking there are a couple of roles where KM efforts should feature heavily once the target has been acquired:

To identify the valuable/redundant knowledge sources at PRASA: One of the major causes of failure in acquisition is that during the restructuring process at the signaling department at PRASA where key people in the department are given new roles that that are not capable off this are disruptive. This is mostly in the top management when the chief executive officer made changes.

To combine the relevant knowledge with PRASA's knowledge assets to achieve interaction: This is the essence of many acquisition; the notion that the whole should be greater than the sum of its parts. Integrating acquired department at PRASA for example all engineering services is a difficult task, heavy on people management and the creation of a common culture. The same principles on knowledge sharing, reuse, and creation apply here, with a particular focus on culture, networks, and incentives, within a different and potentially hostile environment.

Recruitment involves the determination of an organisation's knowledge requirements and enrolling individuals deemed to possess such knowledge into the organisation (Corredoira and Rosenkopf, 2006; De Long, 2004, Harman and Brelade 2000). The findings on the acquisition of tacit knowledge through recruitment were obtained through interviews. The responses of the participants show that there is a shortage of resources and that this issue must be addressed by the human resources department. They also emphasised that it is not an easy task to recruit someone into the signalling department. The findings show that when human resources recruit a person they need to follow certain processes.

These are filling in an application form, shortlisting, assessment or knowledge test, a one to one interview as well as checking that the candidate has a diploma in electrical engineering. The aim of this process is to identify the gap between skills and knowledge a candidate has. This will enable the company to place a person according to their knowledge and capabilities.

Appendix G shows that there is a shortage of skills and competence in the signalling department. This puts the organisation at risk because to run trains capacity in terms or resources is needed as well as a high level of competency.
This means that the process of recruitment must happen quickly, followed by coaching and mentoring as a succession plan for the organisation. The organisation needs to know the risks associated with the current knowledge base (Hylton 2002; Paramasivan 2003). The understanding of the knowledge base is key to tacit knowledge and knowledge management systems.

6.5 Conclusion

This study focused on the need to think differently about KMS, especially in the light of recent changes in the way organisations view KM. The results of our qualitative

analysis confirm the appropriateness of the scope of the proposed KMS process, but suggest that this should be more strongly integrated within the overall technology used in the railway sector. Thus, rather than studying KMS as a separate entity, more focus should be given to placing the KM process in the real and proper context of the railway situation and integrating KMS with other technologies. By so doing, the KMS will be able to support the railway sector in achieving their mandate and goals, while maintaining a high standard of safety, reliability and operational services for the transportation of passengers. The contribution of our work is to identify the problems and needs of the railway sector when implementing a KMS, particularly in identifying any issues of integration that may arise when the various departments are unified in working with one common system.

LIST OF REFERENCES

Abdul-Jalal, H., Toulson, P. & Tweed, D. 2013. Knowledge Sharing Success for Sustaining Organizational Competitive Advantage. *Procedia Economics and Finance*, 7: 150–157. http://dx.doi.org/10.1016/S2212-5671(13)00229-3 [2 March 2014].

Abdul-Munaim, A.M. & Lutfi Hussain, M.A. 2014. Determination of the suitability period of S-3 diesel oil when used in tractor engines. *AMA, Agricultural Mechanization in Asia, Africa and Latin America,* 45(1): 20–22. http://www.scopus.com/inward/record.url?eid=2-s2.0-84897853819&partnerID=tZOtx3y1[1 June 2014].

Ackoff, R. L. 1989. From data to wisdom. Journal of Applied Systems Analysis 15: 3-9

Adeleke, A. & Alegbeleye, G. 2013. Knowledge Management Practices and Organisational Performance of Manufacturing Industry in Nigeria. *A pre-field Seminar in the University of Ibadan, NIGERIA.* http://xa.yimg.com/kq/groups/22150699/2080130133/name/Project.pdf [6 May 2014].

Alavi, M. & Leidner, D. 2001. Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS quarterly*, 25(1): 107–136.http://www.jstor.org/stable/3250961 [23 March 2014].

Alavi, M. & Tiwana, A. 2002. Knowledge integration in virtual teams: The potential role of KMS. *Journal of the American Society for Information Science and Technology*, 53(12):1029–1037 http://onlinelibrary.wiley.com/doi/10.1002/asi.10107/full [6 May 2014].

Al-Jamimi, H. A. & Ahmed, M. A. 2013. Machine learning approaches for predicting software maintainability: a fuzzy-based transparent model. *IET Software*, 7(6): 317–326. http://digital-library.theiet.org/content/journals/10.1049/iet-sen.2013.0046 [6 March 2014].

Altaher, A.M. (2010) 'Knowledge Management Process Implementation 2011', International Journal of Digital Society (IJDS), Vol. 1, Issue 4, December, pp. 265-271

Alves, D., Martinez, L.M. & Viegas, J.M. 2012. Retrieving real-time information to users in public transport networks : an application to the Lisbon bus system. *Social and Behavioural Sciences*, 54(2011): 470–482.

Armistead, C. & Meakins, M. 2002. A Framework for Practising Knowledge Management. *Long Range Planning,* 35(1): 49–71. http://linkinghub.elsevier.com/retrieve/pii/S0024630102000171 [1 March 2013].

Babur, M., Ali, S. 2006. Externalizing tacit knowledge for improving leadership practices: Experiences from leadership programmes under ESRA. Quality in education: *Teaching and leadership in challenging times*, 1, 70-84.

Bakshi, A. 2005. Key Issues in Knowledge Management: Introductory Analysis. *Pakistan Journal of Social Sciences*, 35(1): 715–723. http://docsdrive.com/pdfs/medwelljournals/pjssci/2005/715-723.pdf [6 May 2014].

Bartol, K. & Srivastava, A. 2002. Encouraging knowledge sharing: the role of organizational reward systems. *Journal of Leadership & Organizational Studies* , 9(1): 64-76. http://jlo.sagepub.com/content/9/1/64.short [30 April 2014].

Basden, A. & Klein, H.K. 2008. Data & Knowledge Engineering New research directions for data and knowledge engineering : A philosophy of language approach. *Data & Knowledge Engineering*,67: 260–285.

Baskerville, R. & Dulipovici, A. 2006. The theoretical foundations of knowledge management. *Knowledge Management Research & Practice*, 4, 83–105. http://www.palgrave-journals.com/kmrp/journal/v4/n2/abs/8500090a.html [7 April 2015].

Bellinger, G., Castro, D. & Mills, A. 2004. Data, information, knowledge, and wisdom. *Data & Knowledge Engineering(2004).* http://www.systems-thinking.org/dikw/dikw.htm [8 April 2015].

Benedict, R.H.B., Wahlig, E., Bakshi, R., Fishman, I., Munschauer, F., Zivadinov, R. & Weinstock-Guttman, B. 2005. Predicting quality of life in multiple sclerosis: accounting for physical disability, fatigue, cognition, mood disorder, personality, and behavior change. *Journal of the Neurological Sciences*, 231(1-2): 29–34. http://linkinghub.elsevier.com/retrieve/pii/S0022510X04005039 [7 April 2015].

Bititci, U.S., Ackermann, F., Ates, A., Davies, J., Garengo, P., Gibb, S., MacBryde, J., Mackay, D., Maguire, C., Meer, R. Van Der, Shafti, F., Bourne, M. & Firat, S.U. 2011. Managerial processes: business process that sustain performance. *International Journal of Operations and Production Management*, 31 (8). 851 – 891.

Bjørnson, F.O. & Dingsøyr, T. 2008. Knowledge management in software engineering: A systematic review of studied concepts, findings and research methods used. Infor*mation and Software Technology*, 50(11): 1055–1068. http://linkinghub.elsevier.com/retrieve/pii/S0950584908000487 [21 July 2014].

