KNOWLEDGE MANAGEMENT WITHIN THE PYROMETALLURGICAL INDUSTRY

by

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PREFACE

I want to acknowledge the following persons for assisting me during the writing of this mini dissertation:

• My Heavenly Father for giving me this unique opportunity
• My study leader, Mr. Johan Coetzee for all his patience, motivation and guidance.
• My family for giving me the time and space to work on this research.
• All the respondents to the survey questionnaire for their valuable input.
• To my employer for funding this research study.
Abstract:

The aim of this study is to provide a theoretical background on the knowledge management principles required in determining the current state of knowledge management within the Pyrometallurgical industry. Emphasis is placed on identifying initiatives that is required for embedding tacit knowledge within an organisation.

Knowledge is what people know and there is no knowledge without someone knowing it. Knowledge can be present in ideas, judgement, relationships and concepts. Unlike data and information, knowledge is never static but is continually shaped inside peoples’ heads through experience, reasoning and the inflow of new stimuli. Tacit knowledge is the information about work processes and products that individuals hold above and beyond what organisations has documented. It is the “tricks of the trade” that promote smooth organisational functioning, overall know-how, and competitive advantage. In order to ensure that an organisation maintains its competitive advantage, special focus must be placed on tacit knowledge management.

The state of knowledge management within the Pyrometallurgical industry in South Africa was assessed in the use of survey questionnaires. The Pyrometallurgical industry has still got a long way to go in order to ensure that the tacit knowledge is embedded within their organisations. Key areas of concerns are the lack of experienced mentors as well as enough resources in order to foster tacit knowledge transfer. A practical tacit knowledge management framework is proposed in order to assist management in looking after this critical asset of their organisation.

Key words:

Tacit knowledge, explicit knowledge, Pyrometallurgical industry, knowledge management, knowledge management strategy, succession planning, mentorship program, knowledge sharing.
Opsomming:

Die oogmerk van hierdie studie is om 'n teoretiese agtergrond daar te stel vir kennisbestuur. Hierdie teoretiese agtergrond sal dan gebruik word om die stand van kennisbestuur binne die Pirrometallurgiese industrie te bepaal. Klem word geplaas op initiatiewe wat benodig word om te verseker dat onuitgesproke kennis behoue bly in 'n organisasie.

Kennis is wat mense weet en daar is geen kennis sonder dat iemand dit weet nie. Kennis kan teenwoordig wees in die vorm van idees, oordeel, verhoudinge en konsepte. Anders as data en informasie, is kennis nooit staties nie, maar word kontinu gevorm binne mense se denke deur ondervinding, redenering en die invloei van nuwe stimulus. Onuitgesproke kennis is die informasie oor werksprosesse en -produkte wat individue besit bo en behalwe wat die organisasie gedokumenteer het. Dit is die vakgeheime wat gladde functionering in 'n organisasie bewerkstellig, die indiepte kennis wat kompeteterende voordeel verseker. Om te verseker dat 'n organisasie sy kompeteterende voordeel behou, moet spesiale fokus geplaas word op die bestuur van onuitgesproke kennis.

Die stand van kennisbestuur binne die Pirrometallurgiese industrie is ondersoek deur middel van die ontleding van vraelyste. Daar was gevind dat die Pirrometallurgiese industrie nog 'n lang pad moet stap om te verseker dat onuitgesproke kennis behoue bly binne hul organisasies. Sleutel areas van kommer is die gebrek aan ervare mentors sowel as genoegsame hulpmiddele om oordrag van onuitgesproke kennis te verseker. 'n Praktiese onuitgesproke kennisbestuursraamwerk word voorgelê om bestuurders by te staan om hierdie belangrike bate van hul organisasies op te pas.

Sleutelwoorde:

Onuitgesproke kennis, uitdruklike kennis, Pirrometallurgise industrie, kennisbestuur, kennisbestuurstrategie, suksesie beplanning, mentorskap program, kennis oordrag.
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Chapter 1: Orientation and problem statement

1.1 Introduction

Have you ever been faced with the situation that one of your key personnel decided to leave the organisation in order to start their own consulting business? Have you experienced high employee turnover? Do you feel that you have lost an employee that really made a difference to the organisation and knew all the aspects of the process and business? If the answer is yes to any of the three questions you have experienced the loss of tacit knowledge.

One of the great assets of South Africa is all the minerals deposits that serve as one of the primary drivers for the South African economy. These minerals are mined and processed through various different fields. One of these fields is the Pyrometallurgical field where minerals are processed by means of high temperature melting methods. This specialised field requires knowledge and experience in order to bring nature to be where it does not want to be, in a safe and responsible manner.

However with the noticeable outflow of skilled and experienced metallurgical engineers leaving South Africa it becomes difficult to recruit knowledgeable Pyrometallurgical Engineers. Do the Pyrometallurgical organisations make use of their current information systems to embed the knowledge and experience of the people leaving the organisation and the country? Do they incorporate the basic knowledge management's principles or are some of them facing a challenge of training up young inexperienced candidates without an experienced coach? This study will focus on the different aspects that can be used in order to embed tacit knowledge within an organisation and specific research will be done on the South African Pyrometallurgical organisations in order to establish the state of knowledge management within this industry.
1.2 Knowledge management in short

The focus of this mini dissertation is on knowledge management and in specific the management of tacit knowledge. In order to understand the complexity of this field of study, one need to start at the beginning in defining what knowledge is. Knowledge exists within people, part and parcel of human complexity and unpredictability. Traditionally we think of assets as definable and “concrete,” but knowledge assets are much harder to pin down. Knowledge offers speed and it allows its possessors to deal with situations quickly, even some complex ones that would baffle a novice (Davenport & Prusak, 2000:11). With the change in the global economy, knowledge has become one of the core competencies in order to create sustainable advantage. This knowledge needs to be actively managed within an organisation.

Chaffey and Wood (2005:227) define knowledge management as the capabilities by which communities within an organisation captures the knowledge that is crucial to them, constantly improve it and make it available in the most effective manner to those people who need it, so that they can exploit it creatively to add value as part of their work. In order to manage knowledge one needs to distinguish between the different classifications of knowledge. Knowledge can be classified into explicit and tacit knowledge. Explicit knowledge can be expressed in words and numbers and shared in the form of data, manuals and universal principles. Tacit knowledge on the other hand is highly personal and hard to formalise and include aspects like subjective insights, intuitions and hunches (Desouza, 2003:85). Tacit knowledge is not so much transferred as it is acquired and the process of acquiring tacit knowledge required personal experience (Eucker, 2007:12).

From the short introduction on knowledge management above it can be concluded that the management of the tacit knowledge requires special focus. Organisations must acknowledge the value of this intangible asset. In the following section the objectives of this study will be discussed.
1.3 Objectives of the study

The main objective of this study is to do a research on the different aspects of knowledge management with specific reference to that of tacit knowledge in order to determine the state of knowledge management within the Pyrometallurgical industry. Different initiatives that can be used in order to embed tacit knowledge within an organisation will also be researched. To achieve this main objective of this study, the secondary objectives of this study are as follows:

Theory evaluation:
- Provide an overview of knowledge and knowledge management
- Provide an overview on knowledge management frameworks or models found in literature
- Provide an overview on the concepts of formulating a knowledge management strategy
- Provide a more in-depth look on tacit knowledge. Aspects like why is tacit knowledge important for organisational success and how to embed tacit knowledge within an organisation, will be researched

Empirical research:
- Investigate the opinion of different knowledge management principles within the Pyrometallurgical industry
- Investigate the state of knowledge management within the Pyrometallurgical industry
- Investigate different ways and practices used within the Pyrometallurgical industry in order to embed tacit knowledge

Proposal of a tacit knowledge management framework
- From both the theory and empirical research the final objective is to propose a practical framework which can be used in order to embed tacit knowledge within an organisation

As can be seen from these objectives, a number of aspects relating to knowledge management will be research. From the research
recommendations will be made regarding the state of knowledge management within the Pyrometallurgical industry.

1.4 Scope and demarcation of the study

The empirical study focuses on the Pyrometallurgical industry within South Africa. The target population for this study is the managers and engineers that are responsible for the operation of the different pyrometallurgical units. The Pyrometallurgical industry is known to be an industry that is highly dependant on the experience of their employees. This experience can be related to tacit knowledge. This is the reason for deciding to limit the research only to operational legs within the Pyrometallurgical industry. In the following the section the research methodology that is used, will be discussed.

1.5 Research Methodology

Both primary and secondary sources of information will be used during the study.

Secondary sources from publications and text books will be used to study the different knowledge management principles.

Primary information will also be gathered by means of an empirical study. A quantitative research approach will be used in order to be able to provide an objective base in order to meet the research objectives. Questionnaires will be distributed to the relevant Pyrometallurgical organisations. All information obtained from the different organisations will be kept confidential.

1.6 Division of chapters

This dissertation is divided into four chapters. Each chapter has different focus areas and will be discussed in the section below.
Chapter 1
The aim of chapter one is to discuss the problem statement that forms the basis for conducting this study. A brief theoretical overview is given on the principles of knowledge management. Research methodologies followed as well as the target population is discussed.

Chapter 2
Chapter two consists of a literature study on knowledge management and focuses on knowledge, knowledge management, knowledge management strategies and the importance of tacit knowledge management. Different initiatives that can be used to embed tacit knowledge within an organisation are also researched.

Chapter 3
Chapter three is outlining the methodology used during the empirical study. A short overview of the pyrometallurgical industry is given. The design of the questionnaire is discussed as well as the sample design and process of analysis and evaluation of data. The results from the survey questionnaires are also discussed in detail and reference to the literature study is made.

Chapter 4
Chapter four presents a summary of the opinions from the respondents within the Pyrometallurgical industry on certain knowledge management principles. The state of the knowledge management within the Pyrometallurgical industry is also summarised. A practical framework for embedding tacit knowledge within an organisation is proposed. Final recommendations are made to improve the state of knowledge management within the Pyrometallurgical industry. The dissertation is concluded by mentioning opportunities for future research.

1.7 Conclusion
From chapter one it can be concluded that the need to understand the principles of knowledge management in the Pyrometallurgical industry is of importance to ensure a sustainable competitive advantage. The research
methodologies used have been discussed. The purpose of each of the chapters in this dissertation has also been explained.

1.8 Chapter Summary

The aim of this study is to provide a theoretical background on the knowledge management principles required for determining the current state of knowledge management within the Pyrometallurgical industry. Emphasis is placed on identifying initiatives that is required for embedding tacit knowledge within an organisation.

The literature study will be done in Chapter 2.
Chapter 2: Literature study

*Everyone who lives ought to be wise; it is as good as receiving an inheritance and will give you as much security as money can. Wisdom keeps you safe – this is the advantage of knowledge. – Ecclesiastes 7:11*

2.1 Introduction

Knowledge has always meant power: power to survive, power to adapt, power to thrive in a hard environment. Ever since the first human clan enjoyed the warmth of the first fire, it’s been true that knowledge shared is knowledge multiplied (Buckman, 2004:vii). We live in a world in which technology and globalisation affect every part of our lives. Immense changes in the economic environment have forced companies to transform themselves significantly in order to survive in a world and its new economy (Marquardt, 2002:xi).

According to Kreiner (2002:112), knowledge is the icon of the new economy and has become the desired object of management in modern organisations. It needs to be managed but before it can some kind of transformation of knowledge and information is required. Chaffey and Wood (2005:222) argue that the management of knowledge and the development of knowledge strategies have become priorities for organisations as they have realised how the application of knowledge can be key in adding value and differentiating products and services. The challenge to manage the knowledge assets of the organisation introduces a new business philosophy namely knowledge management, which aims at connecting people to people and people to information to create a competitive advantage (Squier, 2006:3).

