

by J.C. Coetzee*, W.S.B. van Beek**, and A. Buys*

Synopsis

In this article, a case is made for the importance of the transfer and management of tacit knowledge to ensure continued sustainable competitive advantage within the pyrometallurgical industry in South Africa. The state of knowledge management (KM) is assessed through a theoretical and empirical study. The empirical part of the study was conducted by means of a survey questionnaire. An important prerequisite within the research entailed determining the current state of KM within the pyrometallurgical industry, and the findings are presented throughout this article. The research argues for initiatives to address the high turnover of pyrometallurgical knowledge workers. This industry needs to entrench tacit knowledge and therefore address the problems associated with the continuous loss of inherent specialized knowledge. Appropriately, emphasis is placed on identifying initiatives required to embed and retain not only human capital lost through mobility, but rather retaining tacit knowledge through a practical KM framework.

Keywords

tacit knowledge, explicit knowledge, knowledge sharing, knowledge management strategies.

Introduction

Drucker (1989, 2001, 2003) states' (t)here exists a transition from the blue-collar worker, which characterized the 1900s, to the technologist, someone who works both with his/her hands and his/her theoretical knowledge, as a transition towards knowledge workers. These knowledge workers have freedom to move to other companies because knowledge has multiple applications in the information age. A knowledge worker is an organizational employee who, whenever he or she performs knowledge work, adds intellectual value to the organization's memory. A knowledge worker is an empowered person who both knows (has access to) and affects (measurably changes) the organization's memory in a profitable sense. Profitable sense assumes the business process being aligned to organizational strategy and the value (outcome) of the individual's work effort being measurable (Misch and Tobin, 2006).

The research draws attention to the fact that employees acquire knowledge based on individual capabilities. Consequently, this knowledge should be shared within an organization before the knowledge worker leaves, which is a fashionable trend in South Africa.

Knowledge workers contain knowledge within their minds that is an integral part of the human complexity. Traditionally, one thinks of assets as definable and concrete, but the knowledge assets of workers are much harder to quantify. The skills and competencies of knowledge workers are important aspects of sustainable competitive advantage within companies, specifically within the changed global economy. Knowledge offers speed and it allows its possessors to deal with situations quickly, including complex situations (Davenport and Prusak, 2000). Within the context of sustainable competitive advantage for a company, the preservation of such knowledge becomes imperative.

One of the great assets of South Africa is the minerals deposits that serve as one of the primary drivers for the South African economy. These minerals are mined and processed through various fields, of which one is the pyrometallurgical industry, where minerals are processed by means of high-temperature methods. The pyrometallurgical industry is known for its high dependency on experienced and skilled employees. Unfortunately, the pyrometallurgical industry is also known for the high turnover of knowledge workers. Coetzee *et al.* (2011) explained that a high turnover rate exists

- Potchefstroom Business School, North-West University, Potchefstroom Campus, Potchesftroom, South Africa.
- † Lonmin Smelting Operations, North West Province, South Africa.
- † Potchefstroom Business School and Director, Pondera Innovation Cc., Sasolburg, South Africa.
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within the pyrometallurgical industry and the management and retention of knowledge therefore become even more critical. In addition, with the noticeable outflow of skilled and experienced metallurgical engineers leaving South Africa, recruiting becomes difficult. Therefore, before these knowledge workers leave the organization, the knowledge inherent in their work experiences and skills needs to be actively maintained through management interventions.

This view is arguably in line with the research on KM by Nonaka (1994, 1998), Davenport and Prusak (2000), Steyn (2003), Chaffey and Wood (2005, pp. 227, 222), Squier (2006), and Rebernik and Sireč (2007). These mentioned, others, among others, researched the phenomenon of knowledge workers and the management of their knowledge.

Unfortunately, very little research on recommended KM strategies exists within South Africa's pyrometallurgical industry; hence, the suitability of this study.

According to various authors—Nonaka (1994, 1998), Davenport and Prusak (2000), Kreiner (2002), Drucker (1989, 1993, 2001, 2003), Steyn (20030, Chaffey and Wood (2005), Squier (2006), and Rebernik and Sireč (2007)—the knowledge of workers is the emphasis within the new economy and has become the focus of management in modern organizations. Nonaka (1994)] draws a distinction between two types of knowledge inherent within workers, namely tacit knowledge and explicit knowledge.

Explicit knowledge can be expressed in words and numbers and shared in the form of data, manuals, and universal principles. Explicit knowledge can be easily codified and transferred by means of conventional mechanisms such as documents, blueprints, and procedures. Tacit knowledge, on the other hand, is highly personal and difficult to formalize. This type of knowledge includes aspects such as subjective insights, intuitions, and hunches (Desouza, 2003). Tacit knowledge is not normally transferred as it is acquired, and the process of acquiring tacit knowledge requires personal experience (Eucker, 2007). In other words, tacit knowledge is knowledge that cannot be articulated or verbalized. In an organization, people know more than what they verbalize (Foos *et al.*, 2006).

