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**An investigation into tacit knowledge management at the
supervisory level**

A thesis submitted in fulfilment
of the requirements for the degree of

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By

David Williams



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Abstract:

An investigation into tacit knowledge management at the supervisory level

Objective: The purpose of this study was to investigate how supervisors managed tacit knowledge.

Aims: The aims were to understand what tacit knowledge looked like on the shop floor, to understand ‘experience’ in terms of tacit knowledge, and to describe the methods and techniques that supervisors used to manage this elusive resource as they went about the task of achieving organisational goals.

Method: Qualitative data was collected using a novel iterative participant observation method, where the researcher-as-instrument was embedded as a novice (but privileged) employee for extended periods in four different case study sites. Over the course of the study, the researcher took on the role of laboratory technician, electrical engineer, manufacturing process worker, and aircraft maintenance engineer. A grounded theory¹ approach was taken to the analysis of the various field notes, photographs, video, audio, and found objects. The methodology was augmented with specialist qualitative research software to manage the data.

Results: It was found that supervisors’ tacit knowledge management activities can be classified according to formal and informal behaviours that correspond with Nonaka and Takeuchi’s SECI knowledge life cycle. It was also found that a worker's task related tacit knowledge has seven aspects in five levels of competency, and their experience can be described in terms of 10 categories of tacit knowledge working capital.

Insights attributed to the novel method of data collection produced an unexpected finding – the home guard model, which describes how the value of an individual's knowledge sharing activities is related to their power distance and self-confidence.

Conclusions: The findings provide empirical support for existing knowledge management theory, identify specific supervisory behaviours that support tacit knowledge management on the shop floor, and extend the knowledge management discourse with new theories about knowledge sharing behaviours that have direct application to the supervisory role.

¹ Consistent with Perrin (2004), the term *grounded theory* is not generally capitalised in this thesis because it is the “general name of [a] theory” (p. 45) according to the APA style. The only places where it is capitalised are where it appears as part of a specific title, e.g. of a book, table, etc.

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Chapter 1: Introduction

This thesis is the outcome of a four-year investigation into tacit knowledge management at the supervisory level in four New Zealand firms. It describes the conceptual background (literature review) to the project, the methodology, and a novel method of data collection and subsequent analysis. The thesis also describes the case studies in which the research took place, and the findings that resulted. The work contributes to the literature by confirming much of what has already been written, and introduces several new concepts that add to the general understanding of the topic.

1.1. Background to the research

Ever since Michael Polanyi introduced the concept of tacit knowledge in his seminal work *The Tacit Dimension* (Polanyi, 1966), there has been considerable interest in the value that tacit knowledge adds to organisational performance. Polanyi's ideas were further explored in other contributions to the discourse by for example, Nonaka and Takeuchi in their famous *The Knowledge Creating Company* (Nonaka & Takeuchi, 1995), and Davenport and Prusak in *Working Knowledge* (Davenport & Prusak, 1998), which popularised the term Knowledge Management in the business management discourse.

In general it is recognised that there are three major enablers of knowledge management, including Information Technology, Business Processes, and Human Resources or Human Capital (Birkinshaw, Nobel, & Ridderstrale, 2002) . As far as knowledge management is concerned, of the three, information technology seems to have received most attention, probably because of its ability to handle knowledge that is easily explicated and because of the development of information technologies themselves (Carrillo, Herbert, Ahmed, & Chimay, 2004). However, even though the concept of tacit knowledge generated considerable interest and enthusiasm amongst academics and practitioners alike, the operationalisation of tacit knowledge constructs has languished (Ambrosini & Bowman, 2001), quite possibly because of the difficulties associated with the nature of knowledge itself, and possibly because of Polanyi's writing too, which tends to be very dense and difficult to read.

Thus, we find today that even though there are volumes written about the conceptual nature of tacit knowledge and the speculative value it contributes to organisational performance, there is still yet no definitive work on exactly what tacit knowledge *per se* is, and how it can be managed in the workplace. Furthermore, most of what research has taken place on the topic has tended to be done at a high conceptual level within

organisations, e.g. at the level of international business collaboration, or in new product development, using instrumentation that relies on explicated (i.e. explicit rather than tacit) knowledge in the form of interviews or surveys.

Therefore we find a gap in the literature on the operationalisation of tacit knowledge in the workplace, specifically at the shop floor level, and on research methods that have used an embedded approach to data collection (Nonaka & von Krogh, 2009).

1.2. Research problem, propositions/ research issues and contributions

Thus the purpose of this research is to fill this gap in the literature with a study that looks specifically at tacit knowledge as it is operationalised by workers, and which uses a method embedded in the social networks of practice on the shop floor (Seeley-Brown & Duguid, 2001). Therefore, the research aims to answer the generic problem,

How do supervisors manage tacit knowledge on the shop floor?

The problem is broad and examined more precisely later in Chapters 2 and 3, but essentially what the research aims to find out is, what does tacit knowledge look like in process and manufacturing contexts, and how do supervisors leverage it in the interest of maximising firm performance. In other words, what does the label tacit knowledge mean in terms of a knowledge asset, or experience, or intelligence, and what business processes or technologies do frontline supervisors use to implement and support the development and leveraging of tacit knowledge to realise its potential.

The research question is therefore not merely a matter of solving a problem, but is about testing the utility of the high-level generalisations alluded to in the previous section and developing a theoretical or conceptual framework around tacit knowledge management that will support business management praxis at the grassroots level.

To resolve the problem, a novel approach was taken to the collection of data. The method used an iterative participant observation, where the researcher himself was embedded in the workforce as a regular novice employee (albeit with special privileges), and became the data collection instrument himself.

Thus this research makes two contributions to the literature. The first concerns the research topic itself, and the second concerns the method by which the research question was answered.

1.3. Justification for the research

The research is justified on two fronts. Firstly it is argued that the debate over the nature of knowledge – from the time of Plato and Aristotle, through Cartesian dualism, to the proposition of knowledge typologies such as the DIKW (Data, Information, Knowledge, Wisdom) hierarchy, has obfuscated the essentially dualistic nature of knowledge, i.e. it is both explicable and ineffable, and has created a problem where there need not be one.

The problem is exacerbated because the term tacit knowledge is often used synonymously with experience, or euphemistically for intelligence, resulting in the somewhat egregious situation where there is no generally accepted method for measuring the value of knowledge, and hence no universally accepted definition for knowledge management. This research seeks to find an operationalisable definition of tacit knowledge that is able to account for its dichotomous nature, and still be useful as a form of measure.

Secondly, the research aims to use a unique and synergistic approach to data collection and analysis that stretches the capabilities of Human Capital and information technology in order to gain insights that would not normally be accessible using conventional qualitative research methods. By situating the researcher within the research context, rather than beside it as an interviewer or surveyor, it is hoped that new insights would be gained into the factors affecting knowledge management; factors like organisational contexts, or knowledge management styles, and it is hoped that hitherto unacknowledged facilitators and barriers may be identified. Similarly, by using cutting edge information management tools to assist with the grounded theory analysis of massive amounts of data, it is intended that the research will display sufficient methodological rigour to withstand the kind of criticisms often associated with the qualitative research paradigm.

1.4. Methodology

The research took an Interpretivist approach using grounded theory methods to answer the research question, and was designed to take into account Strauss's contention that the work of quantitative research is "often weak on context" (Strauss, 1987, p. 2). Considerable emphasis was therefore placed on the situational and structural contexts within which tacit knowledge is found, i.e. on the shop floor, through the researcher's embeddedness in the cases.

The grounded theory approach was taken because it engages in simultaneous data collection and analysis that leads to progressively more abstract concepts. Because of the time and resource constraints of the research, this method appeared to be the most appropriate when compared with others, such as an ethnography, simple single case study, action research, or phenomenology. An iterative approach was taken to ensure that the data was appropriately focused and bounded and to be able to provide an acceptable level of representativeness, to mitigate any subjects' reactivity effects, and to ensure reliability and replicability of the findings.

Appropriate consideration was given to the ethics of the research, and information given to participants assured them of the confidentiality of their contributions, their safety, the safety of the researcher, conflicts of interest, and the sensitivity of the research itself.

A number of diverse materials comprised the qualitative data collection, including interview transcripts, found artefacts and documents, photographs and recordings, and of course the field observations of the researcher-as-instrument himself. To handle this great mass of data, a dedicated qualitative research analysis software tool (Nvivo™ by QSRInternational.com) was used to manage the data. The functionality of this tool enabled insights to be gained that might not otherwise have been, and also provided a means to evaluate and counter potential problems with the data, such as researcher bias.

The method produced a number of important findings that are summarized in the following Section 1.5: Outline of the report, below .

1.5. Outline of the report

The report is structured as follows,

Chapter 1: Introduction – this chapter which provides an overview of the project as a whole.

Chapter 2: Literature Review and Conceptual Framework – this chapter describes the parent concepts and research problem theory that underpinned the research.

The parent concepts covered discussions around the nature of knowledge, and an extended discussion of some important aspects of The Tacit Dimension. These were considered important because there are a number of difficulties with Polanyi's writing and the resulting controversies over the definition of tacit knowledge and knowledge hierarchies that needed to be resolved before the appropriate foundation for the definitions used in this research could be built. This section also considered tacit

knowledge in terms of intelligence and experience, and briefly discussed the role of information technology in knowledge management.

The research problem theory was also introduced. It included a sufficiently comprehensive discussion of the factors affecting knowledge management (covering contexts, knowledge management styles, the costs of knowledge management, and knowledge assets), facilitators of knowledge management and known barriers and limitations to effective knowledge management, to provide a justification for the research problem.

Chapter 3: Methodology – this chapter describes the research paradigms and methodology and justifies the choice of grounded theory for the research method, which is described in detail – including the use of the Nvivo qualitative research analysis software. (See section 1.4 above for more details)

Chapter 4: Case Studies – this chapter describes in chronological order the four cases in which the research was situated. It describes how the cases were accessed, the research focus for each case, the researcher's daily reality at each case, and provides a selection of observations to illustrate the tacit knowledge phenomena under study. Each case study write-up also provides an explanation of its associated data analysis, including the grounded theory processes of open coding, theoretical coding, and theoretical saturation, and a description of the findings from that case along with an explanation of how the findings from previous cases were triangulated.

The four case study sites included a commercial laboratory that tested milk factory products (Case 1), an electrical engineering workshop that serviced electric motors and generators (Case 2), a factory that manufactured automatic doors for public transport systems, i.e. buses, trains, and ferries (Case 3), and a civil aviation airline maintenance facility that serviced turbo-prop aeroplanes (Case 4).

Chapter 5: Findings and Discussion – this chapter describes the findings from the case studies. These include how supervisors managed tacit knowledge effectively, a model of knowledge counter agent archetypes (labelled the Home Guard Model), a generic measure of task related tacit knowledge, an explanation of the tacit knowledge aspects of experience, and identifies the knowledge factors that affect worker performance on a daily basis. It then goes on to discuss how these models might be applied in practice.

Chapter 6: Conclusion – this chapter provides conclusions about each of the research issues and the research problem. It discusses their implications for theory, policy, and practice, and makes a suggestion about directions for future research.

1.6. Definitions

Because of the somewhat controversial nature of tacit knowledge itself, there are a number of terms germane to the research that need to be explicitly defined to avoid confusion. The justification and rationale for the selection of these particular definitions are provided in detail in Chapter 2, so this section simply lists them.

Knowledge: a justified true belief (Plato in Chappell, 2009)

Tacit Knowledge: a justified true belief, which arises from experience, and includes some aspects that are explicable, and others that are not. (Developed from various authors – See Chapter 2 for more details)

Tacit Knowledge Management: the set of organisational communication methods, including culture, business processes, and technology, that deal with the identification, collection, storage, application, and enhancement of tacit knowledge assets for the purposes of optimising organisational performance. (Developed from various authors – See Chapter 2 for more details)

Experience: the non-documented accumulation of knowledge or skill that results from direct participation in events or activities. (Cook & Seely-Brown, 1999)

Knowledge Asset: “Firm specific resources that are indispensable to create value for the firm ... the inputs, outputs, and moderating factors of the knowledge creating process”. (Nonaka, Toyama, & Konno, 2000, p. 20)

Knowledge Agent: “Someone or something whose work consists largely of converting information to knowledge using their own competencies for the most part, but sometimes with the assistance of suppliers of information or specialized knowledge”. (Johannessen, Olsen, & Olaisen, 1999, p. 123)

Intellectual Working Capital: Workaday information of experienced workers. (Ammar-Khodja & Bernard, 2008)

1.7. Delimitations of scope and key assumptions, and their justifications

This research project was situated within industrial laboratory and commercial engineering process and manufacturing contexts within New Zealand, which possibly sets the boundary for the generalisability of the findings.

However the findings, which are focused on relatively low level and generic knowledge management constructs are consistent with the high-level findings in the literature, so it is reasonable to suppose they may be applicable across the board in a variety of other contexts, since they deal primarily with the nature of knowledge management rather than the knowledge content at each of the case study sites. That is to say the findings may be applicable in not only process and manufacturing contexts, but also in service industries such as hospitality and tourism, and in public service. Similarly, the research participants included a wide variety of ethnicities and nationalities from around the world, so although it is possible that the findings are only applicable within the New Zealand context, the richness of the participant observation experiences suggests the findings may also be applicable elsewhere.

Although the research took place in a variety of cases, some of which were firms that employed thousands of people, the situated nature of the participant observations meant that the research focused quite narrowly on relatively small groups of people at any one time. This suggests that the findings may be applicable in any size organisation where the practical work unit consists of a supervisor/frontline manager with up to a dozen or 14 direct reports.

Again, given the nature of the organisations that were studied – two were large corporates, one was a small business that had been subsumed into a large corporate, and one that was a medium-size business in its own right – it may be possible to generalise the findings across both the private and the public sector.

1.8. Conclusion

This introductory chapter laid the foundation for this research report, which is squarely within the knowledge management discourse. It identified two gaps in the literature, a conceptual gap about the nature of task related tacit knowledge (or experience), which will be filled by the answer to the research problem of how supervisors effectively manage tacit knowledge at the shop floor, and a methodology gap, which will be answered by the application of a novel method that involved an iterative participant observation with an embedded researcher.

A number of definitions of terms germane to the research were presented, and the methodology was briefly described and justified. The structure of the report was outlined with a précis of each of the four main chapters, and the limitations to the research were mentioned. The report proceeds on these foundations with a detailed description of the research using a structure suggested by Perry (1998).

Chapter 2: Literature Review and Conceptual Framework

2.1. Introduction to the Literature Review

This chapter sets out the conceptual framework for the research. It is a review of the literature around tacit knowledge management and has the purpose of placing the research question, "How do supervisors manage tacit knowledge?" into the context of a contemporary understanding of knowledge management as a whole.

The chapter is divided into two main sections. The first covers some of the overarching ideas or *parent concepts* (Perry, 1998) pertaining to knowledge and knowledge management, including a rationale for the definitions used in this study. The second looks more closely at the *research problem theory* (Perry, 1998), and explores known factors affecting tacit knowledge management. Together these two sections provide the conceptual backdrop to the research.

The literature this review covers is on knowledge management in the business domain. The range of the literature can be traced back at least as far as the mid 1960s to Michael Polanyi's seminal work, *The Tacit Dimension*. Although interest in the topic languished somewhat over the next few decades, two other important works, *The Knowledge Creating Company* by Nonaka and Takeuchi (1995), and *Working Knowledge* by Davenport and Prusak (1998) were instrumental in shaping the discourse, and since then there have been ongoing debates about knowledge management particularly in regard to the nature of knowledge itself (see section 2.2.1 below), and regarding knowledge in the context of work. What consensus there is suggests some kinds of knowledge are more difficult to manage than others, which is why this particular topic is so important; it aims to uncover ways that the difficult knowledge can be managed.

2.2. Parent Concepts

2.2.1. *The nature of knowledge*

Even a cursory review of the knowledge management literature suggests philosophical discussions around the nature of knowledge could fill libraries; the concept is endlessly complex. This initial section does not offer a comprehensive review of the nature of knowledge, but rather provides a sufficient review of modern Western thought to rationalise the choice of definition of tacit knowledge as used in this research. This is important since the definition and management of tacit knowledge is a recognised problem (Alvesson & Kärreman, 2001; Teece, 2000) with its roots in a philosophical debate about the nature and characteristics of knowledge itself that has exercised

philosophers for more than 2000 years, therefore without a definition this research has no foundation.

2.2.1.a. The debate over the nature of knowledge

Back around 450 BC the Greek philosopher Socrates introduced the Socratic Method of intellectual debate, which was a harbinger to early thinking about the nature of knowledge. Following on from him, Aristotle, Socrates' famous student identified *aesthesis* – knowledge acquired through the senses, and *logos* – affirmative or negative truth as different aspects of knowledge. Within *logos*, Aristotle further identified the perennial phenomena of *episteme* (intellectual certainty), *sophia* (wisdom), and *nous* (intellectual as opposed to sensory knowledge) and the changing phenomena of *techne* (craft like knowledge) and *phronesis* (practical knowledge) (Capurro, 2002; Johannessen, Olsen, & Olaisen, 2005). But it was Plato, Aristotle's famous student in his turn, who is probably credited with the first working definition of knowledge as a “true belief with an account” (*meta logou alêthê doxan*) (Chappell, 2009), or more popularly referred to as “a justified true belief” (JTB).

2.2.1.a.1. Knowledge as a justified true belief (JTB)

The Platonic definition seemed to suffice up to the modern age, until a problem was identified. The problem is that in a rationalist search for knowledge as absolute truth (Nonaka & Takeuchi, 1995), the conditions of a JTB do not in themselves constitute a sufficient condition for the truth of a proposition, because it is possible for a person to be justified in believing a proposition that is in fact false (Gettier, 1963). There are several responses to this epistemological problem. One of them, known as the causal condition, suggested that knowledge is JTB if the truth of a belief has caused the subject to have that belief (Goldman, 1967). Another was the proposal that knowledge is undefeated justified true belief. In other words, JTB counts as knowledge if, and only if, it is also the case that there is no further truth that had the subject known it, would have defeated the present justification for the belief (Lehrer & Paxson, 1969). It seems that these epistemological and tautological difficulties with JTB are predicated on knowledge being tied to both truth and belief. This may be a particularly Western cultural perspective, since in other cultural contexts there are no Gettier problems with JTB, since “it seems that what counts as knowledge on the banks of the Ganges does not count as knowledge on the banks of the Mississippi!” (Weinberg, Nichols, & Stich, 2008, p. 30).

2.2.1.a.2. Rationalist vs. Empiricist views on knowledge

Possibly as a result of the Gettier problem, the sceptical pursuit of knowledge in Western philosophy could be what has stimulated numerous philosophers to search for a method to help them establish the ultimate truth of knowledge beyond all doubt (Nonaka & Takeuchi, 1995, pp. 20-31). The result of this scepticism has been the emergence of at least two major philosophical schools of modern Western thought, i.e. rationalism and empiricism.

Rationalism, considered to have been fathered by the French philosopher Rene Descartes, is the school of thought that posits true knowledge is not the product of sensory experience but of some idealised cognitive process, i.e. it is *a priori* knowledge that does not need to be justified by sensory experience. In other words, "absolute truth is deduced from rational reasoning grounded in axioms" (Nonaka & Takeuchi, 1995, p. 21). An example of this kind of reasoning includes mathematics. Rationalism says that knowledge can be deduced by drawing on mental constructs such as concepts, laws, or theories. Apparently this thinking came about from Descartes' *method of doubt*, where methodological scepticism was reflected in the question, "What can I hold as true beyond any doubt?" (Nonaka & Takeuchi, 1995, p. 23)

Descartes said that one could question all beliefs except the existence of the questioner, and expressed this with the phrase, "I think, therefore I am" (*cogito, ergo sum*), which suggested that ultimate truth can only be deduced from the existence of a thinking-self, since it assumes that the thinking-self is independent of body or matter, "because while a body or matter does have an extension ([i.e.] all existence we can see and touch) in space, [it] does not think, while a mind has no extension, but thinks ... Thus, true knowledge about external things can be obtained by the mind, but not by the senses" (Nonaka & Takeuchi, 1995, p. 24).

Empiricism (developed by John Locke) on the other hand, suggested that things existing in the real world are naturally objective. He said,

"even if the sensory perception of things is illusory, it is undoubtedly evident that something can be perceived. Locke compared the human mind to a *tabula rasa* or white paper, void of all characters and having no *a priori* idea. He used this metaphor to reject the rationalist argument that the human mind is already furnished with innate ideas or concepts, and argued that only experience can provide the mind with ideas." (Nonaka & Takeuchi, 1995, p. 24)

Furthermore according to Locke,

"there are only two kinds of experience, sensation and reflection, where sensation is sensory perception, which is the source of most of our ideas, and reflection, which is the perception of the operation of our own minds within us, i.e. "the other foundation from which experience furnisheth the understanding with ideas." (Locke, 2003, p. 133).

Empiricism therefore posits that the only source of knowledge is sensory experience, i.e. there is no *a priori* knowledge, and that in fact, "everything in the world has an intrinsically subjective existence. Even when one has an illusory perception, the very fact that something is perceived is significant." (Nonaka & Takeuchi, 1995, p. 24) An example of this kind of reasoning includes experimental science where knowledge is deduced from specific sensory experiences (Nonaka & Takeuchi, 1995).

2.2.1.b. Cartesian dualism and knowledge typologies

This rationalist vs. empiricist argument over the nature of knowledge has led to what is now referred to as the Cartesian Split (after Descartes) or the Cartesian Dualism of subject and object or mind and body, and has a strong grip on contemporary explorations of the nature of knowledge (Cook & Seely-Brown, 1999). The split follows on from the assumption that the essence of being a human depends on the rational thinking self, which itself from the rest of the world and other human beings in the search for knowledge (Nonaka & Takeuchi, 1995). It is characterised in Western theoretical traditions of knowledge by number of features including, a dualism between subject and object, a view of applied knowledge as a separate element, the conviction that knowledge mirrors reality, and a longing for eternal, i.e. universally valid laws of nature (Molander, 2002). However, this split is contrary to what Polanyi identified in 1966 as the tacit dimension, as is discussed in the following section.

2.2.1.b.1. Establishing the context for the research: Polanyi revisited

Although he is often credited with being the progenitor of modern knowledge management thought, it is unlikely that Polanyi developed his ideas in isolation. Although he does not explicitly acknowledge it, it is highly likely that his thinking was influenced by contemporaneous philosophers such as Habermas, Russell, Keynes, Moore, and Ramsey. Since however, this thesis is predominantly focussed on the operationalisation of tacit knowledge constructs, it is considered that a broad and/or deep treatment here of Polanyi's philosophical foundations would be speculative and distract from the purpose of the thesis.

However, it is probably salient to suggest that one of those who most likely influenced him would have been Ludwig Wittgenstein, that famous German philosopher of the early 20th century. Wittgenstein's treatment of "ostensive definition" (Wittgenstein, 1958, p. 4e) and the staircasing of meaning, e.g. from a name, through significance to application, and assertions and assumptions, are strongly signposted in Polanyi's writings. Indeed, such was Wittgenstein's influence on the debate that even modern contemporary discussions of the definition of tacit knowledge refer to the Wittgensteinians. They make distinctions between, "tacit knowledge as something that **cannot** be articulated verbally **in principle** in contrast to tacit knowledge as something that **is not** articulated by verbal means, but **can** be articulated linguistically" (Yu, 2007, p. 10 author's emphasis), yet still acknowledge that there are different interpretations of the concept.

To highlight the importance of the debate to this research though, this section revisits Polanyi's seminal work, and then discusses several contemporary definitions of knowledge including the dichotomous distinction between tacit-ness and explicit-ness, to show how complex and important it is to begin the study with a robust definition of knowledge itself.

It was into somewhat turbid philosophical waters that Michael Polanyi introduced *The Tacit Dimension* via a series of lectures delivered at Yale University in 1962 (Polanyi, 1966). The prescient genius of Polanyi's writing presaged what many contemporary writers appear to be doing today, which is to restate his ideas, albeit in more accessible language. Because Polanyi's ideas about tacit knowledge are considered so important in the context of this research, this section takes a somewhat detailed look at them for later comparison with the modern-day opinions that have formed the foundations of current thinking in the field of knowledge management. This section reviews Polanyi's insights into human knowledge, examines his analysis of knowledge, and describes his views on how humans acquire knowledge through the process of subception. Finally, it précisés his views on the relationship, structure and aspects of his observations.

Polanyi (1966) re-considered human knowledge by starting from the statement that, "we can know more than we can tell" (p. 4). He pointed out that,

"this fact seems obvious enough, but it is not easy to say exactly what it means. [He chose the example of knowing a person's face, and said that] we can know a person's face and can recognize it among ... a million. Yet, we usually cannot

tell how we recognize the face we know. So most of this knowledge cannot be put into words.” (Polanyi, 1966, p. 4)

However, he could also point out that in recent times police have developed ways that this knowledge can be shared, and then described what is known as a photo fit composite image. This, Polanyi suggested, indicates that it is possible to “communicate after all, our knowledge of a physiognomy, provided we are given adequate means for expressing ourselves,” (Polanyi, 1966, p. 5). But, he pointed out, the application of the police method does not “change the fact that previous to it we did know more than we could tell” (p. 5) at the time. Moreover, he noted that the use of the police method depended on people knowing how to match features they remembered with those in the photo fit collection, and to do it without being able to tell how this was done.

In other words, the “very act of communication displays a knowledge that we cannot tell” (Polanyi, 1966, p. 5). He described many other instances of how it is possible to recognize things that cannot be fully described in words or pictures. But in each instance, he pointed out the teaching of appearances through the use of practical exercises depended not only upon the actions of the master/teacher but also by “relying on the pupils’ intelligent co-operation for catching the meaning of the demonstration” (p. 5).

Polanyi (1966, p. 5) said that, “any definition of a word denoting an external thing must ultimately rely on pointing at such a thing.” This naming-cum-pointing is known as “ostensive definition”, which according to Polanyi conceals a gap that requires an intelligent effort on the part of the person to whom the description is being given. In other words, the message leaves out something that could not be told, but which required the hearer to discover for himself or herself.

Polanyi recognized that his analysis of knowledge was closely linked to a discovery of Gestalt psychology, that we may know a physiognomy by integrating an “awareness of its particulars without being able to identify these particulars” (p. 6). He described this discovery as taking place “through the spontaneous equilibration of its particulars impressed on the retina or on the brain” (p. 6). But he looked at Gestalt as the “outcome of an act of shaping of experience performed in the pursuit of knowledge,” (p. 6) which he held to be “the great and indispensable tacit power by which all knowledge is discovered and, once discovered, is held to be true” (p. 6). Gestalt psychology, according to Polanyi, centred its attention on *perception*, but the attention this gave to “knowing what” and “knowing how” left perception as an “impoverished form of tacit knowing,”

when it was in fact “the bridge between the higher creative powers of man and the bodily processes which are of prominence in the operations of perception” (p. 7).

Polanyi reported that psychological experimentation had isolated the principal mechanism by which knowledge is tacitly acquired. This faculty, by which “we apprehend the relation between two events, both of which we know, but only one of which we can tell,” was a process known as “subception” (p. 7), a form of subliminal perception (Bruner, 1957; Dixon, 1957; Goldiamond, 1958; Jenkin, 1957). According to Polanyi, subception has the structure of a skill since like a skill it combines elementary muscular acts, which are not identifiable, with relationships that we cannot define.

The psychological experiment referred to in the previous paragraph induced subception in volunteers by subjecting them to electric shocks (Polanyi, 1966, p. 8). In one experiment, volunteers learned to expect an electric shock after certain verbalisations, and in a second experiment they learned to suppress certain verbalisations that would evoke the shock. In both experiments the shock producing particulars remained tacit, i.e. the “subject could not identify [the particulars], yet relied on [his/her] awareness of them for anticipating the ... shock.” (p. 9) According to Polanyi, this illustrated the basic dualistic structure of tacit knowing. He called the two parts of tacit knowing, term 1 and term 2. In the experiments, he referred term 1 to the verbalisations and associations that induced the shock and term 2 to the shock itself.

Once the subject was able to connect these two terms, he/she was able to avoid the shock. Polanyi said that the connection itself remained tacit because the volunteer was paying attention to (i.e. attending to) the electric shock whilst relying on his awareness of the shock producing particulars, only as far as they had any bearing on the electric shock itself. The volunteer, “learned to rely on his awareness of these particulars for the purpose of attending to the electric shock” (Polanyi, 1966, p. 9).

This then led to a *functional relationship* (Polanyi, 1966, p. 10)) between the two terms of tacit knowing (see Figure 1 below), i.e. the first term is known only by depending on an awareness of it through the attention that is paid to the second. “In an act of tacit knowing, [people] *attend from* something for attending *to* something else, [i.e.] *from* the first term *to* the second term of the tacit relation.” (p. 10) He used the language of anatomy to call the first term proximal and the second term distal, and said that it is the proximal term that people have a knowledge of, but which they may not be able to tell.

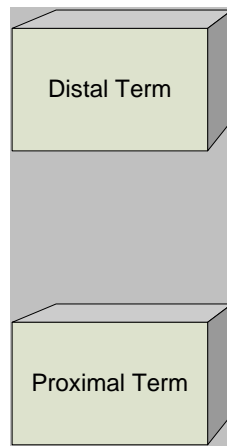


Figure 1: Polanyi's *Functional Relation* between the 1st (Proximal) term and the 2nd (Distal) terms of tacit knowing (Polanyi, 1966, p. 10)

Therefore, according to Polanyi, the *functional structure* of tacit knowing can be demonstrated when it is relied on for an “awareness of a combination of muscular acts for the purpose of attending to the performance of a skill” (p. 10) - see Figure 2 below. That is to say that when attention is not paid to the (proximal) elementary movements, but instead to the achievement of the (distal) joint purpose, then people are usually unable to identify or describe the elementary acts.

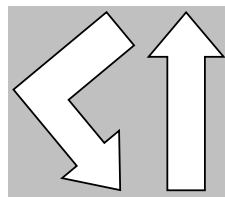


Figure 2: Polanyi's *Functional Structure* suggests we rely on our awareness of a combination of muscular acts for attending to the performance of a skill (Polanyi, 1966, p. 10)

He went on to describe a *phenomenal structure* (p. 11) of tacit knowing as the awareness of the proximal term of an act of tacit knowing in the appearance of its distal term (see Figure 3 below). In other words, “we are aware of that from which we are attending to another thing, in the appearance of that thing” (p. 11).