Botha, A., Kourie, D., and Snyman R, (2008) Coping with Continuous Change in the Business Environment, Knowledge Management and Knowledge Management Technology, Chandice Publishing Ltd.

Brandt, S.C., Morbach, J., Miatidis, M., Theißen, M., Jarke, M. & Marquardt, W. 2008. An ontology-based approach to knowledge management in design processes. *Computers & Chemical Engineering*, 32(1-2): 320–342. http://linkinghub.elsevier.com/retrieve/pii/S0098135407001032 [18 August 2014].

Bryman, A. 2004. Qualitative research on leadership: A critical but appreciative review. *The Leadership Quarterly*, 15(6): 729–769. http://www.sciencedirect.com/science/article/pii/S1048984304000840 [30 April 2014].

Bush, B.A. & Tiwana, A. 2005. Designing sticky knowledge networks. Communications of the ACM May 2005, 48(5): 67–71.

Cascetta, E. & Pagliara, F. 2008. Integrated railways-based policies: The Regional Metro System (RMS) project of Naples and Campania. *Transport Policy*, 15(2): 81–93. http://linkinghub.elsevier.com/retrieve/pii/S0967070X07001060 [11 March 2014].

Chang, H., Tsai, M. & Tsai, C. 2011. Knowledge-Based Systems Complex organizational knowledge structures for new product development teams. *Knowledge-Based Systems*, 24(5): 652–661. http://dx.doi.org/10.1016/j.knosys.2011.02.003 [17 August 2014].

Chang, S.J, 2013. Is the Knowledge Management System Truly Cost Effective ? Case Study of KM-Enabled Engineering Problem Solving. *Journal of Construction Engineering and Management*, 139(2), 216–224.

Chen, C., Chang, M. & Tseng, C. 2012. Human factors of knowledge-sharing intention among taiwanese enterprises: A model of hypotheses. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 22(4), 362–371.http://onlinelibrary.wiley.com/doi/10.1002/hfm.20286/full [8 April 2015].

Cheng, J., Yeh, C. & Tu, C. 2008. Trust and knowledge sharing in green supply chains. Supply Chain Management: *An International Journal*, 13 (4), pp.283 – 295.http://www.emeraldinsight.com/doi/abs/10.1108/13598540810882170 [7 April 2015].

Cheung, C.F., Li, M.L., Shek, W.Y., Lee, W.B. & Tsang, T.S. 2007. A systematic approach for knowledge auditing: a case study in transportation sector. *Journal of Knowledge Management*, 11(4): 140–158. http://www.emeraldinsight.com/10.1108/13673270710762774 [4 March 2014].

Chou, H.-W., Lin, Y.-H., Lu, H.-S., Chang, H.-H. & Chou, S.-B. 2014. Knowledge sharing and ERP system usage in post-implementation stage. *Computers in Human Behavior*, 33(2014): 16–22. http://linkinghub.elsevier.com/retrieve/pii/S0747563213004767 [28 May 2014].

Clarke, C.B. & Bailey, C. 2000. Managing knowledge for personal and organisational benefit. *Journal of Knowledge Management,* 5 (1): 58 – 68.

Collins, H. 2010. Tacit and explicit knowledge.Library of Congress Catalogue in Publication Data, University of Chicago Press, Published 2010. http://books.google.co.za/books?hl=en&lr=&id=ONzRalXOtEMC&oi=fnd&pg=PR7&dq=tacit+and+explicit&ots=TeWJj9YsYb&sig=QRyE780PlS2ypgD2q3UwJ7XYJzY [29 July 2014].

Coombs, R., Hull, R., Marshall, C., Prusak, L. & Shpilberg, D. 1998. " Knowledge management practices " and path-dependency in innovation. *Research Policy*, 27 (1998) 237–253.

Correa, R., Alvarenga, D. De, Souza, R.R., Dom, F. & Fdc, C. 2005. Knowledge Management Implementation : a Process Design Proposition at Brazil ' s ONS (National Operator of the Interconnected Power System). *Electronic Journal of Knowledge Management ,* 7(5): 593–604.

Creswell, J. W. 2013. Research design: Qualitative, quantitative, and mixed methods approaches. *Sage publication, 3*:3-36 http://books.google.co.za/books?hl=en&lr=&id=jMfVyU8ida4C&oi=fnd&pg=PR1&dq=research+design+by+John+W.Creswell&ots=kSPRDhbQse&sig=fjB9m_a0uN_R87HsV-hh4chmaDU

Curado, C. & Bontis, N. 2011. Parallels in knowledge cycles. *Computers in Human Behavior*, 27(4): 1438–1444. http://linkinghub.elsevier.com/retrieve/pii/S0747563210002876 [22 August 2014].

Davenport, T.H. and Prusak, L. 2000. Working Knowledge: How Organizations Manage What They Know, *Harvard Business School Press, Boston, MA*.

Davenport, T. H.2013. Process innovation: reengineering work through information technology. *Harvard Business Press*.

Grant, R. M. 2013. The Development of Knowledge management in the oil and Gas Industry. *Universia Business Review*, (40), 92-125.

Dorasamy, M., Raman, M. & Kaliannan, M. 2013. Knowledge management systems in support of disasters management: A two decade review. *Technological Forecasting and Social Change*, 80(9): 1834–1853. http://linkinghub.elsevier.com/retrieve/pii/S004016251200323X [19 February 2014].

Durcikova, A., Fadel, K. J., Butler, B. S., & Galletta, D. F. 2011. Research Note-Knowledge Exploration and Exploitation: The Impacts of Psychological Climate and Knowledge Management System Access. *Information Systems Research*, *22*(4), 855-866.

Elgort, I., & Warren, P. 2014. L2 vocabulary learning from reading: Explicit and tacit lexical knowledge and the role of learner and item variables. *Language Learning*, *64*(2), 365-414.

Elliot, M. J., Bull, H. T., Pulford, C. I., Shadbolt, N. R., & Smith, W. 1995. Constructive knowledge engineering. *Knowledge-Based Systems*, *8*(5), 259-267.http://linkinghub.elsevier.com/retrieve/pii/ August 2013.

Erden, Z., von Krogh, G. & Nonaka, I. 2008. The quality of group tacit knowledge. *The Journal of Strategic Information Systems*, 17(1): 4–18. http://linkinghub.elsevier.com/retrieve/pii/S0963868708000048 [16 July 2014].

Estrada, M., Roca-Riu, M., Badia, H., Robusté, F., & Daganzo, C. F. 2011. Design and implementation of efficient transit networks: procedure, case study and validity test. *Transportation Research Part A: Policy and Practice*, *45*(9), 935-950.

Floyde, A., Lawson, G., Shalloe, S., Eastgate, R. & D'Cruz, M. 2013. The design and implementation of knowledge management systems and e-learning for improved occupational health and safety in small to medium sized enterprises. *Safety Science*, 60: 69–76. http://linkinghub.elsevier.com/retrieve/pii/S0925753513001410 [28 May 2014].

Frenkel, A., Bendit, E. & Kaplan, S. 2014. Knowledge Cities and Transport Sustainability: The Link between the Travel Behavior of Knowledge Workers and Car-Related Job Perks. *International Journal of Sustainable Transportation,* 8(3): 225–247. http://www.scopus.com/inward/record.url?eid=2-s2.0-84884320437&partnerID=tZOtx3y1 [7 May 2014].

Galunic, C., Sengupta, K., & Petriglieri, J. L. 2014. Deus ex machina? Career progress and the contingent benefits of knowledge management systems.*European Management Journal*, *32*(1), 13-23.http://www.sciencedirect.com/science/article/pii/S0263237313000807 [7 April 2015].