In South Africa, KM is still a new field of study, although much research on KM has been linked with other themes such as retention, multiculturalism, and principles and practices. Sutherland and Jordaan (2004) researched the factors affecting the retention of knowledge workers, Finestone and Snyman (2005) investigated the phenomenon of managing knowledge within an added dimension of multiculturalism, and Squier (2006) considered the principles and practices of KM.

Most importantly, Coetzee *et al.* (2011) concluded that a noteworthy 79 per cent of the respondents in their research agreed that an organization's core competencies reside in the minds of a few key employees.

On the other hand, Steyn (2003) states that the technology explosion has misled some organizations into believing that technology could replace the knowledge and skills of an experienced person. This narrow focus could have far-reaching and long-term negative implications for the sustainable competitive advantage of companies. In addition, Coetzee *et al.* (2004) found that 93 per cent of the respondents disagreed that technology could replace the skills and experience of an employee. Therefore, the present study

argues that knowledge resides in people's minds and not in technology. In an attempt to address the underlying issue of retaining tacit knowledge within the pyrometallurgical industry in South Africa, the main objective is the promotion of a practical KM framework.

Theoretical framework

Creating knowledge in an organization

According to Squier (2006), the challenge in managing the knowledge assets of the organization introduces a new business philosophy, namely KM. KM, in turn, aims at connecting people to people and people to information. In order to facilitate knowledge sharing activities within an organization, Von Krogh *et al.* (2000) proposed five general enablers for knowledge creation:

- ➤ Introduce a knowledge vision
- ➤ Manage the conversation
- Maximize the efficiency of talented employees in order to mediate their tacit knowledge between what is and what should be
- ➤ Create the correct context for knowledge creation
- ➤ Globalize the tacit knowledge within a specific unit with the rest of the units in the organization.

Figure 1 explains the process of organizational knowledge-creation by an employee, which is a continual interaction between tacit and explicit knowledge. The original model by Nonaka and Takeuchi (1995) was adapted by Villalba (2006).

The model is referred to as the SECI (socialization, externalization, combination, and internalization) model. Squier (2006) states that all four processes need to be realized as an integrated process of knowledge creation. Unless shared knowledge is articulated, it cannot easily be controlled by the organization as a whole. The process can be explained as follows:

- ➤ The tacit-to-tacit quadrant is, for instance, when a production manager discusses and learns about the latest process difficulties with one of his colleagues. According to Nonaka (1998), the process of creating tacit knowledge through shared experiences is called socialization
- ➤ The tacit-to-explicit quadrant is a process where, for example, the production engineer puts his thoughts

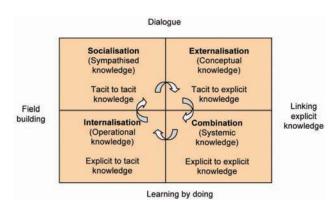


Figure 1—Adapted Nonaka's tacit/explicit model – SECI model (Source: Villalba, 2006)

- into an electronic mail describing how to solve the difficulty based on previous experience. This process is called externalization and is important for the knowledge creation process
- ➤ In the explicit-to-explicit quadrant, the production supervisor reads the electronic mail and combines the solution with his current operating procedures to resolve the problem
- ➤ In the explicit-to-tacit quadrant, the production manager combines the knowledge from the engineer and the actions of the supervisor into standard operating procedures. This is the process of embodying explicit knowledge into tacit knowledge and is closely related to learning by doing (Nonaka, 1998).

Nonaka and Takeuchi (1995) and Villalba (2006) maintain 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 organizational level. Nonaka and Takeuchi (1995) and Villalba (2006) also conclude that some form of management needs to take 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 can be created, resulting in a more competitive organization.

Interestingly, Coetzee *et al.* (2011) explain that the pyrometallurgical industry requires a fair amount of practical experience and knowledge. This principle was tested by making three similar statements to the respondents. Eighty-seven per cent of the respondents agreed that they have learned more from interacting with work colleagues than from theory. This is quite significant and refers directly to the transfer of tacit knowledge. Eighty-nine percent of the respondents agree that pyrometallurgical engineers do require specific knowledge and experience in order to operate processes effectively.

Tacit knowledge is the information about work processes and products that individuals hold above and beyond what organizations have documented. It is the 'tricks of the trade' that promote organizational functioning, overall expertise, and competitive advantage (Droege and Hoobler, 2003). Internal individual processes, such as experience, reflection, internalization, and individual talent create tacit knowledge. This cannot be conveyed through lectures or found in databases, textbooks, manuals, or internal newsletters (Rebernik and Sireč, 2007). Rebernik and Sireč, as well as Droege and Hoobler, touch on two very important aspects of tacit knowledge, namely expertise and experience, which outlive the best equipment, resources, and textbooks.