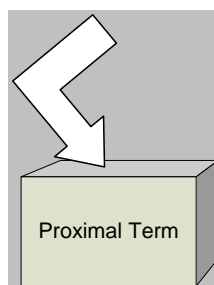


Figure 3: Polanyi's *Phenomenal Structure* suggests we are aware of that thing from which we are attending to another thing in the appearance of that thing, e.g. we are aware of a concert pianist's skill in the performance of that skill (Polanyi, 1966, p. 11)

The awareness of the proximal term arises out of its meaning to us, which Polanyi refers to as the *semantic aspect* (p. 13) of tacit knowing (see Figure 4 below). By way of illustration, he provided the following two examples. In the case of a known person's face, a characteristic physiognomy is the meaning of its features, as for example when a face expresses a particular mood. In other words, the identification of a face amounts to a person relying on being aware of its features at the same time as attention is given to their joint meaning.

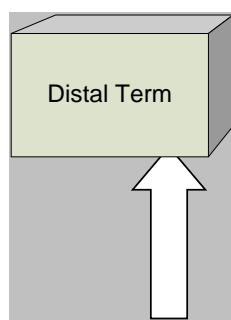


Figure 4: Polanyi's *Semantic Aspect* suggests we attend to the meaning, e.g. of a tool's impact on our hands, in terms of its effect on the things to which we are applying it, e.g. in the use of that tool (Polanyi, 1966, p. 13)

Since the meaning of the features is observed at the same spot where the features are situated it is difficult to mentally separate the features from their meaning even though the two are distinct. It may be possible to know a face without being able to specify its particulars. The second example is in the use of a probe to explore a cave, or "the way a blind man feels his way by tapping the stick" (p.12). In this example, the separation of a meaning from that which has the meaning is wide, but Polanyi said that it is possible to observe the process by which the separation gradually takes place.

"Anyone using a probe for the first time will feel its impact against his fingers and palm. But as we learn to use a stick for feeling our way, our awareness of its impact on our hand is transformed into a sense of its point touching the objects we are exploring. This is how an interpretive effort transposes meaningless feelings into meaningful ones, and places these at some distance from the original feeling. We become aware of the feelings in a hand in terms of their meaning located at the tip of the probe or stick to which we are attending." (Polanyi, 1966, p. 12)

This is also true when considering the use of a tool, when a person attends to the meaning of the tool's impact on their hands in terms of its effect on the things to which they are applying it.

Polanyi deduced as a fourth aspect of tacit knowing, that which he called its *ontological aspect* (p. 13), which is that meaningful relationship between the two terms, the proximal and distal. It is a relationship that can be identified as the “*understanding* of the comprehensive entity, which [the] two terms jointly constitute” (p. 13) see Figure 5 below. Polanyi extended his argument about the duality of tacit knowing to include perception, empathy, indwelling, and interiorisation (e.g. acceptance to moral teachings) as all aspects of the proximal term in that they are all things that we attend from, to another.

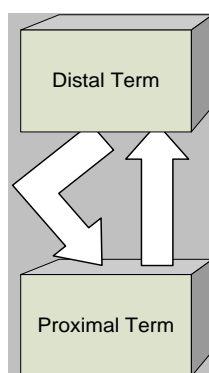


Figure 5: Polanyi’s *Ontological Aspect* suggests we comprehend the entity by relying on our awareness of its particulars for attending to their joint meaning (Polanyi, 1966, p. 13)

Perhaps it was in response to Polanyi’s efforts to describe knowledge as having proximal and distal terms, and having a functional relationship between its phenomenal structure and ontological aspects that later writers have attempted to clarify differences in how knowledge (and tacit knowledge in particular) is understood. Indeed, in many contemporary writings, some of which will be referred to later, the Semantic Aspect of this functional relationship (or awareness of the distal term) appears to have become the explicable de facto *know-what*, and the Phenomenal Structure (or performance of a skill or awareness of the proximal term) has become the ineffable de facto *know-how*.

2.2.1.c. Contemporary descriptions of knowledge

If, as Zins writes, “to know is to understand on the basis of making a difference between message (or meaning), and information (as meaning selection)” (2007, p. 481), what then is knowledge? In contemporary lay literature, e.g. the Oxford English Dictionary, knowledge is defined as expertise and skills acquired by a person through experience or education, or the theoretical or practical understanding of a subject, or what is known in a particular field (including the totality of facts and information), or an awareness or familiarity gained by experience of a fact or situation (Wikipedia, 2010). Knowledge is

also considered to be a recursive element in the Information/ Knowledge/ Data/ Wisdom hierarchy, although more on this later in this section on page 23.

By comparison, the suggestion is made here that the academic literature itself does not provide any better definition of knowledge (as explored below) than the lay literature, because it dichotomises the dual nature of knowledge. In the tacit knowledge discourse this dichotomisation is not particularly useful, because of Polanyi's assertion that the tacit dimension has both proximal and distal parts that are inseparable without losing meaning. For example, a dichotomous distinction is drawn between tacit and explicit knowledge, perhaps most famously by Nonaka and Takeuchi in "The Knowledge Creating Company" (Nonaka & Takeuchi, 1995). Other dichotomous distinctions, which may be due to what Gertler (2003, p. 77) identified as Polanyi's "felicitous phrase"², include Capurro's (2002) implicit and explicit types of knowledge, and Eraut's (2000) identification of codified and personal knowledge, both of which are suggestive of Polanyi's proximal and distal terms of the tacit dimension.

The idea that the dichotomisation of knowledge is not helpful is supported by other suggestions in the literature (e.g. Seeley-Brown & Duguid, 2001) that such simple dualistic terms do not suffice. Two terms provide only partial perspectives, or metaphors of only limited utility, because knowledge is the sticky, leaky, mobile *know how* and *know that* that are independent and cannot be reduced to one another since knowledge is embedded in the social networks of practise and have social-epistemic bonds. This view seems to be supported by other writers who view knowledge (at least in the business context), as actually information, reliable, actionable, and based partly on experience (Leonard & Sensiper, 1998), or as a localised public good, the application and productive use of which is dynamic, non-excludable, and non-rival (Roberts, 2000). All of which ideas are again highly suggestive of Polanyi's concepts, but this time of the functional relationship between the two terms of the tacit dimension.

Whatever the distinction, it seems that there is fairly universal agreement that knowledge *per se* is "the individual capability to draw distinctions within a domain of action, based on an appreciation of context, or theory, or both" (Tsoukas & Vladimirou, 2001, p. 973), which once again invokes Polanyi and his phenomenal structure. Or as Davenport and Prusak (1998, p. 5) have somewhat famously described it, knowledge ...

² Gertler's perhaps somewhat tongue in cheek reference is to Polanyi's phrase, "We can know more than we can tell"

“... is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practises, and norms.”

Along with the understanding that knowledge is all of the above, other writers suggest more value laden descriptions of knowledge, saying it is actually a source of power and can be threatened by restrictions and routines (Akbar, 2003). Again this is consistent with Polanyi’s argument that the duality of tacit knowing includes interiorisation.

What is obvious from the above is that discussions around knowledge in the management discourse have apparently shifted from a sceptical search for absolute truth, to a search for ways of valuing what is recognised as organisational knowledge assets. These assets include the technological, competitor, and supplier experiences embedded in operations and practises diffused throughout the organisation, but which are unfortunately poorly understood by economists, social scientists and managers alike (Tece, 2000).

2.2.1.c.1. Aristotelian typologies

In all of this debate, it appears that Aristotle’s thoughts continue to influence current thinking on knowledge as having types. His typology, which has modern equivalents in the form of know-how (corresponding with *techné*), know-why (corresponding with *episteme*), and know-what (corresponding with *phronesis*) (Zahn, 2000 in Capurro (2002)), may be what has stimulated others to develop typologies of their own. For instance, in order to make sense of what Alvesson and Karreman (2001) describe as a vague, inconsistent, broad, two-faced and unreliable concept, other authors have added knowledge types such as know-where, know-when, and know-who (e.g. Capurro, 2002).

2.2.1.c.2. Socially embedded typologies

Similarly, a number of approaches to clarify distinctions between knowledge types based on a social context have been developed, with several authors having identified four types of knowledge, e.g. tacit, explicit, individual and group (e.g. Cook & Seely-Brown, 1999). The suggestion here is that there is a distinction between knowledge and knowing, or action (behaviour imbued with meaning) and practice (action informed by meaning). Similarly, in an integrated framework, knowledge is said to be tacit, explicit, individual

and collective (Lam, 2000), and socially embedded and rooted in coordination mechanisms and organisational routines.

2.2.1.c.3. Explicit knowledge

Continuing in this theme of a contemporary focus on the dichotomous nature of knowledge, numerous attempts have been made to define the differences between tacit and explicit knowledge. While there is reasonable consensus over the nature of explicit knowledge, the same is not true for tacit knowledge, which seems to be particularly problematical.

Explicit knowledge is generally agreed as knowledge “that can be expressed in formal and systematic language and shared in the form of data, scientific formulae, specifications, manuals and such like, and can be processed, transmitted and stored relatively easily” (e.g. Nonaka et al., 2000, p. 7). In that sense, explicit knowledge can be “easily processed by a computer, transmitted electronically, or stored in databases” since it can be codified and recorded or transmitted in the form of symbols, e.g. writing or drawings (Nonaka & Takeuchi, 1995, p. 9). It can also be embodied in a tangible form, e.g. in a physical skill (Leonard & Sensiper, 1998), in machinery or tools (Roberts, 2000), or “represented by some artefact such as a document or a video, which has typically been created with the goal of communicating with another person” (Marwick, 2001, p. 814).

In some cases, explicit knowledge is synonymous with theory, a broad notion that includes any framework, or set of generalising principles, or abstract instructions. For example, in the same way that “a judge brings a set of legal principles to bear on a particular situation, so [does] a copier technician [draw] upon ... a set of abstract instructions to repair a faulty photocopier. In other words, whatever abstract principle enables an individual to generalize across contexts counts as theory [or explicit knowledge] and forms a basis for exercising judgement” (Tsoukas & Vladimirou, 2001, p. 979).

2.2.1.c.4. Tacit knowledge

Tacit knowledge on the other hand is identified as a natural (as opposed to a nominal) concept that is used ostensively, and is acquired on one’s own with little environmental support. It is described as procedural, and is conceptualized at cognitive representational, behavioural and articulated levels, or modelled in terms of the mental processes of memorising, i.e. encoding and storing and retrieving information, with distinctions drawn between episodic, semantic, and procedural memory (Sternberg et al.,

2000). Essentially, it is non-codified knowledge that is acquired via the informal take-up of learned behaviours and procedures (Howells, 1995 in; Roberts, 2000).

Along the same lines, tacit knowledge is also described as knowledge that arises not only from implicit acquisition but also implicit processing (Eraut, 2004), and is also the most important basis for the generation of new knowledge (Marwick, 2001). Several authors suggest that it is possible to use tacit knowledge to generate explicit knowledge and when explicit knowledge is acquired, the tacit knowledge is still possessed (Cook & Seely-Brown, 1999; Nonaka & Takeuchi, 1995).

Tacit knowledge is also described as,

“a factor of practical intelligence, or a function of an individual's practical ability to learn from and to solve everyday problems in order to adapt to, to select, and to shape their environment in pursuit of personal goals. [Thus it distinguishes between] more and less successful performers in different domains”, (Hedlund et al., 2003, p. 118)

and is expressed in everyday phrases like *professional intuition* or *common sense* that are relevant to competent performance. It is difficult to communicate to others because it is not openly expressed or readily stated (Hedlund et al., 2003) since it is “an analogue process that requires a kind of simultaneous processing” (Nonaka et al., 2000, p. 7). Others suggest that it is knowledge “largely acquired through experience about how to act in specific situations, but which is not readily articulated” (Hedlund et al., 2003, p. 118) nor widely shared, because it is “what the knower knows derived from experience” (Marwick, 2001, p. 814).

Other conversations have focused on the technical aspects of tacit knowledge, or on labour processes that draw on capacities and attributes located within the employee, including their self-awareness of their own social skills. Thus it is possible to view self awareness as a form of tacit knowledge, since it allows workers to consciously use their emotions to influence their performance of their work (Teigland & Wasko, 2009).

If one looks beyond the jargon and somewhat pontifical nature of these discussions, it is possible to discern that these are all descriptions of a complex construct and are remarkably evocative of Polanyi's illustration of the blind man and a stick.

Continuing with the theme of difficulty in describing it, tacit knowledge is also described as “informal, inchoate, or obscure” and unable to be codified or articulated (Cook & Seely-Brown, 1999, p. 384). Or, it is knowledge that is not yet explicated (Leonard &

Sensiper, 1998) because it resides in the background of consciousness and is imperfectly accessible to conscious thought, i.e. it is knowledge that “cannot be reduced to a simple, formalised rule that can be readily conveyed to others” (Hedlund et al., 2003, p. 118). According to some writers, tacit knowledge embodies beliefs and values, and is actionable knowledge, and therefore the most valuable because it is deeply rooted in action, procedures, routines, commitment, ideals, values and emotions (e.g. Schon, 1983 in Nonaka et al, 2000, p. 7). Or yet again, it is knowledge that is highly personal and hard to formalise, since it includes subjective insights, intuitions and hunches or flashes of inspiration, and decisions based on *gut feel* (Leonard & Sensiper, 1998; Nonaka et al., 2000), which all invoke a ready comparison with Polanyi’s ideas about subception.

These contemporary descriptions of tacit knowledge appear to be attempts to clarify in layman’s terms what Polanyi so cogently described as the semantic and ontological aspects of the tacit dimension, and are thus simply attempts to describe the functional relationship and phenomenal structure that exists between the proximal and distal terms of the everyday phenomena in people’s lived experiences.

2.2.2. The dichotomous view at odds with Polanyi

The dichotomous view of knowledge as tacit or explicit is at odds with Polanyi’s (1966) original concept of the tacit dimension because he had cast the whole structure of Gestalt into the logic of tacit thought, which he said changed the range and perspective of the subject. He said that the highest forms of this Gestalt integration, i.e. “the outcome of the active shaping of experience performed in the pursuit of knowledge, ... are manifested in the tacit power of scientific and artistic genius” (Polanyi, 1966, p. 6). After this Polanyi says, comes the art of the expert diagnostician and the performance of skills, both artistic, athletic and technical. These Polanyi gave as examples of knowing both intellectually and practically; “wissen” and “konnen” in German, or the “knowing what” and “knowing how” of Gilbert Ryle (Polanyi, 1966, p. 7).

So when he talked about knowing, Polanyi always did so to include both practical and theoretical knowledge. He also interpreted the use of tools, probes and pointers as further instances of the art of knowing as well as the denotative use of language, which he described as “a kind of verbal pointing” (p. 7), saying that “these two aspects of knowing have similar structure and neither is ever present without the other” (Polanyi, 1966, p. 7), and he always spoke of “knowing” to cover both practical and theoretical knowledge.

It seems that what Polanyi was saying is that tacit knowing is a true belief justified by *both* logic *and* sensory experience, and he never saw a distinction between explicable (logical) and inexplicable (sensory) tacit knowing. What he did allude to though, was that sometimes we may not know what knowledge is explicable without it losing its meaning (Polanyi, 1966, p. 18). Polanyi is therefore quite clear about the nature of the tacit dimension; it is at the same time logical and sensory, explicable and ineffable.

2.2.3. *Difficulties with Polanyi*

One of the problems with Polanyi's writing as Spender (2008) implies, is that it is very dense – which makes it difficult for Western thinking in two ways. In the first, Polanyi's complex language obscures his ideas and it is difficult to see the distinctions that he makes between what is explicable and what is not. The second is that when a Western reader is introduced to Polanyi's subtle distinctions between one element of the tacit dimension and another, that reader's probable Western style and typically dichotomous mental model, (either rationalist or empiricist) may come into play.

Perhaps it is difficult for a Western mindset with its *either/or* Cartesian perspective to hold a *both/and* point of view, which may be why it needs to dichotomise his concepts to make some kind of sense of the complexity. It could well be that the Western reader tends to hang what is comprehensible in Polanyi's writing onto either a rationalist or an empiricist peg, thus implying that in the tacit milieu there is an *either/or* distinction about the nature of tacit knowledge, i.e. either it is explicable or it is not. This distinction arises perhaps not because of what Polanyi said, but because of the way he said it. It may well be that it is his "felicitous phrase" (Gertler, 2003, p. 77) that we can know more than we can tell, that lies at the heart of the distinction between tacit and explicit, and also what makes a hierarchical knowledge typology, such as the DIKW in the following section, so seductive.

2.2.4. *The DIKW hierarchy*

As has been described earlier in this chapter, philosophical efforts to get around the Gettier problem with JTB in the contemporary knowledge management discourse have resulted in numerous attempts to define knowledge. One attempt of particular note is what is known as the DIKW hierarchy, a typology that has been first ascribed to Russell Ackoff (1919 – 2009) – who also included Understanding as a category (as cited in Spender, 2008).

This hierarchy is important to this research project for two reasons. Firstly, on the face of it distinctions between the different levels or domains in the hierarchy make a kind of

intuitive albeit problematical sense. For instance, in the context of modern information technology, a clear distinction between Data, Information, Knowledge (and Wisdom or Understanding – depending on the author) suggests a clear-cut difference between the domains, somewhat akin to the dichotomous distinctions within the tacit dimension just discussed (Alavi & Tiwana, 2003). It is easy to see how this could have happened since the terms are common enough in everyday language to imply that there are clear divisions. Perhaps the perception was initiated when the poet and playwright T.S. Eliot formalised the differences in the opening stanza of the choruses from “The rock: A pageant play” (Eliot, 1934),

Where is the Life we have lost in living?

Where is the wisdom we have lost in knowledge?

Where is the knowledge we have lost in information?

or perhaps it was another American writer, Frank Zappa, who concretised the perception in “Packard Goose”, a track from the 1979 album, Joe’s Garage (Zappa, 1979), with

Information is not knowledge

Knowledge is not wisdom

Wisdom is not truth

Regardless of how the distinctions arose, they resonate with the Cartesian dualism talked about earlier, and the implication that an ability to make sense of one domain makes it possible to make sense of another (Birkinshaw & Sheehan, 2002; Bordum, 2002). Since information technology helps us to make sense of data and information, it is not too much of a stretch of the imagination to suppose that it can make sense of knowledge and wisdom too (DeGard, 2006).

However, the previous discussion about the nature of knowledge suggests that these distinctions may be more of a hindrance than a help to an understanding of how to manage tacit knowledge. The idea that all that is required to make sense of a tacit phenomenon is an appropriate amount of deconstruction into its proximal and distal parts is untenable, (that is to say, to deconstruct wisdom into knowledge, knowledge into information, and information into data), because according to Polanyi this would completely destroy their functional relationships and hence destroy any meaning.

Polanyi explained that he could see how "an unbridled lucidity can destroy our understanding of complex matters," (1966, p. 18) when he pointed out that by closely

scrutinising the particulars of a comprehensive entity, their meaning becomes effaced (or destroyed) and the conception of the entity is destroyed. One of the examples that he gave included the case of repeating a word several times, i.e. attending carefully to the motion of the tongue and to the sound that is made eventually causes the word to lose its meaning. He also considered that if pianists concentrated all their attention on their fingers, they could temporarily paralyse their movements. Similarly, people can make themselves lose sight of a pattern or a face, by examining its individual parts under sufficient magnification.

Although the destruction of the meaning of the coherent entity that is being closely scrutinised can be made good, by "interiorizing the particulars once more" (Polanyi, 1966, p. 18) so that the entity recovers its meaning and its comprehensive relationship, Polanyi said that it is important to note that this recovery never brings back the original meaning – instead it may improve on it. For examples, he cited motion studies, which although they tended to paralyse a skill, actually improve the skill when followed by practice. Another example was the “meticulous dismembering of a text, which can kill its appreciation, but can also supply material for a much deeper understanding of it” (p. 19).

Detailing the particulars, which by itself destroys the meaning, can also guide their subsequent integration by establishing a more secure and accurate meaning of them. Polanyi offered a warning here that the “damage done by the specification of particulars may be irremediable” (p. 19), although in general particulars are more tangible than coherent entities, and can lead to the mistaken belief that knowledge of the particulars offers a true conception of things, which leads to the second reason why the DIKW hierarchy is important for this study.

A hierarchy implies that different domains are discrete and self-explanatory. The previous discussion about the nature of knowledge notwithstanding, and based on the previous paragraphs on Polanyi’s discourse on making sense of tacit phenomena, there is another reason why the DIKW hierarchy is not tenable in this study.

Even though contemporary discussions consider each domain in the hierarchy to contain implicit parameters of the next level, such that data implicitly contains parameters from the domain of information etc., the *converse* is also true. That is to say, “knowledge contains parameters from the domain of information, and information contains parameters from the domain of data, [and] ... although they can be considered discrete” (Williams, 2006, p. 82) they are - consistent with Polanyi - also recursive. This clearly puts tacit knowledge, which is already difficult to pin down, simultaneously both

inside and outside such a hierarchy and therefore not truly a knowledge element in the DIKW hierarchy.

2.2.5. *Tacit knowledge and experience*

Given the problems with its definition then, for the purposes of this research it is probably worth considering tacit knowledge in terms of experience rather than in terms of dichotomous divisions or hierarchies.

In popular literature, the word "experience" itself is both a verb and a noun (Oxford_University_Press, 2010) and in the academic literature around tacit knowledge it is also used in both of these senses, ascribing it to groups and individuals equally (e.g. Gabbay & le May, 2004; Gertler, 2003).

Where the word is used as a noun, it is typically associated with the non-documented accumulation of knowledge or skill that results from direct participation in events or activities (Cook & Seely-Brown, 1999). When it is used as a verb, it is associated with a group or an individual undergoing an event (e.g. Choi & Lee, 2003), or an emotional sensation such as trust (e.g. Seeley-Brown & Duguid, 2001), or to be in a particular state of mind such as a feeling of uncertainty (e.g. Koh, Gunasekaran, & Saad, 2007). In some cases, it is associated with the passage of time. Indeed some writers go so far as to say that it "takes at least 10 years" (Swap, Leonard, Shields, & Abrams, 2001, p. 97) to develop true expertise, although there is a weak correlation between the amount of knowledge accrued as a result of time (Hedlund et al., 2003).

Experience is also equated to genre, a group experience that is so common that the group is unconscious of it (Cook & Seely-Brown, 1999), and to shared norms, conventions, values, expectations and routines in institutional frameworks (Gertler, 2003). It is also equated to *mind-lines* – "collectively reinforced, internalised, tacit guidelines" informed by reading or by personal interactions with colleagues, opinion leaders, and other stakeholders, e.g. patients or pharmaceutical representatives (Gabbay & le May, 2004, p. 1). It is also synonymous with procedural knowledge that is associated with practical problem solving, but which is not easily articulated or shared, e.g. about how to act in specific situations (Hedlund et al., 2003).

Experience that is bodily, action oriented, practical, and individual refers to context-specific tacit knowledge. In spite of the difficulties associated with this, efforts have been made to formalise it into explicit knowledge, e.g. through tacit knowledge inventories, or explication processes - such as the generalising of learning from

uncertainty (Hedlund et al., 2003; Koh et al., 2007; Lam, 2000; Nonaka et al., 2000). Similarly, esoteric experience is associated with an idiosyncratic knowledge base, and integrated technical and managerial expertise (Lam, 2000). Attempts have been made to aggregate the tacit knowledge of decision makers, to enable subsequent decision makers to make decisions based on experience they do not have personally (Noh, Lee, Kim, Lee, & Kim, 2000).

In firms, both formal and informal experiences are recognised in the distinctions between how knowledge is acquired and promoted to improve performance, such as in faster responses to customers. Depending on their strategies for managing knowledge, firms either emphasise system-oriented styles that focus on codifying and reusing knowledge, or human-oriented styles that emphasise interpersonal experience (Choi & Lee, 2003). From this it can be concluded that both formal and informal (practical) experiences are considered important in terms of competence, since competence is characterised by broad conceptions of knowledge, based on formal theory (study) and on practical skills or work (Lam, 2000).

Based on the preceding paragraphs, it can be seen that there are difficulties in discerning the distinctive and specific knowledge that experience provides, and one is left with the potentially confusing burden of interpreting in any given context what the knowledge content of that experience might be. In almost all cases in the literature the term *experience* is used synonymously with tacit knowledge, even though it has been found to be poorly correlated with its acquisition (Hedlund et al., 2003). In addition, if one uses Davenport and Prusak's definition of knowledge (on page 18 of this chapter), and considers knowledge to be a process for incorporating new experiences, it is not clear how that knowledge can be conceptualised (Tsoukas & Vladimirou, 2001). Furthermore, there is confusion over other ways that experience is discussed. For instance, Kolb and Fry's (1975) widely recognised Learning Cycle talks about concrete experiences as if they were observations and reflections (Eraut, 2000), which appears to discount experiences as processes of sensory reception. Neither does the Learning Cycle distinguish between experience as a single incident or episode, when it could be considered the accumulated learning from multiple episodes, or as something either under our conscious control or not (Cunliffe, 2002; Eraut, 2004).

What is clear though, is that the more experience in a particular context a person has, the greater the likelihood that they will have an opportunity to accrue more tacit knowledge pertaining to that context, even if they are unable to articulate what that knowledge

might be. This may be because discrete experiences become distinguished from the flow of other life experiences only when they are given attention and reflected upon (Eraut, 2004). This thought is consistent with Polanyi, who said that with the identification of two terms of tacit knowing, (proximal and distal) and the recognition that when one attends from the first to the second, an integration of the particulars to the coherent entity to which one is attending is achieved. In other words, it is possible to make certain things function as the proximal term of tacit knowing ...

"so that instead of observing them in themselves, we may be aware of them in their bearing on the comprehensive entity, which they constitute." In other words, it is not just by simply looking at things, but by dwelling in them, that we understand their joint meaning (Polanyi, 1966, p. 17).

The implication of Polanyi's statements is that as long as people have experiences, and have the opportunity to (as quoted above) "be aware of them in their bearing on the comprehensive entity" -perhaps through specifically set aside *dwelling in* processes, e.g. of reflection, they will develop tacit knowledge in that context. Therefore, for this study it seems appropriate to think of tacit knowledge in terms of types of bodily and perceptual coherence, perhaps even intelligence, which grows from reflecting on experiences.

2.2.6. *Tacit knowledge in terms of intelligence*

Having considered tacit knowledge as an asset, or as experience, or as common sense, or even as coherence, it is not that much of a stretch of the imagination to also consider it as intelligence. If one takes Howard Gardner's view that to it is "helpful to think of ... intelligences ... as sets of know-how – procedures for doing things" (Gardner, 2004, p. 69), then it is relatively easy to create a conceptual bridge between a theory of multiple aspects of tacit knowledge and his theory of multiple intelligences. This is especially so if one takes into account Gardner's warning that,

There is a universal human temptation to give credence to a word to which we have become attached, perhaps because it has helped us to understand a situation better ... intelligence is such a word; we use it so often that we have come to believe in its existence, as a genuine tangible, measurable entity, rather than as a convenient way of labelling some phenomena that may (but may well not) exist. (Gardner, 2004, p. 69)

Gardner says that "intelligences are specifically linked to content" and claims that "human beings have particular intelligences because of informational contents that exist

in the world – numerical information, spatial information, information about other people” (2004, p. xxxv). He goes on to argue that “there is persuasive evidence for the existence of several relatively autonomous human intellectual competences” (2004, p. 8) which he calls “frames of mind”. Each of these frames of mind can be conceived of as an intelligence because they comply with all the requisite criteria for an intelligence, i.e. potential isolation by brain damage, existence of idiots savants, prodigies and other exceptional individuals, an identifiable core operation or set of operations, a distinctive developmental history, a definable set of expert “end-state” performances, an evolutionary history and plausibility, support from experimental psychological tasks, and susceptibility to encoding in a symbol system (Gardner, 2004, Ch. 4).

Gardner goes on to say it is “helpful to think of the various intelligences chiefly as sets of know how – procedures for doing things” (2004, p. 69). Since the literature clearly says that tacit knowledge is as much about know how, i.e. doing things, as it is about know what, i.e. content e.g. (Chen, Sun, & McQueen, 2010; Hau & Evangelista, 2007; Wang & Wang, 2009), it makes sense to think of tacit knowledge in terms of the same criteria as Gardner’s frames of mind. The implications for this research are that rather than examining tacit knowledge through the lenses of language or logic, tacit knowledge phenomena could be examined directly through observing and participating in the acts of intelligent knowing how and knowing what.

2.2.7. Knowledge management

Moving on from discussions about knowledge, this review now turns to the literature on its management. Implicit in the literature is the suggestion that the management of knowledge is subtly different from the management of other resources. Because knowledge has an inherent power (Schultze & Stabell, 2004) that is both the mysterious (Starbuck, 1992) and can be wielded (Cook & Seely-Brown, 1999; Martins, 2007), care must be taken in how knowledge is obtained, e.g. through observation (Collins & Hitt, 2006), and how and with whom it is shared - whether they be partners (Connell, Klein, & Powell, 2003) or employees/followers (Costigan et al., 2006). Care must also be taken with how it is applied, e.g. in analysis (Keller & Dungan, 1999; Klein & Myers, 1999), because it is empathy and trust that are needed in the push and pull of individual knowledge sharing (Denning, 2006) rather than the more bureaucratic approaches associated with management such as hierarchy, formalisation, control and direction from above (Alvesson & Karreman, 2001).

It seems that the management of knowledge is more associated with coaching, e.g. on quality, culture, business process, technical issues, etc. (Chen & McQueen, 2010; Chen et al., 2010; Cortese, 2005), or coping with diversity (Alvesson & Karreman, 2001), or large amounts of data (Ambrosini & Bowman, 2001), or ambiguity (Baumard, 2002), or uncertainty (Cohen, 2007), as it is about grappling with challenges (Economist, 2006), new initiatives (Anand, Ward, Tatikonda, & Schilling, 2009), and new knowledge (Edmondson, Winslow, Bohmer, & Pisano, 2003).

In many cases, it seems the practical management of knowledge is about how an organisation goes about handling things; whether that be handling situations according to best practice (Connell et al., 2003), handling relations (Cortese, 2005), handling routines (Economist, 2006), or somewhat prosaically, handling bread dough (Nonaka & von Krogh, 2009).