Georgiev. N. 2013. Knowledge Management System for Improvement of Quality of Railway Transport Service. : *Faculty of Transport Management -Higher School of Transport, Bulgaria* 1(4):3–6.

Gharehbiglo, H., Shadidizaji, B., & Yazdani, S. 2012. The Survey of Affecting Factors on Knowledge Management (Case Study: Municipality of the City of Rasht in Iran). *Procedia-Social and Behavioral Sciences*, *62*, 1155-1163.

Gold, A. H., & Arvind Malhotra, A. H. S. 2001. Knowledge management: An organizational capabilities perspective. *Journal of management information systems*, *18*(1), 185-214.

Gourlay, S. 2006. Conceptualizing knowledge creation: A critique of Nonaka's theory*. *Journal of management studies*, *43*(7), 1415-1436.

Griffith R., Kathleen M., & Zheng K.2013. "A positive deviance perspective on hospital knowledge management: analysis of Baldrige Award recipients 2002-2008." *Journal of Healthcare Management* 58(3) (2013): 187.

Hall, R., & Andriani, P. 2003. Managing knowledge associated with innovation. *Journal of business Research*, *56*(2), 145-152.

Hall, R., & Andriani, P. 2002. Managing knowledge for innovation. *Long Range Planning*, *35*(1), 29-48.

He, W., Qiao, Q., & Wei, K. K. 2009. Social relationship and its role in knowledge management systems usage. *Information & Management*, *46*(3), 175-180.

Hendriks, P. H., & Vriens, D. J. 1999. Knowledge-based systems and knowledge management: friends or foes?. *Information & Management*, *35*(2), 113-125.

Herschel, R. T., Nemati, H., & Steiger, D. 2001. Tacit to explicit knowledge conversion: knowledge exchange protocols. *Journal of knowledge management*, *5*(1), 107-116.

Hey, J., & Nielsen, R. 2004. Multilocus methods for estimating population sizes, migration rates and divergence time, with applications to the divergence of Drosophila pseudoobscura and D. persimilis. *Genetics*, *167*(2), 747-760.

Holsapple, C. W., & Joshi, K. D. 2000. An investigation of factors that influence the management of knowledge in organizations. *The Journal of Strategic Information Systems*, *9*(2), 235-261.

Holsapple, C. W., & Joshi, K. D. 2001. Organizational knowledge resources.*Decision support systems*, *31*(1), 39-54.

Hung, S., Durcikova, A., Lai, H. & Lin, W. 2011. The influence of intrinsic and extrinsic motivation on individuals ' knowledge sharing behavior. *Journal of Human Computer Studies*, 69(6): 415–427.

Ismail, M. B., & Yusof, Z. M. 2010. The impact of individual factors on knowledge sharing quality. *Journal of Organizational Knowledge Management*,*13*.

Jain, P., Cullinane, S. & Cullinane, K. 2008. The impact of governance development models on urban rail efficiency. *Transportation Research Part A*, 42(9): 1238–1250. http://dx.doi.org/10.1016/j.tra.2008.03.012.

Jennex, M. E., Smolnik, S., & Croasdell, D. 2007. Towards defining knowledge management success. In *System Sciences, 2007. HICSS 2007. 40th Annual Hawaii International Conference on* (pp. 193c-193c). IEEE.

Jeong, S. J., Lee, C. G., & Bookbinder, J. H. 2007. The European freight railway system as a hub-and-spoke network. *Transportation Research Part A: Policy and Practice*, *41*(6), 523-536.

Jung, S.H., Lee, K.S., Song, Y.W., Lim, H.C. & Choi, Y.K. 2005. Developing the Knowledge Management System Based on Business Process. Department of Architectural Engineering, Soong sil University : 1353–1358.

Kairu-Wanyoike, S. W., Kiara, H., Heffernan, C., Kaitibie, S., Gitau, G. K., McKeever, D., & Taylor, N. M. 2014. Control of contagious bovine pleuropneumonia: Knowledge,

attitudes, perceptions and practices in Narok district of Kenya. *Preventive veterinary medicine*, *115*(3), 143-156.

Karadsheh, L. 2009. A theoretical framework for knowledge management process: towards improving knowledge performance. *Journal of Communications of the IBIMA*, 7, 67–79.

Kebede, G. 2010. Knowledge management: An information science perspective. *International Journal of Information Management*, 30(5): 416–424. http://linkinghub.elsevier.com/retrieve/pii/S0268401210000290 [19 August 2014].

Koh, S. L., Gunasekaran, A., Thomas, A., & Arunachalam, S. 2005. The application of knowledge management in call centres. *Journal of Knowledge Management*, *9*(4), 56-69. http://www.emeraldinsight.com/doi/abs/10.1108/13673270510610332 [8 April 2015].

Köhler, J., Philippi, S., Specht, M. & Rüegg, A. 2006. Ontology based text indexing and querying for the semantic web. *Knowledge-Based Systems*, 19(8): 744–754. http://linkinghub.elsevier.com/retrieve/pii/S0950705106001067 [22 August 2014].

König, M., Dirnbek, J. & Stankovski, V. 2013. Architecture of an open knowledge base for sustainable buildings based on Linked Data technologies. *Automation in Construction*, 35: 542–550. http://linkinghub.elsevier.com/retrieve/pii/S0926580513001118 [2 March 2014].

Krogh, G. & Nonaka, I., 2009. Perspective-tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory. *Organization science*, *20*(3), 635-652.

Kruger, C. N., & Johnson, R. D. 2010. Information management as an enabler of knowledge management maturity: A South African perspective. *International journal of information management*, *30*(1), 57-67.

Kulon, J., Mynors, D.J. & Broomhead, P. 2006. A knowledge-based engineering design tool for metal forging. Journal of Materials Processing Technology , 177: 331–335.

Larsen, T.J. & Olaisen, J. 2013. Innovating strategically in information and knowledge management: Applications of organizational behavior theory. *International Journal of Information Management*, 33(5): 764–774. http://linkinghub.elsevier.com/retrieve/pii/S0268401213000741 [6 March 2014].

Li, Z. C., Lam, W. H., Wong, S. C., & Sumalee, A. 2011. Design of a rail transit line for profit maximization in a linear transportation corridor. *Procedia-Social and Behavioral Sciences*, *17*, 82-112.

Liao, S. H. 2003. Knowledge management technologies and applications—literature review from 1995 to 2002. *Expert systems with applications*, *25*(2), 155-164.

Liao, S.-H. & Wu, C. 2010. System perspective of knowledge management, organizational learning, and organizational innovation. *Expert Systems with Applications*, 37(2): 1096–1103. http://linkinghub.elsevier.com/retrieve/pii/S0957417409005946 [24 February 2014].

Liebowitz, J. 2011. Knowledge retention: What practitioners need to know, *KM World*, [electronic], 20(2):1-3 available: http://www.kmworld.com/Articles/Editorial/Features/Knowledge-retention-What-practitionersneed-to-know-73363.aspx

Liebowitz, J., & Megbolugbe, I. 2003. A set of frameworks to aid the project manager in conceptualizing and implementing knowledge management initiatives. *International Journal of Project Management*, *21*(3), 189-198.

Lindner, F. & Wald, A. 2011. Success factors of knowledge management in temporary organizations. *International Journal of Project Management*, 29(7): 877–888. http://linkinghub.elsevier.com/retrieve/pii/S0263786310001328 [17 August 2014].

Liu, H., Mao, B., Wang, B., Du, P. & Ding, Y. 2011. Optimization of Railway Section Signalling Layout Based on Quasi-Moving Block. *Journal of Transportation Systems Engineering and Information Technology*, 11(4): 103–109. http://linkinghub.elsevier.com/retrieve/pii/S1570667210601365 [11 March 2014].