Knowledge management strategies

Various KM frameworks and models are available in the literature and most of them have similar inherent communalities. An integrated conceptual KM model is described by Uit Beijerse (2000) and focuses on nine streams of KM. As evident from Figure 2, the central aim is to make knowledge productive.

This can be achieved by aligning the nine streams of KM within the organization. In addition, the nine streams of KM should be supported by the organization's culture, structure, and strategy. The process of creating the nine streams of

knowledge commences with the identification of the type of knowledge required, followed by identifying the type of knowledge already available, resulting in the identification of a knowledge gap. The knowledge gap can be addressed through the creation and/or acquiring of new knowledge. Once the gap is closed, the knowledge is locked within the organization and needs to be shared and utilized. The last of the nine streams of knowledge is the evaluation of the utilized knowledge. To ensure the continuous creation of productive knowledge, the process should commence again from the beginning.

According to Uit Beijerse (2000), a KM strategy is important mainly for the evaluation of knowledge and remains the primary mechanism of managing knowledge within the organization. Structure as the secondary mean is important for the development, acquisition, and locking of knowledge. The third organizational procedure is culture. Culture is important for the sharing and utilization of knowledge. Such a culture is characterized by openness, flexibility, and an inclination for taking risks. Marquardt's (2002) top-ten strategies for KM are quite similar to that of Uit Beijerse (2000):

- ➤ Share responsibility for collecting and transferring appropriate knowledge
- ➤ Systematically capture relevant external benchmarked knowledge
- ➤ Organize internal learning events, including strategic reviews on the competitive environment, system audits to review effectiveness, internal benchmarking reports, and symposia that bring together customers, suppliers, and experts
- ➤ Instil creativity and innovation through small-scale experiments with feedback, reward imaginative and risky efforts, as well as to encourage brainstorming of multiple ideas to produce one good idea
- ➤ Encourage and reward innovation
- ➤ Train staff in appropriate knowledge storage and retrieval
- ➤ Maximize knowledge transfer across the boundaries through job rotation and team mixing
- ➤ Develop a knowledge coded and stored database around organizational values and learning needs
- ➤ Create mechanisms for collecting and storing learning. Knowledge development is included in the personnel evaluation process
- ➤ Apply theory in practice to create new knowledge within the organization.

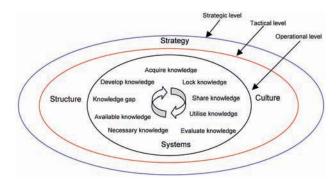


Figure 2—Integral knowledge management model (Uit Beijerse, 2000)

Similarly, Chaffey and Wood (2005) describe the European Framework of KM, which portrays a holistic view of the business processes, knowledge processes, and capabilities required to support knowledge management. The framework offers a perspective on KM that places organizational business processes at the core. Chaffey and Wood further note that businesses should understand how knowledge adds value to business performance and place emphasis on the inclusion of all participants. Five main processes, referred to as the processing life cycle, according to Chaffey and Wood, are as follows:

- ➤ Identify knowledge required as well as the knowledge gap that needs to be closed
- ➤ Innovation is vital and knowledge can be created through training, learning, doing, and problem-solving
- Store knowledge, memorized and tacit, in documents or databases
- ➤ Share knowledge between the right people, at the appropriate time, via documents and databases
- ➤ Apply knowledge in order to make correct decisions.

The framework offers a perspective on KM that places organizational business processes at the core. Chaffey and Wood's KM strategy is a defined and co-ordinated plan of action that enables core business processes to operate. In general, a KM strategy should be aligned with the corporate business objectives and activities; it also needs to enable all elements of the knowledge processing lifecycle and it should be balanced between individual and organizational capabilities (Chaffey and Wood).

In research by Kruger and Snyman (2005), it was concluded that business strategies and KM strategies should feed upon each other and need to work interdependently. Knowledge should drive strategy and KM should be driven by strategy. Therefore, before launching a KM programme, one needs to return to strategy and the governance thereof.

According to Villalba (2006), KM strategies enforce a lifelong perspective of learning that promotes constant opportunities for skills development and learning, both formal and informal.

The various KM frameworks and models have similar communalities within them. Most importantly, any KM strategy should be aligned with the business strategy. However, the various KM strategies as frameworks have not addressed management's role to retain or lock the tacit knowledge within the organization. Therefore, in pursuit of the objective, the next section highlights the importance of the retention of tacit knowledge by

- ➤ Elaborating on the concept of tacit knowledge
- ➤ Identifying the process of embedding and transferring tacit knowledge
- ➤ Exploring the impact of losing tacit knowledge.