This chapter focuses on the fundamental concepts around which the research study is built. The following concepts will be discussed:

- Knowledge and the creation of knowledge
- Management of knowledge using frameworks and strategies
- Tacit knowledge and the impact of losing it
• Embedding and transferring of tacit knowledge

The aim of the following sections is to define and explain the different aspects found in knowledge management.

2.2 What is Knowledge?

2.2.1 Defining the concept knowledge

In the proceeding section the author will discuss different definitions and models found in literature relating to knowledge within an organisation.

In order to understand the definition of knowledge within an organisation, it is important to differentiate it from related terms such as information, data and expertise. Figure 2.1 represents a traditional model used to distinguish between knowledge, information, data and expertise.

![Figure 2.1: Knowledge hierarchy](image)

(Villalba, 2006:10)

Data constitute the bricks from which the pyramid of knowledge is built (Villalba, 2006:10). In managerial terms, data is that which is available without much restriction in the knowledge society, on the Internet, in
databases, and in daily activities. Information results from placing data within some context and it can be viewed as processed data (Freeze and Kulkarni, 2007:104). Knowledge is the translation of data and information into decision- and action-relevant meaning. In Villalba's (2006:10) terms, information is transferred into knowledge when the individual processes it and internalises it. New information has to be integrated into the individual's existing knowledge structure in order to produce learning. If one masters a certain subject or area of knowledge you will become an expert in that field.

According to Squier (2006:14) knowledge is what people know and there is no knowledge without someone knowing it. Knowledge can be present in ideas, judgement, relationships and concepts. Unlike data and information, knowledge is never static but is continually shaped inside peoples' heads through experience, reasoning and the inflow of new stimuli.

Davenport and Prusak (2000:5) suggests a working definition of knowledge: Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluation and incorporating new experiences and information. It originates and is applied in the minds of knower's. In organisations, it often becomes embedded not only in documents and repositories but also in organisational routines, processes, practices and norms.

Since knowledge is perishable and changes continuously, the implication is that people and organisations should continuously create more knowledge. Steyn (2003:211) argues that knowledge is an asset to be nurtured and valued, like any other asset in an organisation. Rebernik and Sireč (2007:406) explain that knowledge is a living asset, dynamic and volatile, often difficult to observe and understand. Unlike information it is not final and stored, but emerging and being constantly recreated and socially reconstructed in a particular work context. Knowledge may be tangible or intangible by its nature.
Nonaka (1994:16) draws a distinction between two types of knowledge: tacit knowledge and explicit knowledge. According to Foos, Schum and Rothenberg (2006:7) tacit knowledge is knowledge that cannot be articulated or verbalized. In an organisation people know more than what they can tell. Explicit knowledge on the other hand can be easily codified and transferred by more conventional mechanisms such as documents, blueprints, and procedures.

This dissertation is mainly focused around the management of tacit knowledge within an organisation. In order to understand the value that knowledge can bring to a specific business process it is vital to understand the nature of organisational knowledge and how the knowledge is created and converted. In the next section the author will focus on the different mechanisms in which knowledge can be created.

2.2.2 Creation and conversion of knowledge in organisations

Knowledge resides in people’s minds and not in technology. According to Steyn (2003:210) the technology explosion has misled some organisations into believing that technology can replace the knowledge and skills of an experienced person. However the knowledge acquired by an experienced employee has to be managed in such a way that it contributes to organisational effectiveness. It is thus of utmost importance that the management of organisations understands the different processes in which knowledge is created and transferred.

Organisational-knowledge creation is a continual interaction between tacit and explicit knowledge. Nonaka and Takeuchi (1995:18) suggest that when knowledge is socialised and shared, it passes through four different processes. From Figure 2.2 it can be seen that knowledge moves through a knowledge creation spiral from tacit to explicit and back to tacit knowledge again. The process can be explained as follows:
An example of the *tacit to tacit* quadrant is where a production manager discusses and learns about the latest process difficulties with one of his colleagues. According to Nonaka (1994:19) the process of creating tacit knowledge through shared experiences is called socialisation.

The *tacit to explicit* quadrant can be described as a process where the production engineer puts his thoughts on an e-mail describing how he would solve the process difficulty based on his previous experience. This process is called externalisation and is important for the entire knowledge creation process.

In the *explicit to explicit* quadrant the production foreman reads the e-mail from the process engineer and combines the solution with his current operating procedures to resolve the problem.

Finally in the *explicit to tacit* quadrant the production manager combines the knowledge from the engineers e-mail and the actions of the foreman into a procedure that can be used to resolve future difficulties. Internalisation is the process of embodying explicit knowledge into tacit knowledge and is closely related to learning by doing (Nonaka, 1994:20).

**Figure 2.2: Adapted Nonaka’s tacit/explicit model – SECI Model**

![SECI Model Diagram](image)

(Villalba, 2006:40)
The model with its four processes is called the SECI Model after the first letter of each of the conversion processes. Squier (2006:29) states that all four processes need to be realised as an integrated process of knowledge creation. Unless shared knowledge is articulated, it cannot easily be controlled by the organisation as a whole. Nonaka and Takeuchi (1995:225) maintains that it is the individual who performs the transfer between explicit and tacit knowledge; however the individual has to share the knowledge in order to create the knowledge-creating spiral at an organisational level. It is thus important for an organisation to support a framework that will foster the exchange of ideas that in turn will create new knowledge.

In order to facilitate these knowledge sharing activities Von Krogh, Ichijo and Nonaka (2000:5) proposed five general enablers for knowledge creation.

- The first enabler is to introduce a knowledge vision. Knowledge creation must become a core process within the organisational strategy and must be supported by top management.
- The second enabler is to manage the conversation. Discussions and reflections of different views of ideas foster innovation. Thus finding a way to facilitate communication is a key enabler to knowledge creation.
- The third enabler is to maximise the efficiency of talented employees in order to mediate their tacit knowledge between what is and what should be.
- The fourth enabler consist of “creating the right context” for knowledge creation. The more chaos an organisation has inside its built-in structure the more innovation can be promoted.
- The fifth enabler is to globalise the tacit knowledge within a specific unit with the rest of the units in the organisation.

From the discussion on knowledge creation it is evident that some form of management needs to be taken place in order to ensure that the knowledge of the individual worker is being shared with co-workers. When facilitated within the correct context new knowledge could be created resulting in a more competitive organisation. This is where knowledge management plays a large
role in modern organisations. In the following section the author will define and discuss the concept around knowledge management.

2.3 A conceptual view on knowledge management

2.3.1 Knowledge management defined

Knowledge was earlier defined as the processing of information and is based on the previous understanding, procedures and experience of an individual. This knowledge capability can be considered to be an individual asset of managers or a collective asset for the organisation as a whole. Knowledge management seeks to share this experience within the company (Chaffey & Wood, 2005:36). Power (1999) provides the following definition for knowledge management on his decision support systems glossary:

Knowledge management is the distribution, access and retrieval of unstructured information about 'human experiences' between interdependent individuals or among members of a workgroup. Knowledge management involves identifying a group of people who have a need to share knowledge, developing technological support that enables knowledge sharing, and creating a process for transferring and disseminating knowledge.

Steyn (2003:207) highlights that knowledge management requires the transformation of personal knowledge into an institutional knowledge that can be disseminated throughout the institution and appropriately applied. In the post-industrial world the success of organisations will depend more on intellectual abilities than on physical assets.

Knowledge management is an integrated approach aimed at identifying, sharing and capitalising on the know-how, experience and intellectual capital of staff in an organisation (Steyn, 2003:212). Knowledge management can improve the organisations efficiency, make professionals learn more efficiently and effectively, provide a better foundation for making decisions and improve communication and synergy among staff members.
Knowledge management can also be defined as the achievement of the organisation's goals by making the factor knowledge productive. This is done primarily by facilitating and motivating people to tap into and develop their capacities and to stimulate their attitude to intrapreneurship (Uit Beijerse, 2000:165).

In order for organisations to tap into this pool of knowledge certain structures and frameworks are required to successfully manage knowledge within an organisation. The following section will focus on some of the different types of knowledge management frameworks found in literature.

2.3.2 Knowledge management framework and models

Various knowledge management frameworks and models are available in literature and most of them have similar communalities within them. Of importance is that the knowledge management strategy must be aligned with the business strategy. Chaffey and Wood (2005:227) describe the European Framework of Knowledge Management which takes a holistic view of the business processes, knowledge processes and capabilities required to support knowledge management. The framework offers a perspective on knowledge management that places organisational business processes at the core. Chaffey and Wood further note that businesses must understand how knowledge adds value to business performance and place emphasis on the inclusion of all players in the value chain.

The European Framework of Knowledge Management was developed in analysing more than 100 knowledge management frameworks. Five core processes called the processing life cycle will be discussed below (Chaffey & Wood, 2005:228).

- Identify knowledge: what knowledge is required to achieve objectives? If knowledge is lacking a knowledge gap is identified that needs to be closed.
• Create knowledge: innovation is vital and knowledge can be created through training, learning by doing and problem solving.

• Store knowledge: knowledge assets form the knowledge base of organisations. These assets may be stored in documents or databases or memorised as tacit knowledge.

• Share knowledge: knowledge must be shared to the right people at the right time or can be shared via documents and databases.

• Use knowledge: apply what we know in order to make correct decisions for the business.

Another integrated conceptual knowledge management model is described by Uit Beijerse (2000:168) and focuses on nine streams of knowledge management as the core of the model. As can be seen from Figure 2.3 the central aim is to make knowledge productive. This can be achieved by aligning the nine streams of knowledge management within the organisational means supported by culture, structure and strategy.

The nine streams of knowledge starts with identifying what knowledge is necessary and then what is already available. This results in a knowledge gap that needs to be closed in developing new knowledge or acquiring knowledge if it cannot be developed. Once the gap is closed the knowledge is locked within the organisation and needs to be shared and utilised in the business. The last stream of knowledge is to evaluate the utilised knowledge in order to determine if sufficient knowledge is available with which the process can be started from the beginning.
According to Uit Beijerse (2000:168) the knowledge management strategy is mainly important for the evaluation of knowledge and remains the primary means of the organisation. Structure as the secondary mean, is important for the development, the acquisition and the locking of knowledge. The third organisational mean is culture. Culture is important for the sharing and the utilisation of knowledge. Such a culture is characterised by openness, flexibility and an inclination for taking risks.

From the knowledge management framework discussions it is evident that an organisation should develop a knowledge management strategy in order to tap into the benefits such a strategy could give. Both the above mentioned frameworks can be used in developing such a strategy.

2.3.3 Knowledge management strategy

Chaffey and Wood (2005:222) define a knowledge management strategy as a defined and co-ordinated plan of actions to enable core business processes using knowledge management techniques. According to Villalba (2006:26)
knowledge management strategies enforce a lifelong perspective of learning through continuous emphasis on the creation of knowledge and skills upgrading. It also promotes constant opportunities for skill development and learning, both formal and informal. In general a knowledge management strategy must be aligned with the corporate business objectives and activities; must enable all elements of the knowledge processing lifecycle and must be balanced between the individual and organisational capabilities (Chaffey & Wood, 2005:231).

From his book "Building the Learning Organization", Marquardt (2002:170) lists the top ten strategies for knowledge management. All ten strategies will be briefly summarised by the author.

- **Share responsibility for collecting and transferring knowledge**: Employees should be aware of the kind of knowledge that might benefit the organisation so that they can capture it as it goes by.