Louwerse, I. & Huisman, D. 2011. Adjusting a railway timetable in case of partial or complete blockades. *European Journal of Operational Research*, 235(3): 583–593.

Luban, F., & Hîncu, D. 2009. Interdependency between simulation model development and knowledge management. *Theoretical and Empirical Researches in Urban Management*, *4*(1),10.

Mahboob, Q., Zahid, F.M., Schöne, E., Kunze, M. & Trinckauf, J. 2012. Computation of component importance measures for reliability of complex systems. In World Scientific Proc. Series on Computer Engineering and Information Science 7; Uncertainty Modeling in Knowledge Engineering and Decision Making - *Proceedings of the 10th International FLINS Conference*. pp. 1051–1057.

Malavasi, G., Molková, T., Ricci, S., & Rotoli, F. 2014. A synthetic approach to the evaluation of the carrying capacity of complex railway nodes. *Journal of Rail Transport Planning & Management*, *4*(1), 28-42.

Marras, W.S. & Hancock, P.A. 2014. Putting mind and body back together: a human-systems approach to the integration of the physical and cognitive dimensions of task design and operations. *Applied ergonomics*, 45(1): 55–60. http://www.scopus.com/inward/record.url?eid=2-s2.0-84885175197&partnerID=tZOtx3y1 [1 May 2014].

Maruta, R. 2014. The creation and management of organizational knowledge. *Knowledge-Based Systems*, 67(2014): 26–34. http://linkinghub.elsevier.com/retrieve/pii/S0950705114002330 [14 July 2014].

Maruta, R. 2012. Transforming knowledge workers into innovation workers to improve corporate productivity. *Knowledge-Based Systems*, *30*, 35-47. http://linkinghub.elsevier.com/retrieve/pii/S0950705111001328 [17 July 2014].

Mary, B., Pierson, E. & Tech, V. 2013. Characteristics of a Knowledge Harvesting and Management System. *TechTrends*, 57(2): 26–32.

Maxwell, J.A. 2012. *Qualitative Research Design: An Interactive Approach (Google eBook)*. SAGE Publications. http://books.google.com/books?hl=en&lr=&id=xAHCOmtAZd0C&pgis=1 [30 April 2014].

McLeod, R. W., Walker, G. H., & Moray, N. 2005. Analysing and modelling train driver performance. *Applied ergonomics*, *36*(6), 671-680.

McInerney, C., & Koenig, M. E. D. (2011). Knowledge Management Processes in Organizations: Theoretical Foundations and Examples of Practice 1(2): 96-136

Mentzas, G., Apostolou, D., Young, R., & Abecker, A. 2001. Knowledge networking: a holistic solution for leveraging corporate knowledge. *Journal of knowledge management*, *5*(1), 94-107.

Milton, N., Clarke, D. & Shadbolt, N. 2006. Knowledge engineering and psychology: Towards a closer relationship. *International Journal of Human-Computer Studies*, 64(12): 1214–1229. http://linkinghub.elsevier.com/retrieve/pii/S1071581906001212 [22 August 2014].

Moradi, M., Aghaie, A. & Hosseini, M. 2013. Knowledge-collector agents: Applying intelligent agents in marketing decisions with knowledge management approach. *Knowledge-Based Systems*, 52: 181–193. http://linkinghub.elsevier.com/retrieve/pii/S095070511300244X [19 February 2014].

Mostert, J. C., & Snyman, M. 2007. Knowledge management framework for the development of an effective knowledge management strategy. South African journal of information management, 9(2).

Nevo, D., & Chan, Y. E. 2007. A Delphi study of knowledge management systems: Scope and requirements. *Information & Management*, *44*(6), 583-597.

Nieto, M. 2003. From R&D management to knowledge management: An overview of studies of innovation management. *Technological Forecasting and Social Change*, *70*(2), 135-161.

Nomura, T. 2002. Design of “Ba” for successful Knowledge Management—how enterprises should design the places of interaction to gain competitive advantage. *Journal of Network and Computer Applications*, 25(4): 263–278. http://linkinghub.elsevier.com/retrieve/pii/S1084804502901396 [22 August 2014].

Nonaka, I. 1994. A dynamic theory of organizational knowledge creation.*Organization science*, *5*(1), 14-37. http://pubsonline.informs.org/doi/abs/10.1287/orsc.5.1.14 [8 April 2015].

Nonaka, I., & Takeuchi, H. 1995. The knowledge-creating company: How Japanese companies create the dynamics of innovation. Oxford university press.

Nonaka, I. 1994. A dynamic theory of organizational knowledge creation.*Organization science*, *5*(1), 14-37.

Nonaka, I., Toyama, R., & Hirata, T. 2008. *Managing flow: A process theory of the knowledge-based firm* ,19. New York: Palgrave Macmillan.

Nonaka, I., Toyama, R., & Konno, N. 2000. SECI, Ba and leadership: a unified model of dynamic knowledge creation. *Long range planning*, *33*(1), 5-34.

Noruzy, A., Dalfard, V.M., Azhdari, B., Nazari-Shirkouhi, S. & Rezazadeh, A. 2012. Relations between transformational leadership, organizational learning, knowledge management, organizational innovation, and organizational performance: an empirical investigation of manufacturing firms. *The International Journal of Advanced Manufacturing Technology*, 64(5-8): 1073–1085. http://link.springer.com/10.1007/s00170-012-4038-y [20 February 2014].

Novak, M. J., & Hammer, M. 2009. Tacit Knowledge Transfer in a State Transportation Agency. In *Ohio Transportation Engineering Conference, Oct* (pp. 27-28).

Ölçer, F. 2007. 'Practices of Knowledge Management in Companies: A Turkey Survey', Proceedings of I-KNOW '07, Graz, Austria, September 5-7

Ooi, K.B. 2014. TQM: A facilitator to enhance knowledge management? A structural analysis. *Expert Systems with Applications*, 41(11): 5167–5179. http://linkinghub.elsevier.com/retrieve/pii/S0957417414001420 [28 May 2014].

Parent, M.M., MacDonald, D. & Goulet, G. 2014. The theory and practice of knowledge management and transfer: The case of the Olympic Games. *Sport Management Review*, 17(2): 205–218. http://linkinghub.elsevier.com/retrieve/pii/S1441352313000351 [28 May 2014].

Passanger Rail Agency of South Africa, P.C. 2012. Passenger Rail For Quality Public Transport in South Africa.Corporate Plan 2012.

Patil, S. K., & Kant, R. 2014. A fuzzy AHP-TOPSIS framework for ranking the solutions of Knowledge Management adoption in Supply Chain to overcome its barriers. *Expert Systems with Applications*, *41*(2), 679-693.http://www.sciencedirect.com/science/article/pii/S0957417413005940 [7 April 2015].

Pawlowski, J., & Bick, M. 2012. The global knowledge management framework: Towards a theory for knowledge management in globally distributed settings. Electronic journal of knowledge management, 10(1), 92-108.

Pezzillo , M., Martinez, M., Mangia, G., & Galdiero, C. 2012. Knowledge creation and inter-organizational relationships: the development of innovation in the railway industry. *Journal of Knowledge Management*, *16*(4), 604-616.

Pollalis, Y. A., & Dimitriou, N. K. 2008. Knowledge management in virtual enterprises: A systemic multi-methodology towards the strategic use of information. *International Journal of Information Management*, *28*(4), 305-321.

Polanyi, M. 1969: The Logic of Tacit Inference. Knowing and Being, Routledge & Keagan Paul, London

Pridmore, P., Thomas, L., Havemann, K., Sapag, J., & Wood, L. 2007. Social capital and healthy urbanization in a globalized world. *Journal of Urban Health*,*84*(1), 130-143.