Methodology

The main objective of this study was to conduct research on the different aspects of knowledge management with specific reference to tacit knowledge in order to create a practical KM framework within the pyrometallurgical industry. Different initiatives that could be utilized to embed tacit knowledge within an organization were also explored. To achieve the main objective, the secondary (theory evaluation) objectives of this study were identified as:

- ➤ To provide an overview of KM with an emphasis on tacit knowledge creation and sharing
- ➤ To provide an overview of KM frameworks or models found in literature to formulate a KM strategy.

Empirical research objectives

The aim of the empirical research was to determine strategies for sustainable competitive advantage through KM within the pyrometallurgical industry. This resulted in a newly created and proposed practical KM framework that could be utilized by industries to assist in the retention of tacit knowledge for sustainable competitive advantage.

A quantitative approach was chosen to meet the research objectives. The reasons for this decision were based on the amount of time and cost involved in conducting a qualitative research study compared to a quantitative study. Consequently, for this study, questionnaires were utilized and sent by means of electronic mail. Open-ended questions, dichotomous questions, as well as scaled-response questions were exploited in the measuring instrument. Open-ended questions assisted the research regarding the creation of new ideas or novel points of view (Fisher, 2007).

Because of the large number of pyrometallurgical units within the South African industry, it was not possible to determine accurately the sampling frame. Therefore, nonrandom purposive sampling was employed. Purposive sampling is often called judgemental sampling, because the researchers pick the sample that they think would deliver the best information in order to satisfy the research objectives in questions (White, 2002). Managers and engineers were selected from various pyrometallurgical units. 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 (Fisher, 2007; Struwig and Stead, 2004). In order to meet the research objectives, the sample size was selected based on a required margin of error of 10 per cent at a ninety per cent confidence level. The sample size calculation is indicated in

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

where:

S =sample size required

N = number of people in population (550)

P = estimate of people who possess attribute of interest (80 per cent)

A = accuracy desired (10 per cent)

Z = number of standard deviations of the sampling distribution corresponding to the desired confidence level. A factor of 1.64 was used for a 90 per cent confidence level. (Struwig and Stead, 2004).

It is estimated that between 500 and 600 engineers and managers are servicing the production leg within the pyrometallurgical industry. From Equation [1], the calculated sample size for this population should have yielded a requirement of 40 questionnaire responses for analysis. In total, 105 survey questionnaires were sent out via electronic mail. The response rate from the survey was 36 per cent and yielded 38 returned questionnaires. The response rate is in line with the average response rate achieved from electronic

mail surveys. The number of returned questionnaires is close to the calculated sample size with a small margin of error of 0.05 per cent. It can therefore be concluded that the results from analysing the questionnaires will have a 10 per cent accuracy coupled with a 90 per cent confidence interval level.

In order to assess the internal consistency of the survey questionnaire, the Cronbach alpha test was utilized. The Cronbach alpha test assesses how reliably survey questions are answered (Field, 2005). Cronbach's alpha values range between zero and one, where values above 0.7 suggest higher internal consistency. A historical benchmark value of 0.7 is commonly utilized to suggest that at least some of the items measure the same construct (subjects or topics). From the Minitab 15 statistical software package, the formula for calculating the Cronbach alpha value for internal consistency was employed.

Results

Quantitative research discussion

A total number of 38 engineers and managers responded to the tacit knowledge management survey. The respondents represented five of the six main pyrometallurgical categories found in South Africa. The only exception was that of the aluminium industry. The ferrochrome together with the ironand steelmaking respondents represent 50 per cent of the industry. This is in line in terms of the magnitude of the ferrochrome and steelmaking operations found in South Africa, respectively. Of concern is the number of engineers and managers who have resigned in the last two years. Fiftyone per cent of the respondents have more than two engineers or managers who have resigned.

Initiatives used to embed tacit knowledge within the industry

Various multi-choice scaled-response questions were posed to the respondents in order to determine whether the pyrometallurgical industry is practising some of these initiatives. The respondents could choose from a number of options. The first category consisted of an option between 'Yes', 'No', 'Not Sure', and 'In the process of doing it.' The second category consisted of the options 'Yes, but not working', 'Yes, and it is working', 'No', 'In the process of implementing', and 'Not sure'. The distinctive categories gave more information compared to conventional categories. The various questions and the responses are shown in Tables I–III. The headings of the discussion of these three tables will be referred to as the discussion flows and the responses grouped accordingly.

Two questions were employed to determine whether the pyrometallurgical industry has implemented a KM strategy and whether the strategy is linked to the business strategy.

These are:

- 1. In the event that one of 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 organization?
- 2. In your view, what systems must be in place to ensure that the tacit knowledge of key individuals is embedded within the organization?