- **Systematically capture relevant external knowledge**: This refers to benchmarking best practices in the industry, and attending conferences and forums.

- **Organise internal learning events**: Examples of note are strategic reviews on the competitive environment, system audits to review effectiveness, internal bench marking reports, and symposiums that bring together customers, suppliers and experts to share ideas and learn from each other.

- **Be creative about thinking and learning**: Install small scale experiments with feedback, reward imaginative and risky efforts, and encourage brainstorming of multiple ideas to produce one good idea.

- **Encourage and reward innovation**: To survive in the global market place means continually creating new ways of producing better products and services. Companies must encourage experimentation and reflection.

- **Train staff in knowledge storage and retrieval**: Organisations must keep their employees informed about the kind of knowledge required, their values and memory systems, and their resources for storing knowledge.
• **Maximise knowledge transfer across the boundaries:** Job rotation and team mixing are two effective ways to transfer knowledge in an organisation.

• **Develop a knowledge base around organisational values and learning needs:** Knowledge is ineffective unless it is coded and stored in a way that makes sense to individuals and organisations. Identify and store information by assessing its value.

• **Create mechanisms for collecting and storing learning:** Knowledge transfer is seen as a professional responsibility and part of everyone’s job. Knowledge development is included in the personnel evaluation process.

• **Transfer classroom learning to on the job utilisation:** To be able to apply theory in practice creates new knowledge within the organisation.

Kruger and Snyman (2005:67) conclude that business strategies and knowledge management strategies should feed upon each other and need to work interdependently. If knowledge drives strategy, and strategy drives knowledge management, then in order to launch any knowledge management programme, one needs to turn to a point before knowledge management. One needs to return to strategy and specifically to what gives strategy governance.

How should an organisation start with formulating a knowledge management strategy? What is the first step? What knowledge is required? In order to answer these questions the traditional tools such as SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis and PEST (Political, Economic, Social and Technology) analysis should be used to assess the general business environment (Chaffey & Wood, 2005:232). Four questions should be asked during the SWOT analysis.

• What areas of our business benefit from applied and valued knowledge?
• What areas of our business lack knowledge?
• Are there opportunities to exploit knowledge?
• What threats are there to knowledge being lost or losing value?
The knowledge management strategy as well as the frameworks discussed up to this point has not addressed what management can do to retain or lock the tacit knowledge within the organisation. In the following section the author will focus on broadening the definition of tacit knowledge, what the impact is on the loss of it as well as what organisations can do to embed and transfer it in the organisation.

2.4 Tacit knowledge retention

2.4.1 The concept of tacit knowledge

In section 2.2.1 explicit and tacit knowledge have been briefly discussed. The SECI model was discussed describing the flow from tacit to explicit and back to tacit knowledge. The following section will focus more intensively on what literature is revealing about the concept of tacit knowledge.

Tacit knowledge is highly personal. It is hard to formalise and therefore, difficult to communicate to others. Tacit knowledge is also deeply rooted in actions and in an individual's commitment to a specific context. Tacit knowledge has also an important cognitive dimension. It consists partly of technical skills (know-how) but also mental models, beliefs, and perspectives so ingrained that we take them for granted (Nonaka, 1998:28).

This is confirmed by Jackson, Hitt and Denisi (2003:14) where it is indicated that tacit knowledge is grounded in experience and difficult to express through mere verbal instruction; individuals know it but cannot articulate it. Because tacit knowledge is difficult to codify, it is passed along to others through direct experience. Tacit knowledge is most critical for organisational success because it is based on the knowledge and skills that an organisation accumulates over time through the experiences of its employees (Jackson et al., 2003:210).

Tacit knowledge is less tangible than explicit knowledge. It refers to experience on how to react to a situation when many different variables are
involved. It is more difficult to encapsulate this knowledge, which often resides in the heads of employees. Examples include knowing how to react when changes occur in the marketplace, such as a competitor launching a new product or a merger between two major competitors (Chaffey & Wood, 2005:37).

Now that the concept of tacit knowledge has been discussed it becomes necessary to investigate the impact of the loss of tacit knowledge within an organisation.

2.4.2 Impact on an organisation when losing tacit knowledge

From the discussion in section 2.4.1 it is necessary to establish the significance of retaining tacit knowledge in order for an organisation to be successful? Further research done by the author indicates that tacit knowledge is obtained by internal individual processes, such as experience, reflection, internalisation and individual talent. It cannot be given in lectures and found in databases, textbooks, manuals or internal newsletters for diffusion. It is internalised in the human body and soul (Rebernik & Sireč, 2007:409). Tacit knowledge is the information about work processes and products that individuals hold above and beyond what organisations have documented. It is the "tricks of the trade" that promote smooth organisational functioning, overall know-how, and competitive advantage (Droege & Hoobler, 2003:53). Both Rebernik and Sireč as well as Droege and Hoobler touch on two very important aspects of tacit knowledge namely know-how and experience. An organisation can have the best equipment, resources and text books, but without the know-how and experience of its employees it is not worth the paper it is written on.

In the next 10 years, 43 percent of the workforce in the US will be eligible for retirement and five hundred of the largest companies can expect to lose 50 percent of their senior management in the next 5 years (Eucker, 2007:10). According to Eucker (2007:12) when you have a problem one of the first steps in solving the problem is finding someone who has solved it or similar
problems before. "We preliminary want someone we trust in terms of confidence in what they know and who can and will be willing to help us". So what happens if these persons are not available in the organisation anymore?

Employees are becoming ever more highly educated and mobile, as they increasingly carry the means of production around with them in their heads and there has been a shift in focus to the internal resources and capabilities of organisations as a key determinant of competitive advantage (Misch & Tobin, 2006:134). As relationships become embedded in social structures, trust develops, promoting norms of reciprocity. Employee turnover disrupts established social relationships which in turn can have a deleterious effect on the firm's performance (Droege & Hoobler, 2003:55).

Further more voluntary employee turnover translates into lost value to a firm with respect to tacit knowledge unless that knowledge has been previously captured through the transmission of employees' "know-how" to others with whom the employee has worked (Droege & Hoobler, 2003:53). Research has shown a relationship between voluntary employee turnover and a decrease in organisational efficiency; declines in productivity and loss of organisation-level social capital. From another angle the difficulty of expressing, codifying and transmitting tacit knowledge makes it easier for a company to protect it than explicit knowledge. The difficulty of copying tacit knowledge also enables tacit knowledge to be the basis of an inimitable competitive advantage (Rebernik & Sireč, 2007:411).

In summary to transform tacit knowledge into company property, is a legitimate managerial goal. It makes good sense to find ways in taking care of the knowledge that leaves the company at night (Kreiner, 2002:122). It can be argued that the loss of tacit knowledge does have a negative effect on the performance of an organisation. It is thus imperative for organisations to understand how to embed tacit knowledge within the organisation as well as the issues related to the transferring of tacit knowledge in order to utilise it as a competitive advantage.
2.4.3 Embedding and transferring of tacit knowledge

Tacit knowledge that was developed and internalised by the knower over a long period of time, is almost impossible to be reproduced in a document or database. Such knowledge incorporates so much accrued and embedded learning that its rules may be impossible to separate from how an individual acts (Davenport & Prusak, 2000:70). If tacit knowledge is then so difficult to reproduce what must an organisation strategically do in order to embed and transfer this tacit knowledge within the organisation?

The old concept of structure follows strategy becomes important in answering the question. Firstly an organisation must ensure that there is an interaction between senders of tacit knowledge and the receivers of it. According to Davenport and Prusak (2000:101), knowledge transfer involves two actions namely transmission and absorption. If the presenting knowledge to the potential recipient is not absorbed it has not been transferred.

In order for knowledge transfer to happen enough human resources must be made available in for the interaction to proceed. Venter (2007:12) refers to the law of requisite variety where the variety of actions in the system must be larger than the variety of the perturbations in order to achieve control. Thus the variety of tacit knowledge that is present in an organisation needs to be controlled by allocating adequate resources to the management of tacit knowledge. Nonaka (1994:29) explains that the concept of requisite variety refers to the construction of information process channels that match the information load imposed by the environment. In practical terms it requires that everyone is given access to necessary information with the minimum number of steps. Employees should know who owns what information and they should be related to the least number of colleagues so that they are not loaded with information in the excess of each one's cognitive capacity. Gorelick, Milton and April (2004:208) states that HR practitioners who provide performance evaluations support should help equip managers to handle the extracting of tacit knowledge. Dedicated resources should be committed to knowledge management projects and senior management will have to
prioritise activities and commit time in order to align with the knowledge management strategy.

Three organisational strategies are proposed by Droge and Hoobler (2003) in order to promote tacit knowledge diffusion. The first strategy is to promote tie-building activities by means of mentoring systems or buddy systems. The second strategy is the modification of technological interdependency by encouraging individuals and departments to work together to share information and resources on how they complete tasks. The third strategy is a reward system that may be used to motivate employees to engage in knowledge sharing.

The importance of tacit knowledge to prosperity is calling for the addition of techniques and cultures to promote tacit knowledge transfer. As discussed in section 2.2.2 the first step of the SECI model is a process of having face to face socialisation. This can be supported by interpersonal solutions such as apprenticeships, mentoring and narrative storytelling (Jimes & Lucardie, 2003: 24). Some transfers of tacit knowledge are intentional, resulting from training events, or conferences, while others are more unintentional, resulting from job transfers, interdepartmental task forces, and informal networks and employee interactions. According to Holste and Fields (2005) the willingness and capacity of individuals to share what they know are a key factor to ensure tacit knowledge transfer. Their research found that tacit knowledge sharing depends on both affect and cognition-based trust among co-workers. Thus investing in information technology alone will not translate into better transfer and use of tacit knowledge because individuals decide whether they will share tacit knowledge and individuals also decide whether they will use the tacit knowledge available.

Rebernik and Sireč (2007) states that sharing knowledge requires that time are taken away from other responsibilities that have a higher priority. The importance of social interaction for the diffusion of tacit knowledge supports the statement that time is to be shared in order to make this social interaction possible. The globalisation, diversification and virtualization of business that
obstruct face to face interaction are therefore, a threat to tacit knowledge diffusion.

Companies committed to transferring tacit knowledge often set up formal mentoring programs and make passing of knowledge to young employees an explicit part of the job descriptions of skilled senior staff (Davenport & Prusak, 2000:95). Tacit knowledge transfer can be facilitated by the use electronic technology in the form of an Internal Information Interview Network. This network consists of a database that lists employees who are willing to meet with colleagues and share information. Another use of technology to transfer tacit knowledge is where organisations record the stories and experiences of senior practitioners on video before they leave the company.

Nonaka and Takeuchi (1995:127) introduced a term “middle-up-down” in order to describe how knowledge is created. As strange as this term may sound, it best communicates the continuous interactive process by which knowledge is created. According to Nonaka and Takeuchi (1995:128) knowledge is created by middle managers, who are often the leaders of a team or task force, through a spiral conversion process involving both top and the first-line employees. The process puts middle management at the very centre of knowledge management, positioning them at the intersection of the vertical and horizontal flows of information within the company. Middle managers try to solve the contradiction between what top management hopes to create and what actually exists in the real world (Nonaka and Takeuchi, 1995:129). It is for the above mentioned reasons that this study is focused on how the tacit knowledge is managed within the group of middle management within organisations.

The embedding and transferring of tacit knowledge depends on various aspects within an organisation. Organisational structure and culture, employee trust and relationships, the ability to give some of your own time, the commitment of senior management, the willingness to share your knowledge, the reward systems in place and the structured forums in order to exchange knowledge are but a few aspects that an organisation can focus on
in order to retain the tacit knowledge within the organisation. This list is not exhaustive and further research is required in order to establish what else an organisation can do to embed and transfer tacit knowledge.