What the literature therefore suggests is that supervisory management *per se* is the day-to-day systematic treatment of assets through the processes of planning, budgeting, delegating, problem solving, and controlling, and is involved with details, structure, and predictability, including understanding people. Supervisory management therefore pertains to a subset of knowledge management activities in the workplace, and for supervisors specifically, tacit knowledge management refers to the identification, capture, storage, retrieval, and application of knowledge assets applied in the context of work done by the people under their supervision. From a practical applied research perspective then the questions that need to be asked in this project should be about how can supervisors manage tacit knowledge in a way that is mindful of any balance of power that may exist in the workforce, that does not stifle the natural individual push and pull of knowledge by over bureaucratisation, and develops organisational coping strategies that can handle complex modern work environments.

2.2.7.a. Knowledge management definitions

The term knowledge management can be traced back to the emergence of the communications technologies that created access to computerised networks and allowed real time interaction, irrespective of physical distance, e.g. internet, and e-mail (Alvesson & Karreman, 2001). Even though it is associated with knowledge work, knowledge intensive firms, organisational learning, and organisational culture, there is yet no definitive definition of the term knowledge management. Indeed, in a recent (yet to be published) survey of knowledge management practitioners over 130 different responses

were received in answer to the question whether they had a definition of knowledge management and what it was? (Oesterreich, 2010)

The general consensus seems to be that knowledge management includes the set of business processes that emphasise technology and people. More than just building a large electronic library, knowledge management is about connecting people so they can think together. It is “an umbrella term for a wide spectrum of academic orientations [including] information systems, organisational learning, [as well as] strategic management and innovation” (Alvesson & Karreman, 2001, p. 996). Knowledge management also facilitates the manifestation and enforcement of norms for sharing and documenting circumstances in organisations, such as cases or experiences, or about past and current development efforts. It provides a company wide system for publishing or ameliorating experiences, and for making them more accessible across the organisation. Knowledge management makes it possible for people to contact those who have specific expertise on specific topics, and if it has a high visibility within a company, it makes it possible to enforce norms since one of its functions includes identifying how much members contribute (Alvesson & Karreman, 2001; Ramesh & Tiwana, 1999).

The knowledge management process deals firstly with practical issues such as identifying organisational knowledge assets, and then with collecting, storing, and optimising them according to scientific methods so that they can be delivered to where they can be integrated with other knowledge, and turned into value (Spender, 2008).

Ironically, some consider the term knowledge management to be somewhat oxymoronic because there is research that shows typically the more focus that is placed on management, the less is placed on knowledge, and vice versa (Alvesson & Karreman, 2001; Spender, 2008).

2.2.7.b. The value of knowledge to organisations

One of the values of knowledge management is the ability it provides to search for specialised knowledge and to communicate among members. However it is difficult to value knowledge management initiatives because unfortunately business is stuck with an investment model that is geared primarily towards technology implementation (Alvesson & Karreman, 2001). When this is combined with the high costs associated with maintaining knowledge and keeping knowledge current in terms of both information technology (IT) and human resource management (HR) (Choi & Lee, 2003), it is difficult to accurately assess the value of knowledge management in financial terms. For example, although a large proportion of practitioners perceive intangible

value in their knowledge management systems (70% in a recent poll), less than half (46%) see clear financial returns from knowledge management (Oesterreich, 2010).

This may not always be the case though because recent advances in applied information economics (AIE), a theory first mooted in the 1960's as an approach to understanding the future development of accounting theory (Crandall, 1969), suggest that there may be a method that can account for the intangible risks and uncertainties associated with imperfect knowledge. AIE is slated to be able to calculate the financial return on investment (ROI) from knowledge or information (McShea, 2009). The idea has been taken further by Hubbard (2010) who suggests that AIE can be used to calculate the expected (dollar) value of information (EVI), a.k.a. knowledge. This value can be predicted with a 90% confidence interval (CI) degree of accuracy using a Fermi deconstruction (i.e. the deconstruction of an observable phenomenon into its constituent factors), and brute force probability calculations such as a Monte Carlo probability analysis to evaluate a range of specified outcomes from any given scenario.

2.2.7.c. The value of knowledge management to organisations

Aside from financial values, the intangible benefits of knowledge management include the creation of an organisational memory “in the form of different repositories, stored and maintained for future use” (DeGard, 2006, p. 8). Knowledge management also represents an effort to avoid mistakes, and can be an insurance policy against the loss of the organisational memory in the future. But to do this, firms require a new mentality from over *use/get data* mindset to *learn/contribute knowledge* habit. Another value is that it helps to ensure compliance with set requirements, or corporate mandates – addressing legal, security, and privacy concerns (DeGard, 2006).

The value of managing tacit knowledge specifically is that as the more codifiable, i.e. explicit and tradable knowledge can be accessed “the more crucial tacit knowledge becomes for sustaining and enhancing the competitive position of the [company. This is because] success depends upon the ability to produce new or improved products and processes for which tacit knowledge constitutes the most important basis” (Gertler, 2003, p. 78). Hence the three problems associated with tacit knowledge; how to produce it, how to find or appropriate it, and how to reproduce or share it, are associated with the goal of knowledge management, which is to create value by accumulating and leveraging intangible assets (Gertler, 2003).

Knowledge management is also thought of as an approach to tackling uncertainty, i.e. unpredictable events in an environment that disturb operations and performance, and

bounded rationality; a rational choice that takes into account limitations of cognitive capacity and knowledge (Spender, 2008). This is important for enterprises because they need to provide quick and robust responses to unpredictability and to be able to problem solve (Spender, 1993), particularly in the light of the increasing power of the mass customisation market (which increases the power of customers), and the requirement to compete in a seamless supply chain (to ensure reliable supplies). This is particularly important since organisations are vulnerable to using an ad-hoc approach to problem solving, especially when uncertainties are treated as one-off scenarios (Koh et al., 2007).

Other areas in which knowledge management has value include the provision of answers to questions around best practise. For instance it has been shown that the successful sharing of best practices requires close interactions between parties. A knowledge management strategy can help to define 'close' in terms of proximity, as well as in terms of cultural commonality (Gertler, 2003). It can help to establish those communities of practise that enforce or establish best practise (Gabbay & le May, 2004; Koh et al., 2007), and it can help to provide a virtual coffee pot to take the place of the traditional one, where people would congregate to share their ideas (Tece, 2000). Or on the other hand, when so called *best* practice is in fact only *second best* because of the limitations that an externalised process places on restricting upgraded or fine tuned deviations (Akbar, 2003), an effective knowledge management strategy can help to overcome this internal organisational knowledge stickiness (Seeley-Brown & Duguid, 2001), whilst at the same time preventing external knowledge leaks.

Another important area where knowledge management can add value is in innovation. For example, a knowledge management strategy can facilitate knowledge integration and application (Johannessen et al., 1999). It does this through rhythmic processes of search, selection, exploration, synthesis and divergent thinking and decision making (Leonard & Sensiper, 1998), giving rise to the requisite variety of ideas and potentially creative alternatives for viable product options or actionable next steps, where for example prototypes are explored. Knowledge management has been applied in engineering design, new product development, maintenance management, production management, quality management, and supply chain management (Koh et al., 2007; Yakhlef, 2005).

The sharing of knowledge, particularly tacit knowledge, through teams and networks is particularly effective for controlling corporate networks and is done through informal task forces and committees, which nurture learning and the development of sharing

linkages. (Athanassiou & Nigh, 1999). Similarly, an organisation's competitive edge and survival depends on its own specific ability to coordinate its divisions better than its competitors or the markets (Gabbay & le May, 2004; Seeley-Brown & Duguid, 2001), and complex systems of products and services require the merging of knowledge from diverse perspectives, including national, disciplinary and personal skill-based (Leonard & Sensiper, 1998) .

Knowledge, along with expertise, has also been described by economists and business strategists as a central feature of competitive advantage in post-industrial societies, particularly by Alvin Toffler, who identified we were living in a society of accelerated change (Toffler, 1970). Similarly in the current context where markets, products, technologies, competitors, regulations, and even societies change rapidly, continuous innovation and the knowledge that enables such innovation have become important sources of sustainable competitive advantage. Hence, management scholars today consider knowledge and the capability to create and utilise knowledge to be the most important source of a firm's sustainable advantage (Nonaka et al., 2000; Ramesh & Tiwana, 1999).

These strategists and economists suggest that wealth creation is less about a dependence on bureaucratic control of resources, than it is about a dependence on the exercise and management of specialist knowledge and competencies. This being the case, it has been proposed that because of technological changes, team organisation is becoming of critical importance and employees generally should be managed as knowledge workers (Blackler, 1995). This is because falling transaction costs, due in part to outsourcing and technology, strip away aspects of routine that are better dealt with elsewhere, making the production and coordination of knowledge assets more dominant and critical (Seeley-Brown & Duguid, 2001) especially where in-house designs of products that require specific technical skills are difficult to migrate to customers (Yakhlef, 2005). Similarly, breakthrough innovations, competitive advantage and differences in firm performance result from the harnessing of tacit knowledge possessed by individuals and project teams (Mascitelli, 2000; Srdoc, Sluga, & Bratko, 2005; Teece, 2000).

Knowledge management also adds value to values. This happens in the structured reflective socialisation processes of sharing personal experiences that create tacit knowledge stocks, which in turn enhance the sharing of values and moral judgements (Athanassiou & Nigh, 2000; Branson, 2007). Such is the potential for knowledge management to identify and enhance values that numerous studies have been conducted

on how this can be achieved (Liebowitz, Ayyavoo, Nguyen, Carran, & Simien, 2007). For instance seven value dimensions of harmony, embeddedness, hierarchy, mastery, affective autonomy, intellectual autonomy, and egalitarianism have been identified, with distinctive divisions between the War Generation, the Baby Boomers, and the GenXers. One of the outcomes of such studies is the finding that GenXers seem to be more tolerant of various social groups and are more in favour of intrinsic work values than older generations. This has significant implications for how firm strategies should be designed, and relates directly to knowledge management implementations. Another values related outcome is a finding about how individuals evaluate their own and others performance in what could be called the Kruger Dunning effect. This appears to be the propensity for individuals to underestimate their own performance when working in with others, but at the same time to overestimate their own performance when working in isolation (Kruger & Dunning, 1999).

2.2.7.d. Knowledge management and decision making

Knowledge management is associated with the decision making in firms, since it deals with the documents, systems, and databases that provide the standardised criteria and procedures for decision making (Choi & Lee, 2003), and problem solving (Fessey, 2002), for example around deciding where to locate future facilities (Gertler, 2003).

Since individuals have the responsibility for deciding what information they should attend to when making decisions, it is important that knowledge management systems are able to supply all relevant knowledge when decisions are being made (Hedlund et al., 2003). Indeed that is one of the primary reasons for the development of computerised knowledge storage and retrieval systems (Noh et al., 2000). This leads to the idea that knowledge can be considered a decision making contingency variable, that needs a risk assessment in its own right (Birkinshaw et al., 2002) .

Following on from the idea that knowledge is an organisational asset and should be managed, comes the idea that it can be managed. However, since the terms tacit knowledge and experience are somewhat vague and in need of further explication, there is still debate as to what actually constitutes the management of knowledge and tacit knowledge in particular. For instance, how can knowledge be identified, captured, stored, retrieved, and applied if it is embodied in an individual, or how can organisational knowledge grow if it is treated as a static, finite resource?

2.2.8. *The role of information technology in knowledge management*

As mentioned previously, the term knowledge management is associated with the emergence of communications technologies and their corresponding access to computer networks. As such, information technologies provide both a boon and a barrier to tacit knowledge management.

On the one hand information technologies, such as intranets and the internet facilitate the flow of information or explicit knowledge (Teece, 2000) – which although rarely providing a source of sustained competitive advantage do at least serve as catalysts and connectors for knowledge creation, for which tacit knowledge is a precursor (Ramesh & Tiwana, 1999). Similarly, multi-media integration that forces users to think through processes by articulating dependencies and assumptions can be useful for capturing knowledge that cannot be explicitly codified or written down, or for recording contexts that may not be codifiable. Along the same lines, distributed workspaces help prevent repetitions of past mistakes (and their associated learning experiences), and the retrieval of informal information can be supported with the use of Meta tags. Also, versioning of process knowledge can be supported by knowledge management systems, as can decisions from past or current projects, thus potentially reducing time spent reinventing solutions and/or costs (Ramesh & Tiwana, 1999). Another valuable function of information technology is in the ability to *disembed* and then *reembed* knowledge across space and time (Seeley-Brown & Duguid, 2001) through discussion forums, videoconferencing, and brain storming software. These are useful connecting devices along with webcasts, podcasts, e-newsletters and list serves, that provide virtual alternatives to more traditional networking practises, such as conferences and workshops (Birkinshaw & Sheehan, 2002). Information technologies can also be used to synthesise information or knowledge in one form and reproduce it in another, such as financial reports from financial information, or operational concepts from corporate visions (Nonaka et al., 2000)

However, a drawback of information technology in terms of tacit knowledge management is that it has led to *individualism diffusion* (DeGard, 2006). This is the propensity for individuals in firms to create their own information organisation structure on their own personal computers, with no agreement across the organisation on hierarchies of folders, nor naming conventions for files, and inconsistent uses of templates and forms. Other problems that information technologies face include absorptive capacity barriers on the part of recipients of explicit knowledge, such as

contextual cues, beliefs and assumptions, and user abilities (Ramesh & Tiwana, 1999). Even though information technology assists greatly with the “storage, retrieval, and transfer of codified knowledge” (Teece, 2000, p. 41), there is a view that the term knowledge management is too narrowly defined to apply in an information technology context, because however efficiently knowledge is organised, it is still simply efficiently organised knowledge; a helpful tool, but not much more (Teece, 2000).

In terms of tacit knowledge management then, what technology does do is to bring people together in a way that is not possible without it. For the majority of business applications, human (or tacit) knowledge will continue to be a valuable resource for the foreseeable future, and technology that helps to leverage that knowledge will be increasingly valuable (Marwick, 2001).

2.2.9. Summary of Parent Concepts and Definitions used in this research

2.2.9.a. Definition of knowledge in this research

Given that it is unlikely a definition for knowledge in terms of an unquestioned scientific truth of reality will be fully established in the foreseeable future, particularly from an organisational theorist’s point of view, it was decided for this research to use the ancient Platonic definition of knowledge, i.e. a justified true belief, in spite of its difficulties. This is because,

“... if companies, or the individuals within them, have *justified true beliefs* [researcher’s italics] about, say, customers and their intentions, that would seem pretty useful, and there may well be others in the firm who need to have that knowledge if the situation’s potential is to be realized. It may also be important to keep this knowledge from competitors.” (Spender, 2008, p. 162)

Furthermore, in this research project, issues around handling knowledge take precedence over arguments about what it is, and understanding what knowledge is matters less than understanding how people, in this case supervisors, make best use of it (Spender, 2008). So for the purposes of this project, the following definition of knowledge is provided.

Knowledge is a justified true belief

2.2.9.b. Definition of tacit knowledge in this research

In the previous discussion it was argued that the differences of opinion about the nature of tacit knowledge are essentially a philosophical disagreement between two schools of thought over whether knowledge is a true belief justified by logic, or whether it is a true

belief justified by sensory experience (Nonaka & Takeuchi, 1995; Spender, 2008). The position taken by those who say that tacit knowledge can be explicated appears to come from the rationalist school, which posits that knowledge is isolated from the world. Whereas those who say that tacit knowledge is ineffable appear to come from the empiricist school, which seems to say that knowledge does not have an existence independent of sensory perception. The major differences between these two schools really boils down to the answers to these two questions, "What constitutes the actual source of knowledge?" and, "What is the method by which knowledge is obtained?" The difference between the two camps is then over whether (tacit) knowledge is explicable and able to be separated from the body, or whether it is ineffable and remains bound within the body. Regardless of whether or not it can be explicated, tacit knowledge is personal knowledge.

Similarly in "technical areas, or where more strategic decisions are involved, tacit knowledge is more likely to be used for generating hypotheses or possible sources of action, which are then checked against other evidence or discussed with other people" (Eraut, 2004, p. 253). On occasion tacit knowledge may be used uncritically. That is to say people simply either believe that it works well for them, or they suffer a lack of time or their personal predisposition prevents them from looking for anything better, which is a common situation when they are overworked or alienated (Eraut, 2004). In any case, people act out of what they believe to be true at the time, which in this research project (as mentioned previously) is ample justification in spite of its philosophical difficulties, to use the ancient Platonic definition of knowledge.

The implication of this for this research project is that the description of *tacit knowledge* rests on a foundation of *experience* as observations and reflections, as well as *experience* as processes of sensory reception. Since knowledge can be considered a construction of reality rather than something that is true in an objective or universal way (Popadiuk & Choo, 2006), it is these experiences that give rise to a justified true belief. So for the purposes of this research the following definition of tacit knowledge is provided.

Tacit knowledge is a justified true belief, which arises from experience, and includes some aspects that are explicable, and others that are not.

This means tacit knowledge includes the Data, and Information, and Knowledge, and Wisdom domains in a nested and recursive typology, as well as emotional and affective states of mind. Because of its nature therefore, tacit knowledge cannot be assessed directly, but it can be evaluated in terms of how it is applied. For the purposes of this

research then, the general term *tacit knowledge phenomena* is used to include all knowledge related activities that can be referenced in observations. This includes not only descriptions of what the researcher perceived or felt with his own senses, but what others perceived with theirs too. Thus, tacit knowledge phenomena include actions and perceptual responses to stimuli, including attitudes and emotions as well as beliefs.

2.2.9.c. Definition of tacit knowledge management in this research

Building on the previous two subsections then and from a tacit knowledge management perspective as far as supervisors are concerned, it is not experiences (noun) that should be managed, but experiences (verb), because based on the previous discussion it is experience (verb) that gives rise to tacit knowledge. Furthermore, from an empiricist perspective it could be implied that because something is perceived it is therefore significant and worthy of knowing, which suggests that one of the keys to effective tacit knowledge management is not the knowing *per se*, but the communication of the knowing. So for the purposes of this research then,

Tacit knowledge management is the set of organisational communication methods, including culture, business processes, and technology, that deal with the identification, collection, storage, application, and enhancement of tacit knowledge assets for the purposes of optimising organisational performance.

The implication of this definition for this study is that tacit knowledge management, at the supervisory level at least, is about setting up and implementing processes that identify who has tacit knowledge and locating where it is in the organisation in terms of competencies. It is also about implementing processes that encourage and facilitate activities that generate, share, use, or build tacit knowledge assets in the minds of workers. This puts tacit knowledge management predominantly into the Leadership, Organisational Learning, and Human Resource Management type domains, and only peripherally in the domain of information technology, where it would be more about how supervisors can effectively use technology to bring people together in shared experiences.

2.3. Research Problem Theory

Having now identified tacit knowledge and tacit knowledge management, the following sections turn to what is already known about factors affecting its effectiveness.

2.3.1. Factors affecting knowledge management

It is axiomatic that numerous factors affect knowledge management, so this section discusses those that seemed to be of most importance to this research. These include supervisors and the supervisory role, the contexts in which knowledge is important to businesses, knowledge management styles, models, and methods, and the costs of managing knowledge. It also discusses tacit knowledge assets in terms of workers, agents and measures, and identifies known facilitators of, and barriers and limitations to effective tacit knowledge management.

2.3.2. Knowledge management enablers

Generally speaking, scholars and practitioners alike recognise that there are three major enablers for knowledge management, including information technology, business processes, and human resources or human capital (Birkinshaw et al., 2002; Herrera, Muñoz-Doyague, & Nieto, 2009). Of the three, information technology seems to have received the most attention, probably because of its ability to handle knowledge that is easily explicated (often referred to as explicit knowledge), and because of the development of information technologies themselves (Carrillo et al., 2004; Desouza, 2003).

This particular research project aims to build on the findings in the literature, and to fill some of the gaps in our understanding of how to manage the other kind of knowledge that is less easily explicated (or impossible – depending on the discourse), particularly at the supervisory level.

2.3.2.a. Supervisors and the supervisory role

Given that the focus of this research is around tacit knowledge management by supervisors, it could be argued that the most important factor affecting knowledge management at the supervisory level are the supervisors themselves.

To understand why this should be so, it is necessary to first understand the role of the supervisor and the value that they provide to organisations. By understanding the challenges they face, the rationale for them as the focus of this study becomes clear.

2.3.2.a.1. The supervisory role defined

Supervisors hold a unique position in work organisations as the interface or bridge between upper management and workers (Dowell & Wexley, 1978; Ramsey, 1993), and can be seen as crucial since they play a key role in the day to day conduct and decision-making regarding work and workers (Nethero, 1984; Parry, 1997). The role has

been likened to walking a circus high wire, because it requires an ability to maintain a balance between the conflicting forces of the need to harmonise the demands of management, the collective work force, and the work in hand. The position is often made more difficult because even though they have the responsibility for implementing goals of upper management, supervisors' organisational authority is frequently unclear and insufficient (Nelson, 1986; Sasser & Leonard, 1980; Wolfe, 1983).

Typically supervisors have been promoted from within the ranks of the workers themselves, and as such, they usually have a store of idiosyncratic knowledge that is of high value to the company (Collis & Winnips, 2002). In some countries, e.g. Germany, this knowledge base has been achieved through a higher level of training, but in others, e.g. the UK, simply through greater experience (Prais & Wagner, 1988).

2.3.2.a.2. Modern changes to the supervisory role

The role of the supervisor has evolved from the early days of the industrial age when the supervisor (or Foreman as the position was commonly called) acted as a "wholly independent contractor to a manufacturing plant owner" (Kerr, Hill, & Broedling, 1986, p. 104). The supervisor had responsibility for hiring, instructing, supervising, and paying a crew, and if he was dissatisfied with their performance, their dismissal as well, and no one told him how to do his job. However, near the turn of the last century when the concept of scientific management was popularised, by e.g. Fredric Taylor (Serpell & Ferrada, 2007), the independence of the Foreman/supervisor was eroded as organisations themselves began to assume responsibility for selecting and training workers, and over time the supervisor began to play the role of middleman between labour and management (Kerr et al., 1986).

During the 1970s the first-line supervisor's job was defined by work activities rather than job titles or individual characteristics. These work activities included supervision, employee contact and communications, union – management relations, manpower coordination and administration, work organisation, planning and preparation, and manufacturing process supervision and administration (Dowell & Wexley, 1978; Loban, 1979).

Later during the 1980s, new responsibilities were added to the supervisor's role, including solving problems and setting and accomplishing objectives through the work team (Johnston, 1983), maintaining harmony in departments, enforcing rules, planning and controlling use of personal time (Bittel & Ramsey, 1982), motivating workers and

creating work environments free from anxiety (Lucato, 1987) by ensuring procedural justice, i.e. making sure all workers are treated justly (Zainal & Abdullah, 2008).

Although the role was formally described in the Taft-Hartley act as,

"having authority, in the interest of the employer, to hire, transfer, suspend, lay off, recall, promote, discharge, assign, reward, or discipline other employees ... or effectively to recommend such action if ... the exercise of such authority is not of a merely routine or clerical nature ..."(Kerr et al., 1986, p. 104),

unionism has eroded the supervisor's prestige by winning wage increases, job security, and better working conditions for its members.

Latterly, the influences of information technology in the command and control role and structural changes induced through downsizing in organisations have resulted in the removal and reduction of hierarchical layers that have made supervisors increasingly accountable for demanding performance targets. This means that supervisors are becoming progressively more the focal point for managing teams rather than the traditional management hierarchy (MacNeil, 2004) since there is no one left to go up to, and they have to go directly to their colleagues to plan, build systems, resolve conflicts, and encourage change (Zenger, 1988).

The role has now evolved to include being a facilitator for encouraging knowledge sharing and developing collective learning capabilities. This presents a problem since typically while facilitators leave when a team is fully functioning, supervisors remain with the continuous role of encouraging knowledge sharing, but the different power relationship and collection of tensions between the supervisor as manager of the team and team members can mitigate against this facilitation role (MacNeil, 2004).

2.3.2.a.3. Knowledge management challenges to the supervisory role

These tensions present a problem if personnel are seen as the main source of value added and not a mere cost, because it requires that supervisors adopt a type of management for which they have not been trained (Serpell & Ferrada, 2007). This idea resonates with other writers who have identified that the quality of information sharing via both formal and informal communication channels is vital for adequate customer service, and the suggestion that the content of communications can affect the quality of decision-making in the workplace (Brunetto & Farr-Wharton, 2008). Thus, attention has been drawn to the need for empirical research concerning the supervisor's role in knowledge management that have resulted in a number of questions in the literature,

including “How do supervisors facilitate tacit knowledge sharing in teams?” (MacNeil, 2004, p. 99), which is the main focus of this research.

2.3.2.b. Contexts

An important factor that affects tacit knowledge management is its context, and there are a variety of aspects to context that are important to this study. Widely recognised among these are social contexts, such as societal, social and organisational cultures (Choi & Lee, 2003; D'Eridata & Barreto, 2006), individual and cognitive contexts, boundary and geographical contexts, and virtual contexts.

2.3.2.b.1. Social or cultural contexts

On a macro scale, societal contexts of knowledge management require that participants know each other – in the sense that they have achieved mutual understanding of issues based on a common membership in communities defined by culture, language, ideology, desire, mutual identification (Gertler, 2003; Hau & Evangelista, 2007), or other forms of bonding – such as a common industry (Teece, 2000). Thus in a Global sense, collaborative efforts across national boundaries require participants be sensitive to a diverse set of norms and attitudes, i.e. they should display a high level of cultural intelligence (Leonard & Sensiper, 1998).

In a more local sense, collaborative efforts that cross generational boundaries demand that relationships take on a mentoring aspect in order to encourage knowledge flows between individuals. The reason for this is simply because people have less time to get familiar with organisational mores as they move from one organisation to another, particularly in the cases of apprentices and journeymen (Liebowitz et al., 2007; Swap et al., 2001), and where official channels of communication are too slow and cumbersome to convey norms and values efficiently (Swap et al., 2001).

These societal contexts require that social skills and competencies be considered in the recruitment and selection of workers, not just the processes of doing work. That is to say, it is not only technical skills that are important for effective knowledge management, but also big picture knowledge of the institution (Leonard & Insch, 2005), and personal awareness, where workers have an understanding of themselves that allows them to consciously use their emotions to influence the quality of their product (Thompson, Warhurst, & Callaghan, 2001). From this research's perspective, this suggests that effective understanding of knowledge work in organisations requires an immersion in that organisation's culture (Fielden, 2006).

At the organisational level, several authors have emphasized that organisational culture, i.e. the shared values, beliefs, norms, and social relations embedded in socialisation activities, signs, symbols, and stories, rites and ceremonies, norms and values, and organisational rewards (e.g. Hill & Jones, 1999, p. 435 & 436)) forms the social context for knowledge management, because it is an “important precondition and constraint for knowledge management” initiatives (Alvesson & Karreman, 2001, p. 1015). It is in this context that knowledge is understood not as objective facts and causal relationships, but as a situated, community-based set of meanings, i.e. justified true beliefs. That is to say, knowledge is encultured, and meaning systems become related to the processes of socialization through the vehicles of shared language, imagery, and metaphor (Blackler, 1995). Thus, knowledge management initiatives that manipulate the organisational culture are likely to affect rates of knowledge acquisition and dissemination (Chen & Mohamed, 2007), because it is people that convert ideas into physical capital and routines (Starbuck, 1992). Because of its situated nature, organisational culture is considered an aspect of tacit knowledge (Rebernik & Sirec, 2007), which because of the difficulties associated with sharing it is recognised as a unique resource in organisations (Roberts, 2000), and in some cases an internal competitive intelligence asset (Williams, 2006), or if it is particularly rigid, a liability in others (Sigala & Chalkiti, 2007).

2.3.2.b.2. Individual and cognitive contexts

Since knowledge is dynamic, and created in social interactions amongst individuals and organisations (Nonaka et al., 2000), individual knowledge contexts are related to time and space as well as the individual’s interpretations of learning, practise, and the idiosyncratic forces bearing on them (Seeley-Brown & Duguid, 2001). These forces include rapidly changing situations that affect routines and embedded practises (Eraut, 2004). It is an individual’s intelligence (Gardner & Moran, 2006) or cognitive ability (Eraut, 2004) and their individual absorptive capacity (Seeley-Brown & Duguid, 2001) applied to meaningful participation in activities, e.g. through problem framing, decision making, or intuitively applied attention, which shapes their interpretations of the world. In that sense, individual knowledge inevitably reflects the social context in which codified knowledge is acquired, and it is the integration of personal as well as public concepts in the form of propositional knowledge, that forms the tacit dimension of individual knowledge.

Since “people tend to hold overly favourable views of their abilities in many social and intellectual domains” (Kruger & Dunning, 1999, p. 1121), and they display a wide variety

of intelligent performances (Gardner & Moran, 2006), it has been proposed that the role of knowledge management is not so much about the application of technology to knowledge, as it is the application of human effort to knowledge (Marwick, 2001). This idea is supported in the literature on the sociology of knowledge, which emphasises the social processes of knowledge production and sharing – the implication being that knowledge is a function of its social system (Birkinshaw et al., 2002). Thus deep levels of knowledge are manifested in the deeply contextualised rules of thumb that experts apply when making sense of unusual or exceptional experiences (Swap et al., 2001).

2.3.2.b.3. Boundary and geographical contexts

In a certain sense processes of knowledge creation transcend boundaries between individuals and their environment, and between work communities and their sectional, departmental, or divisional boundaries (Nonaka et al., 2000), but boundaries to knowledge management initiatives in organisations usually refer to operational contexts.

If for instance, an organisation operates across international markets, it is the face to face socialisation processes, e.g. discussions between people who have had experience in those linked markets, that creates tacit knowledge stocks rather than the sharing of knowledge via more external or explicit processes, such as exporting, licensing and franchising (Athanassiou & Nigh, 2000). A boundary in this case might refer to the ability (or lack thereof) for people to communicate personally, in the flesh, face to face.

However, even if socialisation processes are embedded within the organisation, there are still boundaries between the dedicated physical infrastructures for the various functional activities of the organisation, e.g. in research, engineering, manufacturing, etc., that have the potential to hinder the *coevolution* of knowledge. This is because knowledge has a causal ambiguity and complexity that is embedded in its location and depends on a particular time and space (Birkinshaw et al., 2002; Nonaka et al., 2000). Those organisations that recognise this, who overcome infrastructural barriers and implement a conservative knowledge management style that exploits internal knowledge, tend to outperform organisations that aggressively explore knowledge outside of the organisational boundaries (Choi & Lee, 2003), mostly because innovation cannot be outsourced in its entirety (Teece, 2000).