From Question 2, Table I, KM strategy implementation, it can be concluded that 42 per cent of the industry does not have a KM strategy. Only 16 per cent of the respondents are of the opinion that the KM strategy is implemented and

Table I Qualified yes and no questions							
Cate	egory	Yes but not working	Yes and it is working	No	In the process of implementing	Not sure	
2.	We have implemented a knowledge management strategy in our organization	5%	16%	42%	26%	11%	
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	3%	13%	79%	3%	3%	
6.	A formal system is in place in order for a person to shadow another person during his last month notice period.	0%	24%	66%	8%	3%	
8.	A social network system is in place in order for us to share information or solve each other's problems across departments	3%	34%	47%	11%	5%	
9.	The condition of employment forces me to codify my tacit knowledge and key learnings before leaving the organization or moving to another department	0%	5%	92%	0%	3%	
10.	Succession planning forms part of our knowledge management process.	18%	32%	26%	21%	3%	
12.	We have implemented a mentorship programme in order to facilitate practical knowledge exchange	21%	24%	26%	26%	3%	
13.	Job rotation is practised in order to transfer knowledge between departments.	3%	18%	63%	13%	3%	
14.	Our organization's document management system is assisting in the transfer of knowledge	13%	32%	32%	18%	5%	
16.	Our organizational structure allows for enough resources in order to transfer knowledge to succession planning candidates.	0%	24%	63%	11%	3%	
18.	Our organization is exploiting captured knowledge creatively to add value to the organization	3%	24%	53%	11%	11%	
20.	Our organization has enough coaches and mentors to train young engineers in order to foster knowledge transfer	16%	24%	39%	11%	11%	
21.	We are making use of videos or DVDs in order to capture training lectures presented by key employees	3%	13%	66%	16%	3%	
22.	We have a department that is dedicated to the management of the knowledge within the organization	8%	11%	66%	8%	8%	

Table II Unqualified yes and no questions							
Category		Yes	No	Not sure	In process of implementing		
15.	Our department has identified the knowledge that is critical for our organization's success	55%	26%	5%	13%		
17.	Our organization is capturing the crucial knowledge that resides in the minds of our employees	18%	66%	13%	3%		
19.	Our information management system allows easy access to information that can be used in decision-making	58%	16%	13%	13%		

Table III Frequency questions							
Category		Frequently	Sometimes	Never	Not sure		
1.	Formal structured technical knowledge exchange forums are being used in order to foster knowledge transfer	16%	58%	26%	0%		
5.	Benchmarking activities are being conducted in order to gain and share know-how	29%	61%	11%	0%		
7.	Our organization will retain the knowledge of an experienced worker by contracting him in as a consultant after leaving the company	21%	47%	26% 5	5%		

working. In terms of the linkage between the KM strategy and the business strategy, 37 per cent indicated that it is not interlinked (Question 2, Table I).

Droege and Hoobler (2003) suggested that a reward system might be used to motivate employees to engage in knowledge sharing. From the empirical study, an overwhelming 79 per cent of the respondents indicated that their balanced scorecard system does not reward them for sharing their knowledge (Performance management of knowledge transfer: Question 4, Table I). On the positive side, 13 per cent of the industry respondents indicated that they are measured and rewarded for transferring their knowledge.

Companies committed to transferring tacit knowledge often set up formal mentoring programmes and make the passing of knowledge to young employees an explicit part of the job descriptions of skilled senior staff (Davenport and Prusak, 2000). The question regarding the implementation of mentorship programmes (Question 12, Table I) reveals that 45 per cent of the respondents indicated that a mentorship programme is implemented, but only 24 per cent are of the opinion that it is working. An alarming 26 per cent do not have a mentorship programme. As Davenport and Prusak state, mentorship programmes are about passing on knowledge from skilled senior staff to younger employees. Thirty-nine per cent of the respondents feel that their organizations do not have enough mentors to transfer the knowledge to younger employees (Enough mentors and coaches to transfer knowledge (Question 20, Table I)).

According to Davenport and Prusak, 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 the question regarding, succession-planning part of knowledge management (Question 10, Table I), 50 per cent of the respondents indicated that succession planning forms part of the KM process. The calculated margin of error for this question is 16 per cent. This again indicates that a larger sample size would reduce the error. As with the

mentorship programme, 26 per cent of the respondents indicated that no succession planning is practised within their organizations.

In terms of job rotation, 63 per cent of the respondents indicated that job rotation is not practised within their organizations (Practising of job rotation to transfer knowledge: Question 13, Table I). This is alarmingly high and is one possible reason for the relationship between job rotation and having enough resources.