2.5 Conclusion

From the above literature research various aspects of knowledge and the management thereof have been discussed. It can be concluded that knowledge is the building block of an organisation and forms part of the core competencies that enable an organisation to be successful. Knowledge can be seen as an asset of the organisation and therefore needs to be nurtured. Various ways of nurturing this asset can be implemented. An organisation can start of by entrenching the five general knowledge enablers in order to foster knowledge creation. Strategy, structure and culture are key areas in an organisation in order to implement knowledge management within an organisation. The organisational strategy and knowledge management strategy must be interdependent but the organisational strategy must govern the knowledge management strategy.

It can further be concluded that retaining an organisation’s tacit knowledge is a key success factor to ensure competitive advantage. Tacit knowledge resides in the minds of the employees and it not as tangible as explicit knowledge. Organisations are facing even higher employee turnover than before. Thus in order for them to stay competitive the transfer of tacit knowledge is what it all boils down to. The structure within the organisation should support setting up social networks to connect key employees in order to transfer their tacit knowledge. However this is not enough. The willingness to share ones knowledge as well as the willingness to absorb someone else’s knowledge is highly dependant on mutual trust, cultural background and the time and forums available to make this happen. An incentive scheme must be in place for key individuals to reward them for sharing their knowledge and expertise. The use of technology forms a key aspect of tacit knowledge transfer. Recording interviews with key individuals before leaving the organisation or
setting up a knowledge forum on the intranet can assist employees to tap into the knowledge of their fellow workers in different departments.

From the literature study no framework or model for tacit knowledge management could be found. Various researchers have suggested certain initiatives in order to manage tacit knowledge. The aim of the empirical research will be to determine the state of knowledge management within the Pyrometallurgical industry and whether other initiatives not mentioned in this literature study can be used to embed tacit knowledge within an organisation.

2.6 Chapter Summary

In this chapter the various concepts relating to knowledge management were discussed. Firstly a definition of knowledge was researched and it was found that knowledge can be present in the mind of knowers as ideas, judgement, relationships and concepts.

The second concept that was discussed related to knowledge creation. The distinction between tacit and explicit knowledge was made. The four quadrants of the SECI model have been discussed in order to illustrate the relationship between tacit knowledge and explicit knowledge creation.

The third concept that was discussed focused on management of knowledge. It was found that knowledge management can improve the organisations efficiency, make professionals learn more efficiently and effectively, provide a better foundation for making decisions and improve communication and synergy among staff members.

The fourth concept that was discussed related to the different frameworks and models found in order to assist the knowledge management process. Both these frameworks highlighted the importance of assessing what knowledge is required for organisational success and what the current gap of knowledge is. To close this knowledge gap the organisational culture and management involvement is of utmost importance.
The fifth concept that was discussed focused on the importance of implementing a knowledge management strategy. It can be concluded that business strategies and knowledge management strategies should feed upon each other and need to work interdependently. If knowledge drives strategy, and strategy drives knowledge management, then in order to launch any knowledge management programme, one need to turn to a point before knowledge management. One needs to return to strategy and specifically to what gives strategy governance.

The sixth concept researched was that of tacit knowledge. It was found that the embedding and transferring of tacit knowledge depends on various aspects within an organisation. Organisational structure and culture, employee trust and relationships, the ability to give some of your own time, the commitment of senior management, the willingness to share your knowledge, the reward systems in place and the structured forums in order to exchange knowledge are but a few aspects that an organisation can focus on in order to retain the tacit knowledge within the organisation.
Chapter 3: Research Methodology and Findings

3.1 Introduction

The literature study conducted in Chapter 2 focused on the concept of knowledge, knowledge management and in specific the management of tacit knowledge. A number of aspects were identified from the literature study that can enable organisations to preserve the tacit knowledge within their organisation. The aim of Chapter 3 will be to describe the research methodology that was be used in order to meet the research objectives set out in section 1.3 of Chapter 1. Both the research methodology used and the findings from the results will be discussed in the following chapter.

3.2 Overview of the South African Pyrometallurgical Industry

Pyrometallurgy is the processing or extraction of metals and materials at high temperatures, using a suitable source of thermal energy. The word Pyro originates from the Greek word *Pura* which means fire. The use of fire made it possible for ancient people to produce gold articles by melting and casting tiny particles found in rocks. Together with the steam engine, pyrometallurgy is the origin of the Industrial Revolution (Habashi, 2004:563). Pyrometallurgy technology has been applied successfully to most of South Africa's abundant mineral resources using the competitive energy sources of coal and electricity. The pyrometallurgical processes used in South Africa can be grouped into roughly six categories, namely Iron & Steel, Ferro alloys, Ferro Chrome, Stainless steel, Aluminium and Platinum Group Metals (Barcza, 1996:237). Pyrometallurgy is also referred to as being an ancient art that only became a recent science. It is for this reason why tacit knowledge management is of utmost importance. Within the Pyrometallurgical processes, a lot of skill, experience and visual contact are required. Process variability is in the order of the day as a result of the variability in raw materials and input materials.
In order to reach the objectives set out in section 3.1 the author will focus this research on the population of managers and engineers that resides within the operational environment within the Pyrometallurgical industry in South Africa.

3.3 Quantitative research discussion

Researchers can use various methods to collect, analyse, and interpret information. There are various schools of thought in how information is acquired and understood. These can be grouped under the two headings of quantitative research and qualitative research approaches. Quantitative research is a form of conclusive research involving large representative samples and fairly structured data collection procedures. Qualitative research employs research methods such as participating observations, archival source analysis, interviews, focus groups and content analysis (Struwig & Stead, 2004:11).

Quantitative methods are based on the collection of facts and observable phenomena, and scientists use these to deduce laws and establish relationships. Research in business and management also uses quantitative methods and these provide a more objective base to guide professional practice (White, 2002:47). As a result of the exploratory nature of this study, a hypothesis was not formulated. A quantitative approach was chosen by the author in order to be able to provide an objective base in order to meet the research objectives. Reasons for this decision was based on the amount of time and cost involve conducting a qualitative research study compared to a quantitative study.

Different techniques like surveys, interviews, questionnaires and experiments are available to collect data and information. For this study postal questionnaires was used and was sent out by e-mail. During the design of the questionnaire the author made use of open-ended questions, dichotomous questions as well as scaled-response questions. Open-ended questions are vital when the researcher is interested in new ideas or novel points of view or cannot anticipate the likely answer (Fisher, 2007:198). It is for this reason that
the author have chosen to make use of open ended questions in order to establish the different techniques used in order to embed and transfer tacit knowledge.

With any form of research, it is usually impossible to question every member of the population involved. The total population in question is termed the sampling frame and the individuals within the population are called the sampling units (White, 2002:61). The sampling frame for this study comprises of the managers and engineers reporting into the operational leg within the Pyrometallurgical organisational structure. The sampling frame is highlighted in red in Figure 3.1.

There are two basic ways of choosing samples: random (probability) sampling and non-random (non-probability) sampling. As a result of the large amount of Pyrometallurgical units within the South African industry it is not possible to determine accurately the sampling frame in the time frame allowed to conduct the research. For this reason non-random purposive sampling was used. Purposive sampling is often called judgemental sampling, because the researcher picks the sample they think will deliver the best information in order to satisfy the research objectives in questions (White, 2002:64).
The author has selected managers and engineers from various Pyrometallurgical units. The source of the contact details of the managers and engineers originated from mailing lists from previous Pyrometallurgical conferences. The downside is that the lack of randomness in the sample means that any calculation of the margin of error that might be done is unreliable (Fisher, 2007:191).

The decision about the size of the sample can be very complex and can be influenced by the population characteristics, research objectives, time, statistical precision and judgement (Struwig & Stead, 2004:120). In order to meet the research objectives, the sample size were selected based a required accuracy of 10% at a 90% confidence level.

The sample size calculation is indicated in Equation 3.1 and can be described as follows:

**Equation 3.1: Sample size calculation**

\[ S = \frac{P(1-P)}{A^2} \left( \frac{1}{N} + \frac{Z^2}{P(1-P)} \right) \]

Where:
- \( S \) = Sample size required
- \( N \) = Number of people in population (550)
- \( P \) = Estimate of people who possess attribute of interest (80%)
- \( A \) = Accuracy desired (10%)
- \( Z \) = The number of standard deviations of the sampling distribution that correspond to the desired confidence level. A factor of 1.64 was used for a 90% confidence level.

The exact numbers of managers and engineers within the sampling frame is not known. It is estimated that between five hundred to six hundred engineers and managers are servicing the production leg within the Pyrometallurgical
industry. From Equation 3.1, the calculated sample size for this population yielded a number of forty questionnaires that needed to be analysed.

A total of hundred and five survey questionnaires were sent out by electronic mail to various engineers and managers within the Pyrometallurgical industry. The response rate from the survey was thirty six percent and yielded thirty eight returned questionnaires. The response rate is in line with the average response rate achieved from electronic mail surveys. The amount of returned questionnaires is close to the calculated sample size number. It can thus be concluded that the results from analysing the questionnaires will have a 10% accuracy coupled to a 90% confidence interval level.

In order to assess internal consistency of the survey questionnaire, the Cronbach’s alpha test was used. The Cronbach's alpha test assesses how reliably survey questions are answered (Field, 2005:667-678). Cronbach's alpha values range between one and zero where values above 0.7 suggest higher internal consistency. A historical benchmark value of 0.7 is commonly used to suggest that at least some of the items measure the same construct. From the Minitab 15 statistical software package, Equation 3.2 can be used for calculating the Cronbach’s alpha value for internal consistency.

**Equation 3.2: Formula for calculating the Cronbach’s alpha value**

\[
\alpha = \frac{k}{k-1} \left[ 1 - \frac{1}{k} \sum_{i=1}^{k} S_{i}^2 \right] \]

Where
\(\alpha\) = Cronbach's alpha value  
\(k\) = the number of items in analysis  
\(S_{i}^2\) = sample variance of the \(i^{th}\) item  
\(S_T^2\) = sample variance of the total
From the survey questionnaire six questions have been selected in order to test the internal consistency. The first three questions focused on succession planning, mentorship and coaching that in essence measures the same theme. The detail on the questions asked can be found in Appendix 1. The Cronbach’s alpha test yielded a number of 0.6407 that is close to the benchmark of 0.7 indicating a high level of internal consistency. Minitab 15 was used as a statistical software package in order to calculate these results. The results can be seen in Table 3.1 as well as in Figure 3.2.

Table 3.1: Cronbach’s alpha test on questions 10, 12 and 20

<table>
<thead>
<tr>
<th>Variable</th>
<th>Count</th>
<th>Mean</th>
<th>StDev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 10</td>
<td>38</td>
<td>2.5789</td>
<td>1.1060</td>
</tr>
<tr>
<td>Item 12</td>
<td>38</td>
<td>2.6579</td>
<td>1.2689</td>
</tr>
<tr>
<td>Item 20</td>
<td>38</td>
<td>2.7632</td>
<td>1.1725</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>2.0000</td>
<td>2.6304</td>
</tr>
</tbody>
</table>

Cronbach’s Alpha = 0.6407

Figure 3.2: Cronbach’s alpha test on questions 10, 12 and 20

The second set of questions that was used to measure internal consistency only yielded a Cronbach’s alpha number of 0.4212 (Table 3.2). These questions focused on the importance of experience that is required within the Pyrometallurgical industry. Although the Cronbach’s alpha value of 0.4212 is
lower the benchmark of 0.7, it is far from zero. A moderate internal consistency can thus be expected as indicated in the matrix plot found in Figure 3.3.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Count</th>
<th>Mean</th>
<th>StDev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
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<td>4.289</td>
<td>1.088</td>
</tr>
<tr>
<td>Item 3</td>
<td>38</td>
<td>4.132</td>
<td>0.875</td>
</tr>
<tr>
<td>Item 8</td>
<td>38</td>
<td>4.026</td>
<td>0.716</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>12.447</td>
<td>1.841</td>
</tr>
</tbody>
</table>

Cronbach's Alpha = 0.4212

From the above discussion on sample size and internal consistency it can be concluded that the survey results can be used in order to draw conclusions from. The respondent's views can thus be used to draw conclusions regarding the state of knowledge management within the Pyrometallurgical industry. The information captured from the questionnaires were compiled and analysed by the author and will be discussed in section 3.4.