Qipeng, S. U. N., Xuesong, F. E. N. G., & Kai, B. I. A. N. 2011. Operation and Organization Management of High-speed Railway in Japan. *Journal of Transportation Systems Engineering and Information Technology*, *11*(5), 11-16.

Quaglietta, E. 2014. A simulation-based approach for the optimal design of signalling block layout in railway networks. *Simulation Modelling Practice and Theory*, *46*, 4-24.

Reed, M.S., Fazey, I., Stringer, L.C., Raymond, C.M., Akhtar-Schuster, M., Begni, G., Bigas, H., Brehm, S., Briggs, J., Bryce, R., Buckmaster, S., Chanda, R., Davies, J., Diez, E., Essahli, W., Evely, A., Geeson, N., Hartmann, I., Holden, J., Hubacek, K., Ioris, A.A.R., Kruger, B., Laureano, P., Phillipson, J., Prell, C., Quinn, C.H., Reeves, A.D., Seely, M., Thomas, R., van der Werff Ten Bosch, M.J., Vergunst, P. & Wagner, L. 2013. Knowledge Management for Land Degradation Monitoring and Assessment: An

Analysis of Contemporary Thinking. *Land Degradation & Development*, 24(4): 307–322. http://www.scopus.com/inward/record.url?eid=2-s2.0-84882729842&partnerID=tZOtx3y1 [12 May 2014].

Renzl, B. 2008. Trust in management and knowledge sharing: The mediating effects of fear and knowledge documentation. *Omega*, 36(2): 206–220. http://linkinghub.elsevier.com/retrieve/pii/S030504830600096X [16 July 2014].

Rodrigue, J. P., Comtois, C., & Slack, B. 2013. The geography of transport systems. Transportation and geography ,3: 10-269.

Rubenstein-Montano, B., Liebowitz, J., Buchwalter, J., McCaw, D., Newman, B., Rebeck, K., & Team, T. K. M. M. 2001. A systems thinking framework for knowledge management. *Decision support systems*, *31*(1), 5-16.

Rubin, H. J., & Rubin, I. S. 2011. *Qualitative interviewing: The art of hearing data*. Sage.

Sandidzadeh, M. A., & Dehghani, M. 2013. Intelligent condition monitoring of railway signaling in train detection subsystems. *Journal of Intelligent & Fuzzy Systems: Applications in Engineering and Technology*, *24*(4), 859-869.

Saxena, A., & Jaiswal, M. P. 2013. Impact of Enterprise Systems on Firm Performance: A Business Integration Capabilities Perspective .*IUP Journal of Operations Management*, *12*(3), 29.

Schalekamp, H. & Behrens, R. 2010. Engaging paratransit on public transport reform initiatives in South Africa: A critique of policy and an investigation of appropriate engagement approaches. Research in Transportation Economics, 29(1): 371–378.
Sher, P. J., & Lee, V. C. 2004. Information technology as a facilitator for enhancing dynamic capabilities through knowledge management. *Information & management*, *41*(8), 933-945.

Silverman, D. 2013. Doing qualitative research: A practical handbook. SAGE Publications Limited.http://books.google.com/books?hl=en&lr=&id=LySjM0tY-tEC&pgis=1 [2 May 2014].

Simperl, E. 2009. Data & Knowledge Engineering Reusing ontologies on the Semantic Web : A feasibility study. *Data & Knowledge Engineering*, 68(10): 905–925.

Singh, M.D. and Kant, R. 2008. Knowledge management barriers: An interpretive structural modelling approach*, International Journal of Management Science and Engineering Management*,3(2):141-150

Soo, C., Devinney, T., Midgley, D. & Deering, A. 2002. *Knowledge management: philosophy, process, and pitfalls.* https://opus.lib.uts.edu.au/research/handle/10453/10055 [7 April 2015].

Stephens, S. L., & Fulé, P. Z. 2005. Western pine forests with continuing frequent fire regimes: possible reference sites for management. *Journal of Forestry*, *103*(7), 357-362.http://www.ingentaconnect.com/content/saf/jof/2005/00000103/00000007/art00007 [7 April 2015].

Storey, C. and Kahn, K.B. 2010. 'The Role of Knowledge Management Strategies and Task Knowledge in Stimulating Service Innovation ', *Journal of Service Research*, 13(4):397-410

Stover, M. 2004. Making tacit knowledge explicit: The ready reference database as codified knowledge. *Reference Services Review*, *32*(2), 164-173.http://www.emeraldinsight.com/journals.htm?articleid=861778&show=abstract [29 July 2014].

Sutton, J., & Mcilwain, D. J. 2008. Breadth and depth of knowledge in expert versus novice athletes. *The Routledge Handbook of Sports Expertise. London: Routledge*.

Swan, J., Newell, S., Robertson, M., & Scarbrough, H., 2009. *Managing knowledge work and innovation*. Palgrave Macmillan.

Tyugu, E. 2006. Understanding knowledge architectures. *Knowledge-Based Systems*, 19(1): 50–56. http://linkinghub.elsevier.com/retrieve/pii/S0950705105000936 [22 August 2014].

Vandergrift, L., Goh, C. C., Mareschal, C. J., & Tafaghodtari, M. H. 2006. The metacognitive awareness listening questionnaire: Development and validation.*Language learning*, *56*(3), 431.http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9922.2006.00373.x/abstract [7 April 2015].

Voelpel, S. C., & Han, Z. 2005. Managing knowledge sharing in China: the case of Siemens ShareNet. *Journal of Knowledge Management*, *9*(3), 51-63.

Wallace, D.P., Van Fleet, C. & Downs, L.J. 2011. The research core of the knowledge management literature. *International Journal of Information Management*, 31(1): 14–20. http://linkinghub.elsevier.com/retrieve/pii/S0268401210001465 [19 February 2014]. February 2014].

Ward, J., & Peppard, J. 2007. A Framework for Business IT Alignment in Turbulent Environments Athens .*Journal of Technology Engineering* 1(2): 103-118.http://www.atiner.gr/journals/technology/2014-1-2-2-Amarilli.pdf [7 April 2015].

Warkentin, M., Sugumaran, V. & Sainsbury, R. 2012. The role of intelligent agents and data mining in electronic partnership management. *Expert Systems with Applications*, 39(18): 13277–13288. http://linkinghub.elsevier.com/retrieve/pii/S0957417412007907 [5 February 2014].

Watson, S., & Hewett, K. 2006. A Multi-Theoretical Model of Knowledge Transfer in Organizations: Determinants of Knowledge Contribution and Knowledge Reuse*. *Journal of management studies*, *43*(2), 141-173.

Wellman, J. L. 2009. Organizational Learning: How Companies and Institutions Manage and Apply Knowledge, Palgrave Macmillian.

Wilson, J. R., & Norris, B. J. 2005. Rail human factors: Past, present and future. Applied ergonomics, 36(6), 649-660.

Wiltshier, P. & Edwards, M. 2014. Managing knowledge transfer partnership for a rural community: The outcomes at Wirksworth, UK. *Kybernetes*, 43(3): 629–651.

Wohlin, C., & Aurum, A. 2014. Towards a decision-making structure for selecting a research design in empirical software engineering. *Empirical Software Engineering*, 1-29.

Wong, K. Y., & Aspinwall, E. 2004. Knowledge management implementation frameworks: a review. *Knowledge and Process Management*, *11*(2), 93-104.

Wu, J., Guo, B. & Shi, Y. 2013. Customer knowledge management and IT-enabled business model innovation: A conceptual framework and a case study from China. *European Management Journal*, 31(4): 359–372. http://linkinghub.elsevier.com/retrieve/pii/S0263237313000236 [19 February 2014].