As can be seen from Question 16, Table I (Enough resources for knowledge transfer), 63 per cent of the respondents indicated that their organization does not have enough resources to transfer knowledge to succession planning candidates. This could possibly be attributed to the absence of job rotation.

One of the strategies proposed by Droege and Hoobler (2003) to promote tacit knowledge diffusion encourages individuals and departments to work together to share information and resources. To ensure implementation, a social network system should be in place. According to the question asked on the availability of a social network that exists in order to share information (Question 8, Table I), 47 perc ent indicated that no social network system is in place. This again is alarming and it indicates that the departments are working in isolation.

No information was found from the literature regarding tacit KM during an employee's notice period. It is suggested that this aspect of tacit KM should be researched. In this study, three aspects were identified. The first aspect relates to whether the organization requires the employee to codify tacit knowledge and key learning before leaving the company. A convincing 92 per cent indicated that this was not expected from them (Codifying of tacit knowledge part of condition of employment: Question 9, Table I).

The second aspect investigated shadowing of employees during their notice period. From the analysis of the response to the question on shadowing of people leaving the organization (Question 6, Table I), it can be concluded that most of the pyrometallurgical organizations do not have a formal

shadowing system in place during the notice period. This issue is again highlighted in the discussions of the openended questions.

The third aspect is that of employing previous employees as consultants to elicit tacit knowledge. From the response given on the topic of the contracting of previous employees (Question 7, Table III), it is clear that 47 per cent of the respondents stated that their organization sometimes contracts in a previous employee, and 21 per cent said that they do it frequently. Therefore, in total, 68 per cent of the organizations do from time to time contract in previous employees.

Gorelick, Milton, and April (2004) stated that dedicated resources should be committed to KM projects. In order to evaluate current practice in the pyrometallurgical industry, respondents were asked whether their organization had a department dedicated to KM.

Question 22, Table I (Dedicated knowledge management department) indicates that although 66 per cent have no such department, 19 per cent indicated that they do. This is encouraging and shows that some organizations perceive KM seriously.

Uit Beijerse (2000) lists nine streams of KM. The nine streams ultimately identify knowledge gaps that need to be addressed through the development of new knowledge or the acquisition of knowledge. Once the gap is filled, the knowledge is locked within the organization, ready to be shared and utilized. The empirical research focused on three of the nine streams (i.e., identification of critical knowledge, locking the knowledge within the organization, and utilizing the knowledge to the benefit of the organization). From Question 15, Table II (Identification of critical knowledge), it is evident that 55 per cent of the respondents stated that their department had recognized that it is crucial to share knowledge.

Although 55 per cent indicated that they have identified the critical knowledge needed, only 18 per cent of them are capturing the knowledge that resides in the minds of their employees (Capturing of crucial knowledge: Question 17, Table II). This correlates with the 53 per cent of respondents indicating that captured knowledge is not exploited (The usage of captured knowledge: Question 18, Table I).

Based on the information on identification, capturing, and the utilization of knowledge, it is concluded that most of the pyrometallurgical organizations need to address these issues. According the Davenport and Prusak (2000), one could also transfer tacit knowledge through the recording of stories and experiences of senior practitioners on video before they leave the company. Question 21, Table 1 (Using media to capture knowledge) indicates that the above proposed practice is used by only 16 per cent of the organizations.

Tacit knowledge that has been codified into explicit knowledge should be managed via a document management system in order to ensure that new employees could benefit from the captured tacit knowledge. According to the response given on Question 14, Table 1 (Success of document management system) 45 per cent of the respondents indicated that the document management system is used with the objective to assist them in the transfer of knowledge.

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Information results from placing data within some context, which can then be viewed as processed data (Freeze and Kulkarni, (2007). It is therefore important for this information to be easily available. From the response to Question 19, Table II (Easy access to information), 58 per cent of the respondents indicated that their organization's information management system allows 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 assist with tacit knowledge transfer. Tacit knowledge could be transferred intentionally or unintentionally. Formal forums like conferences and benchmarking are seen as intentional tacit knowledge transfer.

Question 1, Table III (Formal knowledge exchange forums) and Question 5, Table III (Use of benchmarking activities) indicate a relationship and show that intentional knowledge transfer does not occur that frequently. Of concern is that 26 per cent of the organizations never conducted a formal technical knowledge exchange forum.

Different opinions and suggestions came from the openended questions posed to respondents, and can be summarized in three categories. Firstly, 23 per cent of the respondents were of the opinion that it is too 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 proactive 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 his or her colleague. Rotation of employees on a three-yearly interval would then also assist in tacit knowledge transfer. The respondents did, however, suggest that in the event that an employee resigns, a person should be allocated to him in order to capture all tacit knowledge not captured previously.