3.4 Discussion of survey findings

From the literature study a number of initiatives were identified that could assist in embedding tacit knowledge in an organisation. Questions were
designed in order to test if the same initiatives are being used within the Pyrometallurgical industry. In this section the demographic profile of the respondents participated in the survey will be discussed. This will be followed by a discussion on the opinion of the respondents related to the importance of tacit knowledge transfer. The initiatives that are being used in the Pyrometallurgical industry will then be compared with those found in literature.

3.4.1 Demographic profile of respondents

A total number of thirty eight engineers and managers responded to the tacit knowledge management survey. The respondents represented five from the six main pyrometallurgical categories found in South Africa as described in section 3.2. The only exception was that of the Aluminium industry. As can be seen from the percentage distribution in Figure 3.4, the Ferro Chrome and Iron and Steel Making respondents, represents fifty percent of the industry. This is in line in terms of the magnitude of the Ferro Chrome and Steelmaking operations found in South Africa.

The distribution of the number of years of working experience is quite evenly distributed. The fact that sixty five percent of the respondents illustrated in Figure 3.5, were having more than fifteen years of working experience contributes towards the weight that the results of this survey carries.
As this survey focuses on the Pyrometallurgical Industry it is with no surprise that seventy one percent of the respondents studied either Metallurgical or Chemical engineering (Figure 3.6).

The respondents were also very evenly distributed between the different levels within management. As can be seen from Figure 3.7, only eleven percent of the respondents formed part of first line management. This in conjunction with the number of years of working experience described in Figure 3.5 indicates the maturity level of the respondents participating in the survey.
Of note is that seventy one percent of the respondents had more than five people reporting directly into them. Of concern is the number of engineers and managers that have resigned in the last two years. From Figure 3.8 it can be seen that fifty one percent of the respondents have lost more that two engineers or managers within their department.

From the discussion on the demographic profile of the respondents it can be concluded that although non-random purposive sampling was used the broad Pyrometallurgical industry is still well represented with the mix of management, years of experience and the different fields within the Pyrometallurgical industry. The opinions regarding tacit knowledge management of this representative group of respondents will now be discussed in the following section.
3.4.2 Opinion on importance of tacit knowledge transfer

From the literature study it was found that knowledge is the building block of an organisation and forms part of the core competencies that enable an organisation to be successful. This knowledge needs to be managed and effort must be put in place in order to ensure that it is embedded in the organisation. A number of statements were posed to the respondents and they had to choose from a Likert type scale ranging from Strongly Agree, Agree, or Uncertain to Disagree or Strongly Disagree. The margin of error of some selected question has been calculated at a 95% confidence level. Equation 3.3 has been used in determining the margin of error on selected questions (Fisher, 2007:199).

Equation 3.3: Calculation of margin of error for selected questions

\[ L = 2 \sqrt{\frac{p(100-p)}{n}} \]

Where:
- \( L \) = the margin of error
- \( p \) = the percentage of answer to the question in the questionnaire
- \( n \) = the number of questionnaires

In the following section, outcomes of the opinions regarding certain knowledge management principles will be discussed by making use of descriptive statistics as well as the margin of error on selected questions.

- **High employee turnover does affect an organisation's performance**
  As stated in section 2.4.2, employee turnover translates into lost value to a firm with respect to tacit knowledge (Droege & Hoobler, 2003:53). Research has shown a relationship between employee turnover and a decline in productivity. The above statements are again confirmed by eighty nine percent of the respondents who agree that employee turnover does affect the production performance. This is graphically indicated in Figure 3.9. By using Equation 3.3 the margin of error for
this question is roughly ten percent. In order to reduce this margin a larger sample size could have been taken.

Two of the demographic questions that were posed to the respondents were aimed at determining the employee turnover percentage in the Pyrometallurgical industry. The summary statistics of the calculated data is shown in Figure 3.10 and indicates that the data is not normally distributed (p-value is greater than 0.05). In an extreme case eighty percent of a specific department resigned over a two year period. However of note is the mean that indicates a twenty eight percent employee turnover rate over a two year period. With this high turnover rate the managing and retaining of knowledge becomes even more critical.
Experience and plant specific knowledge does matter

Being in the pyrometallurgical industry requires a fair amount of practical experience and knowledge. This principle was tested by stating three similar statements to the respondents. From Figure 3.11 eighty seven percent of the respondents agreed that they have learned more from interacting with their work colleagues than from theory. This is quite significant in the fact that this interaction refers directly to the transfer of tacit knowledge. In the same breath eighty nine percent of the respondents agree that the pyrometallurgical engineers do require specific knowledge and experience in order to operate the process effectively. In addition to this ninety three percent of the respondents disagreed that technology can replace the skills and experience of an employee.
Figure 3.11: Interaction in order to transfer knowledge

Experience over theory

- **Effect of cultural background on the sharing of knowledge**

From the integral knowledge management model described by Uit Beijerse in section 2.3.2 the culture is important for the sharing and the utilisation of knowledge. Such a culture is characterised by openness, flexibility and an inclination for taking risks. In order to verify this, a statement was posed to the respondents to see if they think that the cultural background could be a stumbling block for one person to transfer his knowledge to another person. From Figure 3.12 it can be seen there is mixed opinions amongst the respondents. The calculated margin of error of respondents that agreed yielded an error of sixteen percent (Equation 3.3). Further investigation is required in order to establish the difference in opinions on this specific topic.

Figure 3.12: Influence of cultural background on sharing of knowledge

- 8. I have learned more from interacting with my work colleagues than from theory on how to operate our process effectively.

- 17. The different cultural backgrounds is not a stumbling block for person A to share his knowledge and experience with person B.
- **Effect of trust on the sharing of tacit knowledge**

According to Holste and Fields (2005) the willingness and capacity of individuals to share what they know is a key factor to ensure tacit knowledge transfer. Their research found that tacit knowledge sharing depends on both affect and cognition-based trust among co-workers. It was found that willingness to share knowledge depends on the opinion of the sender about what he or she thinks of the receiver of tacit knowledge. From Figure 3.13 fifty eight percent of the respondent agreed that they will be reluctant to share their knowledge based on their opinion of the receiver.

![Figure 3.13: Willingness in sharing of knowledge based on opinion](image)

From Figure 3.14 it is also evident that trust does not seem to be that important. Persons are willing to share their knowledge although they have not established a trust relationship with that person. This stands in contradiction with the findings of Holste and Field.
Social events vs. formal forums on sharing of tacit knowledge

As stated in section 2.4.3 some tacit knowledge transfers are intentional and some are unintentional. The weight however fall more to the intentional way of transferring of tacit knowledge. From Figure 3.15 it can be concluded that sixty nine percent of the respondent will rather share their tacit knowledge in a formal "intentional" forum than at a social event.

Finally of note is that seventy nine percent of the respondents agreed that an organisations core competencies resides in the minds of a few key employees (Figure 3.16).
This raises the question on how organisations are ensuring that these core competencies that mainly consist of tacit knowledge are retained or embedded within the organisation. These core competencies results in enhancing the sustainable competitive advantage of an organisation. In the following section the initiatives in order to embed tacit knowledge within an organisation will be discussed.
3.4.3 Initiatives used to embed tacit knowledge within the industry

In the previous section the opinion of the respondents in terms of certain knowledge management principles were discussed. In this section the initiatives that can be used in order to embed tacit knowledge within an organisation will be discussed. Various questions were posed to the respondents in order to determine if the Pyrometallurgical industry is practicing some of these initiatives.

A total of twenty three questions were posed. The respondents could choose from a number of selections. The author has presented two selection categories in order to determine to what extent these initiatives are being used. The first selection category consisted of a selection between “Yes”, “No”, “Not sure” and “In the process of doing it”. The second selection category consisted of “Yes, but not working”, “Yes and it is working”, “No”, “In the process of implementing” and “Not sure”. The distinctive selection categories gave the author a bit more information that could be achieved through conventional selection categories.

- **Extend of implementation of a Knowledge management strategy**

  As stated in section 2.2.3 a knowledge management strategy must be aligned with the corporate business objectives and activities (Chaffey & Wood, 2005:231). Two questions were used to determine whether the Pyrometallurgical industry has implemented a knowledge management strategy and whether it is linked to the business strategy. From Figure 3.17 it can be concluded that forty two percent of the industry does not have a knowledge management strategy. Only five percent of the respondents are of the opinion that the knowledge management strategy is implemented and working. In terms of the linkage between the knowledge management strategy and the business strategy, thirty seven percent indicated that it is not interlinked.
Figure 3.17: Knowledge management strategy implementation

![Knowledge management strategy implemented](image)

- **Rewarding employees for sharing knowledge**
  In the discussion regarding tacit knowledge sharing Droege and Hoobler (2003) suggested that a reward system may be used to motivate employees to engage in knowledge sharing. From the empirical study an overwhelming seventy nine percent of the respondents indicated that their balance score card system does not reward them for sharing their knowledge (Figure 3.18). On the positive side thirteen percent of the industry is indicating that they are measured accordingly in order to be rewarded for transferring their knowledge.

Figure 3.18: Performance management of knowledge transfer

![Performance management includes transferring of knowledge](image)

- 4. The performance management system includes a part where I am measured in terms of the time and effort spent to transfer my knowledge to my peers.
• **Use of mentorship programs**
As discussed in section 2.4.3, companies committed to transferring tacit knowledge often set up formal mentoring programs and make passing of knowledge to young employees an explicit part of the job descriptions of skilled senior staff (Davenport & Prusak, 2000:95). Figure 3.19 reveals some interesting information. Forty five percent of the respondents indicated that a mentorship programme is implemented, but only twenty four percent is of the opinion that it is working. An alarming twenty six percent do not have a mentorship programme.

![Figure 3.19: Implementation of mentorship programme](image)

As Davenport and Prusak states mentorship programs is about passing on knowledge from skilled senior staff to young employees. Thirty nine percent of the respondents feel that their organisation does not have enough mentors to transfer the knowledge to younger employees (Figure 3.20).
Figure 3.20: Enough mentors and coaches to transfer knowledge

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- **Succession planning and job rotation**

Under the discussion regarding structure that follows strategy, an organisation must ensure that there is an interaction between senders of tacit knowledge and the receivers of it. According to Davenport and Prusak (2000:101), knowledge transfer involves two actions namely transmission and absorption. In order to ensure that this transmission occurs succession planning and job rotation are required to start the process.

According to Figure 3.21 fifty percent of the respondents indicated that succession planning forms part of the knowledge management process. The calculated margin of error of this question is sixteen percent. This again indicates that a larger samples size can reduce the error. In order to achieve a ten percent margin of error, ninety questionnaires should have been returned compared to the actual of thirty eight.