Wyatt, J. C. 2001. Management of explicit and tacit knowledge. *Journal of the Royal Society of Medicine*, *94*(1), 6.

Wu, J., Du, H., Li, X., and Li, P. 2010. 'Creating and Delivering a Successful Knowledge Management Strategy', in M. Russ (Ed.), Knowledge Management Strategies for Business Development (pp. 261-276).

Xu, J. & Quaddus, M. 2012. Knowledge-Based Systems Examining a model of knowledge management systems adoption and diffusion : A Partial Least Square approach. *Knowledge-Based Systems*, 27: 18–28.

Yip, M.W., Ng, A.H.H., and Lau, D.H.C., .2012. 'Employee Participation: Success Factor of Knowledge Management', International Journal of Information and Education Technology ,*2*(3):262-264

Yu, C., Yu-Fang, T., & Yu-Cheh, C. 2013. Knowledge sharing, organizational climate and innovative behavior: A cross-level analysis of effects. *Social Behavior and Personality: an international journal*, *41*(1):143-156.

Yun, E.K. 2013. Predictors of attitude and intention to use knowledge management system among Korean nurses. *Nurse education today*, 33(12): 1477–81. http://www.ncbi.nlm.nih.gov/pubmed/23806194 [21 February 2014].

Zhao, J., Feng, Z., Chu, F., & Ma, N. 2013. *Advanced theory of constraint and motion analysis for robot mechanisms*. Academic Press.http://www.sciencedirect.com/science/article/pii/B9780124201620000035 [30 April 2014].

Zhen, L., Wang, L. & Li, J.-G. 2013. A design of knowledge management tool for supporting product development. *Information Processing & Management*, 49(4): 884–894. http://linkinghub.elsevier.com/retrieve/pii/S0306457313000149 [27 February 2014].

Zieba, M. 2013. Knowledge Intensive Business Services (KIBS) and Their Role in the Knowledge Based Economy. In *Proceedings of the 14th European Conference on Knowledge Management* ,1: 785-792

BIBLIOGRAPHY

Akhavan, P., Jafari, M., and Fathian, M. 2005, Exploring Failure-Factors of Implementing Knowledge Management Systems in Organizations, *Journal of Knowledge Management Practice, [electronic]*, 6: 1-8, Available: http://www.tlainc.com/jkmpv6.htm

Al-Hakim, L.A.Y. and Hassan, S. 2011. The role of middle managers in knowledge management implementation for innovation enhancement, *International Journal of Innovation, Management and Technology*, 2(1):86-94.

Bermell-Garcia, P., Verhagen, W.J.C., Astwood, S., Krishnamurthy, K., Johnson, J.L., Ruiz, D., Scott, G. & Curran, R. 2012. A framework for management of Knowledge-Based Engineering applications as software services: Enabling personalization and codification. *Advanced Engineering Informatics*, 26(2): 219–230. http://linkinghub.elsevier.com/retrieve/pii/S1474034612000079 [19 August 2014].

Chigada, J. & Ngulube, P. 2015. Knowledge management practices at selected banks in South Africa. *SA Journal of Information Management*, 17(1): 1–10. http://www.sajim.co.za/index.php/SAJIM/article/view/634 [30 June 2015].

Costa, G., Prior, M. & Rogerson, S. 2010. Why link knowledge management, organizational culture and ethics: Inquiring results. In E. Tomé (Ed.), *Proceedings of the 11th European Conference on Knowledge Management* (pp. 1144-1152).http://www.scopus.com/inward/record.url?eid=2-s2.0-84871168837&partnerID=[7 May 2014].

Cullinane, K., Firth, M., Fung, M. K., Gong, S. X., Law, J. S., & Zhang, A. 2011. Development of Air Transport Industry In The Asia-Pacific Region. *Pacific Economic Review*, *16*(1), 42-46.

Davenport, T., De Long, D., and Beer, M.C. 1998. Successful knowledge management projects, *Sloan Management Review*, 39 (2), pp. 43-57.

Davenport T. and Volpel S. 2001. The rise of knowledge towards attention management, *Journal of Knowledge Management*, 5(3), pp. 212–221.

Daniela, H., & Florica, L. 2013. On Some Issues about Knowledge Management System Implementation.

Evans, A.W. 2010. Fatal train accidents on Europe's railways : 1980 – 2009. *Accident Analysis and Prevention*, 43(1): 391–401.

Evans, A. W. 2013. The economics of railway safety. *Research in transportation economics*, *43*(1), 137-147.

Frické, Martin. 2009. The knowledge pyramid: A critique of the DIKW hierarchy. Journal of Information Science 35: 131-142.

Haywood, R. 2007. Britain's national railway network: fit for purpose in the 21st century?. *Journal of Transport Geography*, *15*(3), 198-216.

Hu, M.-C., Sharif, N. & Baark, E. 2014. Information Technology Services: A Key Knowledge-Intensive Business Service Industry in Hong Kong SAR, China. *Science Technology &*

Society, 19(1): 27–55. http://www.scopus.com/inward/record.url?eid=2-s2.0-84893531762&partnerID=tZOtx3y1 [21 May 2014].

Johnson, J.F., Bagdasarov, Z., MacDougall, A.E., Steele, L., Connelly, S., Devenport, L.D. & Mumford, M.D. 2014. Improving ethical knowledge and sensemaking from cases through elaborative interrogation and outcome valence. *Accountability in research*, 21(5): 265–99. http://www.scopus.com/inward/record.url?eid=2-s2.0-84897887714&partnerID=tZOtx3y1 [7 May 2014].

Kane, H., Ragsdell, G. & Oppenheim, C. 2006. Knowledge Management Methodologies. *Electronic Journal of Knowledge Management*, 4(2):141-152.

Kuby, M., Xu, Z. & Xie, X. 2001. Railway network design with multiple project stages and time sequencing. *Journal of Geographical Systems*, 3(1): 25–47.

Kuznetsov, N. A., Minashina, I. K., Pashchenko, F. F., Ryabykh, N. G., & Zakharova, E. M. 2014. Design and Analysis of Optimization Algorithms for Multi-agent Railway Control System. *Procedia Computer Science*, *37*, 211-219.

Lamont, B.J. 2006. Transportation : Communities of practice leverage knowledge. , *Knowledge Management World,KMW* ,1: 14–16.

Lee, H., and Choi, B. 2000. Knowledge Management Enablers, Processes, and Organizational Performance: An Integration and Empirical Examination, *Journal of Management Information Systems*, 20(1): 179-228.

Lovett, P.J., Ingram, A. & Bancroft, C.N. 2000. Knowledge-based engineering for SMEs Ð a methodology. *The International Journal of Advanced Manufacturing Technology*, 107: 384–389.

Mahboob, Q., Schöne, E., Kunze, M., Trinckauf, J., & Maschek, U. 2012. Application of importance measures to transport industry: Computation using Bayesian networks and Fault Tree Analysis. In *Quality, Reliability, Risk, Maintenance, and Safety Engineering (ICQR2MSE), 2012 International Conference on* (pp. 17-22). IEEE.

McDermott, R., & O'dell, C. 2001. Overcoming cultural barriers to sharing knowledge. *Journal of knowledge management*, 5(1), 76-85.

Mishra, B. & Bhaskar, A. U. 2011. Knowledge management process in two learning organisations. *Journal of Knowledge Management*, 15(2): 344–359. http://www.emeraldinsight.com/10.1108/13673271111119736 [23 February 2014].

Munyua, H., & Stilwell, C. 2010. A mixed qualitative-quantitative-participatory methodology: a study of the agricultural knowledge and information system (AKIS) of small-scale farmers in Kirinyaga District, Kenya. *Library management*, *31*(1/2), 5-18.