Another reason for recognising the importance of boundary contexts in knowledge management is because knowledge creating activities are not necessarily located specifically in space and time (Yakhlef, 2005). Undesirable, i.e. leaky, flows of knowledge occur across a firm's boundaries to its competitors (Seeley-Brown & Duguid, 2001).

Although this leakiness is usually associated with personal knowledge, knowledge losses can also occur either through deliberate transfer, e.g. learning agreements, or inadvertent transfer, e.g. spillovers in alliances (Teece, 2000). An implication of this leakiness is that as part of a knowledge management strategy, firms need to create protective governance structures (Williams, 1981 in Seeley-Brown & Duguid, 2001) or regimes of appropriability (Teece, 1986 in Seeley-Brown & Duguid, 2001) to prevent knowledge leaking out. This is particularly important when knowledge is shared across organisational boundaries via practitioners and their networks of contacts and relationships (Gertler, 2003).

One way perhaps to overcome the problem of leaky knowledge is to consider the organisation as a mechanism for producing an homogenous culture – in a local context – that agrees on certain policies (Gabbay & le May, 2004), and thus create a community that uniquely creates and warrants knowledge (Seeley-Brown & Duguid, 2001).

When one considers the highly contextual nature of knowledge, it becomes apparent that there is a problem with the dominant policy discourse in government and industry, which is that problems are treated as if they are well defined, or easily solvable, and therefore susceptible to formalised, standardised training to specific targets. This public treatment of training tends to ignore the complexity that contextual factors add to knowledge and over-simplifies the processes and outcomes of learning (Eraut, 2004; Thompson et al., 2001), which makes the role of knowledge management at the supervisory level even more important if organisations are to leverage their tacit knowledge.

2.3.2.c. Knowledge management styles, models, and methods

The original knowledge management problem of how to find and appropriate tacit knowledge is equivalent to the quality revolution in manufacturing during the 1980s and early 1990s (Gertler, 2003), in that it is about how to promote and measure knowledge flows in organisations. However, if the issue is considered in terms of a knowledge life cycle, i.e. that knowledge changes form as it diffuses through populations (Birkinshaw & Sheehan, 2002) from tacit through explicit and back to tacit again (Nonaka & Takeuchi, 1995), then a managerial focus on knowledge can be placed on its dichotomised explicit and tacit aspects. An emphasis on explicit knowledge is then about organisational capabilities to create, store, share and use explicitly documented knowledge, while an emphasis on tacit knowledge is about knowledge sharing through interpersonal interactions. Depending on which direction a firm takes, it will either pursue an entirely

explicit or entirely tacit focus, or it will pursue a simultaneous approach to both tacit and explicit knowledge (Choi & Lee, 2003).

2.3.2.c.1. Knowledge management styles

These different foci result in a number of different knowledge management styles. Each of which can be compared in terms of how knowledge is acquired (either explicitly or tacitly, or a combination of both), shared (either explicitly or tacitly), or applied (either to all firms and industries in general, or specifically to one firm or industry). Styles can also be categorised according to their purpose, i.e. to embrace and improve performance and effect change, or according to their attitude to knowledge, e.g. loner, exploiter, explorer, or innovator, or according to dichotomies, e.g. codification vs. personalisation, conservative vs. aggressive, or cognitive vs. aggressive. Alternatively, they can be considered in terms of corporate performance, e.g. financial or other measures (Choi & Lee, 2003).

If an organisation adopts a knowledge management system that is confined to codified knowledge, it will be constrained in cases where the knowledge they have does not cover the problems they face, or in how to use the knowledge they have in new situations. It may also try to transform forms of knowledge, such as cultural or personal knowledge that are not susceptible to transformation, into computer based forms, with the result that significant parts of that knowledge will not be captured (Eraut, 2004).

2.3.2.c.2. Knowledge management models

Which knowledge management model a firm adopts follows, in the macro sense, from its knowledge management style and will reflect the interactive relationships between three social forces; “the patterns of work in organisations, the prevailing education and training system, and types of labour market and careers” (Lam, 2000, p. 499). Worker qualifications and promotions shape how work is coordinated and organised because different categories in a workforce exhibit different degrees of “professionalism” (Lam, 2000, p. 499) depending on the relative importance of formal recognition of qualifications and mastery of practical or tacit skills. For instance in an occupation-based labour market, there is a high degree of market control of skills and competency criteria, with a strong tendency towards formalisation and codification of knowledge, while in a firm-based internal labour market the firm controls the definition of expertise and there are lower levels of standardisation of expertise around formal knowledge.

Within firms or organisations themselves, their own structures and processes interact to create institutional configurations that generate different types of knowledge, patterns of

learning, and of innovation. That is to say within organisations, the degree of formalisation of high-level expertise - based on either abstract theoretical knowledge or on concrete problem solving - and the degree of academic bias or elitism, is manifested in the relative importance and distribution of resources, e.g. for education, which in turn influence the knowledge base and learning capabilities of the firm. These then determine the relative importance of a formal education vs. employer definition of expertise, the opportunities and incentives for individual workers to acquire knowledge (with a commensurate effect on organisational capability), and the shape of individual careers and social identity (Lam, 2000).

According to Lam (2000) these two forces, i.e. the formalisation of high-level experience and the degree of academic elitism, create four contrasting societal models of knowledge and learning with different emphases on the roles of tacit knowledge and innovation. Lam's framework includes the Professional, the Bureaucratic, the Occupational Community, and the Organisational Community models.

In the Professional model, a narrow elitist education is emphasised in an occupation-based labour market with a high level of specialised and explicit knowledge. The model generates explicit knowledge and favours individual learning. Incentives and social structures for tacit knowledge diffusion and accumulation are weak, while a professional bureaucracy with embrained knowledge dominates. This model prevails where professionalism is deeply rooted in society as a whole, e.g. in Britain and the USA, and a narrow approach to learning inhibits innovation.

The Bureaucratic model is similar to the Professional model, but differs in that it is emphasized in a firm-based internal labour market. This model seeks to control and eliminate tacit knowledge, takes a superficial approach to learning, and has little capacity to innovate.

The Occupational Community model features an occupation-based labour market that is focussed regionally, e.g. around interdependent clusters of occupations or firms. Within the community there are high rates of inter-firm mobility, which in turn develop social networks that facilitate knowledge transmission. An occupational community, e.g. Silicon Valley, is a pre-requisite for fostering the capability to innovate in the operating adhocracy, which can only be sustained if it operates as a member of a localised firm network. In an open labour market that has no boundaries, the operating adhocracy comes under pressure to bureaucratise because of the difficulties in accumulating and transferring tacit knowledge, because it is the networks of social relationships that

provide the social capital and information signals that are needed to ensure the efficient transfer of tacit knowledge in the interfirm career network. It is the shared industry specific values in the region that provide the incentives to engage in tacit know-how learning, and it is the occupational community that fosters the know-who network, which supports job mobility. It is social reputation that makes tacit knowledge visible, and it is only the stable social structure within the occupation-based labour market itself that enhances learning opportunities. In a career mobility sense, the social and technical networks within the community operate as a kind of super-organisation.

The Organisational Community model is similar to the Occupational Community model, except that it features a firm-based internal labour market, with a broad-based education system, broadly defined jobs, and a continuous career hierarchy. The model favours a decentralised organisation with cooperative problem-solving, tacit knowledge transmission and accumulation of knowledge via the collective learning within the organisation. The organisational community has the ability to generate innovation continuously and incrementally but is bounded within the firm. It tends to be conservative and radical innovation is inhibited (Lam, 2000).

2.3.2.c.3. Knowledge management methods

Regardless of the organisation's knowledge management style or model, there are four main types of work activity or methods, which regularly give rise to learning. These include, (a) participation in group activities set up for special purposes, (b) working alongside others, which allows for observation and listening to different kinds of knowledge and expertise, (c) tackling challenging tasks that require on-the-job learning, and (d) working with clients to learn about them, their novel problems, and to develop new ideas in joint consultation (Eraut, 2004).

There are also three main criteria that determine how a knowledge transfer will work in any given situation. These include who the intended receiver of the knowledge is - in terms of the similarity of task and context, the nature of the task - in terms of how routine and frequent it is, and the type of knowledge that is being transferred (Dixon, 2000).

In the case of intended receiver(s), their absorptive capacity is crucial. This relates to the team or individual who must already have enough related knowledge to be able to absorb the new knowledge. This prior related knowledge may include basic skills, a shared language, and technical knowledge. With respect to the nature of the task, it must be considered whether it is routine or non-routine, and its frequency – daily, monthly,

yearly. With regard to the type of knowledge being transferred, whether it is tacit or explicit, and its scope are important factors, as well as how many functional areas of the organisation will be impacted by implementing the knowledge.

Choosing the most effective way to transfer knowledge is also important. There are several methods, including Serial Transfer, where the source team and the receiving team are one and the same, Near Transfer, which moves explicit knowledge from location to location, Far Transfer, which includes the leveraging of people who have very specialised and critical knowledge, Strategic Transfer, which is where the implementation of very complex and/or vital knowledge transferred knowledge impacts large parts of the system, and finally Expert Transfer, which is where transferring explicit knowledge about a task may be done infrequently (Dixon, 2000).

Within each knowledge management style or model, knowledge management methods are implemented by an agent or agency, i.e. the knowledge manager, who should have considerable authority and discretion, and be grounded in a formal position with an asymmetrical relation to non-managers (Alvesson & Karreman, 2001). Thus the knowledge manager's responsibility lies variously – from organisational learning to database management – in approaches to adding or creating value by actively leveraging know-how, experience, and judgement. Knowledge management methods are broadly directed at the “acquisition, development, protection, sharing and use or exploitation of knowledge, skill, and expertise within the firm” (Alvesson & Karreman, 2001, p. 1003), and (depending on who the author is) also on sourcing, mapping, and measuring of knowledge. Other methods of knowledge management include information management, the use of architectures for the spreading of knowledge, community building and the encouragement of care and altruism (Swan et al, 1999; Quintas et al, 1996; Storey and Quintas, 2001; Brown and Duguid, 1998; von Krogh, 1998 in Alvesson & Karreman, 2001).

2.3.2.d. Costs of knowledge management

Knowledge management does not happen frictionlessly in organisations. There are costs associated with it. Typically, knowledge management costs are measured in terms of IT and HR expenses. In firms that focus on IT, the costs of maintaining knowledge and keeping knowledge current are high. Accordingly, those that focus on systems tend to make relatively little investment in HR activities because low cost, standardised training is usually adopted. Those with a focus on HR tend to spend on recruiting people carefully (Choi & Lee, 2003) and the costs of keeping people in touch with each other –

creating *ba*, can also be high (Nonaka et al., 2000). Unsurprisingly perhaps, firms that have a passive or little interest in knowledge management, tend to have lower costs for both IT and HR (Choi & Lee, 2003).

According to some authors, (e.g. Akbar, 2003), when knowledge sharing behaviours are explained in terms of cost/benefit ratios, then they are assumed to be rational transactions. In other words, when there are high costs to learning, rational responses to knowledge sharing include defensive attitudes e.g. of specialists, protection of favourable positions, inward looking bureaucracies, and superficial learning or adoption of change, because they reduce the scarcity value of new knowledge. Similarly, even when there is a marginal outlay cost associated with knowledge gaining, for example when it is situated, contextual, and relatively exhaustible, then the scarcity value of individual knowledge increases and information exit barriers are erected, such as a reluctance to share accurate information.

According to Akbar (2003), this is particularly true in situations where mistakes are regarded as inefficient ways to learn. However when the knowledge base is expanded, willingness to learn is reinforced, and the cost benefit of sharing relative to withholding knowledge is improved. The result is that individuals become repositories of knowledge and their status in the organisation is enhanced, and inventing new knowledge becomes a way of behaving rather than a specialised activity. Along that same lines, when explicit knowledge is gained formally, costs can be directly compared with knowledge levels, but when highly contextual and situational tacit knowledge is gained it is difficult to allocate costs (Akbar, 2003). Thus an under-provision of knowledge makes learning private and costly, partly because of a lack of economies of scale and partly due to the demanding nature of the self-reflection required to achieve it (Branson, 2007).

Another cost of knowledge management is in the trade-off between exploration and exploitation of knowledge. When work-place routines shift activities from mostly adaptive, improvisational, knowledge producing exploration, to mostly repetitive rote behaviour, then insights or inventions are almost inevitably lost. Currently, because the costs of organising activities are higher than the costs of transacting changes to activities, organisations may need to use their hierarchical control systems to maintain coordination of firm activities, by limiting disruptive changes to only certain communities or areas within the firm (Seeley-Brown & Duguid, 2001).

One approach to managing costs of knowledge management is to consider the value of network relationships. One reason for developing networks is that they give access to

know-how, which is at the middle of a scale between tacitness and codifiability, between specificity and generability (Roberts, 2000). Networks help to ameliorate the effects of information overload because they reduce information redundancy by making it clear where information can be located and where knowledge is stored (Nonaka et al., 2000). This is important because future payoffs for investments in knowledge management will depend less on enhancing systems that track down information, and more on developing strategies to help workers use their knowledge (Jacobson & Prusak, 2006) to develop profitable activities (Gertler, 2003).

2.3.2.e. Tacit knowledge assets

According to some authors, knowledge, and tacit knowledge in particular, has been identified as a strategically important resource in a firm and the basis of competitive advantage (e.g. Ambrosini & Bowman, 2001; Teece, 2000) but it has resisted operationalisation. Because there is or will be “a significant premium associated with the ownership and orchestration of knowledge” (Teece, 2000, p. 44), there is a commensurate “need to know more empirically about the nature of tacit knowledge” (Jensen, 1993, p. 9), so attempts have been made to operationalise it by viewing it as an asset.

2.3.2.e.1. Knowledge workers and knowledge assets

Unfortunately for knowledge managers, and particularly Westerners, “management is mostly concerned with [the] efficient use of tangible resources that can be counted, routinely depreciated, and easily valued, [with] balance sheets” (Fruin, 1997, p. 47) where people are residual resources rather than core, and markets for knowledge assets are inefficient (Johannessen et al., 1999; Teece, 2000). So the goal of knowledge management is to produce knowledge assets through knowledge workers engaged in knowledge producing processes. In the literature knowledge assets are defined as,

“Firm specific resources that are indispensable to create values for the firm. Knowledge assets are the inputs, outputs, and moderating factors of the knowledge creating process. For example, trust is an output of the knowledge creating process, and at the same time it moderates how *ba* – the shared context for knowledge creation – functions as a platform for the knowledge creating process” (Nonaka et al., 2000, p. 20),

and a knowledge worker is an employee who is a highly qualified, educated, and professional. Their work consists largely of converting information to knowledge, using mostly their own competencies, but sometimes with the assistance of suppliers of

information or specialised knowledge (Thompson et al., 2001). A knowledge intensive company is one that has few tangible assets, and whose intangible assets are far more valuable.

A problem with knowledge assets is that an effective system or tools for evaluating and managing knowledge assets does not exist. Although a variety of measures have been proposed and investigated, existing accounting systems are inadequate for capturing the value of knowledge assets due to their dynamic tacit nature; snapshots at a single point in time are not enough to evaluate and manage knowledge assets properly (Nonaka et al., 2000; Srdoc, Sluga, & Bratko, 2005). What makes the problem worse is that “information float” (Teece, 2000, p. 38), the time lapse between knowledge discovery or creation and its transfer and use, is extremely expensive in terms of opportunity cost especially if a technology leader is a laggard in terms of transfer, or if speed is an important indicator of service quality (Tsoukas & Vladimirou, 2001).

Attempts have been made to understand knowledge assets in terms of how they are created, acquired and exploited (Nonaka et al., 2000), with the following typology as an example;

Experiential knowledge assets – consisting of shared tacit knowledge built through hands-on experience, and include know-how and skills,

Conceptual knowledge assets – consisting of explicit knowledge articulated through images, symbols and language,

Systemic knowledge assets – consisting of systematised and packed explicit knowledge that is visible and easily transferred, e.g. product specifications, manuals, and finally

Routine knowledge assets – consisting of tacit knowledge that is routinised and embedded in the organisations practices and actions.

Knowledge assets then consist of both information and know-how, with some being relatively high in information, such as patents, and others being relatively high in know-how, e.g. organisational routines.

The operationalisation of this information vs. know-how distinction has been taken further with the suggestion that knowledge assets can be understood in terms of four dimensions, (a) tacit – articulate, (b) observable in use – not observable, (c) complex – simple, and (d) element in a system – independent. These distinctions are related to the ease with which the asset can be transferred (Winter, 1987 in Birkinshaw et al., 2002). This approach to understanding knowledge assets is a departure from others that define

technology as a category of knowledge asset, because it recognises and relates knowledge to firm competitiveness in terms of (a) voluntary and involuntary transfer, and (b) the intrinsic nature of knowledge - rather than how knowledge is used.

The advantage of Winter's approach from an academic perspective is that avoids a problem with the lack of discriminant validity between measures of technology and organisation structure (Birkinshaw et al., 2002). Winter's dimensions, which have been operationalised (Zander and Kogut, 1995 in Birkinshaw et al., 2002), are important given that knowledge acquisition and utilisation play important roles in the development of organisational knowledge assets (Chen & Mohamed, 2007). Of particular note is that the higher the intensity of these two activities, i.e. knowledge acquisition and knowledge utilisation, the larger the organisational knowledge pool, which in turn demands greater abilities to disseminate knowledge.

Another approach to understanding knowledge assets has been to consider them in terms of core competencies or capabilities, such as skills or managerial systems. Along with these are included norms and values, since they are also important for building knowledge assets, because they govern how and whether individuals actually behave when it comes to creating, accessing, absorbing, and diffusing knowledge (Swap et al., 2001).

In all of the above, the literature talks perhaps somewhat blithely about knowledge assets in terms of them being tacit and/or explicit, and having value e.g. measured by the difference between book value and stock value (Gertler, 2003), or as an "aggregate concept" (Teigland & Wasko, 2009), or even as the opposite of "knowledge – absences" (Spender, 2008), but from a supervisory perspective these definitions are obscure at best, and practically useless

2.3.2.e.2. Knowledge agents and knowledge agency

When considering how and between whom knowledge is created, shared, or used, there are a number of different vectors or knowledge agents. These include individual people (Baumard, 2002; Dienes & Perner, 1999; Dixon, 1957; Kolb, 2008), formal organisations (Birkinshaw et al., 2002; Jacobson & Prusak, 2006), organisational structures or hierarchies (Coff, Coff, & Eastvold, 2006; Gertler, 2003), and even objects such as information, stories, and narratives (Swap et al., 2001; Yolles, 2007; Zins, 2007).

In a job context, a knowledge agent could be considered someone or something whose work consists largely of "converting information to knowledge using their own

competencies for the most part, [but] sometimes with the assistance of suppliers of information or specialized knowledge” (Johannessen et al., 1999, p. 122). Knowledge agents include both *knowledge* workers, and *knowledgeable* workers (Thompson et al., 2001), especially those with *deep smarts*. These are the people who have,

“a huge store of tacit knowledge and experience built up [over time, and who have the characteristics of experts, i.e. are able] to make swift decisions on the basis of pattern recognition, [can] extrapolate from the known to the possible, [are able] to make subtle distinctions that are invisible to a novice, [and can] take a systems view of a complex product, organization or environment to predict interactions and interdependencies” (Hammer, Leonard, & Davenport, 2004, p. 17).

Individual knowledge agents can include specialists, such as medical clinicians (Gabbay & le May, 2004), as well as generalists such sales representatives.

Interestingly teams, who are not so much agents as they are networks for extending knowledge or practice (Seeley-Brown & Duguid, 2001), are believed to increase individual commitment and performance because of the relationships that exist between members (Ramesh & Tiwana, 1999), i.e. other knowledge agents, and because the team members will each have unique tacit knowledge stocks (Athanassiou & Nigh, 1999) that are differentially distributed (Athanassiou & Nigh, 2000). These teams or networks are populated by gatekeepers, translators, and knowledge brokers or other specialists who know how to either consciously or unconsciously (Spender, 1993) select, interpret, and integrate knowledge into useful contexts that can be used to create value (Teece, 2000).

In environments where there is a high value placed on expertise there is pressure for individuals to become competent quickly, and managers, as knowledge agents, need to become skilled at recognizing and encouraging knowledge flows between people at different levels of experience (Swap et al., 2001). They can do this by seeking out those in the organisation who consistently do a good job of applying newly gained knowledge and watching how they work, to look for common techniques (Jacobson & Prusak, 2006). These high performers are likely to be experts, because their knowledge has been implicitly organized as a result of experience, “for rapid, efficient and effective use” (Eraut, 2004, p. 254).

It has been found that the success of knowledge sharing activities can be influenced by the actions of key individuals who engage in explicit coaching, for example in the use of

telecommunications infrastructures (Roberts, 2000), which suggests that mentoring should be recognised as a valuable contribution to the organisation (Swap et al., 2001). Among those who are “crucial to the processes of knowledge management [are the] middle managers, who are at the intersection of the vertical and horizontal flows of information in the company” (Nonaka et al., 2000, p. 22) and who are actively involved with others in processes of knowledge creation by participating and leading *ba*. However, not all these middle managers regard themselves as mentors and there is some suggestion that they should not be for new hires, but rather peer mentoring should be encouraged for at least the first six months of new employment.

In the early 1990s, companies were concerned with knowledge generation around their own products and services (Nonaka et al., 2000) with a focus on creating knowledge and disseminating it throughout the firm. But now knowledge agency, in for example innovation related tasks, is being devolved to “customers, ... market players, knowledge brokers, and information or innovation intermediaries, [or new players called innomediaries, i.e. innovation intermediaries, who] ... bridge a gap between producers and consumers [to] speed up [the] innovation process” (Yakhlef, 2005, p. 229). Firms are outsourcing their innovation related knowledge to intermediaries because they are the ones with the superior abilities to organize communities of consumers, users, or scientists; it is easier and less costly to push innovation to where tacit knowledge resides, rather than to extract it from where it is and bring it to the firm. By involving the customer, risks of failure are reduced and production cycles are sped up (Yakhlef, 2005). Different categories of people are involved in the different stages of innovation with first generation innovation based on engineers’ technological knowledge. Subsequent generations of innovation call on other sources, such as marketing, production, etc (Yakhlef, 2005).

Within firms it has been suggested that knowledge agents enact a knowledge management system depending on “psychological safety - the shared beliefs held by members of a team that the team is safe for interpersonal risk taking, and the rate of episodic change experienced by the team” (Bernard, 2006, p. 1). These shared beliefs include generational influences, e.g. younger generations will tend to value personal ambition and older workers will want to have a balance in life (Liebowitz et al., 2007). Similarly, it is the societal norms embedded in organisations that influence whether knowledge agency will be treated as a professional bureaucracy, a machine bureaucracy, an operating adhocracy or as a J-form organisation (Lam, 2000).

This very broad conceptualisation of a knowledge agent suggests that in a participant observation study such as this, all participants are knowledge agents and are therefore grist to the mill. This means the observations of workers are as important as observations of supervisors for understanding effective tacit knowledge management.

2.3.2.e.3. *Knowledge measures or levels*

As mentioned earlier in this chapter, knowledge is defined as a justified true belief resulting from perceptions of experiences. Because perceptual experience is necessarily the outcome of a categorization process that has a representative function (Bruner, 1957), it is axiomatic that there be knowledge categories that represent different measures or levels of knowledge.

This is important for this study because knowledge measures or learning metrics need to be instituted to processes to account for transfers of pertinent information (DeGard, 2006), to judge the value of tacit knowing (because not all tacit knowing is valuable or accurate) (Leonard & Sensiper, 1998), and to develop both a comprehensive theory of knowledge (Spender, 1993), and a practical guide for knowledge management (Ahn & Chang, 2004).

However, because tacit knowledge is not readily articulated, different approaches to measuring knowledge levels have been taken. A common approach has been to rely on observable indicators such as responses to scenarios that reflect an individual's ability to recognise and take appropriate action in a given situation (a.k.a. tacit knowledge inventories), and which presumably also reflect that person's procedural knowledge (Sternberg et al., 2000). Thus the product, i.e. *know-what*, and the process, i.e. *know-how*, dimensions of knowledge (Akbar, 2003) are typically employed as intermediaries between knowledge and its contribution to business performance. They are classified on the basis of the degree of coherence in an individual's knowledge, which at its most rudimentary lower levels is cursory and disjointed, but at higher levels is explained in terms of *know-why*, or understanding. This coherence can be categorised by work attributes, such as ward work (in hospitals), technical work, problem solving, and leadership skills that are validated by experienced practitioners (Fessey, 2002).

An example of a coherence model of knowledge levels has been promulgated by the Dreyfus brothers, Hubert and Stuart, who took a phenomenological approach to describing *knowing how* and *knowing that* in terms of five steps of competency, including, novice, advanced beginner, competent, proficient and expert (Dreyfus & Dreyfus, 1986). In their model each level is described in terms of "qualitatively different" (p. 19)

stages of acquired skill that include modes of decision making, and perceptions of the task. This model seems to have gained some traction with both organisations and academics. For example, in London, England, the Institute of Conservation has taken the Dreyfus' principles and applied them to their own organisational context (ICON, 2010), and Swap, Leonard, Shields and Abrams (2001) have developed a continuum that incorporates novice and apprentice at the low expertise end, and journeyman and master at the high expertise end. A semantic point that perhaps needs to be mentioned here is that in the above mentioned levels it is important to remember that *incompetence* is not an absolute measure, so much as it is a matter of degree that is not domain general, i.e. someone may be incompetent in one domain, but not necessarily in another (Kruger & Dunning, 1999).

When an evidence-based kind of assessment of practice, such as the Dreyfus' model, is implemented there is an assumption that practice is what is observed. But it is more useful to describe practice in terms of a person or team's capability (i.e. what they are capable of doing rather than what they have capably done), because this identifies what it is that practitioners bring to a situation that enables them to do what is observed; some of which is tacit and invisible.

The implication of this is that practice can only be investigated in terms of competences that feature descriptors, because few practitioners can be assessed as simply competent or not competent (Eraut, 2004). Thus *know-how* is significant, because it refers to the ability to do things involving complex linkages between skill formation and personal knowledge. As an aside, in this respect know-how pervades our activities to such a large extent that it is routinely taken for granted. It is also highly gendered in that it often distinguishes between ways that ownership of skills or differences are ascribed to people in social settings (Evans, Kersh, & Kontiainen, 2004), for example mothering, nursing, farming etc.

These competencies or sensory-perceptual abilities are equated with intelligence and have an advantage in that they can be seen experimentally, i.e. can be manipulated by standard cognitive psychological and sociological research interventions (Gardner & Moran, 2006). One of these experiments for instance, has shown that "incompetent individuals lack the meta-cognitive skills necessary for accurate self-assessment" (Kruger & Dunning, 1999, p. 1122) and that people tend to overestimate their ability relative to their peers. Also and possibly more importantly, those who performed particularly poorly relative to their peers were oblivious of this. Similarly,

“work on the nature of expertise has revealed that novices possess poorer metacognitive skills than do experts, [e.g.] novices are less accurate than experts in judging the difficulty of physics problems (Chi, Glaser, & Rees, 1982). [Also in chess,] novices are less calibrated than experts about how many times they need to see a given chessboard position before they are able to reproduce it correctly (Chi, 1978), [and] in tennis, novices are less likely than experts to successfully gauge whether specific play attempts were successful (McPherson & Thomas, 1989). (Kruger & Dunning, 1999, p. 1122)

Apart from knowledge levels articulated in terms of know-what, -how, and -why (e.g. Johnson, Lorenz, & Lundvall, 2002), attempts have also been made to measure knowledge in terms of the density of business networks (Athanasidou & Nigh, 1999), or in terms of observability and system embeddedness and the influence that these have over a business unit’s level of autonomy and inter-unit integration (Birkinshaw et al., 2002). Other multidimensional models of tacit knowledge have been developed but they tend to be highly domain specific (Leonard & Insh, 2005), or they are conceptual and generic, e.g. measuring service quality, happy customers, or efficient service (Tsoukas & Vladimirov, 2001).

Moving away from specifically tacit knowledge models of knowledge measurement, other attempts to measure knowledge have been by proxy. One of these methods, knowledge mapping (Nonaka et al., 2000) is unreliable because of the inherently dynamic nature of knowledge assets, although it does recognise the importance of identifying the importance of people involved in the creation and maintenance of organisational knowledge (Ramesh & Tiwana, 1999).

Other methods include by document use (Marwick, 2001), or by usage statistics of knowledge management systems (Wang & Wang, 2009), which aim to measure the usefulness and quality of knowledge by the number of times a document has been cited, or been hyperlinked, or by the business value derived from that document. The idea has merit because these kinds of quality judgments act as gates, and if a document is considered to be of low quality, then it is not distributed. The disadvantage of this is that the method only measures knowledge use, and not knowledge creation, which means that once explicit knowledge, i.e. the document, has been integrated, i.e. cited and remembered then according to the knowledge management system it is no longer valuable. This of course is nonsensical but understandable since the method does not take into account the SECI theory of the knowledge life cycle.

Another kind of measure is in how well employees adhere to role-played company standards, such as in appearance or customer service, but these tend to be a monitoring measure of employee response in terms of output and performance, rather than measures of knowledge (Thompson et al., 2001). Two other proxy indicators of diffused knowledge are also used. One is in the introduction of new “machinery, equipment, and components that incorporate new technology, [and the other is in] the transmission of knowledge or technical expertise in the form of patents [and] licences (Roberts, 2000, p. 431). In international terms, payments for licences give an indication of the scale of the knowledge transfer, but transfers also occur through the movement of personnel, consulting, investments, joint ventures, and cooperative research (Roberts, 2000).

One measure that the value of knowledge cannot be based on is the degree of Research and Development (R&D) cost as a percentage of sales. This is because “so much R&D is outsourced in one way or another, and because the R&D in one industry impacts on the competitive dynamics of others” (Teece, 2000, p. 46).

2.3.2.f. Human Capital

Another way of valuing knowledge is in terms of human capital, which is an aspect of social capital theory that describes relationships with others and personal attributes (Athanassiou & Nigh, 2000). However, it is also a term used as a euphemism for people as a human resource, as in “allocating and developing human capital depending on the business needs” (Ahn & Chang, 2004, p. 404).