As with the mentorship programme twenty six percent of the respondents indicated that no succession planning is practiced within their organisation.
In terms of job rotation a strong sixty three percent of the respondents indicated that job rotation is not practiced within their organisation (Figure 3.22). This is alarming high and one possible reason for this is the good correlation that exists between job rotations and having enough resources.

As can be seen from Figure 3.23 also sixty three percent of the respondents indicated that their organisation does not have enough resources to transfer knowledge to succession planning candidates. This could possibly be the case why job rotation is not practiced that commonly.
Social network system in order the share knowledge

One of Droege and Hoobler (2003) proposed strategies for tacit knowledge diffusion was a strategy that encourages individuals and departments to work together to share information and resources on how they complete tasks. For this to be implemented a social network system must be in place. According to Figure 3.24 a majority of forty seven percent indicated that no social network system is in place. This again is alarming and is an indication the departments are working in silo's not learning from each other.

The above is also supported by the data obtained on knowledge transfer during social events in section 3.4.2, where sixty nine percent
indicated that they will rather transfer their knowledge in a formal setting than in a social manner.

- **What to do during an employees notice period?**

  No information was found from literature regarding tacit knowledge management transfer during an employees notice period. The author however felt that this aspect of tacit knowledge management must also be researched. Three aspects was identified that need to be researched. The first aspect that was researched investigated if an organisation requires from the employee to codify his tacit knowledge and key learning’s before leaving the company. A convincing ninety two percent indicated that this was not expected from them (Figure 3.25).

  ![Figure 3.25: Codifying of tacit knowledge part of condition of employment](image)

  The second aspect looked at the shadowing of employees during their notice period. It is often said that only when an employee has submitted his or her resignation, management start to release how much an employee is worth to the company. From the analysis of Figure 3.26 it can be concluded that most of the Pyrometallurgical organisations do not have a formal system in place in order to shadow an employee during his notice period. This will further be discussed in section 3.4.4 when the open ended questions will be discussed.
The third and last aspect that was researched was if organisation contract previous employees as consultant to tap into their tacit knowledge. From Figure 3.27 it was found that forty seven percent of the respondents stated that their organisation sometimes contract in a previous employee and twenty one percent said that they do it frequently. Thus in total sixty eight percent of the organisations do from time to time contract in previous employees.

- **Dedicated knowledge management department and capturing of knowledge**

  From the literature study Gorelick, Milton and April (2004:208) states that dedicated resources should be committed to knowledge
management projects. In order to evaluate what is being practiced in the Pyrometallurgical industry a simple question was asked to determine if they have a department dedicated to knowledge management. From Figure 3.28 it can be seen that although sixty six percent indicated that they have no such department, nineteen percent indicated that they do. This is encouraging and shows that in some organisations knowledge management is taken seriously.

Figure 3.28: Dedicated knowledge management department

Under the discussion of the knowledge management framework in section 2.3.2, Uit Beijerse (2000:168) lists nine streams of knowledge management. The nine streams of knowledge starts with identifying what knowledge is necessary and then what is already available. This results in a knowledge gap that needs to be closed by developing new knowledge or acquiring knowledge if it cannot be developed. Once the gap is closed the knowledge is locked within the organisation and needs to be shared and utilised in the business. The empirical research focused on three on the nine streams namely the identification if critical knowledge, locking the knowledge within the organisation and thirdly utilizing the knowledge to the benefit of the organisation. From Figure 3.29 it can be seen that fifty five percent of the respondents stated that their department had identified the knowledge that is critical.
Although fifty five percent indicated that they have identified the critical knowledge needed, only eighteen percent of them are capturing the knowledge that resides in the minds of their employees (Figure 3.30). This in conjunction with the fifty three percent of respondents that indicated that captured knowledge is not exploited (Figure 3.31) is quite alarming.
Based on the information on identification, capturing and the utilisation of knowledge it can be concluded that most of the Pyrometallurgical organisations still need to address these issues.

- **Utilising technology to capture tacit knowledge**

  According to Davenport and Prusak (2000: 95) another use of technology to transfer tacit knowledge is where organisations record the stories and experiences of senior practitioners on video before they leave the company. From Figure 3.32 it can be seen that the above proposed practice is only used by sixteen percent of the organisations.
Tacit knowledge that has been codified into explicit knowledge must be managed via a document management system in order to ensure that new employees can benefit from the captured tacit knowledge. In Figure 3.33 forty five percent of the respondents indicated that the document management system does assist them in the transfer of knowledge.

**Figure 3.33: Success of document management system**

Information results from placing data within some context and can be viewed as processed data (Freeze and Kulkarni, 2007:104). It is thus important for this information to be easily available. From Figure 3.34, fifty eight percent of the respondents indicated that their organisation information management system is allowing easy access to the information required in decision making.
Although little media is used to transfer tacit knowledge, it can be concluded that the document management systems and information management system performs fairly well in order to assist with tacit knowledge transfer.

- **Structured tacit knowledge transfer**
  From the literature study it was found that tacit knowledge can be transferred intentionally or unintentionally. Formal forums like conferences and benchmarking are seen as intentional tacit knowledge transfer. Figures 3.35 and 3.36 follows the same correlation and is an indication that intentional knowledge transfer does not occur that frequent. Of concern is that twenty six percent of the organisations never conduct a formal technical knowledge exchange forum.

**Figure 3.35: Formal knowledge exchange forums**

1. Formal structured technical knowledge exchange forums are being used in order to foster knowledge transfer.
The preceding analysis of the different initiatives in order the transfer tacit knowledge yielded a number of valuable conclusions. Quite a number of results compared with that found in literature. This conclusions and comparisons will be further discussed in Chapter 4. The final part of the empirical research will focus on the results of two open ended questions posed to the respondents.

3.4.4 Discussion on open ended questions

Two open ended questions were posed to the respondents. The first question was aimed at determining what an organisation can do to capture an employee's tacit knowledge in the event when the employee resigns. The second open ended questions focused on the initiatives that need to be in place in order to embed tacit knowledge in the organisation.

3.4.4.1 Open ended question number one

Different opinions and suggestions came from the respondents and can be summarised in mainly three categories.

- **Too late to transfer tacit knowledge during notice period**
  Twenty three percent of the respondents were of the opinion that it is to late to transfer an employee's tacit knowledge during his
notice period. Tacit knowledge transfer requires a considerable length of time to transfer. A more pro-active approach was suggested, whereby continuous transferring of tacit knowledge is done by means of knowledge exchange forums and personal contact during normal day to day activities. Succession planning is also a key enabler to ensure tacit knowledge transfer to the employee earmarked to relieve in his or her colleague place. Rotation of employees on a three yearly interval will then also assist in tacit knowledge transfer. The respondents did however suggest that in the event that an employee resigns, a person must be allocated to him in order to transfer the last bit of tacit knowledge that was not captured.

• Let the employee finish the project and write up what he or she knows

The next school of thought consisted of eighteen percent of the respondents. They suggested that more focus must be given on documenting what the resigning employee knows. This can be done by reviewing what that person knows that needs to be captured. The employee must then be removed from his normal duties and he or she must then need to document all key learning's of the process and organisation. All reports on projects must be either completed or updated. The employee must draw up a list of uncompleted work as well as future work that is crucial for organisational success. Another important aspect is that of understanding what knowledge is captured in that person’s files and electronic data folders on his personal computer. The resigning employee must index all files and documents in order to add context for the next employee. Finally one on one session must be conducted with this employee in order to capture that last bit of insight that the organisation requires.
• Shadowing of the employee
The majority of employees (fifty eight percent) suggested that the resigning employee should be shadowed by another person for the remaining notice period. An interview must be conducted as soon as possible between the resigning employee, successor and immediate manager. During this interview key area's of knowledge transfer needs to be identified and transferred. This can also be done through letting the successor shadow the resigning employee for two weeks. After the two weeks the roles will change over and the successor will then be shadowed by the resigning employee. Relationship building is still critical and the contact details of the resigning employee need to be kept to date in order to facilitate future knowledge transfer. In the event that no successor is available a care taker should take the responsibility to acquire as much knowledge as possible.

3.4.4.2 Open ended question number two

The second open ended question focused on the systems that need to be in place to ensure that tacit knowledge is embedded within an organisation. It is the opinion of the author that the respondents really gave good suggestions to the question posed. A brief summary of the different initiatives required to embed tacit knowledge will be given in the following section.

• Succession planning is the key
First of all an organisation must practice succession planning. This requires that employees must be well matched in order to ensure that trust is the basis of their knowledge transfer. Another requirement is that organisations must have enough resources to facilitate succession planning. A lean organisational structure can save cost on the short run but on the long run the organisation will pay for the knowledge lost as a result of it. A “train up to be promoted” concept must be practiced. This
implies that the experienced coach can only be promoted once he or she has trained up a successor that can do his or her work just as good or even better.

- **Mentorship and coaching program**
  A formal mentorship program must be in place in order to transfer the knowledge and experience for the older generation in the organisation to the younger generation. Meetings must be scheduled on a monthly basis. An incentive system must also be in place in order to reward the mentor for going that extra mile to transfer his or her knowledge to the younger engineers. Informal coaching between engineers with more seniority to junior engineers must also be rewarded.

- **Capturing of knowledge in documents**
  Focus must be placed on ensuring that reports are in the first place written after completing a project of study. The content of the report must focus on the lessons learned. Problems that were experienced during the project and the solutions towards it must be well documented. Report writing should also form part of the key performance indicators to ensure that knowledge is documented.

  Once the report is written it must be stored on a document management system that will ensure that the next person will be able to find information with ease. Key word searches based on plant specific location can assist in future searches. A culture of using old reports must be created. All new engineers must first read through all previous reports during their training phase.

  Another important aspect of reports is that the key learning's must be incorporated in the training material of the process. This will require that a central person is responsible to administrate all
the documents and reports. At the end all Pyrometallurgical processes must strive to have an overarching "manual" that contains all previous learning's and experiences on how things are done.

- **Forums to assist knowledge transfer**
  Most of the respondents indicated that formal forums must be held on at least a quarterly basis. During such forums the technical aspects of the work being done will be discussed through presentations on completed and current projects. An industry specialist can also present to the young engineers during such a forum. It is also important not to only involve the engineers but also to involve the foreman's operating the process. The link between theory and practice can thus be closed by facilitating an open discussion. A culture of talking about technical aspects will also be nurtured in such a forum.

- **Training facilitator and material**
  Most organisations have outsourced their training. This however is not good for knowledge transfer, because that training facilitator does not have the first hand knowledge and experience of the process. It is thus important to hand pick your training facilitators in order to ensure that the right knowledge is transferred within the right context. Usually a well experience foreman or engineer is used in such a role. The use of training aids such as DVD recordings and computer based training can also assist in transferring the knowledge from previous experienced employees that left the organisation.

- **"Management by walk about"**
  Another important aspect of tacit knowledge transfer is that of interaction by the concept of "Management of walk about". There has to be regular and genuine interaction by management
and engineers on the shop floor. This in turn leads to dissemination of information (both ways, up and down), through team building and mutual respect. Far too many young professionals are only too happy to hide behind computers and become “Microsoft metallurgists or engineers” and effectively shy away from the personal contact or interface where the job really takes place.

- **Benchmarking and networking**

Benchmarking with other Pyrometallurgical operations can foster tacit knowledge transfer between different departments and organisations. During such benchmarking events knowledge is interchanged between two parties on how things are being done. The newly acquired knowledge from benchmarking activities should also be well documented for future reference. Another spin off from benchmarking is that of building up a network of professionals around the globe. This network list needs to be kept up to date and regular contact must be established to nurture the channel of knowledge exchange.