Nonaka, I., & Konno, N. 2005. The concept of “5, 4”: building a foundation for knowledge creation. *Knowledge management: critical perspectives on business and management*, *2*(3), 53.

Nonaka, I., Umemoto, K., & Senoo, D. 1996. From information processing to knowledge creation: a paradigm shift in business management. *Technology in society*, *18*(2), 203-218.

Sağsan, M. 2006. A new life cycle model for processing of knowledge management. In *Study Presented at 2nd International Conference on Business, Management and Economics* : 1-9.

Schiuma, G. 2012. Managing knowledge for business performance improvement. *Journal of knowledge management*, *16*(4), 515-522.http://www.emeraldinsight.com/doi/abs/10.1108/13673271211246103 [8 April 2015].

Sharma, P., Chrisman, J. J., & Gersick, K. E. 2012. 25 years of family business review: Reflections on the past and perspectives for the future. *Family Business Review*, *25*(1), 5.

Wallace, D. P., Fleet, C. V., & Downs, L. J. 2010. The use of research methodologies in the knowledge management literature. *Proceedings of the American Society for Information Science and Technology*, *47*(1), 1-7.

Walters, J. 2008. Overview of public transport policy developments in South Africa. *Research in Transportation Economics*, 22(1): 98–108. http://linkinghub.elsevier.com/retrieve/pii/S073988590800019X [11 March 2014].

Wallace, D. P., Fleet, C. V., & Downs, L. J. 2010. The use of research methodologies in the knowledge management literature. *Proceedings of the American Society for Information Science and Technology*, *47*(1), 1-7.

Yaghoubi, N.M. and Maleki, N. 2012. 'Critical Success Factors of Knowledge Management (A Case Study: Zahedan Electric Distribution Company)', J. Basic Appl. Sci. Res., 2(12):12024-12030.

Yazdani, B, O., Yaghoubi N, M., and Hajiabadi, M. 2011. 'Critical Success Factors for Knowledge Management in Organization: An Empirical Assessment', European Journal of Humanities and Social Sciences, 3(1): 95-117.

APPENDIX A

REQUEST FOR DATA COLLECTION

Cape Peninsula University of Technology

Office of the Director: CPUT Libraries
Dr E.R.T Chiware
E-mail: chiwareE@cput.ac.za
Tel: 021 959-6320/6322
Fax: 021 959-6109

29th May, 2014

To whom it may Concern

Dear Sir/Madam,

Introductory letter for the collection of research data

Mluleki Majavu is a registered student for the M Tech (MBIS) degree at CPUT (210181400). The title of his thesis is:

Application of a knowledge management system for tacit knowledge in the railway sector in South Africa

The aim is to develop a model that will help the railway industry in South Africa to implement a knowledge management system that facilitate the process of extracting tacit knowledge from experienced employees and to make them explicit knowledge to sustain organizational.

The supervisor(s) for this research is/are: Dr. Elisha R. T. Chiware and telephone +27 (0)21 959 6322 / 6320, email ChiwareE@cput.ac.za

In order to meet the requirements of the university's Higher Degrees Committee (HDC) the student must get consent to collect data from organisations which they have identified as potential sources of data. In this case the student will use interviews collection technique(s) to gather data.

If you agree to this, you are requested to complete the attached form (an electronic version will be made available to you if you so desire) and print it on your organisation's letterhead.

For further clarification on this matter please contact either the supervisor(s) identified above, or the Faculty Research Ethics Committee secretary (Ms V Naidoo) at 021 469 1012 or naidoovve@cput.ac.za.

Regards

Dr. Elisha R. T. Chiware
29/05/2014

APPENDIX B

REGIONAL APPROVAL LETTER

HDC Committee
Cape Peninsula University of Technology
Bellville

Date : 29th May 2014

#274445

TO WHOM IT MAY CONCERN

I Mthuthuzeli Swartz in my capacity as Regional Manager Metrorail Western Cape hereby gives consent to allow Mr. Mluleki Majavu, a student at the Cape Peninsula University of Technology, to collect data with in Metrorail as part of his MTech (MBIS) research. The student has explained to me the nature of his research and the nature of the data to be collected.

This consent in no way commits any individual staff member to participate in the research, and it is expected that the student will get explicit consent from any participants. I reserve the right to withdraw this permission at some future time.

In addition, the company retains sole ownership of the outcome of the research and may only be made available for public consumption with the explicate permission of PRASA Rail. The company name may be used as indicated below. (Tick as appropriate.)

	Thesis	Conference paper	Journal article	Research poster
Yes	X	X	X	
No				X

Regards

Mthuthuzeli Swartz
Regional Manager
Metrorail Rail Western Cape

Dated 29th May 2014

APPENDIX C

CONFIDENTIALITY AGREEMENT FORM

Be moved prasa

CONFIDENTIALITY AGREEMENT

- for the purpose of conducting research in the PRASA environment, or using Company information for research purposes

I, the undersigned

1. herewith undertake that all information disclosed or submitted, either orally, in writing or in other tangible or intangible form by PRASA, (its subsidiaries, business units, its employees, agents and/or consultants) to me, or made available to me, or details of PRASA's business or interest of which I may become aware of in respect of the research being done by myself for study purposes at Cape Peninsula University of Technology (CPUT) (University/College), to keep confidential and not to divulge to anyone either privately or publicly for which PRASA did not give written consent;
2. guarantee that I will apply the information, detail or knowledge in **clause 1** only for the purpose of my academic research;
3. indemnify PRASA against any claims that may be instituted against it, amounts that may be claimed or losses that PRASA may suffer in consequence of a violation by me of any provision included in this agreement;
4. agree that the provisions of this agreement binds me to PRASA, even if I cease to be a student, employee, representative or advisor of the Cape Peninsula University of Technology (University/College), depending as the case may be after ceasing to be such a person.
5. shall immediately disclose in writing all new information in my possession or under my care relating to the research, provided that such new information must have been developed during the course of the research relating to this agreement.
6. agree that PRASA will have a final say on whether my final work gets published, either in journals, university libraries or any arena where such work may be accessed either electronically or physically. I further accept that PRASA reserves the rights to put limitations on which parts of my work may be published, either in full or in sections. This clause is not applicable to the information that is in the public domain, and/or published in the Annual Reports.

DOCS_MTG-#### Page 1 of 2

2

7. undertake to make my Promoter/Supervisor and/or the University/College aware of the terms and conditions of this agreement.

SIGNED at Cape Town on this 27 day of July 2014

Signature

Name [illegible]

Witnessed by

Name

Address Off Mutual Road Salt River Depot, Observatory

APPENDIX D

LETTER OF CONSENT FROM PRASA

prasa

PRASA HOUSE
1640 Burnett Street
Hatfield
Pretoria

Private Bag X101
Braamfontein, 2017
T: +27 12 748 7000

Ref.: Research permissions/2014

TO WHOM IT MAY CONCERN

Permission to conduct research in the PRASA environment for academic purposes - Student: Mr Mluleki Majavu

Research / Thesis topic: *"Application of a knowledge management system for tacit knowledge in the railway sector in South Africa"*

Permission is hereby granted to Mr Mluleki Majavu to conduct research in PRASA for academic purposes as part of his studies to complete an Mtech in Business Information Systems at Cape Peninsula University of Technology, subject to honouring the Agreement:

"Confidentiality Agreement – for the purpose of conducting research in the PRASA environment and/or using Company information for research purposes"

Mr Majavu has signed the above Confidentiality Agreement with PRASA and agreed that the above research is for academic purposes only and that no part of the research will be published without written approval from PRASA.