Human capital is that private, as opposed to social, dimension of tacit knowledge in firms, otherwise called talent (Gertler, 2003), and is the residence of knowledge in the form of a critical competitive asset (Herrera, Muñoz-Doyague, & Nieto, 2009). In that sense it is also a contextually important, i.e. firm-specific (Coff, Coff, & Eastvold, 2006) knowledge resource (as opposed to other knowledge resources such as technology, patents, brands, and organisational routines), along with physical capital and organisational/ social resources (Birkinshaw et al., 2002). Human capital includes training, expertise, judgement, intelligence, relationships, insights and knowledge (Javalgi, Dixit, & Scherer, 2009), as well as learning capabilities and experience curves (Sigala & Chalkiti, 2007), and is therefore something that a firm can invest in (Mole, 2007).

In knowledge intensive firms especially, human capital is considered a type of capital along with financial and physical capital, but is one that requires a new definition of ownership and way of control (Starbuck, 1992), which is important because

organisations will face a human capital challenge as the baby boomers near retirement age (Liebowitz et al., 2007)

There is considerable debate in the industrial relations literature over the relationship between the private and competitive asset aspects of Human capital, along with how to promote its optimal use. For example, optimal use of human capital can be promoted in a multiskilled workforce (Shaw, Gupta, Mitra, & Ledford, 2005), but assessments of human capital need to take into account a person's position in the organisational hierarchy, their tenure in the organisation, and their level of experience in their area of competence (Teigland & Wasko, 2009).

During the 1980's, another aspect of this debate was the tension between management and unions where attempts to reduce labour power over the control of work by separating its conception and execution, had the effect of degrading and deskilling work (Armstrong, 1988). The argument became somewhat muddled because of the identification of workers as, "skilled, semiskilled, and unskilled" (Gulowsen, 1988, p. 161). This classification was deemed imprecise, because the concepts said little about the potential of workers, nor about how skills affected strategy. The feeling at the time was that workers tended to prevent technological innovations because of the threat they would make skills obsolete (Gulowsen, 1988). However, in the current milieu given the relative autonomy of some groups of skilled workers and the rate of technological change, it could be argued that appropriate measures of task related tacit knowledge could offer a way to a more collaborative approach towards productivity. This may be especially so if a more holistic approach was taken to the analysis of the strategic importance of a task, i.e. one that encompasses technology and tacit knowledge (a.k.a. experience). It could well be then that skill (as an input) becomes less of an issue, than the purpose (as an output) of that task.

In other situations the prevailing strategy, at least in some industries like the European steel industry (Stroud & Fairbrother, 2008), to meet skill deficiencies is through informal training provision. However this practice is perceived to be somewhat regressive and can have "an incapacitating and devastating impact on the employability of production workers" (Stroud & Fairbrother, 2008, p. 12) because they are relatively ad hoc and narrowly job specific.

Brache and Rummler (1995) report that the problem appears to be exacerbated by "HRD professionals [who] are grounded only in the psychology element and fail to incorporate the other elements of economic and systems theory in their performance

efforts” (p. 36), suggesting that a holistic approach to performance improvement is needed to avoid suboptimal interventions.

2.3.2.f.1. Power Distance and Human Capital

This section briefly describes Hofstede's Power Distance cultural dimension and explains why from a theoretical perspective it could be expected to have an effect on knowledge management practices of Human Capital.

Power distance, one of Hofstede's dimensions³ that he developed to describe national cultures, is "the extent to which the less powerful members of organisations and institutions (such as the family) accept and expect that power is distributed unequally" (Hofstede & McCrae, 2004 p. 62). In organisations, "the level of power distance is related to the degree of centralisation of authority and the degree of autocratic leadership" (Hofstede, 1983, p. 81), and is rooted in the mental programming of the members of a society, including those in power as well as those at the bottom of the power hierarchy. Although Hofstede developed his cultural dimensions in the context of nations, the essence of the cultural dimensions also apply at the individual level (Clugston, Howell, & Dorfman, 2000), and within subgroups of populations (Cohen, 2007), which of course has implications for both personal and group tacit knowledge.

Perhaps unsurprisingly, the Power Distance dimension is correlated with conscientiousness (Hofstede & McCrae, 2004) insofar as it affects an individual's personal value system. Bearing in mind that a variance in job-related attitudes may be accounted for by cultural dimensions as well as by individual personality variables or other situational variables (Arvey, Bhagat, & Salas, 1991), what this means in practise is that people with high power distance are more likely to use their own personal discretionary power to serve others than people with low power distance (Hui, Au, & Fock, 2004). They do this by manipulating their environment, i.e. using primary control, or relying on adaptation and powerful others, i.e. using secondary control.

Where this is likely to become an issue is in situations where high power individuals may feel threatened in the workplace. Because high power distance appears to foster dependency-based relationships (Clugston et al., 2000), where "individuals 'have' to stay [continuance-type commitment] due to their beliefs about being subordinate in society" (Clugston et al., 2000 p. 10), and have few alternatives elsewhere. In a situation where an individual has a continuance-type commitment to their workplace and is at the same

³ The other dimensions are, Uncertainty avoidance vs Tolerance for ambiguity, Individualism vs Collectivism, and Masculinity vs Femininity (Hofstede & McCrae, 2004)

time being threatened, e.g. by change, new technology, etc. it is conceivable that they will do anything in their power to manipulate the situation to their own ends to reduce the perceived threat; and in a knowledge management context this could have significant implications as far as knowledge sharing behaviours are concerned.

As a factor affecting knowledge management, Hofstede's Power Distance cultural dimension (Hofstede, 1983; Hofstede & McCrae, 2004) is somewhat under represented in the knowledge management discourse. This is probably not surprising considering the majority of research in the knowledge management domain has been done, at least to a certain extent, at one-step removed from the situational and structural contexts within which tacit knowledge is found. The suggestion is made here that it is not until the researcher-as-instrument is embedded within the research context that Hofstede's cultural dimensions become salient in the data.

2.3.2.f.2. Self Confidence and Human Capital

Another somewhat underreported factor affecting knowledge management is the personal identity of knowledge agents, including their self-confidence. Self-confidence is defined in various ways including the performative aspects of self-efficacy, i.e. "confidence to do", or having belief in ones capabilities to mobilise the motivation, cognitive resources, and courses of action needed to meet given demands. It also is defined as the "confidence to have", which is more to do with a sense of power, control and legitimacy – self assurance (Sturdy, Brocklehurst, Winstanley, & Littlejohns, 2006).

Self-confidence is gained when people find out they are capable of more than they have previously given themselves credit for (Borwankar & Velamuri, 2009), or when they create affirmative statements about themselves, or when they recreate the positive emotional state they had in situations where they felt on top of the world (Eales-White, 2003).

From an ordinary management perspective it is useful for workers to have enhanced self-confidence because it gives them a greater ability to handle ambiguity and uncertainty (Borwankar & Velamuri, 2009), which has implications for organisational performance (Pollitt, 2009). Some of the characteristics of people with high levels of self-confidence are that they are effective at influencing others (Ruderman & Ernst, 2004), they are assertive –not timid or scared (Siegel, 2000), and are able to express themselves and understand areas outside of their immediate competency (Vosburgh, 2003).

If harnessed appropriately, these characteristics have the potential to enable knowledge agents to be particularly effective as knowledge creators and sharers. But the opposite is also true, in that they have the potential to enable contrary knowledge agents to be particularly effective at sabotaging or undermining change.

2.3.2.f.3. Emotional Intelligence and Human Capital

A third factor that is likely to affect tacit knowledge management and is underreported in the literature is the effect of Emotional Intelligence on knowledge agents.

According to Akers (2003), Howard Gardner the doyen of the Theory of Multiple Intelligences is reported to have described a person's emotional quotient, the measure of their Emotional Intelligence, as "the level of your ability to understand other people, what motivates them and how to work cooperatively with them," and Bar-On (in Brown, Bryant, & Reilly, 2006) who is credited with the development of an emotional intelligence metric, concludes that emotional intelligence is a "multifactorial array of interrelated emotional, personal, and social abilities that influence our overall ability to actively and effectively cope with daily demands and pressures" (Brown et al., 2006, p. 332).

Emotional intelligence is also broadly defined as the emotional, affective, and social skills dimension of general intelligence that has implications for team-based job systems, since teamwork is by nature a social endeavour that involves individuals engaged in interpersonal interactions to adapt to an array of individual differences (Frye, Bennett, & Caldwell, 2006). However, although there is some disagreement over the construct validity of EI in the form of convergent and discriminant validity (Conte, 2005), there is a general agreement of EI as a non-academic intelligence with predictive value beyond general intelligence (Stein, Papadogiannis, Yip, & Sitarenios, 2009) in the debate about how EI should be operationalised.

Whatever the conceptual approach to the application of EI, there is no substitute for knowing and controlling your emotions and being able to read the emotions of others (Service & Fekula, 2008), because they are the interpersonal skills important for success (Akers & Porter, 2003). Emotional intelligence then is an important factor in "determining the capacity to be successful in life and in influencing the well-being of individuals, [because] those who are more able to understand and manage their own emotions are probably better able to predict the emotional consequences" of choices (Di Fabio & Palazzeschi, 2009, p. 137).

Because perceived and actual facts (if they can be known) can subdue emotions or be used to justify feelings, the emotional intelligence perspective suggests that decision-making is so highly based in emotions that the useful value of logic in that activity is highly questionable, and leads to the conclusion that an appropriate level of emotional intelligence is a necessary, although insufficient condition, for effective leadership (Service & Fekula, 2008) in those roles and professions that require a high degree of emotional labour, e.g. Leadership (Brown et al., 2006), or Nursing (Jiwan, 2010).

The implications for this in the knowledge management discourse are of course significant. Because so much of the effectiveness of a knowledge management intervention is predicated on organisational culture and the behaviour of human capital, it is incumbent upon supervisors as knowledge agents, who are often closely associated with team systems, to employ their emotional intelligence in their approaches to knowledge creation and sharing (especially given the significance of psychological safety to teams – see section 2.3.2.e.2: Knowledge agents and knowledge agency on page 54 above). The obvious conclusion that can be drawn from this discussion is that supervisors with lower levels of emotional intelligence are less likely to be successful in managing tacit knowledge than those with higher levels.

2.3.2.f.4. Intellectual Capital

Another important categorisation of knowledge as a resource in the knowledge management discourse is the concept of intellectual capital; defined variously as the intellectual material – including knowledge, information, intellectual property, and experience that can be used to create wealth, and is the stock of knowledge in the firm (Bontis, 1998), or the knowledge and knowing capability of organisations, intellectual communities, or professional practices (Nahapiet & Ghoshal, 1998). It has also been described as being among a nation's most valuable assets because it is associated with economic value (Serenko, Bontis, Booker, Sadeddin, & Hardie, 2010), and has been identified as a key factor in an organisation's performance (Nahapiet & Ghoshal, 1998).

Intellectual capital is related to human capital in the form of the knowledge and skills of employees, and relational capital, and includes relationships with customers, suppliers, or other significant stakeholders (Fink, Marr, Siebe, & Kuhle 2005), as well as norms, i.e. the socially defined right to control an action as represented by consensus in a social system (Nahapiet & Ghoshal, 1998). Thus it could be argued that the term intellectual capital is interchangeable with tacit knowledge, since according to these definitions it

does not include structural capital a.k.a. intellectual property assets, such as copyrights, patents, semiconductor topography or design rights, nor trade or service marks (Bontis, 1998) – although the Swedish insurance and financial services company Skandia, an early adopter of the concept of intangible assets does include structural capital, in the form of the patents, processes and practices that remain when employees leave the firm, in their reckoning of their intellectual capital (Fink et al., 2005).

There seems to be broad agreement that the term intellectual capital is also more or less synonymous with the term intellectual asset (e.g. Ammar-Khodja, Perry, & Bernard, 2008), and even though measures or benchmarks for intangible assets such as these are lacking (Chalhoub, 2010; Marr, 2004), the management of this strategic corporate asset is seen as an important activity for driving organisational performance (Bontis & Serenko, 2009; Marr & Spender, 2004); there is even the suggestion that intellectual assets could be worth from three or four times up to as much as seven times the tangible book value of a firm (Bontis, 1998) as measured by Tobin's q – a ratio that measures the relationship between a company's market value and its replacement value. Similarly there are studies on levels of national intellectual capital development that show there is a positive link between human capital investment and financial wealth (Serenko et al., 2010).

Reasons for the lack of measures of intellectual capital are probably related to the difficulties with its operationalisation. For instance, the increase and protection of intellectual capital is both hindered and helped by its appropriability, i.e. is dependent on the nature of knowledge and its transferability within the company and/or network to which it belongs (Hurmelinna, Kylaheiko, & Jauhiainen, 2007). The difficulty lies in the relationships between different knowledge types and the accompanying problems over the interchangeability (or lack thereof) between explicit and tacit knowledge and the inter-dependencies between various knowledge-based assets, including both physical assets and labour (Marr & Spender, 2004).

Although attempts have been made to operationalise intellectual capital, e.g. Marr's five-step process of identification, mapping, measuring, managing, and reporting on intellectual capital (Marr, 2008), the prevailing argument appears to be that the creation of intellectual capital is dependent on two generic processes, i.e. combination and exchange, occurring within social contexts (Nahapiet & Ghoshal, 1998), and requires interpersonal skills to support such collaboration (Saint-Onge, 1996), e.g. as might be encountered between researchers, firms, and consultants (Mouritsen, Larsen, & Bukh, 2001).

However, in order for this combination and exchange of resources to occur though, four conditions have been identified which must be satisfied. These include, (1) the opportunity to make a combination or exchange must exist, (2) the parties involved must expect that the interaction, exchange, and combination will prove worthwhile, (3) people must anticipate that value may be created through exchange or interaction and that it will be worth their while, and (4) the capability to combine information or experience must exist, e.g. there must be the ability to recognise the value of new knowledge and information, and to assimilate and use it (Nahapiet & Ghoshal, 1998).

In the context of this discussion and given the situated nature of this particular research, the suggestion is made here that "intellectual working capital" – Ammar-Khodja and Bernard's (2008, p. 13) term for workaday information that depreciates quickly and changes all the time – may be an important construct and useful starting point for trying to understand and operationalise tacit knowledge in terms of experience and its management by supervisors.

2.3.3. Facilitators of knowledge management

The list of facilitators of knowledge management praxis in organisations is long and includes many that are beyond the scope of this research.

Some of these non pertinent facilitators include for example, reward structures and their impact on knowledge sharing behaviours (e.g. Dixon, 2000; Marwick, 2001), knowledge redundancy – the overlap of knowledge between different groups (Ramesh & Tiwana, 1999), informal knowledge systems such as language, and their social embeddedness at cognitive, organisational, and societal levels (e.g. Birkinshaw & Sheehan, 2002; Branson, 2007; Yolles, 2007), and the role of information technology in the knowledge life cycle or in design work (e.g. Birkinshaw & Sheehan, 2002; Yakhlef, 2005).

For this research however, there are a number of facilitators that were considered important in that they related directly to the work that supervisors do on a daily basis. These facilitators include learning and training, relationships and networks, salience, and absorptive capacity. This section elaborates on how these facilitators affect knowledge management at the supervisory level.

2.3.3.a. Learning and training

It is somewhat axiomatic that learning and training facilitate knowledge management, in that these are knowledge building activities. The relevance that they have to supervisors is that supervisors are in a position to influence to some extent how learning and training

are supported in the workplace (e.g. Swap et al., 2001; Thompson et al., 2001), and hence make decisions on how to make use of them with respect to individual workers.

For the purposes of this discussion, learning and teaching activities are deemed to fall into three reasonably distinct categories, Formal, Semi-Formal, and Informal. Formal activities are associated with classrooms or coursework or other explicitly guided learning, Semi-Formal activities have some formal organisational support, although their actual implementation may be relatively ad hoc, and Informal activities are emergent, unstructured, self-initiated, and unsupported by specific organisational processes or structures. Although these categories are presented as discrete, they are somewhat arbitrary distinctions because common sense suggests that learning and teaching activities as a whole actually lie along a continuum, from formal to informal.

Given the range of learning and training activities available, it suffices for illustrative purposes to simply list some of them (see Table 1 below), because to cover each activity in detail would be to provide more information than is necessary for informing the field work, considering the researcher's pre-existing theoretical sensitivity.

Category	Teaching or Learning activity	Description	Example Reference(s)
Formal	Training	Classroom or coursework related transfer of explicit knowledge	(Ahn & Chang, 2004; Branson, 2007; D'Eridata & Barreto, 2006; Freyens & Martin, 2007)
	Active Learning	Similar to training, but more associated with OTJ training, such as inductions	(Eraut, 2004b; Ramesh & Tiwana, 1999; Swap et al., 2001; Thompson et al., 2001)
	Coaching	As above	(Eraut, 2004)
Semi-formal	Elaboration	Extending ideas through verbalizations	(Birkinshaw & Sheehan, 2002; Fessey, 2002)
	Collaboration	Informal cooperative relationships	(Ramesh & Tiwana, 1999)
	Mentoring	More formalized cooperative relationships, typically between workers of different competency levels	(Athanassiou & Nigh, 2000; Berry & Dienes, 1991; Eraut, 2004a; Kruger & Dunning, 1999; Swap et al., 2001)
	Feedback	Provision of self correcting information	(Kruger & Dunning, 1999; Swap et al., 2001)
	Practise	Repetition for the purposes of performance improvement	(Berry & Dienes, 1991; Swap et al., 2001)
	Heuristics	Controlled vocabulary of memorable events, rules of thumb	(Alvesson & Karreman, 2001; Marwick, 2001; Swap et al., 2001)

Category	Teaching or Learning activity	Description	Example Reference(s)
	Story Telling	Contextually embedded implicit communications of workplace experience – how things are done around here	(Ambrosini & Bowman, 2001; Liebowitz et al., 2007; Ramesh & Tiwana, 1999; Yolles, 2007)
	Metaphors	Communicating meaning when no explicit language is available	(Ambrosini & Bowman, 2001; Kolb, 2008)
	Sharing	Informal investment in social capital, either face to face or via technology	(Ambrosini & Bowman, 2001; Athanassiou & Nigh, 2000; Eraut, 2004; Marwick, 2001)
Informal	Experience	Episodes and incidents – see previous section on page 26	(Fessey, 2002; Kruger & Dunning, 1999; Tsoukas & Vladimirou, 2001; Yakhlef, 2005)
	Observation	Watching and looking to gain insight	(Ambrosini & Bowman, 2001; Jacobson & Prusak, 2006; Liebowitz et al., 2007; Swap et al., 2001)
	Memory	Cognitive state and/or processes for coding, storing, and retrieving personal knowledge	(Berry & Dienes, 1991; Capurro, 2002; Eraut, 2000, 2004; Sternberg et al., 2000)
	Pattern Recognition	Making sense of relationships/ predictability	(Branson, 2007; Eraut, 2004; Leonard & Sensiper, 1998; Ramesh & Tiwana, 1999)
	Dwelling In	Famous Polanyi term to describe the process of making the meaningless meaningful	(D'Eridata & Barreto, 2006; Johannessen et al., 1999; Nonaka & Takeuchi, 1995; Polanyi, 1966)
	Reflective Thinking	Processes of reporting, responding, relating, reasoning, and reconstructing that result in new comprehensions	(Ambrosini & Bowman, 2001; Bain, Ballantyne, & Packer, 1999; Berry & Dienes, 1991; Branson, 2007; Yolles, 2007)

Table 1: Selected Teaching or Learning activities that facilitate tacit knowledge management.

2.3.3.b. Relationships and networks

Relationships and networks are very important facilitators of tacit knowledge sharing because of the observability of knowledge to members (Birkinshaw et al., 2002).

For example, members of social networks and occupational communities “are likely to have more in common with their peers in other organisations, than they are with many of the other employees of their own” firm (Seeley-Brown & Duguid, 2001, p. 4), suggesting that the organisation as a cultural unit is likely to underestimate the contribution these groups make to the organisation as a whole (Seeley-Brown & Duguid,

2001) especially in those unique environments where only members can understand each other (Athanassiou & Nigh, 1999).

Relationships a.k.a. interpersonal interactions at the conscious level, appear to be essential for the innovation process (Leonard & Sensiper, 1998) since they provide the context for some kinds of knowledge, e.g. truth, goodness, and beauty, which when they are internalized by an individual can set off new spirals of knowledge creation when shared with others (Nonaka et al., 2000). For instance, it is through our interactions with others that we pick up expectations of the practical things in life without having the need for specialized training (Tsoukas & Vladimirou, 2001). Networks of informal contacts therefore, particularly those that are characterised by intermediate tie strength - where the frequency, reciprocity, emotional intensity and intimacy of the social relationships are of medium value (Retzer, Yoong, & Hooper, 2010), represent “an important channel of knowledge diffusion” (Liebowitz et al., 2007, p. 1131), since relationships play “a critical role in workplace learning” (Eraut, 2004, p. 255) because of the implicit contracts that exist between people who work together.

It is therefore the “individual capacity for social integration [that provides the] platform for ... collaboration” (Fessey, 2002, p. 53), but it is the behaviour of others monitored by group members, who by their strong social bonds tend to form opinions about them, which in turn moderates knowledge transactions (Fessey, 2002). Even in professional work this emotional dimension is much more significant than normally realized, which is important when a scarcity of time has an impact on the time available to invest in getting to know people, with the result that misjudgements become rife (Eraut, 2004)

At the individual level, it is the sense of identity and self worth that comes from belonging to an organisation (Dixon, 2000) which results in rich, multidimensional, robust relationships (developed through face to face interactions) that are effective in conditions of ambiguity and uncertainty (Athanassiou & Nigh, 2000), and it is the informal, everyday exchange of ideas between people who are physically close to each other that encourages responses to fellow corporate members that need help (Alvesson & Karreman, 2001).

Similarly, networks are important for helping to identify people involved in the creation and maintenance of organisational knowledge (Ramesh & Tiwana, 1999) as in for example the *open source* model; a contemporary innovation in organisation hierarchies. The open source network is a dynamic and ever changing community that originated with hobbyists, but is gaining support among organisations as a non-hierarchical open

approach to supporting critical business processes like innovation (Yakhlef, 2005). Control and management of these kinds of coherent social communities emanates from a metasystem that is communicated using a metalanguage. The resulting viable and sustainable autonomous systems are self-aware, self-directing, self-organising, and self producing (Yolles, 2007).

2.3.3.c. Saliency

A less obvious facilitator of knowledge management is the concept of saliency, i.e. notability or importance, of aspects of knowledge. For instance, the salient features of knowledge management systems vary according to their purpose, because a system should offer techniques and related criteria for acquiring and formalising knowledge (Srdoc et al., 2005), and provide knowledge chunks that include information about *what* and *how* (Ramesh & Tiwana, 1999). For instance, in systems that have been designed to provide a knowledge base of lessons learned, best practises, or case analyses, it is useful to provide features such as expert directories and collaborative tools for both knowledge providers and knowledge seekers (Bernard, 2006).

These system features are important because the saliency of the relationship between input and output variables in a system has an impact on how tasks are controlled. When the relationship is obvious, control of knowledge is more conscious and explicit (Berry & Dienes, 1991) as for example when selecting sentences in a document for a summary (Marwick, 2001). But when saliency is less obvious e.g. in the interactions between and the cultural forces on members which may not be those determined by leaders (Dyck, Starke, Mischke, & Mauws, 2005; Seeley-Brown & Duguid, 2001), system features that affect the *performativity* of the work (Thompson et al., 2001, p. 938) become important, simply because salient or unusual incidents are more easily remembered than everyday behaviours (Eraut, 2004).

Saliency in the minds of practitioners includes the recognition of personal boundaries, e.g. the ability to gain self control, and having self confidence, which helps with the ability to handle conflicting issues (Fessey, 2002).

Thus a goal of the participant observation was to identify salient knowledge and knowledge management activities that supervisors engaged in, whether those be on an isolated or regular basis.

2.3.3.d. *Absorptive capacity*

Apart from the somewhat obvious need for managerial support for knowledge management initiatives in general (e.g. Eraut, 2004; Huang, Kristal, & Schroeder, 2008; Swap et al., 2001), knowledge management initiatives are also impacted by a firm's absorptive capacity, as has been alluded to previously. That is to say, a firm's ability to recognise and value new knowledge, to assimilate new knowledge, and to commercialise new knowledge, impacts positively on its absorptive capability and without a strong motivation and the support to learn, the acquisition of knowledge may yield only moderate results (Hau & Evangelista, 2007). This is because although organisational learning includes the learning that individuals do, it also transcends individuals in the sense that individual learning cannot happen by itself (Dyck et al., 2005).

Thus, a firm's absorptive capacity must include the ability for individuals to self analyse through reflective processes (Bain, Ballantyne, & Packer, 1999) based on both internal and external learning routines which are instrumental in developing process capability (Huang, Kristal, & Schroeder, 2008), since they provide opportunities to practise with the new knowledge. Similarly, cross-learning interactions, such as annotations (to manuals for example) and visualisations (such as sketched depictions), allow the creation of new knowledge and facilitate the organisational learning process, especially if technology is used to capture them and incorporate them into existing information content in what is known as lineage knowledge (Frank & Gardoni, 2005). Along the same lines, boundary spanning individuals, or gatekeepers, are also instrumental in enhancing a firm's absorptive capacity through their interpreter role of "reframing, explaining and clarifying ... information in the context of different work groups." (Cranefield & Yoong, 2007, p. 101)

Interestingly, practice leads to an improvement in task performance, but not verbalisable knowledge, whereas detailed verbal instruction on how to control tasks leads to an improvement in verbalisable knowledge, but not to an improvement in control performance (Berry & Dienes, 1991).

The concept of *ba* – which is almost a prerequisite for absorptive capacity - is supported with the use of information technology, since "one of the most powerful uses of technology seems to be to support people who do already do work together" (Gertler, 2003, p. 87). Although little is known about their constituent elements, organisational infrastructures such as information systems can help to support and sustain knowledge acquisition and use, at least in the continuous improvement domain (Anand et al., 2009).

Similarly information technology can support knowledge sharing and decision making, particularly around risk assessment, although there is a question over how much to rely on such standardising and recording, especially in regard to interpreting information since this is where expertise and judgment are important for the consideration of other variables (Currie, Finn, & Martin, 2007).

A caveat to the above is that the implementation of new technologies requires trial, reflection, repetition, and practise before performance improvements can be realised, and the knowledge gained cannot easily be communicated from external sources such as other teams, publications, or vendor representatives (Edmondson et al., 2003).

2.3.3.e. Trust

The role of trust in the management of knowledge has been well documented. It is recognised that trust is relevant at all levels of an organisation (Hedlund et al., 2003; Roberts, 2000), and along with communication is a critical success factor (Choi & Lee, 2003). However, this critical relevance is associated as much with the acquisition of knowledge, e.g. through problem-solving (Liebowitz et al., 2007), or networking (Gabbay & le May, 2004), as it is with the "acquisition of identity" (Gertler, 2003; Seeley-Brown & Duguid, 2001), and is closely associated with individual commitments and beliefs (Nonaka et al., 2000). This suggests that any model of tacit knowledge management must take into consideration not just knowledge, but the personal nature of the individuals who hold and work with that knowledge as well.

2.3.4. Barriers and Limitations of knowledge management

2.3.4.a. Explication of tacit knowledge

The objection that it is hard to get people to share what they know usually refers to the difficulty in getting people to write something down, or to put it into a database (Dixon, 2000). This may be because knowledge is considered a source of power, and there are costs associated with learning, so defensive attitudes and behaviours are exhibited towards attempts to define knowledge. Similarly, decisions as to whether or not individuals choose to learn "depends upon the benefit - cost relationship of learning" (Akbar, 2003, p. 2008) versus preserving the status quo. Also, the term *knowledge* privileges established professions, and offers opportunities for occupational groups to protect their positions by claiming an attractive mystique and authority, e.g. in medicine, law, or other bodies of complex knowledge (Blackler, 1995).

Another barrier to writing things down is the burden on knowledge providers and intermediaries, who may be constrained by task pressures and time, to provide rich

narratives for a knowledge base because the rate of episodic change is so high that the projected usefulness of the knowledge may be low, i.e. knowledge quickly becomes obsolete. A similar problem confronts knowledge seekers who may not recognise knowledge gaining/ learning opportunities (Bernard, 2006). This problem is compounded when one considers that structured self-reflection, an important element of knowledge creation, is demanding and takes time (Branson, 2007)

Another problem with writing things down is when tacit knowledge becomes ideology,

“because [ideologies appeal] to tacit authority instead of public justification when decisions are made. If generalised and accepted, it [is] not only the knowledge worker who is [instilled with] powers to demand, [e.g.] satisfying jobs, but also the managers, who can reject justifying actions and decisions [by] claiming that their authority is based on tacit knowledge. People in power often feel a diminished need for explaining to others ... what they are doing and why they are doing it. [That] this ... is an exercise of power is clear to everybody, [but] this clarity might disappear if managers explicitly appeal to their tacit knowledge, [since] such an appeal challenges management as knowledge-based and rational *per se*. (Bordum, 2002, p. 53).

Two more problems associated with making tacit knowledge explicit, either through the knower telling or the researcher asking, are having an awareness to begin with, and knowing how to represent it (Eraut, 2000). Similarly, there is the possibility that explicating tacit knowledge may not be beneficial, or unless incentives are provided there may be little reason for explication. Most commonly, people are unaware of the tacit dimension of the knowledge they possess. This is particularly true with newer technologies, where the faster the innovation cycle, the less likely it will be that knowledge will be captured, which is when apprentices become more important to the innovation process (Leonard & Sensiper, 1998)

2.3.4.b. Technology

The proliferation of the use of email and other information technologies means that decision making processes have become more informal, making it difficult to locate specific decision makers (DeGard, 2006). Similarly, it has been identified that,

“challenges associated with knowledge management include technical [ones, such as the design of] human and information systems that make information available, [the] social challenge of developing communities that share

knowledge [yet] maintain diversity, [the] management challenge [of creating an environment where knowledge sharing is truly valued, and the] personal challenge of being open to the ideas of others and to share ideas” (Alvesson & Kärreman, 2001, p. 1005).