Secondly, 18 per cent of the respondents suggested that more emphasis should be placed on documenting what the resigning employee knows. This could be done by reviewing what that person knows that needs to be captured. The employee should then be removed from his normal duties and document all the key knowledge of processes and organization in his possession. All reports on projects should either be completed or updated. The employee should draw up a list of uncompleted work as well as future work that is crucial for organizational success. Another aspect is understanding what knowledge is captured in that person's files and electronic data folders on his personal computer. The resigning employee should index all files and documents in order to add context for the next employee. One-on-one sessions should be conducted with this employee in order to capture all insights required.

Thirdly, the majority of respondents (58 per cent) suggested that another person should shadow the resigning employee for the remaining notice period. An interview should be conducted as soon as possible between the resigning employee, successor, and immediate manager. During this interview, key areas of knowledge transfer need to be identified and transferred. This could also be done by

the successor shadowing the resigning employee for two weeks. After the two weeks, the roles should change over and the resigning employee should then shadow the successor. Relationship building is still critical and the contact details of the resigning employee need to be kept up to date in order to facilitate future knowledge transfer. In the event that no successor is available, a caretaker should fulfil this role.

The second open-ended question focused on the systems that need to be in place to ensure that tacit knowledge is embedded within an organization. Respondents identified the practice of succession planning as a first initiative that requires employees to be matched in order to ensure that trust is the basis of knowledge transfer. Organizations should also have enough resources to facilitate succession planning. A lean organizational structure may have short-term cost savings but in the long run, the organization would pay for the knowledge lost as a result of it. A 'train-to-be-promoted' concept should be practised. This implies that the experienced coach may be promoted only once he or she has trained a successor.

Secondly, a formal mentorship programme should be in place to transfer the knowledge and experience from the older generation in the organization to the younger generation. Meetings should be scheduled on a monthly basis. An incentive system should also be in place in order to reward the mentor.

Thirdly, emphasis should be placed on documenting projects, focusing on lessons learned, problems experienced, and the solutions. This type of report writing should also form part of the key performance indicators to ensure that knowledge is documented. Once the report is written, it should be stored in a document management system to ensure continuity and easy access. Keyword searches based on plant-specific location could assist in future searches. A culture of using old reports should be created. All new engineers should initially read all previous reports during their training phase. Another important aspect of these documents is that the key learnings should be incorporated in the training material. This would require a central person to administrate all the documents and reports. All pyrometallurgical processes should strive to have an overarching 'manual' that contains all previous learnings and

Fourthly, most of the respondents indicated that formal forums should be held quarterly. During such forums, the technical aspects of the work should be discussed through presentations. An industry specialist may also present to the young engineers during such a forum. It is important to involve not only the engineers, but also the supervisors operating the process. The link between theory and practice could be enhanced in such discussions. A culture of talking about technical aspects would also be nurtured in such forums.

Fifthly, most organizations have outsourced their training. This, however, is not to the advantage of knowledge transfer, because outside training facilitators do not have the first-hand knowledge and experience. It is therefore important to hand-pick your training facilitators in order to ensure that the right knowledge is transferred within the right context. Usually, a well-experienced supervisor or engineer is used in such a role. The use of training aids such

as DVD recordings and computer-based training could also assist in transferring the knowledge from previous experienced employees who have left the organization.

A sixth suggestion entailed the concept of 'management-by-walkabout.' There has to be regular and genuine interaction by management and engineers with employees. This, in turn, leads to the dissemination of information upwards, sideways, and downwards.

As a seventh suggestion, benchmarking with other pyrometallurgical operations could foster tacit knowledge transfer between different departments and organizations. During such benchmarking events, knowledge is interchanged. The newly acquired knowledge from benchmarking activities should also be documented for future reference. Benchmarking could assist in creating a network of international professionals. This network list should be kept up to date and regular contact should be established to nurture the channel of knowledge exchange.

Lastly, engineers are caught up in daily activities, resulting in the fact that no or very little time is spent on creating new knowledge and understanding the underlying issues of processes. More time should be made available for engineers to capture and transfer their knowledge. In addition, retention agreements should be drawn up to assist in the retention of the tacit knowledge of engineers.

Concludings remarks

The respondents viewed KM as an important aspect of the organization. Regarding the questions posed, it can be concluded that 68 per cent of the respondents link organizational success to the success of KM. Of concern was the low level of KM implementation. A number of valid and practical suggestions were made by the respondents and have been used in developing the tacit KM framework (Figure 3). From the analysis of the results of the survey questionnaire discussed, some recommendations follow.

Implementing a practical framework to embed tacit knowledge

The analysis from the two open-ended questions discussed yielded suggestions regarding practical aspects that could assist in embedding tacit knowledge within an organization. These aspects, combined with the information from the literature study, formed the basis from which a practical framework was developed. The framework has not been tested to verify its validity.