- **Look after your engineer!**

A lot of times engineers are caught up in fire fighting activities on a daily basis. This requires time and no time is spend on creating of new knowledge and understanding the under relying issues of the process. More time must be made available for engineers to capture and transfer their knowledge.

In any organisation one finds the “high-flyer” engineers and the “pillar” engineers. The organisation needs to balance the mobility of “high-fliers” with the continuity of “pillars” that often form the base of tacit knowledge in that department. Retention agreements must be drawn up in order to assist in retaining the tacit knowledge of such engineers within the organisation.
From both the open ended question valuable suggestions were made by the respondents. These suggestions will be further discussed and used in Chapter 4 where the results of the empirical research are summarised.

3.5 Conclusion

From the discussion on the demographic questions posed to the respondents it can be concluded that the respondents represented most of the South African Pyrometallurgical operations with the exception of the Aluminium industry. The respondents were also quite a matured group and make the validity of the results more trustworthy. Regarding the opinion based questions posed it can be concluded that the majority of the respondents link organisational success to the success of knowledge management. High employee turnover is detrimental to organisational success and strengthens the case for the importance of tacit knowledge management.

It can also be concluded that a good fit between the literature study results and that of the empirical results exists. Two aspects did not correspond to the literature study results. Trust and cultural backgrounds does not seem to be a stumbling block in order for knowledge transfer to take place as indicated by literature. The discussion on the different initiatives that must be in place to embed tacit knowledge within the organisation yielded fruitful results. It can be concluded that succession planning, mentorship programs and rewarding employees for sharing their knowledge forms the basis of tacit knowledge management. Thereafter the documentation and systems to support the storage and retrieval of this documentation is an important aspect to embed a person's tacit knowledge within the organisation. In the following chapter these conclusions will be discussed and recommendations will be made relating to tacit knowledge management within the Pyrometallurgical industry.
3.6 Chapter summary

In Chapter 3 the empirical research methodology used was discussed. An overview of the South African Pyrometallurgical industry was given, highlighting the different fields within the industry. A quantitative research approach was chosen by the author in order to be able to provide an objective base in order to meet the research objectives. The sampling frame consisted of engineers and managers servicing the production leg within the Pyrometallurgical industry. A total of hundred and five questionnaires were sent out to the various fields within the industry. Thirty eight questionnaires were returned and analysed. The internal consistency of the questionnaire was tested and it was found that a moderate to high level of consistency exists.

Analysis of the research results has yielded quite a number of important insights. Insights regarding the demographic profile of the industry indicated that a well matured group of respondents participated in the research. The opinion on the importance of knowledge management indicated that the respondents are viewing knowledge management as an important aspect of the organisation. Of concern was the low level of implementation of knowledge management principles within the industry. Ways to embed tacit knowledge within an organisation was discussed in detail by analysing the responses found from two open ended questions. A number of valid and practical suggestions were made by the respondents and have been used in developing the tacit knowledge management framework. Overall the linkage between the literature study and the empirical research was also drawn on a number of aspects.
Chapter 4: Conclusions and Recommendations

4.1 Introduction

As indicated in section 1.6, Chapter 4 will focus on drawing conclusions and comparisons from both the literature study as well as the empirical study. The state of knowledge management within the Pyrometallurgical industry will be discussed. From the findings discussed in Chapter 2 and Chapter 3 a framework will be proposed that can serve as a practical guideline on how tacit knowledge can be embedded within an organisation. A few recommendations will also be made to assist the Pyrometallurgical industry to improve on their level of knowledge management. This chapter and dissertation will then be concluded with the identification of additional research opportunities within this field of study.

4.2 Opinions corresponding with literature results

From the literature study the author has selected a number of knowledge management principles and aspects and incorporated these principles during the design of the survey questionnaire. The linkage between the knowledge management principles found in literature with that found from analysing the results of the survey questionnaire has been discussed in detail in sections 3.4.1 to 3.4.3. The following two categories serves as a short summary regarding some opinions related to the principles of knowledge management that do and do not correspond with that found in literature.

- **Survey results corresponding with that of literature**
  - High employee turnover does affect an organisation's performance negatively
  - For knowledge transfer to be effective the opinion about the person receiving the knowledge plays a role in determining if the sender will transfer their knowledge
• Survey results not corresponding with literature

According to the respondents an employee's cultural background is not a determining factor on whether they will share their knowledge or not.

Trust between employees does not seem to be a determining factor for ensuring tacit knowledge transfer between two employees. Employees would rather share their tacit knowledge in structured forums than at a social event.

The reasons for the differences in opinion are not clear. One possible explanation is that the respondents are not that familiar with the principles of knowledge management. Therefore some of the "soft" principles that are required for tacit knowledge transfer are currently not seen as important enablers. Further research regarding these aspects is required to better understand the differences in opinion. In the next section the state of knowledge management within the Pyrometallurgical industry will be summarised.

4.3 State of knowledge management in Pyrometallurgical industry

From the literature study various aspects and initiatives has been identified that an organisation could have in place in order to ensure the effective management of organisational knowledge. From the analysis of the results of the survey questionnaire discussed in sections 3.4.1 to 3.4.4 the following conclusions can be drawn on the state of knowledge management within the Pyrometallurgical industry.

• A knowledge management strategy that is interlinked with the business strategy is not commonly practiced and implemented.
• Only nineteen percent of the industry has a dedicated knowledge management department.
• The industry is not rewarding its employees for sharing their knowledge.
• A quarter of the industry has not implemented a mentorship program.
• There is not enough experienced mentors to transfer their knowledge to younger engineers.
• Half of the industry is practicing succession planning, but only a third is practicing job rotation.
• The industry has experienced a twenty-eight percent turnover rate in engineers over the last two years.
• Two thirds of the industry is of the opinion that they do not have enough resources for effective knowledge transfer.
• No formal system is in place that allows for the shadowing of a resigning employee during their notice period.
• Two thirds of the industry is utilising previous employees as consultants on an ad hoc basis.
• More than half of the industry has identified the critical knowledge required for organisational success, but only a fifth is capturing the knowledge.
• The use of media such as DVD recordings is not a common practice.
• The information management systems are not assisting enough to support knowledge transfer, but information is easy to be found.
• Three quarters of the industry is making use of formal knowledge exchange forums but not on a frequent basis.
• Benchmarking is being practiced but also not on a frequent basis.

From the above statements it is clear that the Pyrometallurgical industry has still got a long way to go in order to ensure that the tacit knowledge is embedded within their organisations. Key areas of concerns are the lack of experienced mentors as well as enough resources in order to foster tacit knowledge transfer. Another concern is the lack of a knowledge management strategy that is focused on rewarding employees for sharing their knowledge. This is but only a few of the issues that the Pyrometallurgical industry is facing relating to knowledge transfer. Recommendations in order to improve some of these aspects will be made in section 4.5. In the next section a framework is being proposed that can assist in the practical aspects of embedding tacit knowledge within an organisation.
4.4 Practical framework to embed tacit knowledge

The analysis from the two open ended questions discussed in section 3.4.4 yielded fruitful suggestions regarding practical aspects that can assist in embedding tacit knowledge within an organisation. These aspects combined with the learning's from the literature study formed the base from which a practical framework was developed in order to embed tacit knowledge within an organisation. The framework has not been tested to verify its validity and will thus only serve as a guideline to assist managers in managing this difficult but important aspect of business.

In the literature study, "The European Framework of Knowledge Management" and "The Integral knowledge management model" from Uit Beijerse (2006) has been discussed. One common theme from both is that at one point or another, the knowledge that has been identified must be shared to the right persons at the right time. The proposed framework aim is to assist management in mastering the sharing of tacit knowledge within the organisation.

Figure 4.1 represents the proposed framework namely, "The Practical Tacit Knowledge Management Framework". The framework consists of seven phases that are critical to ensure that tacit knowledge is embedded within the organisation. These phases follow typical process flow patterns starting at phase one through to phase seven. The linkage between phase seven and phase one serves to indicate that the tacit knowledge management framework is a continuous process. Each of these phases will be discussed in more detail in the following sections.
Phase 1 – Set or Evaluate a Tacit Knowledge Management strategy
During the first phase of the framework the senior management within the organisation must embark on a strategic planning exercise. During this exercise tacit knowledge management strategy must be drawn up that is aligned with the business strategy. It is recommended that a SWOT analysis is done on the level of tacit knowledge within the organisation. From the SWOT analysis key strategic areas within the organisation need to be identified that will require the active management of tacit knowledge. During this exercise the senior management must also decide on whether they want to build the tacit knowledge base within the organisation or whether they are willing to bring in outside consultants to fill the tacit knowledge gap.
• **Phase 2 – Establish a clear sense of purpose towards tacit knowledge management**

In order to get the buy in from middle management to action the tacit knowledge management strategy a strong sense of purpose is required. Middle management need to be aligned and committed to the process. This can be achieved by setting a clear end vision and sketching the burning platform on why the tacit knowledge management strategy is important for the organisational success. Aspects like organisational core competencies that create a competitive advantage and the creation of a learning organisation can be used to establish the sense of purpose. Management must not see this as just another fad, but must be able see the potential and power that lies within the sharing of tacit knowledge.

• **Phase 3 – Establish the building blocks required for tacit knowledge transfer**

Within an organisation a number of initiatives can be implemented in order to serve as a base in facilitating tacit knowledge transfer. The implementation of these initiatives does not guarantee the successful embedding of tacit knowledge but is certainly a requirement. The following building blocks are proposed.

- Embark on regular benchmark activities and establish knowledge networks.
- Conduct regular knowledge exchange forums for example on a quarterly basis. Ensure that engineers present their current projects and key learning's. Also ensure that projects across departments are presented to tap into possible synergies.
- Implement standard report writing procedures in order to ensure that all key learning's from projects are well documented. Also ensure that all these reports are stored in such a way that future electronic searches can be done according to plant specific areas or aspects.
The well known saying that structure follows strategy also applies when managing tacit knowledge. Ensure that enough resources are available within the organisation to establish a pool of engineers ranging from experienced to engineers in training. This will set the base for fostering tacit knowledge transfer.

Establish a habit of "Management by walkabout". Engineers and managers must limit their time in meetings and must not shy away behind their computers. There is nothing like actual interaction with the employees and the process. Without this interaction your tacit knowledge base will not increase. A good rule of thumb is to spend at least thirty percent of your time on the plant.

Implement succession planning as a tool to manage tacit knowledge. This allows for key persons to be identified that needs to be trained up to replace other individuals when they are promoted or are leaving the organisation. Another rule of thumb is that the person training another person can only be promoted once the trainee can do the trainers work on the same or even a higher level.

Implement a mentorship program. Identify mentors and establish relationships with the juniors. This relationship must not be for longer than two years, but monthly interaction is required.

These building blocks will take time and effort to implement. Managers must not lose sight of these aspects and review their effectiveness and functioning on a regular basis.

Phase 4 – Identify the key individuals that hold the Tacit Knowledge required for organisational success

After ensuring that the building blocks mentioned in phase 3 are established the process of actively managing tacit knowledge can be started. During this phase managers of each functional area must
embark on an exercise to identify those individuals who holds a considerable amount of tacit knowledge of the process and the running of the day to day activities. The following questions can assist with the identification of such individuals.

- Which engineers can we not afford to lose today?
- What knowledge is giving us the competitive advantage over our competitors? Who in our department holds this knowledge?
- Who is the person that one can always go to when you require a quick and reliable answer about the process?

It is proposed that a detailed list of the identified individuals should be drawn up indicating the niche in tacit knowledge that this individual brings to the organisation.