Technological difficulties with knowledge management include the limitations of automatic extraction of knowledge in the acquisition, interpretation and use of knowledge by computers, and although technology can be used to mediate knowledge sharing the greatest difficulty in knowledge management is still changing people’s behaviour or culture (Marwick, 2001)

2.3.4.c. Approaches to KM

There appear to be two parallel approaches to knowledge management, on the one hand there are advocates of importing explicit knowledge directly from the world of research and incorporating that into practise, and on the other there is an emphasis on eliciting and promulgating practitioners’ tacit knowledge – or knowledge in practice (Gabbay & le May, 2004). But difficulties in understanding tacit knowledge make knowledge management an ambiguous term (Gertler, 2003; Hedlund et al., 2003), so companies are nervous about initiating their own knowledge management programs. Because it is not a trivial task, few companies are capable of adopting knowledge management methods to improve organisational performance since not all methods are equally effective (Choi & Lee, 2003)

Along with this difficulty is an expressed or implied tendency to treat all knowledge as being essentially of one kind, which sets a practical limit to a firm’s ability to assess and support competencies in their own right (Cook & Seely-Brown, 1999). There are also problems with understanding how organisations actually create and manage knowledge possibly because of a lack of general understanding of the knowledge creating process (Nonaka et al., 2000)

2.3.4.d. Different outlooks on knowledge

A common perspective in the knowledge management discourse is the apparent harmony oriented viewpoint that seems to disregard a pragmatic aspect of operational contexts, i.e. that within a company there may be different knowledge paradigms that contribute to conflicts (Capurro, 2002). These might include the very different outlooks of people within an organisation with apparently quite similar jobs, e.g. sales and marketing, accounting and budgeting, nurses and doctors. In these situations distinct practises make communities, and therefore knowledge, distinct – leading in turn to

problematic communications (Seeley-Brown & Duguid, 2001). Along similar lines it is now recognised that R&D departments, which used to be the sites of value creation that presented barriers to entry for competitors, are no longer the points of departure for innovation. This now lies with the customer, since they are the ones who hold the tacit knowledge that relates to product development (Yakhlef, 2005).

The differences in outlook that exist between various sectors of the community, such as between the government and the private sector, can also present barriers to collaborative knowledge sharing. For instance, constraints to knowledge dissemination in the public sector include cultural barriers among the public, a lack of a shared vision between the public and the private sectors, limited decision-making power and/or budget within the public sector, and a lack of trained people to make decisions. Similarly constraints to sharing with the public sector from within the private sector include a focus on short term objectives (due to political constraints), poor information about government policies, and slow governmental decision making processes (Ladkin & Bertramini, 2002).

2.3.4.e. Learning and evaluating knowledge

According to Eraut (2004), the transfer of knowledge from education to the workplace is more complex than commonly perceived. It involves five interrelated stages; (1) the extraction of potentially relevant knowledge from its context, (2) understanding the new situation, which often requires informal socialisation, (3) recognising relevant knowledge and skills, (4) transforming them to fit, and (5) integrating the new knowledge with others in the new situation. This is altogether a much more complicated process than simply desituating, and then resituating a single piece of knowledge. Higher education takes the approach that significance of knowledge is taken for granted, and the workplace will either find it ready to use and accept it, or not. Similarly many groups discourage finding out about the knowledge networks and resources of new members because this is regarded as a diversion from their own work, and therefore they do not seek to learn from the available diversity of experience or perspective.

Furthermore, the pressure of learning new ways of doing things in new contexts can make previously contextually embedded knowledge unavailable in the new setting (Fessey, 2002). This may also be in part due to occupational classification structures, which focus on the form of jobs, rather than the content of labour – as exemplified in US census data that labels librarians and musicians as knowledge workers! (Thompson et al., 2001)

Even if there are favourable conditions for recognising tacit forms of personal competence, the development of universal definitions of competence is restricted by prevailing approaches towards the identification and assessment of those competences. This is particularly true in cross border situations, such as in Europe where attempts have been made to define communication, inter-personal, and problem solving skills across countries (Evans et al., 2004)

Difficulties associated with evaluating competence are rarely satisfied by a “simple binary judgement of ‘competent’ or ‘not competent’, ” (Eraut, 2004, p. 266). Likewise, descriptors on a scale may be unreliable because they do not increase the explicitness of the associated knowledge, and nor do they necessarily account for the socio-cultural origin of knowledge (Eraut, 2004).

2.3.4.f. Market difficulties

Difficulties associated with market transfers of knowledge arise over the asymmetric distribution of information in transactions (between buyer and seller), which leads to adverse selection or moral hazards that prevent transactions occurring. The knowledge market also includes the knowledge transactions between mentors and novices, where a wide gap in knowledge presents problems. Problems arise when experts lack the patience to guide novices, and from the novice’s point of view it may be better for someone more proximate in experience to teach, because the knowledge gap is not as great. This difficulty is related to a preparedness-for-learning problem if the novice lacks the necessary foundations to receive the new knowledge. This is why stories lend themselves to the transfer of different kinds of knowledge since they are well suited to the transfer of critical skills, norms, and values (Swap et al., 2001).

Transactional difficulties are mainly associated with organisational knowledge, since personal knowledge can be readily bought and sold, e.g. when talent is hired. Organisational knowledge, which is embedded in routines, procedures, and structures, cannot be moved “without the transfer of clusters of individuals with established patterns of working together” (Teece, 2000, p. 36). The problem is exacerbated in large enterprises whose global reach, distributed competence, and importance of knowledge to competitiveness makes knowledge transfer especially important. There are friction costs to finding the right person or group with the right knowledge, not necessarily helped by social, professional, and hierarchical contexts (Teece, 2000). Other forms of knowledge transactions that present difficulties include customer queries, which may contain ambiguity. This puts an onus on customer service operators to be adept at

helping customers to articulate their problems, to probe further, and to locate the appropriate information in a timely manner (Tsoukas & Vladimirou, 2001)

2.3.4.g. Other factors

Other factors that hinder knowledge management initiatives include a lack of shared understanding, an inability to contextually understand best practices, and a lack of diversity of expertise. Similarly restrictions on freedoms, for example due to costs, also impact on knowledge workers' abilities to contribute new ideas.

The results of poor knowledge management include an over reliance on the transmission of explicit rather than tacit information, repeated mistakes, reinvention of solutions, and collaboration skills lost post project., usually as a result of an inability to transfer existing knowledge to other parts of the organisation. The outcomes of poor knowledge management include inconsistency in multiple versions of information, evolving assumptions, and a loss of tacit knowledge (Ramesh & Tiwana, 1999).

2.4. Conclusion

This chapter has suggested that in order to try to make sense of Polanyi's "Tacit Dimension", scholars and practitioners appear to have inadvertently created a problem where in reality one probably does not exist. It may be that some of the barriers to effective (tacit) knowledge management – as described earlier in this section – are actually founded on modern managerial requirements for proof, or evidence of knowledge, before actions are taken. Similarly, the rationalist/empiricist divide may also suggest not that tacit knowledge is either explicable or ineffable, but rather that tacit knowledge has some aspects that are sensory based, and some that are based on reflective thinking.

The literature has also identified that an aspect of tacit knowledge that makes it difficult to assess and hence to manage, is its contextual nature. Tacit knowledge contexts can be divided roughly into two groups, community and individual. Community aspects of tacit knowledge include societal, social, and organisational contexts, as well as philosophical influences, while individual aspects of tacit knowledge include cognitive and philosophical contexts, and individual abilities. Given its highly contextual nature, it is perhaps somewhat surprising that the majority of research into tacit knowledge has been at some remove from its context, either through interviews and/or through surveys, which is perhaps what has prompted recent suggestions by authorities such as Nonaka and von Krogh (2009) that,

"Due to the intimate connection between knowledge and social practice giving organisational knowledge creation a "here and now" character, there is a need to conduct extensive research on knowledge conversion in the "concrete lived time" of practitioners" (p. 648)

While time is considered an important element in the development of knowledge and skill, it is not necessarily a good indicator of the amount of development that has occurred, although this is more likely due to a methodological limitation than a conceptual relationship.

Along with the more conventional understanding of business assets, such as resources, location, technology etc, knowledge itself is now recognised as an asset in its own right. However, there is still considerable debate about what actually constitutes a knowledge asset quite apart from the distinctions between tacit and explicit. For example knowledge assets can be in the form of data, or information, or knowledge, or wisdom, and considerable efforts have been made in the information technology domain to make sense of and to manage knowledge in these various forms.

Within this knowledge management discourse it is becoming recognised that there is a distinction between corporate knowledge, often embedded in documented standard operating procedures, processes, patents, copyrights, and software etc., and personal knowledge, which is embodied in individual worker capabilities. This personal knowledge is often described as "experience", but this again is something of a catchall term that does not adequately describe the nuances of an individual's competency and/or capability.

Hence, in order to understand which tacit knowledge management techniques are effective for developing organisational competency and capability, an understanding of the various aspects of experience is needed.

The plethora of language used to describe tacit knowledge suggests that it is something that is not well understood and thus difficult to manage, which provides a rationale for this study. Based on the literature, the question to be answered in the research project is quite simply, what does a supervisor have to do to influence a worker's experience for them to develop experience, and hence support organisational success?

Chapter 3: Methodology

3.1. Introduction

The purpose of this chapter is to describe the procedures the researcher used in this project to reach his conclusions. Building on from what was identified in the literature as a gap in the research on methods appropriate for the topic, the chapter provides a justification for situating this research within the Interpretivist Qualitative paradigm, describes the use of an iterative case study method using ethnographic techniques for data collection, and explains how conclusions were drawn using grounded theory. The explanation of what was studied (the research question), how it was studied (the paradigm, methodology), who was studied (the cases), the data-collection techniques (embedded researcher-as-instrument), and how the data was analysed or interpreted (the method) are provided to demonstrate that the findings are “reliable, credible and interpretable” (Hancock & Algozzine, 2006, p. 137). The chapter is laid out in accordance with suggestions by Perry (1998), and includes an introduction, a justification for the paradigm and methodology, ethical considerations, descriptions of the research procedures, and final conclusions

3.1.1. *The Research Question*

The primary research question was:

How do supervisors manage tacit knowledge?

Along with this primary question, a number of sub questions arose, particularly in the light of the discussion in the literature review, which highlighted the need for an understanding of tacit knowledge typologies, and facilitators and barriers to tacit knowledge management. The literature review identified that before the primary research question (RQ_p) could be answered, three supplementary questions had to be answered first. These included,

RQ_i - *What does tacit knowledge look like on the shop floor?*

RQ_{ii} - *How does tacit knowledge relate to Experience and Human Capital?*

RQ_{iii} - *What does ineffective tacit knowledge management look like on the shop floor?*

As was described in the previous chapter, the supervisory level was selected for study, because it provides a nexus for knowledge flows in organisations. Since most New Zealand firms are relatively small (in global terms) and individually do not employ many supervisors, the research needed to be situated in a variety of settings to gain sufficient

participants for the requisite breadth of data. Coincidentally, this need dovetailed with a secondary requirement of the research question, which was to situate the research in a variety of New Zealand industries. The constraints these needs placed on the research methodology meant the chosen method would have to accommodate multiple sites, multiple contexts, and reasonably brief periods of observation.

3.2. Paradigm and Methodology

Two primary considerations the research needed to accommodate were the highly contextual nature of tacit knowledge, and the proposition that knowledge is a “justified true belief”. These two ideas predicated that the research activities should be situated within a paradigm, and use a methodology that would be able to account for complexity in both the context and the lived experiences of the participants.

3.2.1. Paradigm

Considering Strauss’ contention that the work of quantitative researchers is “often weak on context”, the common sense approach to this study was to situate it within one of the qualitative paradigms, since these place “considerable emphasis on situational and... structural contexts” (Strauss, 1987, p. 2). The question of which these contexts, i.e. the Modernist, the Interpretivist, or the Postmodernist (Locke, 2001), in which to situate the research was then raised. Since the primary goal of the research question was to find out what tacit knowledge management techniques were effective, the research was looking for “a discovered order [guided] more by concept formation than concept application” (Alvesson & Deetz, 2000, pp. 26,30). This meant the research paradigm needed to be located somewhere towards the Consensus and Local/emergent poles of Alvesson and Deetz’s model of contrasting dimensions (see Figure 6 below), and hence squarely in the Interpretivist paradigm.

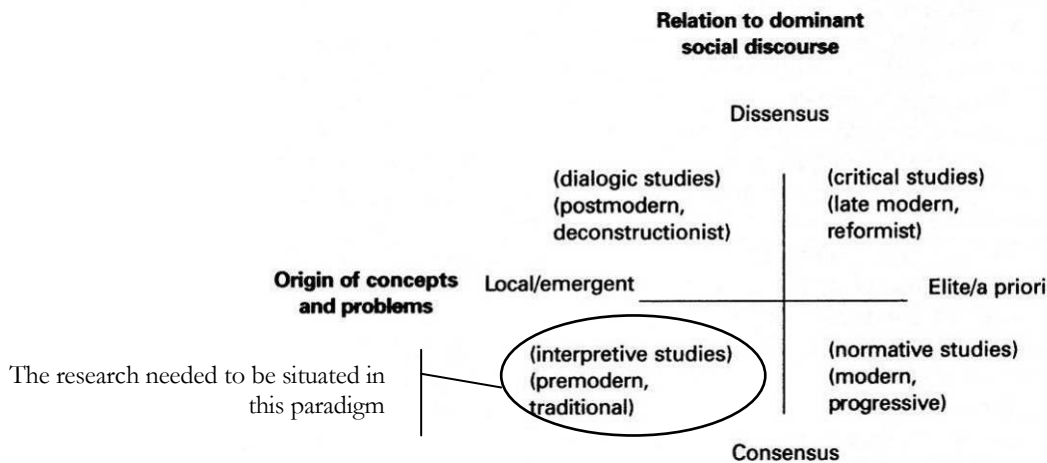


Figure 6: Contrasting dimensions from the metatheory of representational practices (Alvesson & Deetz, 2000, p. 24)

For practical reasons, what this meant for data collection was the researcher needed to become embedded in several workplaces, and become part of their workforces to understand the contextual elements of tacit knowledge and its management at the supervisory level.

3.2.2. Methodology

With respect to Nonaka and von Krogh’s recent assertion, there is “a need to conduct extensive research... in the concrete lived time of practitioners” (Nonaka & von Krogh, 2009, p. 248), the methodological approach for the research had to be concerned with the participants’ “subjective reality” (Locke, 2001, p. 9) to make sense of tacit knowledge phenomena. The next question to be decided then was, what method would be most appropriate? Since qualitative field studies have had questions raised about evidence, it was realized whichever method was used, it needed to be robust enough to withstand challenges to its findings, with respect to representativeness, reactivity, reliability and replicability (Katz, 1983, p. 127). Several methods were considered, but only one selected.

Those that were considered but not selected included:

Ethnography – which would have been appropriate for its flexibility, situated nature, and the manner in which data is collected, but was rejected because of the time constraints of this particular study. It has been recommended that an ethnography should take 6-12 months (Griffin & Bengal-Howell, 2008), but the difficulties in finding participants willing and able to make themselves available for that amount of time made this method unfeasible. Moreover, this method would have limited the research to a

single site over the research period, which would have raised questions about the reliability and replicability of any findings. However having said that though, it is worth noting that ethnographic methods were used extensively in this research.

Single Case Study – which would have been highly appropriate because it would have consisted of an empirical investigation of a contemporary phenomenon within a natural context using multiple sources of evidence (Hancock & Algozzine, 2006). However, the research question sought to understand tacit knowledge phenomena in a variety of settings, so it was deemed highly improbable that a single case study of short duration would provide sufficiently representative insights. (Instead a number of case study sites were eventually selected, which overcame both this limitation and the limitations of the previously mentioned ethnographic method.)

Action Research – which, while suitable because it is grounded in experience, was rejected because it requires an initial identification of potential problems (Kagan, Burton, & Siddiquee, 2008). Since the main focus of the research was on finding what does work, not what the problems might be, this method was rejected as unsuitable as a starting place, although it did have applications at later stages of the observation periods once initial analysis of findings had been made and potential problems identified.

Phenomenology – would have been suitable because it uses rich descriptions of life events developed from a variety of sources as its starting point, e.g. semi-structured interviews, diaries and un-structured life history interviews (Eatough & Smith, 2008). However, it was rejected because of a primary limitation; if a phenomenon cannot be described, such as a bodily experience, then it cannot be analysed (Giorgi & Giorgi, 2008). Since the previous chapter identified aspects of tacit knowledge as bodily and therefore unable to be described, it would have been manifestly inappropriate to have conducted a purely phenomenological study; however the use of elements of this method would be applicable in parts.

Other qualitative methods that were briefly considered, but rejected because of issues around reliability and reactivity, included,

- Conversation Analysis (one dimensional data type, i.e. conversation, and therefore not contextually rich enough),
- Foucauldian Discourse Analysis (drawing data from a wide variety of sources, but having a focus on explicit knowledge in the form of text statements and therefore not applicable to a study of tacit knowledge), and

- Memory Work (drawing data from a group of interested parties, but also focused on explicit knowledge in the form of recorded episodes, or memories and therefore not applicable to a study of tacit knowledge).

Since participant observation and ethnographic interviewing are the methods Interpretivists use to understand and make sense of the world, the researcher needed to use a method that would enable him to compose meaning out of “events and phenomena through prolonged processes of interaction, that involve history, language and action” (Locke, 2001, p. 9). What was needed then was a method that encompassed all of the best parts of Ethnography and Case Study, as well as Phenomenology and Action Research, but was not constrained by any of their particular limitations. The final choice for method was thus,

Grounded Theory – wholly applicable since it “consists of a systematic inductive, comparative, and interactive approach *to* inquiry with several key strategies *for* conducting inquiry” (Charmaz & Henwood, 2008, p. 240). A grounded theory approach made it possible to incorporate multiple case studies using ethnographic methods to observe situated phenomena that could provide opportunities for action research.

The following section provides a description and discussion of the grounded theory method, which provides the background for the subsequent descriptions of how the empirical data was collected and analysed. Specific findings from the research are provided in the individual case studies in Chapter 4.

3.3. The choice of grounded theory

To explain the choice of grounded theory in more detail, this section begins with a description of the logic and processes of the method. It then moves on to a discussion of the evolution of the method, and concludes with a description of how it was used in the collection and analysis of the data for this research.

3.3.1. The logic and processes of grounded theory

The grounded theory method, which was discovered by Glaser and Strauss, and described in their seminal work, *The Discovery of Grounded Theory* (1967), has undergone several permutations over the past 40 years, but its fundamental logic has remained more or less the same. The logic is worked out in a series of processes, as follows.

To begin with, the method engages in simultaneous data collection and analysis where the early analysis informs subsequent data collection (See Figure 7). This then enables the researcher to define and follow hints in the data, which leads to the refining of

categories in an iterative sequence. At each iteration, comparisons are made with data, codes, categories, and concepts, and as the process develops the analysis leads to progressively more abstract concepts. The inductive-abstractive logic Charmaz and Henwood (2008) allude to begins with the analysis of the inductive cases, which is then checked by considering other possible explanations, either confirming or disconfirming them until the “most plausible theoretical interpretation of the observed data is constructed” (Charmaz & Henwood, 2008, p. 242). The strength of grounded theory is that the conceptualisations that emerge from the process can lead to useful, new or unanticipated understandings (Charmaz & Henwood, 2008).

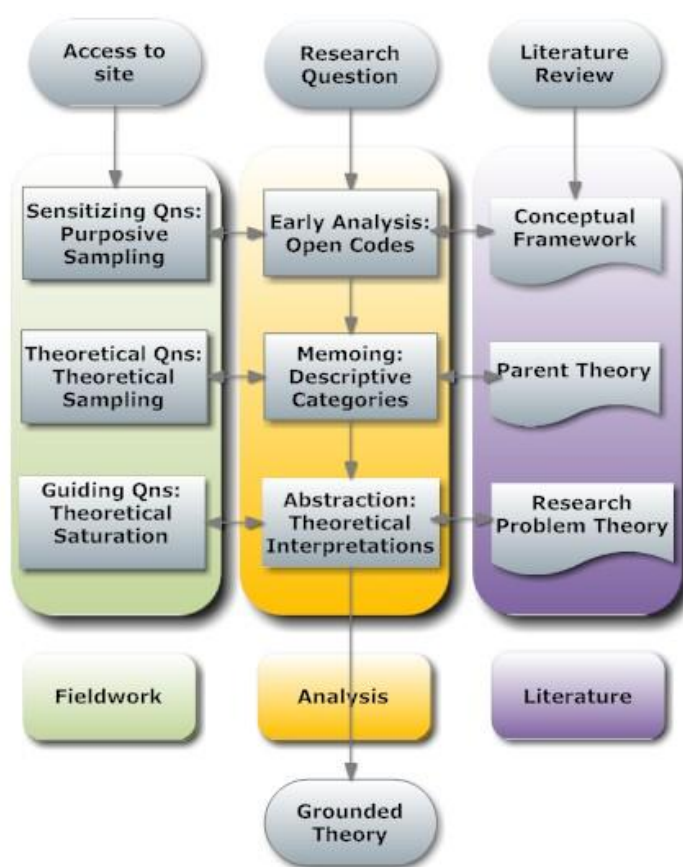


Figure 7: The logic and processes of grounded theory as applied in this research project – developed from Charmaz & Henwood (2008)

Guidelines for the way in which grounded theory logic and its associated processes were applied in this research are explained in more detail in a following section (section 3.3.3), but before that it is worth considering some of the controversies around grounded theory that have evolved since its discovery.

3.3.2. Evolution of grounded theory

In 1967, Glaser and Strauss developed a systematic set of processes for analysing data in qualitative research, which up until that time had been considered something of a poor relation to quantitative research. Quantitative research had sophisticated methods, while qualitative methods tended to be more ad hoc and were in decline. Glaser and Strauss' method countered this trend.

Grounded theory has its basis in the empirical research method Glaser and Strauss developed during their study of the social organisation of dying in hospitals (Glaser & Strauss, 1967). Their system differed from prevailing methods, in several ways. Firstly, they integrated their data collection with analysis. Typically, up until then analysis had been done after data collection. Secondly, they developed "middle-range" theories (Charmaz & Henwood, 2008, p. 243) directly from data, rather than deducing testable hypotheses from existing theories. Thirdly, they considered qualitative research to be rigorous and legitimate in its own right, which up until that time it had not. Lastly, they saw qualitative research as a means of constructing theory, not merely just testing it. These notions were in direct contrast to the positivist conventions of the day, which according to Glaser and Strauss viewed qualitative research as "impressionistic", "non-systematic", "nonrigorous", having small amounts of theory, too descriptive and biased towards a researcher's "own logic" (Glaser & Strauss, 1967, p. 15).

At its inception, grounded theory had both objectivist and constructivist threads. These reflected Glaser's quantitative background (he trained at Columbia University under Paul Lazarsfeld) and Strauss' approach that was more pragmatic, emphasising agency, action, language and meaning, and emergence. Both researchers emphasised process, and Glaser (1978, p. 2) in particular viewed grounded theory as a method for studying social processes.

Since their original publication, the two authors have continued to develop their ideas of grounded theory, but in a "very public disagreement" (Urquhart, Lehmann, & Myers, 2010, p. 361) have diverged in several important ways. Glaser has continued to emphasise positivist ideas such as objectivity and neutrality of data, but has moved away from trying to understand social processes, suggesting that to do so is to try to force data into preconceived ideas. He now favours incident-by-incident coding, as opposed to earlier ideas of line-by-line coding, and has become more committed to comparative methods; defending small samples and dismissing methodological concerns about accuracy and reflexivity, and instead suggesting that theoretical sensitivity provides

sufficient authority (Glaser, 1978). In contrast, Strauss has moved more towards verification, and with his co-author Juliet Corbin, has added several procedures leading to a more formulaic approach. For example, they have developed the idea of “axial coding” (Corbin & Strauss, 2008, p. 195), i.e. crosscutting or relating concepts to each other as a means of reintegrating “fractured data into a coherent whole after taking it apart during initial coding” (Charmaz & Henwood, 2008, p. 244). They have also introduced conditional/consequential matrices for clarifying the connections between micro and macro conditions.

In spite of the differences of opinion between the two divergent directions of grounded theory, i.e. Glaser’s move away from the individual and Strauss and Corbin’s move towards stricter process, both still leave action as the central focus. However the argument as to which of the two approaches is best is still not resolved (Charmaz, 2000, 2006; Charmaz & Henwood, 2008; Glaser, 1992; Robrecht, 1995; Stern, 1994; Urquhart et al., 2010).

Meanwhile, other researchers (e.g. Charmaz & Henwood, 2008) have discussed the epistemological elements of grounded theory and recognised there are perhaps two separate approaches, objectivist grounded theory, and constructivist grounded theory.

For the purposes of this study, the constructivist grounded theory approach, i.e. Glaser’s view (Urquhart et al., 2010) appears to be most appropriate, since it is located in time, space and circumstance, and is aimed at developing abstract understanding rather than explanation and prediction. According to Charmaz and Henwood (2008), constructivist grounded theory assumes;

- The researcher is a part of what he or she sees, not apart from it
- Facts and values are connected, not separate, and
- Views are multiple and interpretive, not self-evident

For this research it was considered that this approach offers a sensible middle road, since it takes into account Glaser’s ideas on Theoretical Sensitivity (even though Miles and Huberman (1994, p. 38) take issue with it over instrument validity and reliability), whilst at the same time it provides sufficient methodological rigour to vindicate criticisms around representativeness, reactivity, reliability, and replicability, i.e. the issues with which Strauss is concerned.

3.3.3. Focusing and Bounding the data

As mentioned previously, qualitative field studies have had questions raised about evidence, so part of the justification for the method for this research includes an explanation of the choice for a multiple case study. Apart from the need to answer the aspect of the research question about how *supervisors* (plural) manage tacit knowledge, a multiple case study can provide opportunities for representativeness, and a guard against participant reactivity, reliability, and replicability.

3.3.3.a. Representativeness

Since the external validity of an analytical research study rests on its internal variety, the ideal representative research site would be one, “both in a period of historical change and has the most differentiated members” (Katz, 1983, p. 135). Such a site could provide empirical evidence for both positive and negative cases of theoretical generalisability. However, given the criticism that any one particular site could be either distinctly homogenous or distinctly heterogeneous in its membership, and that the time constraints of the research prevent the selection of a site in a demonstrable period of change, a multiple case study provides a pragmatic trade-off.

By selecting a variety of different sites chosen on conceptual grounds, it is axiomatic that the set of all their members and contexts provides a range of cases and times, which would help satisfy claims for any generalisable theories developed using grounded theory (Miles & Huberman, 1994, p. 29). The following section describes the selection of the cases for the study.

3.3.3.b. Four cases for representativeness

Four organisations were chosen for this research project, making it a Collective Case Study (Stake, 1995). Cases 1, 2, and 3 were Instrumental Cases, chosen to gain a general understanding of tacit knowledge management phenomena, while Case 4 was chosen because the researcher had prior experience of the organisation, and it was recognised as having a particularly rigorous knowledge management orthodoxy predicated by its industry. Case 4 therefore had intrinsic interest, and was selected as an Intrinsic Case Study (Stake, 1995, p. 3).

Taking advice from Miles and Huberman (1994 Ch.2) and Stake (1995 Ch.1), the criteria for selection of Cases 1,2, and 3 – which would ensure participant observation maximised what could be learnt about the phenomena – were not about which organisations would represent the totality of tacit knowledge phenomena, but rather, which organisations would help to understand the tacit knowledge management issues

supervisors face. For this criterion, a diverse collection of organisations would have been needed to provide suitably rich variations in context, e.g. the size of the organisation, the industry in which it operated, the degree of formal training required by employees to perform their tasks, the degree of documentation (i.e. explicit knowledge) available to workers, the nature of the organisation's management style, and the demographics of the workforce, among many others.

Since the number of organisational characteristics that impact on tacit knowledge management is greater than could be managed with the resources of this project, the main selection criteria were around selecting organisations that were accessible, that recognised tacit knowledge had an important part to play in helping them to achieve their goals, and that had dissimilar characteristics (Stake 1995).

So, although the final selection of cases does not give a compelling representation for tacit knowledge management as a whole, nor a statistical basis for generalisations, the trade-offs made provide confidence that the commonly observed phenomena would point towards theories around effective tacit knowledge management techniques at the supervisory level. The focus of each case then, was to gain an understanding of its particulars so as to be able to make generalisations about it, and then as a collective case study, to make some refined generalisations about the research question as a whole (Stake 1995).

3.3.3.c. Reactivity

Since ethnographic methods are used in the study of groups – as people go about their daily lives – the researcher had to do two things. First, he had to enter into the social setting of the group, and second, he had to participate in the daily routines. To gather data he had to get close to those he was interacting with, which at the very least involved physical and social proximity (Emerson, Fretz, & Shaw, 1995). However, to collect meaningful and important data, the researcher had to immerse himself in their world. This immersion enabled him to experience directly and forcibly the ordinary routines and conditions, as well as the constraints and pressures of those he was observing. In this way, he experienced events and meanings in approximately the same way as the members themselves did. This is consistent with Emerson, Fretz and Shaw's emphasis that fieldwork cannot be done detached and neutrally. Rather, by engaging in the lived experiences of the phenomena under study the researcher should be exposed to varying priorities and points of view, and reactive effects should not be seen as contaminating, but as “the very source” (1995, p. 3) of learning and observation.

The argument then, that participant observations appear to confound substantive findings because subjects' behaviours change in response to the method, i.e. demonstrate reactivity, is countered by the selection of multiple case study sites. Since multiple exposures to the lived phenomena under study supports the basic premises of grounded theory, i.e. iterative comparison, then even though the potential exists for the researcher to change the scenes in which he participates, the data he takes out "will still be about those communities and organisations" (Katz, 1983, p. 137). So long as he remains consistent in his sampling methods, the application of "multiple comparison groups" in the grounded theory method suggest any reactive effects would be mitigated (Miles & Huberman, 1994, p. 29).