The proposed framework aim is to assist management in mastering the sharing of tacit knowledge within the organization. Figure 3 represents a newly created proposed framework referred to by the authors as 'the practical tacit KM framework'. The framework consists of seven phases. These phases follow typical process flow patterns, starting at Phase 1 through to Phase 7. The linkage between Phase 7 and Phase 1 indicates that the tacit KM framework is a continuous process.

Phase 1 – Set or evaluate a tacit knowledge management strategy

During the first phase of the framework, the senior

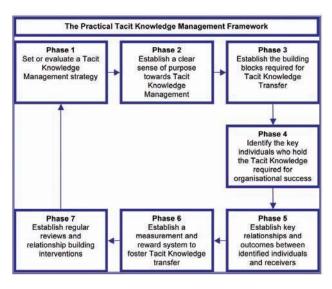


Figure 3—The practical tacit knowledge management framework

management within the organization should embark on a strategic planning exercise. During this exercise, a tacit KM strategy should be drawn up that is aligned with the business strategy. It is recommended that a KM SWOT analysis be completed. From the SWOT analysis, key strategic areas within the organization need to be identified that would require the active management of tacit knowledge. During this exercise, senior management should also decide on whether they want to build the tacit knowledge base within the organization 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 KM strategy, a strong sense of purpose is required. Middle management needs to be aligned and committed to the process. This may be achieved by setting a clear end vision and sketching the importance of KM strategy. Aspects like organizational core competencies that create a competitive advantage and the creation of a learning organization could be identified to establish the sense of purpose. Management should realise the potential and power that lie within the sharing of tacit knowledge.

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

The following building blocks are proposed to facilitate tacit knowledge transfer:

- Conduct regular benchmarking activities and establish knowledge networks
- ➤ Conduct regular knowledge exchange forums.
- ➤ Implement standard well-documented report writing procedures. Also, ensure effective future electronic searches
- ➤ Ensure that enough resources are available within the organization to establish a pool of engineers (i.e. experienced and candidate engineers)

- ➤ Establish regular 'management-by-walkabout'. A good rule of thumb is to spend at least 30 per cent of one's time on the plant
- ➤ Implement succession planning to allow the identification of key personnel that need to be trained to replace individuals resigning or being promoted. Another suggested rule of thumb could be that a person may be promoted only once the trainee can duplicate the trainer's tasks
- ➤ Implement a mentorship programme with monthly interactions and a duration of two years.

Phase 4 – Identify the key individuals who hold the tacit knowledge required for organizational success

After ensuring that the building blocks mentioned in Phase 3 are established, the process of actively managing tacit knowledge can commence. During this phase, managers of each functional area should embark on an exercise to identify those individuals who hold a considerable amount of tacit knowledge of processes. The following questions could 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 processes?

It is proposed that a detailed list of the identified individuals should be drawn up indicating the niche in tacit knowledge inherent in that specific person.

Phase 5 – Establish key relationships and outcomes between identified individuals and receivers

Once the key individuals have been identified, management should analyse the rest of the pool of engineers within their departments. Receivers of tacit knowledge should be identified to be connected to one of the key experienced individuals. The following two questions may assist management in identifying the receivers.

- ➤ Which engineers have 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 should be established between the key individual holding the tacit knowledge and the identified receiver. This may be done by creating a strong sense of purpose that is driven by the vision for tacit knowledge management. Both parties should understand that this relationship is established to build on the tacit knowledge base of the organization. Specific outcomes should also be drawn up for 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 could, however, set

up some measurement system to determine if tacit knowledge transfer occurred. It is proposed that the hours of interaction between the key individual and receiver are tracked and measured. As a starting point, two hours per week of interaction is recommended. Another proposed measurement method is by means of an interview between the key individual, receiver, and manager. During such an interview, plant-specific questions should be asked about the process. The receiver should then prove that he or she understands the underlying principles. A proper reward system should be in place to motivate the sharing of knowledge. The measurement system could be linked to the reward system. An increase in interaction time between the sender and the receiver should lead to a larger reward. Another incentive may be to issue a retention agreement with the key individuals with the understanding that one of the required outcomes at the end of the period is the demonstration of tacit knowledge transfer.

Phase 7 – Establish regular reviews and relationshipbuilding interventions

It is of utmost importance to conduct regular reviews on the established relationships. Relationship-building interventions should be held to ensure that the identified individuals overcome any obstacles that may stand in the way of sharing their knowledge. The outcome of such interventions should be stronger relationships and a better understanding of each other's mindsets. This could also strengthen teamwork in the workplace.

As evident from Figure 3, the proposed framework is a continuous process. The entire process should be reviewed on an annual basis to identify any opportunities or threats that may influence tacit knowledge transfer.

Finally, Proverbs 24:3-6 states '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).

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