• **Phase 5 - Establish key relationships and outcomes between identified individuals and receivers**

  Once the key individuals have been identified, management must analyse the rest of the pool of engineers within their departments. Receivers must be identified that can be connected to one of the key individuals. The following two questions can assist management in identifying the receivers.

  - Which engineers have got great potential, but are still lacking experience and coaching?
  - Which engineers are perceived to be “high flyers” and which engineers are the “pillars” in our department?

  Once the receivers have been identified a relationship must be established between the key individual holding the tacit knowledge and the identified receiver. This can be done by creating a strong sense of purpose that is driven by the vision for tacit knowledge management. Both parties must understand that this relationship is established to build on the tacit knowledge base of the organisation. Specific outcomes must also be drawn up on the identified areas where management feels that tacit knowledge transfer is required.
Phase 6 - Establish a measurement and reward system to foster Tacit Knowledge transfer

Tacit knowledge resides in the minds of employees. This makes it very difficult to measure. One can however set up some measurement system to determine if tacit knowledge transfer occurred. It is proposed that the amount of hours of interaction between the sender and receiver are tracked and measured. For a starting point two hours per week of interaction is required. Another proposed measurement is to conduct an interview between the sender, receiver and manager. During such an interview plant specific questions will be asked about the process. The receiver must then proof that he or she understands the underlying principles.

The saying that knowledge is power can be a stumbling block to ensure that the sender will share his or her knowledge with another person. For this reason a proper reward system must be in place to reward your key individuals for sharing their knowledge. The measurement system can be linked to the reward system. An increase in interaction time between the sender and the receiver will lead to a larger reward. Another incentive can be to issue a retention agreement with the key individuals with the understanding that one of the outcomes at the end of the period must be that proof on tacit knowledge transfer must be shown.

Phase 7 - Establish regular reviews and relationship building interventions

A relationship is just as good as the amount of dedication that the two parties give to maintain the relationship. Therefore it is of utmost importance to conduct regular reviews on the established relationships. As indicated in the literature study, trust is one of the key enablers for tacit knowledge transfer. Relationship building interventions must be held to ensure that the identified individuals overcome any obstacles that can stand in their way to share their knowledge. The outcome of
such interventions must be stronger relationships and a better understanding of each others mind sets. This will also strengthen teamwork at the work place.

As can be seen from Figure 4.1 the proposed framework is a continuous process. The entire process must be reviewed on an annual basis to identify any opportunities or threats that can influence tacit knowledge transfer. It is the opinion of the author that the active management of all seven phases will ensure that tacit knowledge is embedded within the organisation. In the next section some recommendations are made to improve the level of knowledge management within the Pyrometallurgical industry.

4.5 Recommendations

In section 4.3 a number of statements were made regarding the state of knowledge management within the Pyrometallurgical industry. A number of positive aspects have been identified such as the use of formal structured knowledge exchange forums. However there is still a number of things the Pyrometallurgical industry can do to ensure that they retain the tacit knowledge that resides in the minds of their engineers and managers. The following recommendations are made to assist management in their task to embed tacit knowledge within their organisations.

- Value your employees especially your engineers. Let them feel that they are the most valuable asset that the organisation has.
- Ensure that the building blocks mentioned in Phase 3 of the "Practical Tacit Knowledge Management Framework" are entrenched in your organisation.
- The high employee turnover rate is affecting the entire Pyrometallurgical industry. An environment in which your key employees can be creative and feel valued and wanted will assist in retaining them within the organisation.
- Keep the conversation of knowledge transfer alive in all aspects of the business. Continuously search for opportunities where person A can learn from person B.
Finally, keep on focusing on building relationships in order to foster tacit knowledge transfer. In the end, business is all about people and people are all about relationships.

4.6 Conclusion

The aim of this dissertation was to evaluate the state of knowledge management within the Pyrometallurgical industry. Special focus was placed on embedding tacit knowledge within an organisation. The definitions of knowledge, knowledge management as well as tacit knowledge management have been discussed in detail. An extensive survey has also been conducted to determine the opinions about knowledge management principles and the current state of tacit knowledge management within the Pyrometallurgical industry. Practical ways through which tacit knowledge can be embedded has been identified and a framework was proposed to assist managers with this important management aspect. It can thus be concluded that the research outcomes set out for this dissertation has been met. There is however opportunities for further research within this field of study. Such opportunities include aspects like the influence of cultural backgrounds on the sharing of tacit knowledge. Another research opportunity is to determine the effect that trust has on sharing your knowledge to someone else.

Finally this dissertation is concluded by the applicable words found in Proverbs 24:3-6 “By wisdom a house is built, and through understanding it is established; through knowledge its rooms are filled with rare and beautiful treasures. A wise man has great power, and a man of knowledge increases strength; for waging war you need guidance, and for victory many advisers” (Bible, 2001).

4.7 Chapter summary

In Chapter 4 a number of conclusions and recommendations have been made. The chapter started off by correlating opinions that correspond to that
found in literature. The contradiction on the effect that culture and trust has on knowledge sharing has been highlighted. Aspects like the effect of high employee turnover on organisational success do however correspond to that found in literature. The next section of the chapter focused on discussing the state of knowledge management within the Pyrometallurgical industry. It was found that the industry does practice most of the key knowledge management principles. Of concern is the extent to which these principles are practiced. The lack of experienced mentors and resources to foster knowledge transfer is one of the key concerns. In the following section of the chapter a practical framework was proposed in order to assist managers to embed tacit knowledge within their organisations. The framework consists of seven phases. The focus of phase one and two is to ensure that a tacit knowledge management strategy is formulated and communicated to the organisation. Phase three focuses on ensuring that the building blocks required for tacit knowledge management are established. These building blocks include aspects like benchmarking, formal knowledge exchange forums and mentorship programs. Phase four to seven focuses on identifying and connecting the right persons in order to ensure knowledge transfer. Specific outcomes and rewards needs to be in place. The last section of this chapter focused on making recommendation in order to improve the state of knowledge management within the Pyrometallurgical industry. Valuing of your employees, creating an environment of trust and creativity and focusing on maintaining healthy relationships are some aspects that the industry can consider to improve. A final remark is to focus in building relationships in order to foster tacit knowledge transfer. In the end, business is all about people and people are all about relationships.
BIBLIOGRAPHY


**APPENDIX 1 – QUESTIONNAIRE DESIGN**

**Survey Questionnaire on:**

**Tacit Knowledge Management within the Pyrometallurgical Industry**

**Introduction:**

Here you experience losing one of your key employees or colleagues to another company? If the answer is yes and you have some thoughts on how to retain their tacit knowledge within the organisation please feel free to share them. Your information will be used for a mini dissertation focusing on how tacit knowledge is embedded and transferred with an organisation. Thank you for taking the time to complete this questionnaire. All information will be kept confidential.

**Part 1 - Some demographic**

<table>
<thead>
<tr>
<th>Question</th>
<th>Drop down list</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Years of working experience?</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>2. Gender?</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>3. Level within organisation?</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>4. Number of persons reporting directly to you?</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>5. Number of engineers, technicians and managers within your Pyrometallurgical department?</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>6. Number of engineers, technicians and managers within your Pyrometallurgical department that have resigned in the last two years?</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>7. Number of work colleagues that have emigrated in the last two years?</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>8. Field of study?</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>9. Field within the Pyrometallurgical industry?</td>
<td>Select from drop down list</td>
</tr>
</tbody>
</table>

**Part 2 - Opinion on importance of knowledge transfer**

<table>
<thead>
<tr>
<th>Question</th>
<th>Drop down list</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pyrometallurgical engineers does not require specific knowledge and experience in order to manage the process effectively.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>2. High employee turnover does effect our plants production performance.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>3. Technology can replace the knowledge and skills of an experienced employee.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>4. I will share my knowledge with another colleague only once I have built a trust relationship with him or her.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>5. The best way to transfer my knowledge is by coaching and sharing training manuals.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>6. Engineers graduated from our South African Technol's find it easy to link theory with practical.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>7. The different cultural backgrounds is a stumbling block for person A to share his knowledge and experience with person B.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>8. I have learned from interacting with my work colleagues than from theory on how to operate our process effectively.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>9. Our organisation core competency resides within the minds of a few key persons.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>10. Old information that was captured in the files of your predecessor are gathering dust and are eventually thrown away.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>11. I am more likely to share my knowledge and experience during a social event or one on one than in a formal knowledge event.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>12. The knowledge and recommendations from overseas benchmarking visits are always shared and implemented in our department.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>13. During restructuring emphasis is placed first on the transferring of knowledge before a person leaves the department.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>14. I will be reluctant to share my knowledge with a new person joining the organisation for anything less than the time and effort spent to transfer my knowledge and key learning's before leaving the organisation.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>15. Our organisation is spending a lot of time on getting systems in place, requesting to direct all amount of time to learn from each new employee.</td>
<td>Select from drop down list</td>
</tr>
</tbody>
</table>

**Part 3 - Techniques used to embed tacit knowledge**

<table>
<thead>
<tr>
<th>Question</th>
<th>Drop down list</th>
</tr>
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<tbody>
<tr>
<td>1. Formal structured technical knowledge exchange forums are being used in order to facilitate knowledge transfer.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>2. We have implemented a knowledge management strategy within our organisation.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>3. Our knowledge management strategy is integrated with our corporate strategy.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>4. The performance management system includes a part where I am measured in terms of the time and effort spent to transfer my knowledge.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>5. Benchmarking activities are being conducted in order to gain and share knowledge.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>6. A formal system is in place in order for me to leave my knowledge with another person during my last month notice period.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>7. Our organisation will retain the knowledge of an experienced worker by contracting him in a consulting role after leaving the company.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>8. A social network system is in place in order for us to share information or solve each others problems across departments.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>9. The condition of employment forces me to codify my tacit knowledge and key learning's before leaving the organisation or move to another organisation.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>10. Succession planning forms part of our knowledge management process.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>11. We know where to share our intellectual information in order for colleagues to gain access to it in order to make business decisions.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>12. We have implemented a mentoring programme in order to facilitate mental knowledge exchange.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>13. Job rotation is practiced in order to transfer knowledge between departments.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>14. Our organisation's document management system is assisting in the transfer of knowledge.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>15. Our department has identified the knowledge that is critical for our organisation success.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>16. Our organisational structure allows for enough resources in order to transfer knowledge to succession planning candidates.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>17. Our organisation has captured the tacit knowledge that resides in the minds of our employees.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>18. Our organisation has a system that captures and builds on insights that are acquirable by professionals.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>19. Our organisation has developed a system that is able to access and share information that is used in decision making.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>20. Our organisation has enough coaches and mentors to train up young engineers in order to transfer knowledge transfer.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>21. We are using links in videos or DVDs in order to capture training lectures presented by key employees.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>22. We have a department that is dedicated to manage the knowledge within the organisation.</td>
<td>Select from drop down list</td>
</tr>
<tr>
<td>23. The knowledge gained during the commissioning of a new piece of equipment are successfully transferred to the rest of the team.</td>
<td>Select from drop down list</td>
</tr>
</tbody>
</table>

**Part 4 - Open ended questions**

<table>
<thead>
<tr>
<th>Question</th>
<th>Type answer please</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In the event that one or your key employees gives notice and you cannot convince him or her to stay what will you do to tap into his tacit knowledge before he or she leaves the organisation?</td>
<td>Please type your answer in this space.</td>
</tr>
<tr>
<td>2. In your view what systems should be in place to ensure that the tacit knowledge of key individuals are embedded within the department?</td>
<td>Please type your answer in this space.</td>
</tr>
</tbody>
</table>