3.3.3.d. Reliability

The problem of how to become "empirically literate" (Miles & Huberman, 1994, p. 38) lies at the heart of questions surrounding the reliability of qualitative research. Glaser addressed this in "Theoretical Sensitivity" (Glaser, 1978), saying it is the social psychology of the researcher (his skill, fatigue, maturity, cycling of motivation, life cycle interest, insights into and ideation from the data) intrinsically bound up with being steeped in the literature that enables a qualitative researcher to grasp the problems and processes within the data. An implication of Glaser's theoretical sensitivity is that the researcher becomes the data collection instrument, and insofar as he is, Miles and Huberman suggest that,

"the markers of a good qualitative researcher-as-instrument are:

- Some familiarity with the phenomenon and the setting under study
- Strong conceptual interests
- A multidisciplinary approach, as opposed to a narrow grounding or focus in a single direction
- Good "investigative" skills, including doggedness, the ability to draw people out, and the ability to ward off premature closure". (Miles & Huberman, 1994, p. 38)

Other criticisms about the reliability of theory derived empirically from qualitative analysis arise from different problematic issues. These include the interpretation of field notes (which often depend on unrecorded knowledge of the context), the difficulties in transferring field notes to other analysts (e.g. ethical issues such as confidentiality), and researcher bias (e.g. privileging certain samples over others, or selectively disregarding

disconfirming data) (Katz, 1983, p. 143). To some extent this criticism has not yet been totally resolved, (e.g. Brewer & Hunter, 1989; Maxwell, 1992; Warner, 1991), but there is a growing consensus that “the underlying issue here is whether the process of the study is consistent, reasonably stable over time and across researchers and methods” (Miles & Huberman, 1994, p. 278).

So as far as the reliability of the findings from this case study are concerned, use of a clearly articulated method in a multiple case study allowed the researcher to demonstrate consistent and stable use of methods over time, in a way that a single case study could not.

3.3.3.e. Replicability

Katz’s assertion that “methodological constraints are experienced as existential matters, not as matters of methodical convention,” (1983, p. 146) is rejected in this research as somewhat simplistic, and instead as a way to ensure replicability, Miles and Huberman’s replication strategy was employed. They assert multiple-case sampling “adds confidence to findings” (1994, p. 29), because by looking at a range of cases it is possible to understand a single case finding by grounding it in specifications of the *how*, the *where*, and the *why*. Using suggestions from their text *Qualitative Data Analysis*, thirteen different tactics were used in this research to ensure basic quality of the data, to check findings, and to examine emerging explanations. These are listed below, and explained later in the description of the guidelines used in the method.

- Checking for representativeness
- Checking for researcher effects
- Triangulation
- Weighting the evidence
- Checking the meaning of outliers
- Using extreme cases
- Following up surprises
- Looking for negative evidence
- Making “if – then” tests
- Ruling out spurious relations

- Replicating a finding
- Checking out rival explanations
- Getting feedback from informants (Miles & Huberman, 1994, p. 263)

3.3.3.f. *Trustworthiness*

An important aspect of qualitative research is the question of, "how... an enquirer [can] persuade his or her audiences [including oneself] that the findings ... are worth paying attention to" (Lincoln & Guba, 1985, p. 290). According to Lincoln and Guba (1985) there are four criteria by which the trustworthiness and authenticity of qualitative data can be assured, including credibility, transferability, dependability, and confirmability.

3.3.3.f.1. *Credibility*

For qualitative data to be credible it must be trustworthy, and conventional wisdom suggests that data must display isomorphism, i.e. a one-to-one relationship with reality. However this requires an *a priori* knowledge of that reality, but because of the nature of this research (i.e. embedded participant observation using grounded theory methods), this is impossible in this project. The solution is therefore to present reconstructions in the form of write-ups that are "credible to the constructors of the original ... realities" (Lincoln & Guba, 1985, p. 296). To achieve this credibility then, Lincoln and Guba have identified seven practices in which a qualitative researcher must engage. These include,

1. **Prolonged engagement.** This allows for the researcher to learn the culture, to test misinformation, and to build trust (because objects and behaviours take their meaning from contexts). The question of how long is long enough to be considered prolonged depends entirely on the context, but essentially it is, "long enough to be able to survive without challenge while existing in that culture." (p. 304), which means as long as the researcher is able to deal with personal distortions, e.g. his presence, a priori values, and/or constructions, and the respondents' distortions, such as selective perception, retrospective distortion and selectivity, and misconstruction of the investigator's purpose. Prolonged engagement provides an opportunity to build trust, which is a developmental process during which the researcher was able to demonstrate that confidences will not be used against participants, anonymity is honoured, there are no hidden agendas, the interests of the respondents are respected, and the respondents have input into the enquiry process. There are several issues that the researcher must guard against with a prolonged engagement, including "going native" and identification with

the natives (or co-optation) with the concomitant danger of losing research perspective or "detached wonder"(p. 304).

2. **Persistent observation.** This adds salience and depth to observations, and according to Lincoln and Guba is a continuous engagement with the tentative labelling of salient factors that are understood in a non-superficial way, much as Charmaz and Henwood (2008) describe inductive – abstractive logic (see section 3.3.1). A danger of persistent observation is that of premature closure, i.e. coming to a focus too soon, but this can be mitigated by maintaining an "aura of scepticism" (Lincoln & Guba, 1985, p. 305).

3. **Triangulation.** The third mode of improving the probability of credibility is to use multiple and different sources, methods, investigators, and theories. In this project different sources could include multiple copies of one type of source, or different sources of the same information to provide contextual validation. This ensures the validity of evidence by comparing it with other kinds of evidence and enables a source to be evaluated by collecting other kinds of evidence about it. Similarly, different methods of data collection could include the use of interviews, questionnaires, and testing, as well as the observations previously mentioned. The use of alternate investigators and theories are not credible forms of triangulation for this research since they are "epistemologically unsound and empirically empty" (Lincoln & Guba, 1985, p. 307) because an observation/fact is no more believable because it has meaning to more than one observer, or in more than one theory.

4. **Peer debriefing.** This is the process of exposing oneself to a disinterested peer to explore aspects of the research that might otherwise remain implicit. It helps to keep the enquirer honest by ensuring that the investigator is fully aware of his or her posture and processes, it tests working hypotheses, provides an opportunity to test next steps, and is also an opportunity for catharsis. Ideally the debriefer should be the enquirer's peer, someone who knows about the substantive area of enquiry, is neither junior nor in authority over the enquirer, and can play the devils advocate. The danger of peer debriefing though is a diminished enthusiasm for the project and an over influence by the debriefer.

5. **Negative case analysis.** This accounts for all known cases without exception and is an ex post facto procedure that looks for disconfirming data in both past and future observations. There is a problem however with Causal interpretation but the value of

negative case analysis is that it eliminates outliers and increases credibility by reducing the number of exceptions.

6. **Referential adequacy.** This is "a means for establishing the adequacy of critiques written for evaluation purposes under the connoisseurship model" (Lincoln & Guba, 1985, p. 313). The process includes the archiving of data (especially video recordings) for later examination at leisure and comparison with critiques. It can also be used to analyse archive data that has not previously been analysed, i.e. is still raw, and can be used to test reliability and validity. The drawback is that it requires data to be surrendered to the archive, (although this was not a problem in this project because of the amount that was collected), and archived data may not be representative.

7. **Member checks.** This important technique involves continuous formal and informal opportunities for members to check that reconstructions, i.e. case write-ups, are adequate representations of reality. Member checking can be used to assess intentionality, and formal checking is more meaningful for credibility. Problems can occur with member checking when members take adversarial rather than adequacy positions over the fairness of reconstructions or have a tendency towards average or typical positions. The potential also exists for members to conspire to mislead or cover-up, particularly for naive investigators. Member checking is not the same as triangulation, which is carried out with respect to data and its accuracy, but is carried out with respect to reconstructions and overall credibility.

3.3.3.f.2. Transferability

The transferability, and its opposite – the assumption of applicability, of research findings depend on the degree of similarity between the sender and receiver contexts. But since the conceptualised populations of these contexts may themselves be suspect, findings may not be context free (i.e. customary or nomic), nor may they be time free (where principals are taken as true, i.e. nomological). Thus, empirical evidence about contextual similarity should be accumulated and supplied to audiences. This evidence also helps to mitigate threats from selection effects - where constructs are specific to a single group, setting effects - where results are a function of the context under investigation, history effects - where experiences are unique and historical, and construct effects - where constructs are peculiar to the study group, because they can be seen as factors to be accounted when judgements of transferability are made.

3.3.3.f.3. Dependability

The idea of dependability of qualitative research is associated with replicability, which ironically can only be determined within a given framework, which is itself a construction. Dependability refers to the consistency, stability, predictability, reliability, replicability, repetition, dependability (and their opposites) of constructions and/or reconstructions from the data. Lincoln and Guba (1985) suggest that an enquiry audit be conducted to examine the process of the research to ensure that a fair representation of the position and the product is presented. The purpose of the audit is to ensure accuracy through internal coherency, and an audit can also attest to confirmability and dependability of any reconstructions. Confirmability specifies the items in the audit and the algorithm for the audit itself. Audit items should include,

1. **Raw data**, e.g. digital recordings, written field notes, and unobtrusive records.
2. **Data reduction and analysis products**, e.g. write-ups, summaries, theoretical notes, working hypotheses, hunches.
3. **Data reconstruction and synthesis products**, e.g. themes, definitions, relationships, findings, conclusions, final report.
4. **Process notes**, e.g. methodological notes.
5. **Materials relating to intentions and dispositions**, e.g. enquiry proposal, personal (reflexive) notes, expectations.
6. **Instrument development formation**, e.g. pilot forms, schedules, observation formats, surveys.

Other aspects of dependability include a reflexive journal to provide data about the human instrument and about methodological decisions, and could include a daily schedule and logistics, or a personal diary, e.g. for catharsis or reflection, or a methodological log.

Other considerations include the consumer of the research who is concerned about the trustworthiness of the study. If the reconstructions are credible to the respondents, then they should be credible to the consumer. However, the open nature of the study is such that the trustworthiness of the findings cannot be compelling; they can only be persuasive at best. This is because the operationalisation of the theoretical definitions of the trustworthiness criteria is problematical because of the difficulty in specifying the adequacy of audit processes and in establishing minimal acceptable levels of trustworthiness. According to Lincoln and Guba (1985), these will probably be done

empirically over time and a hope of this study is that it will have contributed to the discussion through the extensive use of the analytical software.

3.3.3.f.4. Confirmability

The confirmability of qualitative research findings are to some extent based on the objectivity or neutrality of the reconstructions. However, there are three perspectives on this objectivity; there is the ontological objectivity, which considers its nature, there is the epistemological objectivity, which considers its truth, and there is the axiological objectivity, which considers its value.

According to Lincoln and Guba (1985), the objectivity of observation is isomorphic, i.e. the one-to-one correspondence between data and reality is neither disturbing nor disturbed by the observation, and is value free (although others may disagree). The point is that the main focus of confirmability should be on the data and whether it is confirmable, which is the purpose of the previous three subsections.

In an attempt to persuade consumers of this research that the findings are worth paying attention to, the trustworthiness and authenticity of the reconstructions and substantive theories presented in (chapter 5) are argued in section (4.6) which explains how the trustworthiness of the data was ensured.

Having thus identified the paradigm and methodology, described the basics of grounded theory, and argued for a multiple case study, the rest of this chapter focuses on how some of the ethical issues were grappled with and concludes with explanations of the methods used to gather and analyse the data.

3.4. Ethical Considerations

3.4.1. Ethical Approval

This research was conducted with approval from and in accordance with the University of Waikato's Human Research Ethics Regulations (2005). These regulations, which include requirements for information to be made available for participants about confidentiality, researcher and participant safety, conflicts of interest and research sensitivity, are discussed below.

3.4.1.a. Information for participants

An information sheet was provided to the individual research participants, as well as to the case companies, which explained the research and their part in it, i.e. that they would be observed, interviewed, photographed or videoed. They were asked for their written consent to participate in the exchange and it was explained that any data that was

collected would belong to the researcher and would not be available to them. This was to protect all participants' confidentiality. The participants were also advised that if they chose not to participate, no data would be collected from them. Furthermore, if they wished to withdraw from the research or wanted certain data not to be recorded at any time, they could do so, and that any data that was collected from them would then be destroyed.

The Information Sheet also explained that a summary of the data may be made available to the participants on request, and findings may be discussed with them in the development of interventions in any action research phase of the research. Any findings that were published or reported on would not contain any personally identifiable, proprietary, or other protected information and would belong to the researcher, so no participants' consent would be required prior to publication.

3.4.1.b. Confidentiality

The participants' identities would be concealed with pseudonyms, generic references, or composite characters in any published material.

Apart from the researcher and his supervisors, nobody else would have access to the raw data. This included all observational field notes and reflections, photographs, video and audio. The participants would only have access to analysis and reports that pertained to them specifically. All information was stored on secure electronic media, i.e. a password protected computer hard drive with external backup drive, or in a secure physical storage.

3.4.1.c. Participant safety

There was no anticipation of any risk associated with the participants daily lives for those taking part in the research, because the data collection and analysis consisted of observations and personal reflection that would not be made publicly available. Any action research that was implemented was only done so after careful consideration of its implications and with the explicit support of the participating supervisors. The researcher's role was as a participant observer in the workers' lives, his part was pure observation and recording of what he saw, and there was no expectation that his presence at the research site would alter their lives in any way.

3.4.1.d. Researcher safety

The researcher complied with all safety policies and procedures at the participant firms, and three of the four participant firms insisted that he undertake Health and Safety inductions.

A close association was maintained with the academic supervisors to help the researcher maintain an emotional equilibrium, and to encourage him to remain objective during the data gathering process.

3.4.1.e. Conflicts of interest

The researcher had no associations with anyone in the target participant firms, so there was nothing ethically inappropriate about the research.

A possible conflict of interest could have arisen during the periods of reflective thinking during the participant observations. It was possible that the things that the researcher saw and heard in the process of gathering data could have affected him personally, to the extent that he could have been tempted to behave in a manner damaging to his relationships with those that he was working with/observing. Fortunately, this situation did not arise.

3.4.1.f. Research Sensitivity

Potentially sensitive areas of the research included recording details of the personal experiences of others. Even though data was only collected from participants who had provided written consent to do so, to ensure that the research procedures were sensitive, or not likely to be insensitive, each participant was checked with again before any data such as photographs or video was collected

When a participant requested access to the raw data, he or she was politely declined, citing confidentiality and the need for the researcher to maintain independence.

If a participant had decided that they did not want specific data to be recorded, then the request was honoured. If they had taken the option to withdraw from the study completely, all data from them would have been destroyed, but this situation did not arise.

The research was deemed culturally safe and non-offensive to all participants. This was because the participants were all average New Zealanders going about their daily lives, as was the researcher himself. As far as they were concerned, the individual lab technicians, engineers, and their supervisors did not differ from the researcher in ways that were relevant to the research.

3.5. Method

This section describes how the grounded theory guidelines were used for the data collection and analysis. The data was collected during the participant observations, and the analysis was done using a qualitative data analysis software package called Nvivo (QSRInternational, 2009).

3.5.1. Description of the method: Data Collection

This section describes how the grounded theories were developed, including how the case study sites were accessed, how the data was collected – e.g. instrumentation and sampling – and how the data was managed in the case study write-ups. The process of data sampling phases (illustrated in Figure 8 below) followed in a logical order according to the generally accepted principles of grounded theory, and the data sampling techniques were driven by constant comparative analytical processes.

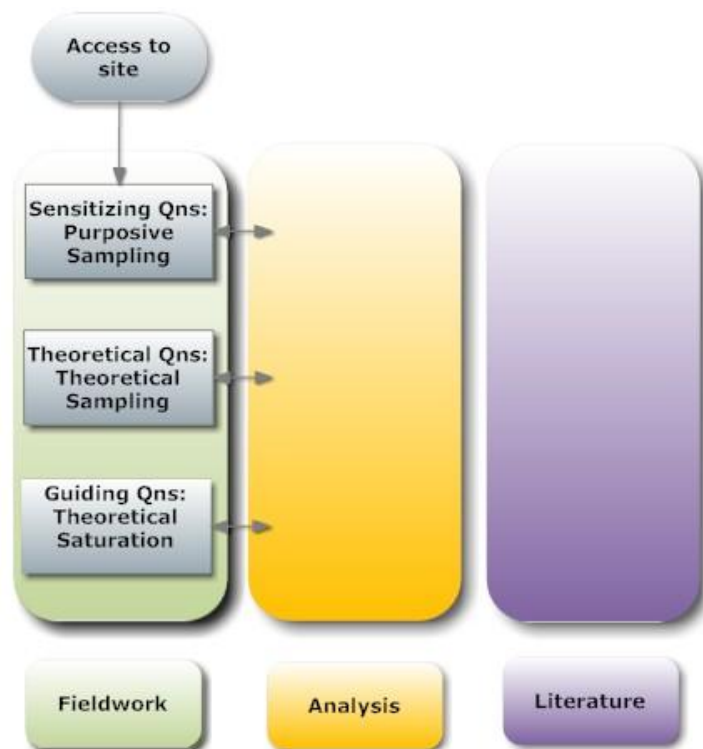


Figure 8: Data Collection Processes

3.5.1.a. Accessing the cases

Access was gained to each of the four cases through the researcher's personal networks. After the potential research sites had been identified, the researcher made informal approaches to senior managers in a variety of companies, with the intention to invite those who were interested in the research topic to participate and support the research. The ideal research participant was a New Zealand production or engineering firm or

division, with a significant export market, employed up to 200 people, had a substantial capital investment in sophisticated production technology, and was interested in participating in potentially groundbreaking research at little or no cost to them.

Once informal contact had been made, the four organisations who expressed an interest were invited to participate via a formal proposal (see Appendix 1 on page 288 below). This proposal was presented to the senior/executive management, the supervisors, and in one case, a union, for their acceptance. During the presentations, the prospective participants were provided with a written information sheet, which told them about the purpose and background of the research, including:

- who was associated with it, and how they could be contacted (i.e. the University of Waikato, and the researcher's supervisors details)
- what was involved for the participants, (i.e., what their part in the research would be)
- what the benefits and potential risks for the participant firms, supervisors, and individuals may be
- how any risks would be managed
- what would happen to the collected data, and
- How they could opt out of the research.

The information sheet also explained that although the supervisors may benefit from the research, the research findings themselves would belong to the researcher (see the appendix for a copy of the information sheet).

After those companies who agreed to participate had accepted the proposal, formal agreements covering confidentiality, indemnity, and ethics were signed, and dates were arranged for the observation periods.

The four observation periods took place in New Zealand during 2008/ 2009 in four different firms and consisted of four separate four-week periods of total immersion at each site.

- The first observation took place during May and June of 2008 in a commercial chemistry-testing laboratory. The laboratory's function was to provide information to the firm's production facilities about the quality and content of the dairy products it was making.

- The second observation took place during August of 2008 in an electrical engineering service and maintenance facility. The engineers worked on a variety of electrical motors and generators, ranging in size from small utility motors, to large industrial generators that fed the national power grid.
- The third observation took place during October of 2008 in a factory that produced automatic door systems for public transport, e.g. buses, trains, and ferries.
- The fourth observation took place during June and July of 2009 in a maintenance hangar of an airline's aircraft fleet.

Each site employed between fourteen and thirty employees on the shop floor in the division where the observation took place, and between them, fourteen supervisors were observed. Altogether over 600 hours of observations were conducted. Data collection methods were used consistently across all four sites, and are detailed in the following section.

3.5.1.b. Immersion data collection design

One of the interesting features of this research, which made it a different from many other projects, was the embedded nature of the data collection process. The researcher-as-instrument was totally immersed in each of the case study sites and behaved to all intents and purposes as if he was a new hire. Over the course of the participant observation period the researcher behaved exactly as if he was a regular employee, i.e. started work at the same time as the other employees, signed in where required, wore standard issue lab coats or overalls where these were issued, took instruction from supervisors and reported to them as if he were a regular employee, took Smoko and lunch breaks when the other employees did and joined them in their social spaces as he did so.

The rationale behind this total immersion data collection method was to situate the researcher completely within the context and structure of the case study site. It was felt that this method allowed for, “the discovery and articulation of what has been heretofore unknown” (Pauleen, Corbitt, & Yoong, 2007, p. 222), since it was considered to give him the greatest chance of observing situated tacit knowledge related phenomena, which by their very nature are often hidden to the participants themselves.

By participating with as well as observing the participants in their natural settings, and experiencing what they experienced, the researcher was able to bring to bear all of his theoretical sensitivity to the data collection processes and thus perhaps be able to gain

analytical insights into the cases that would not have been possible if the data had been collected using instruments that recorded only externalised, i.e. explicit, knowledge, such as surveys, interviews, or documents. A simple observations method, where the researcher sat apart from the participants and observed from a distance, would not have been appropriate either, since it would not have given him the opportunity to build relationships with them and would have confounded efforts to get inside their heads, so to speak.

A few significant risks to the project with this method were identified prior to the data collection periods. First was the risk of not being assimilated into the workforce, which would have prevented the researcher from truly experiencing what they experienced, or perhaps only observing reactivity, i.e. worker behaviours that changed in response to the researcher's presence. The second risk was that of the researcher becoming so totally identified with the workforce that he lost objectivity, and a third risk was the danger of actual physical harm coming to the researcher, or the researcher causing harm to the participants.

Since all three of these risks had been identified prior to the research, considerable efforts were taken to ensure that the researcher was able to build quality relationships with all of the research participants, but yet still remain apart so as to maintain a certain level of objectivity. The risk of actual physical harm was reduced by the researcher taking every effort to maintain situational awareness and to isolate, minimise, or eliminate potential dangers, according to the induction training that was provided.

3.5.1.c. Instrumentation

A number of diverse materials comprise qualitative data, and data collection instruments include interviews, transcripts, field observations, other documents, e.g. diaries, questionnaire answers and statistics (Strauss, 1987), as well as pictures and recordings (Van Maanen, 1979), and of course the researcher him or herself (Miles & Huberman, 1994, p. 35).

In this research, the primary research instrument was the researcher-as-instrument himself, who lays claim to having theoretical sensitivity, because of his background. He trained and worked as a boat builder in a number of environments in New Zealand and overseas, and from that experience he gained a broad knowledge of a number of industrial skills, hence, he has an acute sense of the value of tacit knowledge in the workplace. He is also a tertiary-trained teacher, and from his teaching experience has developed observational and assessment skills that enable him to make accurate

judgements about the quality of observed phenomena. Thirdly, the researcher has also worked as a senior manager and is very aware of the “knowing – doing gap” (Pfeffer & Sutton, 2000) that exists between shop floor and executive office, i.e. the difference between the information that senior managers receive and the knowledge that workers have. Suffice it to say then, the researcher has the requisite social psychology to be an effective instrument in himself.

The other conventional data collection instruments used in this study included,

- Pen and paper – observational notes written on-site, and then written up on a daily basis.
- Digital Voice Recorder – to record interviews and sounds.
- Digital Camera – to record still images and video.

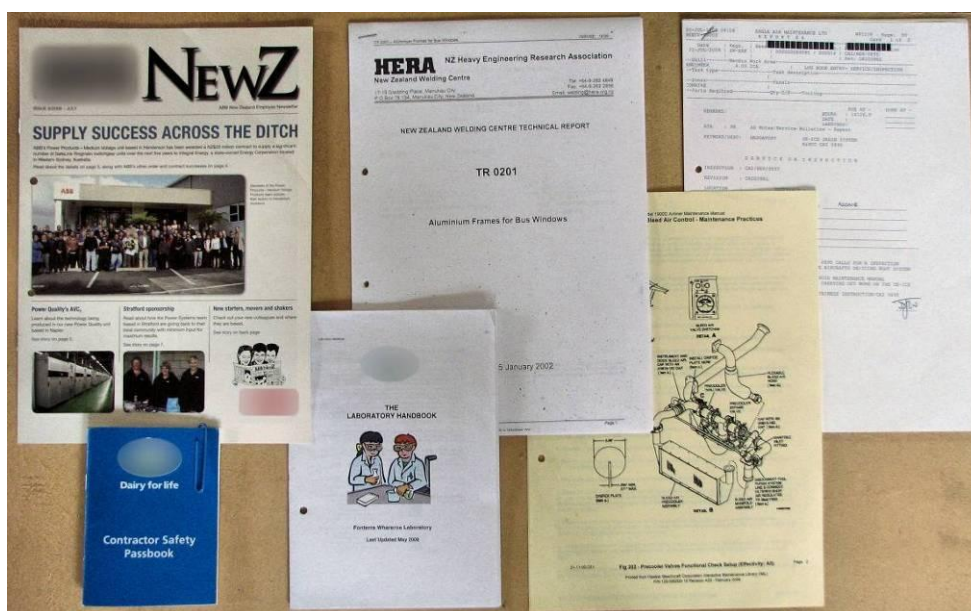


Figure 9: Documents collected during observations included (clockwise from top left) newsletters, research reports, supervisor reports, SOPs, employee handbooks, and induction handbooks.

Apart from collecting observational data with the above instruments, data in other forms was also collected (see Figure 9 above and Figure 10 below) including originals or copies of training records, Standard Operating Procedures, technical reports, newsletters, safety passbooks, laboratory handbooks, engineering notices, pages from an illustrated parts catalogue, quality control signoff sheets, briefing documents, e.g. training videos, newsletters, and artefacts such as worn shaft bearings, burnt out electrical windings, and H&S equipment, e.g. earplugs.



Figure 10: Artefacts collected during observations included (clockwise from top left) videos, ID cards, engineering data sheets, electrical windings, PPE – earplugs, keyrings, U/S bolts and bearings, test specification sheets, CDs.

Together, these samples comprised a comprehensive collection of data on virtually every aspect of the participants’ daily lives, and were collected at various stages of sampling.

3.5.2. Sampling

The focus and bounding of the sample collections were not pre-specified before each observation, and to some extent evolved over the course of each four-week period. However, in order to maintain a consistent approach, the following focussing and bounding processes were used.

3.5.2.a. Purposive Sampling

During the first week of each observation period, the initial data was collected using purposive sampling. The parameters for a purposive sample included generic descriptions of each observational setting, its actors, events, and processes and the collection of documents and or artefacts. Purposive sampling as opposed to random sampling is used in qualitative research because “social processes have a logic and coherence that random sampling can reduce to uninterpretable sawdust” (Miles & Huberman, 1994, p. 27).

The data collected included a general description of each work place, its work processes, and its people to try to make sense of the potentially overwhelming number of new experiences that could swamp details about the phenomena under observation. It was during this time that the researcher began the blending-in process – getting to know

participants names, learning about what they did, learning to help or beginning to contribute where possible – and becoming part of the workforce. Usually this was when the participants were most wary and most curious, and when considerable efforts were made by the researcher to get on side with the supervisors themselves.

The efficacy of this approach was confirmed later on when once the participants, e.g. the lab technicians or the engineers, had become used to the researcher's presence among them they began to open up and share their experiences, and ask questions of the researcher himself, e.g.,

“Why are you doing this?”, “How are you supporting yourself?”, “What’s going to happen to the data?”

As the researcher developed relationships with the participants, he was able to observe them in their natural, i.e. uninhibited work mode, and to elicit information from them about their work. Taking a cue from Eraut (2004), the observations,

- Focused on how people learned to do what they do at work.
- Described (in detail) their ordinary everyday work.
- Recalled activities of current and previous weeks, and described differences.
- Explained the differences.
- Described what types of knowledge, skills, and competencies participants needed to do the work.
- Investigated how participants acquired these.
- Described and attempted to understand the work setting.
- Identified the people in the work setting and their interactions with the participant.
- Identified and described the cultural artefacts (e.g. text, electronic, other forms) that were used in the work.

The samples were treated as generic and evaluative, and “used to initiate conversations about practice and the practice environment” (Eraut, 2004, p. 249). Thus the field notes were sufficiently rich in detail to enable a useful post observation trans case analysis to be conducted.

One of the advantages of this method was that it helped to obviate the problem of collecting data from just the approachable or friendly people, or people who were liked

or who liked the researcher. Since the researcher was embedded in the work processes of the sites, he was able to observe and interact with all members of the various work teams in the same way as any other worker, so the choice of who to talk to, or observe, or collect data from was effectively removed from the researcher himself, and the data was basically collected according to a “what you see is what you get” model – entirely consistent with Alvesson and Deetz’s “discovered order” (see page 81 above).

3.5.2.b. Theoretical Sampling

Usually by the end of the first week, and certainly by the beginning of the second week, the sampling became more focussed. Early Open Coding analysis produced classes of phenomena, so sampling focussed within those and became tactical. For instance, the rich descriptions from the early purposive samples were checked against current observations for researcher effects and representativeness. Often, the early descriptions showed how participant social behaviours were affected by the researcher’s presence, e.g. a lab technician or engineer showing off for the researcher, but the later descriptions showed that these were not representative behaviours. It was also during the theoretical sampling that data began to be weighted. For instance, over time it became obvious that some informants provided “better” data than others did, by virtue of their knowledge or closeness to the phenomena under observation. Similarly, the researcher himself began to be more cognisant of the context and environment, and was able to identify particulars of a class of phenomenon that were relevant.

Towards the end of the second week or during the third week, choices about what participants, episodes, or interactions to sample were made according to concepts emerging from the analysis. At this stage, sampling was not done so much for representativeness, but to check the meaning of outliers, or extreme cases. Similarly, by now the researcher had developed sufficient rapport with the people at each site that he was able to triangulate the data, for example by identifying which contributions had been provided from ulterior motives or deception. This happened at every case, where individual engineers or technicians “latched on” to the researcher and fed him fascinating so-called insights, that later turned out to be a stretching of the truth or in some cases, outright fabrications.

By the latter part of the third week of observation, sufficient data and analysis had been done to enable the researcher to begin looking for specific negative evidence or for conducting “if-then” tests about emerging hypotheses. By now, surprises could be

followed up and spurious relationships between interactions, people, or episodes could be identified.

3.5.2.c. Theoretical Saturation

The final week of observations was spent ensuring that theoretical saturation had been reached. This meant that concepts that had earned the status of category were proven to have theoretical relevance, i.e. phenomena were repeatedly present or notably absent, no new or relevant data emerged regarding categories, the category development had accounted for all paradigm elements along with variation and processes, and the relationships between categories were well established and validated (Strauss & Corbin, 1990).

As part of proving theoretical saturation, the researcher sought to replicate findings. This was done for example, by testing them in different departments of the firm, or checking out rival explanations, often by getting feedback from informants.

In three of the four cases studied, theoretical saturation was achieved within the four week participations, but in the fourth, the aircraft maintenance hangar, the complexity of the theories being developed, meant that the researcher needed to return briefly to the site several times. Fortunately, the relationship that had been built up with the manager, the supervisors, and the engineers themselves was such that these follow-up visits were not only welcomed, but also sought by the participants. During the follow up visits, several theories were further examined and tested with the supervisors, who provided significant input into the theory development.