Yours faithfully

Zwelakhe Mayaba
Chief Strategy Officer: Business Strategy
Passenger Rail Agency of South Africa
e-mail: ZMayaba@prasa.com
Date: 31 July 2014

Directors: SN Sutholer (Chairman), TL Montana (Group CEO), T Goolsarie, X George, M Moore, N Maunge, M Villiers

Company Secretary: L Zide

APPENDIX E

INTERVIEW GUIDE

Introduction:

This interview is intended to assess how the railway industry in South Africa can design and implement a knowledge management system that can facilitate the process of transferring tacit knowledge from experienced employees in the railway signalling department with specialized knowledge before they retire to those that are without the necessary skills. You are kindly requested to answer the questions below as honestly as possible. Your answers will be used specifically for research purposes only, your responses will be treated with the highest degree of confidentiality and privacy, and as such, no names should be supplied on this interview. Participation in this is voluntary. **How can the application of a Knowledge Management System for tacit knowledge help the railway sector in South Africa?**

Kindly, answer all questions as elaborator as you can, make your recommendations if there are any (make your response as short as possible). *(Please note, your information will **not** be sold or given to outside entities. It is for this purpose or internal use only.)*

Demographic Information

Name (Optional):

Age: 0-35 ☐ 36-45 ☐ 46 -50 ☐ 51-60 ☐ over 60 ☐

Position: senior manager HR/ Business performance ☐ middle manager ☐

senior engineer technician ☐

Engineering technician ☐ process worker ☐

ICT infrastructure manager ☐

Years of service: 0-5 ☐ 5-15 ☐ 15 -25 ☐ 25-45 ☐ over 45 ☐

Job description:

Number of years of service:

RSQ 1.1 what is the status quo of tacit knowledge?

IQ 1.1.1 How long each employee takes in class to in order to go for practical?

IQ.1.1.2 Is the any certification around signalling?

RSQ 1.2 how is knowledge captured and stored in the organization?

IQ 1.2.1. In your opinion, is knowledge capturing and storing necessary? If yes, why? If no, why not?

RSQ 1.3 What is the process of extracting tacit knowledge?

IQ 1.3.1 What is the importance of tacit knowledge?

IQ 1.3.2 Is there a need to extract knowledge from the human capital to the system? If yes, why? If no, why not?

IQ 1.3.3 What is the current process for extract tacit knowledge?

IQ 1.3.4. Which stakeholders should be involved in this process?

RSQ 1.4 Why is signalling system related knowledge important in the organization?

IQ 1.4.1 What do you understand about the role of signalling system in railways?

IQ 1.4.2 Does the organization have enough knowledge about signalling? if yes, why? If no, why not?

RSQ 1.5 How can knowledge management system for tacit knowledge be designed and implemented?

IQ 1.5.1 Which mechanisms should be used to design the knowledge management system?

IQ 1.5.2 In the implementation of knowledge management system which stakeholders should be involved?

IQ 1.5.3 Which role will Information Technology play in the designing and implementation of KM system?

IQ 1.5.4 What is the expected outcome when KM system implemented in the organization?

Any other comments

APPENDIX F

SOURCE INFOMATION

Main Question: How to extract or transfer knowledge of employees in the organization into explicit knowledge?

Issue of Investigation	Data Source	Tool/s	Unit of Analysis	Unit of Observation	No. of Participants
Background, Literature review and Methodology	• Literature (print & electronic sources)	• Read, write	• Academic & non-academic content from Books, journals, magazines	• Signalling Department, human resources and IT department	3 Senior Engineering technician 1 Senior Engineering technician 5 Engineering technicians 1HR/Business performance senior manager 1ICT Infrastructure manager 4 Artisans(process worker)
Question relate to the status quo	• Literature (print & electronic sources) • Experts in theory & practical work	• Interview	• Organizational information from developed manuals • Human knowledge about signalling • In house practical	• Knowledge management books & journals (electronic & print). • Senior Engineering technician • Artisans(process worker) • HR/Business performance senior manager • ICT Infrastructure manager • Engineering technicians	
Knowledge capture and store in the organization	• Literature (print & electronic sources) • Organisations that are railway specific	• Interview • Observe	• Non-academic content • Tutor in Koeberg training centre	• Knowledge management books & journals (electronic & print). • Senior Engineering technician • Artisans(process worker) • HR/Business performance senior manager • ICT Infrastructure manager • Engineering technicians	
The process of extracting tacit knowledge	• Organisations that are railway specific • Business process modelling notations	• Interview • Observe	• Business processes • Knowledge-sharing • Mentorship	• Knowledge management books & journals (electronic & print). • Senior Engineering technician	

			• Succession plan	• Artisans(process worker) • HR/Business performance senior manager • ICT Infrastructure manager • Engineering technicians	
Knowledge related to the importance of signalling system in the organization	• Literature (print & electronic sources) • Organisations that are railway specific	• Read, write • Interview • Observe	• Non-academic content • Railway safety regulator act 16 of 2002	• Knowledge management books & journals (electronic & print). • Senior Engineering technician • Artisans(process worker) • HR/Business performance senior manager • ICT Infrastructure manager Engineering technicians	
Designing and implementation of KM system for tacit knowledge	• Technology availability in the IT department	• Interview • Observe	• Use of IT systems • Stakeholder involvement	• Knowledge management books & journals (electronic & print). • Senior Engineering technician • Artisans(process worker) • HR/Business performance senior manager • ICT Infrastructure manager • Engineering technicians	
Knowledge management system design process	• Business process design and notation	• Interview	• Business process designs with the help of ERP system	• Knowledge management books & journals (electronic & print). • Senior Engineering technician • Artisans(process worker) • HR/Business performance senior manager • ICT Infrastructure manager • Engineering technicians	
				Total Participants:	**15**

APPENDIX G

CATEGORIES AND THEMES

Participants	# of TR*	Responses														
		Information Technology	Knowledge management in Railway	Knowledge-sharing and transfer	Knowledge Management System	KM Process	Railway Operations	Performance	Skills shortage(Recruitment)	Knowledge Auditing	Lack of management interest	Safety on train movement	Coaching and mentoring	Succession Plan	Training and development	DK/ NR**	
Senior engineering technician(tutor)_E1		0	6	4	2	5	2	17	5	3	3	1	0	1	4	1	Number of respondents per response item
Middle Manager_M1		4	8	12	2	1	7	10	5	9	3	5	2	1	9	0	
Engineering technician_CT1		0	5	1	0	5	1	10	5	1	0	2	1	0	10	1	
Senior Manager_Ifra1		0	7	9	1	1	2	6	7	6	0	3	4	2	11	1	

Engineering technician_Wyn1	12	0	5	4	0	2	3	4	4	5	0	4	1	2	9	1	
Technical worker_lang1		1	5	5	0	2	1	6	1	3	1	0	3	0	2	0	
Engineering technician_lang1		1	7	6	0	0	3	5	2	0	0	1	3	2	5	3	
Senior Engineering technician(tutor)_F2		3	12	13	0	2	2	5	2	2	2	2	1	1	7	1	
HR/Business performance (HoD)_T1		2	5	4	4	8	1	0	1	0	0	1	1	2	0	3	
Senior Engineering technician (Elsies)_1		1	10	9	0	2	2	6	6	1	1	2	0	1	4	1	
Engineering technician (Elsies)_2		0	5	1	0	1	3	1	1	3	0	0	1	0	3	3	
Engineering technician (Bell)_1		2	4	8	0	1	1	3	5	1	0	2	1	0	8	1	
Totals		**14**	**79**	**76**	**9**	**30**	**30**	**73**	**44**	**34**	**10**	**23**	**18**	**12**	**72**	**17**	

* Total Respondents

** Don't Know/No Responses

***Knowledge management

****Knowledge management system

*****Knowledge management process