3.5.3. Reporting the data in the case write-ups

During the observation periods, even though the researcher spent a full day “at work” in each case, the evenings were spent writing up the daily observations, transcribing them from hastily hand-written notes full of abbreviations into full rich explanations. The use of modern technologies, such as voice recognition software helped enormously here, enabling the researcher to think aloud, and write at the same time; saving considerable amounts of time and effort.

3.5.3.a. Handwritten text:

The field notes were handwritten on a sheet of A4 paper that was kept folded in the researcher's pocket. As the researcher went about his daily tasks he kept an eye out for episodes of tacit knowledge phenomena and when something caught his eye he would whip a sheet of paper out, jot down notes, then stuff the sheet back into his pocket and

carry on with his work. Later when a more opportune moment arose during the day the field notes would be taken out and developed in preparation for the evening write up.

As an example of a field note and its subsequent evening write up, Figure 11 is offered below as an illustration of an episode of tacit knowledge application by an experienced laboratory technician. The figure shows the notes taken during an observation of an incident, and the extended text and reflexive thinking done about it.

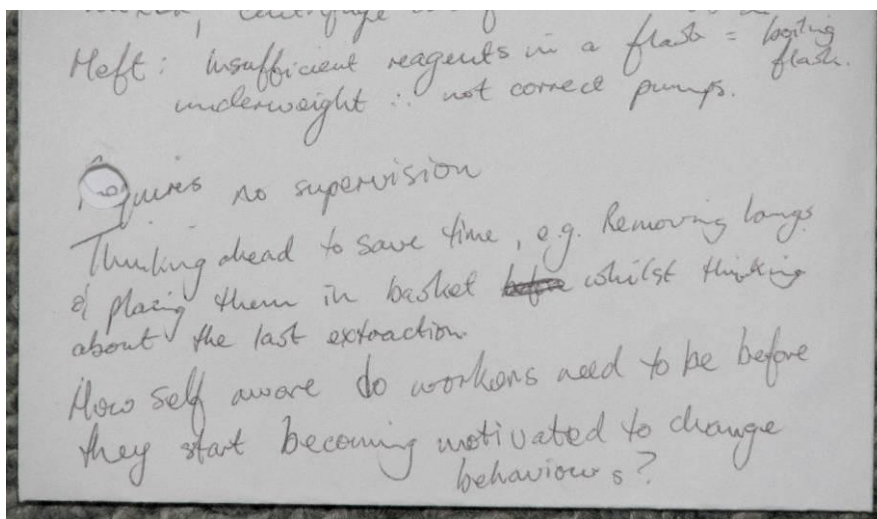


Figure 11: Handwritten daily observation note

Observation

By the heft of the rack of flasks, [technician] was able to tell that there were insufficient reagents in a flask, and was therefore underweight, and by a process of reflective thinking, was able to tell therefore that there were not enough pumps of reagent added.

[The technician] got distracted when talking to me and forgot to add a second pump of a reagent into the Mojo flasks she was preparing. However, the moment she picked the rack up to begin the mixing process, she realised that it was underweight and began to reflect on what she had just done. She soon realised that she had been distracted and hadn't added the extra pump that she should have done, and promptly remedied that by adding the second pump. She required no supervision for this task.

Whilst she was doing this, [technician] was also thinking ahead to save time, she was removing bungs from the Mojo flasks that had completed their cycles, and was placing them in a basket, all whilst she was thinking and talking to me about the last extraction.

Note to Self:

How self aware do the workers need to be before they start becoming motivated to change their behaviours, particularly when confronted with problems and no supervision close at hand?

How about putting a learning tips and tricks page on the computer as a tool for sharing these kinds of problem solving solutions?

3.5.3.b. *Extended text:*

Occasionally, if the rigours of the day meant that the researcher did not have the energy to do the write up; it would be done during the following weekend. Coding of the data with Nvivo was also done during the weekends, which enabled the researcher to move from phase to phase of the sampling process with the confidence that the following week's observations would be cogent and salient.

The sample collection processes described in the previous section formed the guidelines used to collect approximately 100,000 words of observation notes, over four hundred still images, many hours of video and audio, and numerous boxes of artefacts. This large volume of data was carefully filed, but was more than could be usefully represented in the case write-ups.

As a way of usefully condensing this mass of information for each case discussion, only data salient to the analyses is represented in the case write-ups. Table 2 below shows the types of data that were sampled, the focus of the data sample and what that data comprised.

Sample type	Focus	Illustrative data
Purposive	Setting	Rich descriptions of the site
	Actors	Identification of respondents
	Events	Field study notes describing activities involving tacit knowledge phenomena
	Processes	Field study notes describing systematic application of tacit knowledge
Theoretical	Emergent concepts	Tactically selected quality data
Saturation	Categories	Hypothesis testing

Table 2: Reporting the data in the case write-ups

3.5.4. *Description of the method: Data Analysis*

This section describes how the case study data was analysed. It includes a description of the software, and analytical processes used to develop grounded theories of tacit knowledge management. These processes constantly compared “data with data, data with codes, codes with codes, codes with categories, category with category, [and] category with concept” (Charmaz & Henwood, 2008, p. 242). The generic process is illustrated in Figure 12 below.

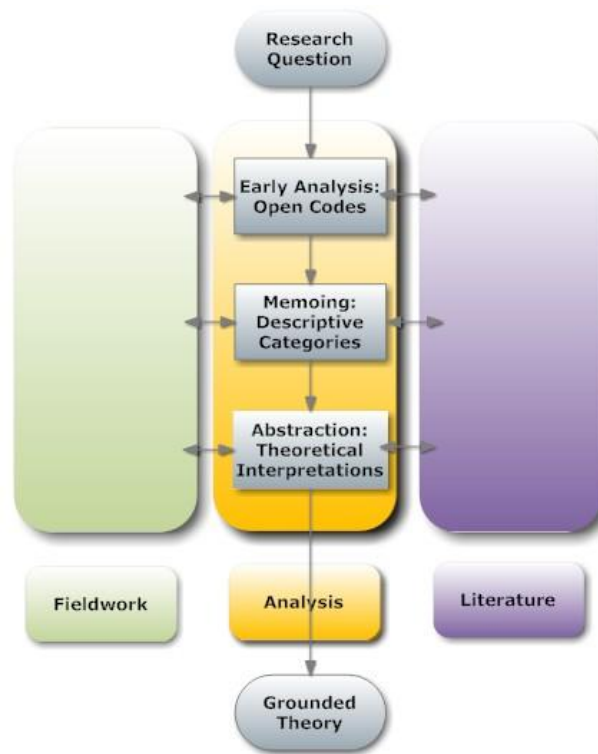


Figure 12: Data analysis processes

3.5.4.a. The software: Nvivo 9

The software used in the data analysis was an application called Nvivo (QSRInternational, 2009), that has been specifically developed for qualitative research. The software enables a researcher to import, or otherwise connect field study data and articles from the literature in a database, and then develop codes, memos, and diagrams with which to make sense of it all. The software also has sophisticated querying functions that facilitate interrogation of the data via codes and attributes, to gain insights that may not have been immediately apparent.

3.5.4.b. Using Nvivo in the literature review

Nvivo was used in the development of the conceptual framework for this project to gain insights from the literature that were not immediately apparent from a manual review, which was particularly helpful in guiding the observations. For instance, one aspect of the conceptual framework that was important for the study was an understanding of the term "management" and how it was used in the context of the knowledge management discourse.

In popular literature, the term management means the "organization and coordination of the activities of an enterprise in accordance with certain policies and in achievement of clearly defined objectives" (Businessdirectory.com, 2010), or "to be in charge of,

oversee: watch and direct, achieve, do: carry on or function, or wield" (Google, 2011), which terms have a sense of formal hierarchical control and direction from above. However, in the knowledge management discourse there are subtly different nuances to this word, because knowledge has an inherent power of its own, and in the literature, the term management has associations with caring, coaching, coping, grappling, and handling. This insight was important for the observations, because it guided the focus of the case studies. The following section describes how Nvivo was used to gain these insights and is illustrative of the way it was used in the analysis of the field notes.

3.5.4.c. Using Nvivo's Word Frequency Query function

One of the ways in which Nvivo was used to gain insights into the literature was with its Word Frequency Query function. For example, reasonably early on in the project the researcher wanted to gain an insight into how the knowledge management discourse viewed the term "management". At that stage there were 169 knowledge management related journal articles in the database, so a text search was conducted to find all instances of the term "management" or its stemmed words and synonyms. The search returned 12,506 instances that were coded into an Nvivo node labelled "txt management".

(The coding in the Nvivo database is stored in nodes. A node indicates a concept that could potentially develop into "network of sub-concepts or dimensions" (Bazeley, 2007), and a node was created for each topic or concept that the researcher wanted to articulate. Apart from journal articles, the software allowed the researcher to code portions of observational text, still image, video or audio file, enabling a mixed media approach to be taken to the data analysis.)

A Word Frequency Query search was conducted on this "txt management" node with the search parameters set to find up to 150 of the most frequently occurring words having a minimum length of five letters, including stemmed words (See Figure 13 below for a screen grab of the Word Frequency Query search parameter dialogue box).

The software has the ability to present the Word Frequency Query solution in a table form that shows several pieces of information, including the found words and their length, the number of times the found word occurred in the node, its weighted percentage, i.e. its frequency relative to the total words counted including a portion of the stemmed word's frequency, and the list of similar or stemmed words that were also counted.

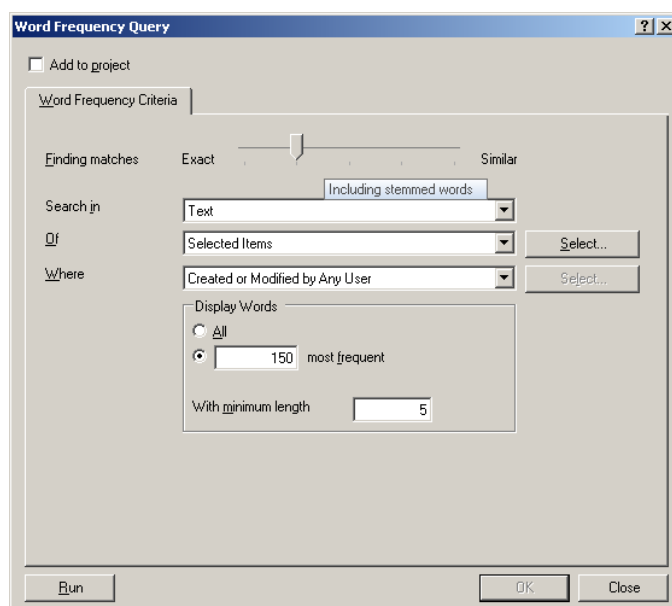


Figure 13: Search parameters dialogue box for a Word Frequency Query in Nvivo 9.

The search returned 18 words and their associated Similar Words (or stemmed words) as illustrated in Table 3 below.

Word	Length	Count	Weighted %	Similar Words
Managing	8	7666	61.30	manag, manage, manageability, manageable, managed, management, managements, manager, managers, manages, managing, managism, managment
Direct	6	945	7.56	direct, directed, directing, direction, directional, directions, directive, directly, directives, directly, directness, directs
Achieving	9	594	4.75	achievable, achieve, achieved, achievement, achievements, achievers, achieves, achieving
Doing	5	386	3.09	doing, doings
Realizing	9	173	1.38	realiz, realizability, realization, realizations, realize, realized, realizes, realizing
Handle	6	124	0.99	handle, handled, handles, handling
Caring	6	122	0.98	cared, careful, carefully, cares, caring
Dealing	7	118	0.94	dealing, dealings, deals
Accomplished	12	106	0.85	accomplish, accomplished, accomplishes, accomplishing, accomplishment, accomplishments
Director	8	81	0.65	director, directorate, directors
Supervision	11	80	0.64	supervise, supervised, supervises, supervising, supervision
Coaching	8	63	0.50	coach, coached, coaches, coaching
Contend	7	37	0.30	contend, contended, contenders, contending, contends
Coping	6	13	0.10	coping
Grappling	9	11	0.09	grapple, grappled, grapples, grappling
Oversee	7	8	0.06	oversee, overseeing, oversees
Wield	5	7	0.06	wield, wielded, wielding
Superintendent	14	5	0.04	superintendants, superintendent, superintendents

Table 3: An example of an Nvivo Word Frequency Query solution

The query solution can also be presented as a Tag Cloud (see Figure 14 below), or as a Tree Map (see Figure 15 below), both of which give intuitive views of the relative word frequencies.



Figure 14: Nivo Tag Cloud of Word Frequency Query solution.

However, in this particular instance these views of the Word Frequency Query solution presented a rather simplistic view from the literature of the constructs associated with the node "txt management", in that they did not tell about the relative importance of the relationship between the terms.

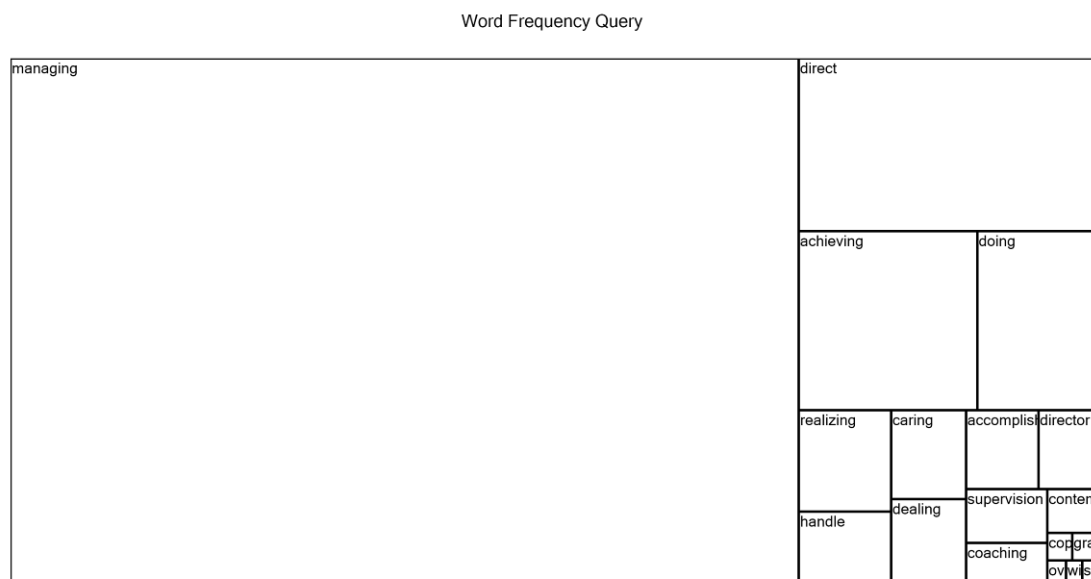


Figure 15: Tree Map of Word Frequency Query solution.

Fortunately, Nvivo also has the ability to show how these terms are correlated according to the Pearson correlation coefficient metric, which gives a better idea of the relative importance of the constructs to the original text search parameters (see Figure 16 below).

The software creates a diagram showing three dimensions, and places the constructs (words and their related stemmed words) from the frequency query within this 3D space

relative to the most frequently occurring word. Since the most frequently occurring word was “managing” – one of the stem words in the original text search for “management”, the diagram showed the relative importance of the most frequently occurring concepts to the most important concept, i.e. management, which had been previously determined in the text search. The more the found words were correlated to the main construct according to the Pearson coefficient, the closer they were placed in the diagram (see Figure 16 below).

What these combined queries show, i.e. the text search and the word frequency query, is that the term *management* is closely associated with the term *managing* (obviously), but also closely with *coaching*, *caring*, *coping*, *handling* and *accomplishing*. The term is also related although to a somewhat lesser extent to *achieving*, *directing*, and *realising*. Similarly, *managing* is also associated with *grappling* and *contending*.

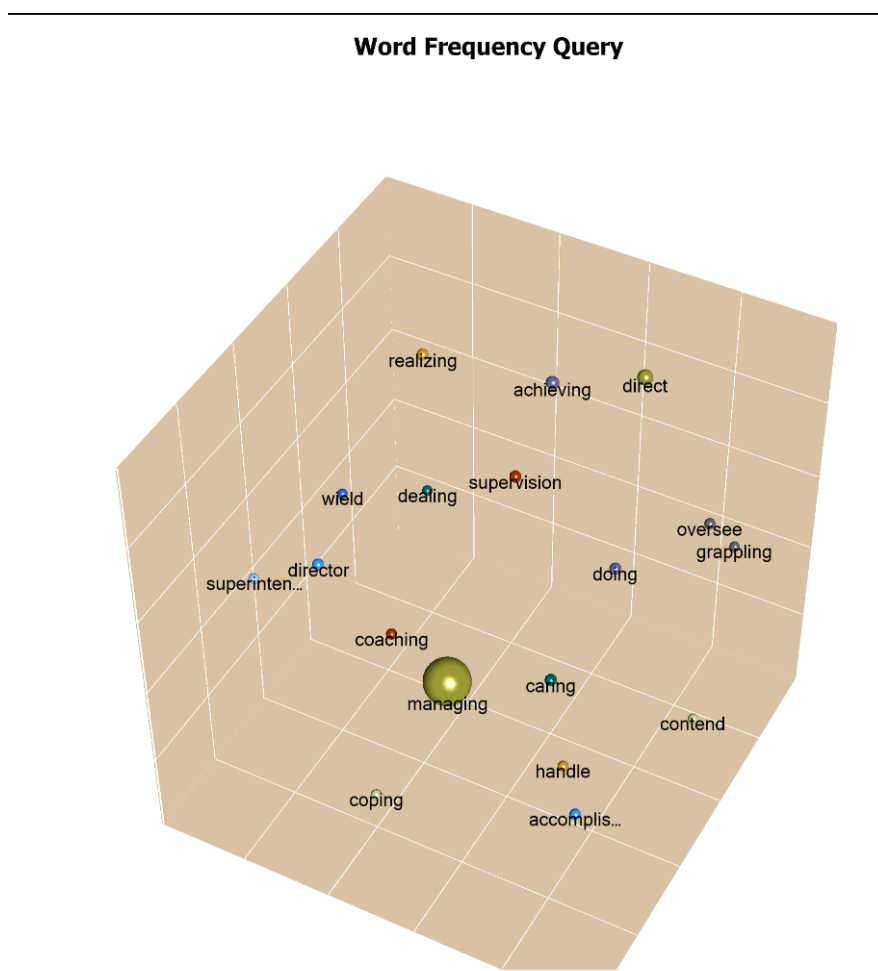


Figure 16: Nvivo illustration of Word Frequency Query solution correlations.

What this correlation diagram suggests is that in the knowledge management discourse at least, management issues are less around being in charge and watching, overseeing, or

directing, but more about coaching, coping and caring with an added complicating veneer of having to contend and grapple with issues, which is consistent with an overall sense that knowledge management is about dealing with difficult constructs like innovation, creativity, and competitive advantage through knowledge leverage.

These insights provided clues about what the observations in the data collection phase could be on the lookout for and hence helped to enhance the researcher's "empirical literacy" (Miles & Huberman, 1994, p. 38).

3.5.4.d. Using Nvivo's Matrix Query function

Another feature of the Nvivo software is its ability to perform a matrix query of intersecting search parameters. The solution to matrix query is presented in a matrix table, which can display the results as the number of sources, or the number of references, or the number of words, or the percentage of the source coded at the intersections. This ability to count references in the data that have been coded at a particular node does not by itself ascribe validity to the node description, but it does give an indication of how often that particular category of phenomenon was observed. It should be noted that a single event in the data could be coded at any number of nodes, so the total number of references in the matrix table does not necessarily equal the number of data points collected.

By comparing references in the matrix query report and engaging theoretical sensitivity, the researcher was able to judge whether he had been suffering from researcher effects such as participant reactivity or biases such as a holistic fallacy.

3.5.4.e. Attribution in Nvivo

Apart from handling the raw data, the software was also used to store metadata, i.e. attribute values of individual people, locations, or other entities such as journal articles. The researcher had total control of the number of attributes and their values, and could create or delete attributes at will. This attribution function was useful for cataloguing specific information about the people or places in the research, e.g. in terms of demographics, locations, quality of respondents' input, etc. and was especially useful when querying the data, as it allowed searching within and across cases for very specific criteria.

Two sets of attributes were created for this study, one for the individual people observed, and one for journal articles. The attributes used in the research are listed in Table 4 on page 116 below.

Participant attributes	Journal attributes
Age	Author and Year
Department	File
First Name	Has Figures
Gender	Journal
Location	Jrnl Impact Factor
Other Skills	References
Participant Firm	Times Cited
Participant Observation finish date	Title
Pay Level	Year
Position Title	
Pseudonym	
Skills	
Start Date	
Surname	
Tertiary Qual	
Time Served Annualised	
Time Served Years	

Table 4: Table of attributes used to describe participants and literature articles

3.5.5. *Developing the Grounded Theories*

Once the data had been uploaded into the Nvivo project database, the process of analysis began with coding.

3.5.5.a. *Open Coding*

The first step in the coding process was to read the notes, and begin the classification of phenomena into nodes. One of the goals of the analysis during the first week of purposive sampling was to get over what the researcher termed, the “gee whiz!” phase of the observation, and to make sense of what could have been an overwhelming experience. At this stage, the coding was open (Strauss & Corbin, 1990), in that the nodes, codes and data were open to further interpretation.

Using Miles & Huberman’s advice for a first cut, the data was coded at nodes that related to the research *setting* i.e. the location and context of the observation, at the various *actors*, i.e. the people about whom data was collected, and then at *events* that the researcher observed as having some salience to the research. Finally the first cut was coded at the *processes* the researcher observed or in which he took part (Miles & Huberman, 1994, p. 30).

As the observation continued, along with the coding, the original open codes were constantly examined and compared for similarities and differences. Questions were

asked about how they reflected the phenomena under investigation and/or the relevant literature. Later, these nodes were reinterpreted according to new insights or observations from both the data and the literature. During this phase the coding was very fluid in that it comprised a collection of Free Nodes (not connected to any other) and a developing set of Tree Nodes (having branches or daughter nodes). Nodes were rearranged, aligned with other nodes, associated with new ideas and/or renamed or deleted altogether. Because the software does not alter the raw data itself, the data could be coded at any number of nodes so the researcher was free to experiment with making sense in any way he chose.

An illustration of the coding process is shown in Figure 17 below. The figure shows a screen grab of the Nvivo interface illustrating the GUI (Graphical User Interface) and some of the tree nodes developed during an open coding phase in the analysis. The picture shows two tree nodes (*Field Notes*, and *Insights*) that were themselves daughter nodes of a higher construct, *Data Collection Sites* (not shown), and their daughter nodes, e.g. under *Field Notes* – *Note to Self* and *Observation*.

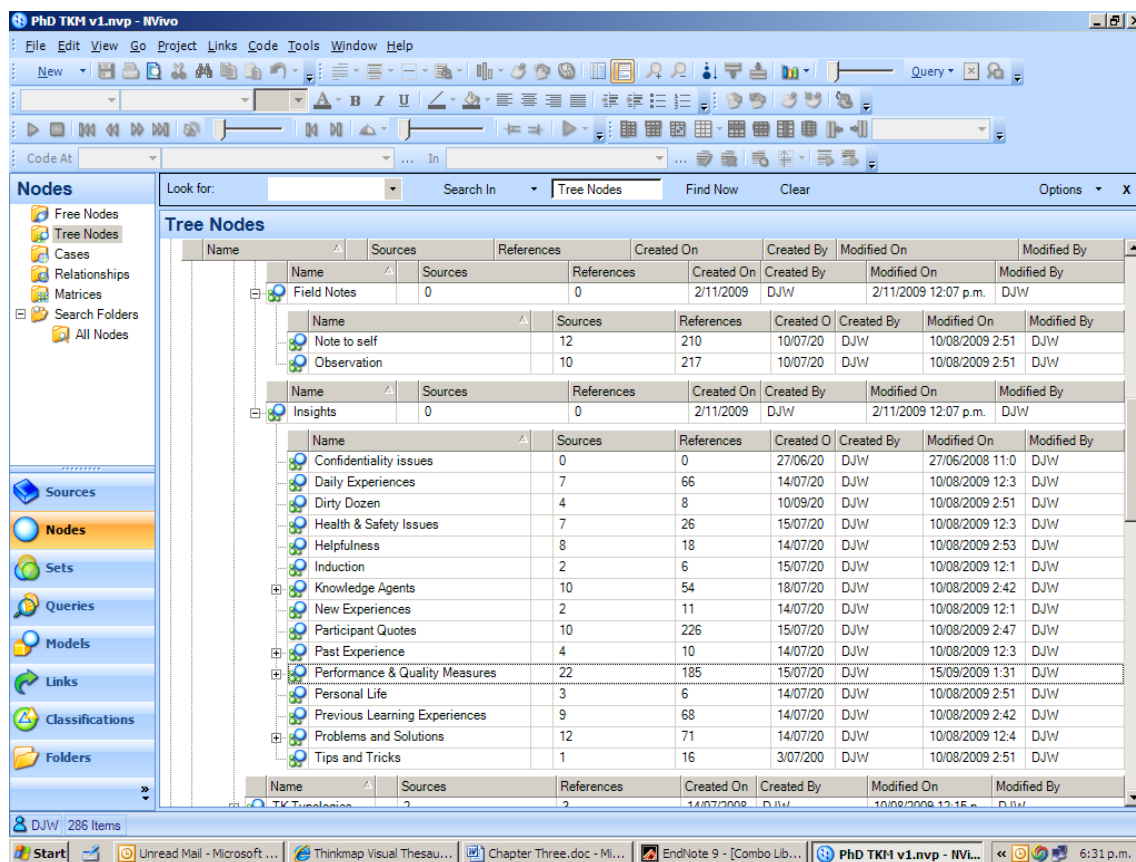


Figure 17: Screen grab of the Nvivo workspace showing early Open Coding

3.5.5.b. Memoing

Once the process of open coding was well under way and patterns in the node structure began to emerge, the researcher began the process of memoing. In Nvivo, this means creating new documents within the project's database to capture ideas, insights, and descriptions of emerging categories. The memos were linked with specific words or images in the data, or with nodes in the database. Because of the flexibility of Nvivo's data management system it was possible to create memos that were, in Strauss & Corbin's words, the "written records of analysis related to the formulation of theory" (1990, p. 197). Memos also included Code Notes, which contained the actual products of the coding such as conceptual labels, paradigm features, or indications of progress, and Theoretical Notes, which contained the products of inductive or deductive thinking about the node trees, or categories and their relevant properties, e.g. their dimensions, relationships, variations, processes, and conditional matrices

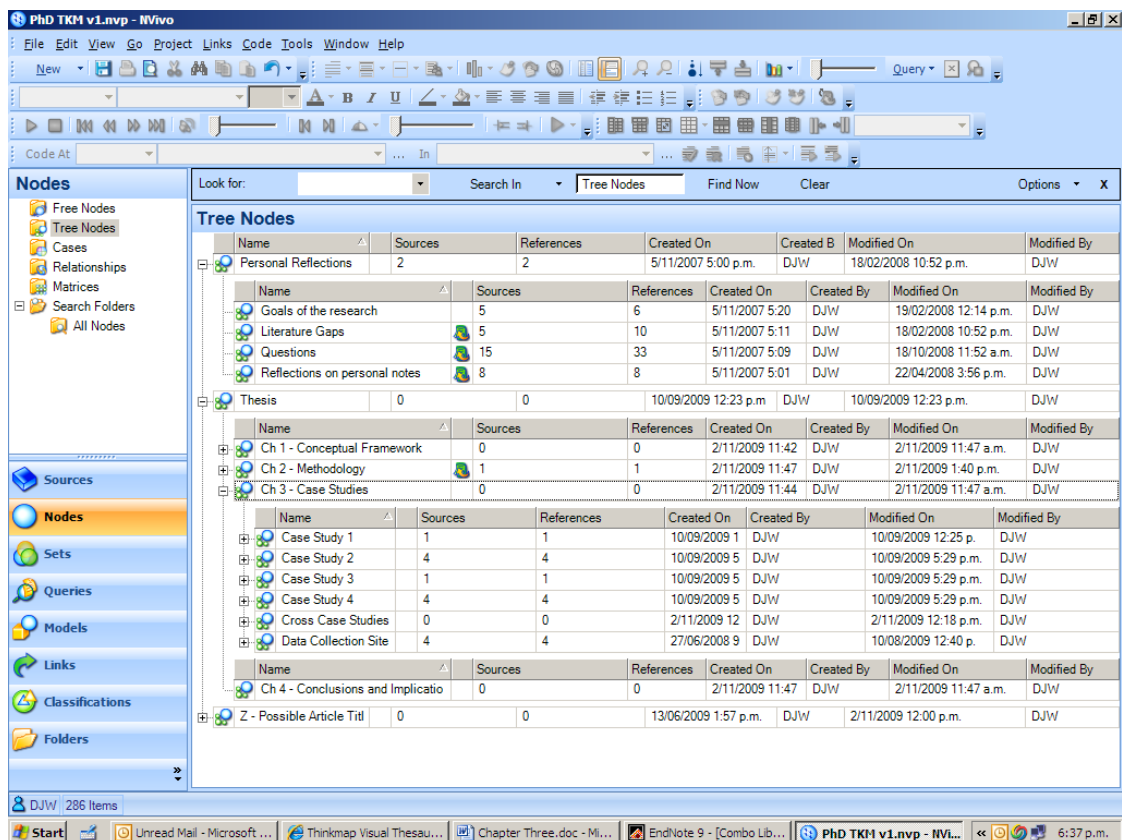


Figure 18: Screen grab of the Nvivo workspace showing final tree node layout for thesis

3.5.5.c. Descriptive Categories

The memoing process resulted in the tentative categorisation of concepts as the relationships between the data, the literature, and the analysis emerged. During this phase of the analysis, the sampling became more theoretical and observations more

focussed. Particular attention was paid to guarding against analytical biases such as the “holistic fallacy” (interpreting events as more patterned and congruent than they actually were), or an “elite bias” (overweighting data from particular sources), or “going native” (losing perspective through co-option into the perceptions and explanations of the informants) (Miles & Huberman, 1994, p. 263). Instead of merely labelling phenomena, nodes served the more abstract purpose of describing emerging theoretical categories.

3.5.5.d. Abstracting and Theorising

Once the conceptualising processes in the previous two iterations of the data analysis began to firm up, i.e. the concepts clearly delineated relationships between phenomena, and the thinking about the coding had segued from pure labelling to descriptive theoretical abstraction of conceptual categories, the observation moved into its final phase.

This phase tested the theories by interpreting data from other parts of the site, or from interviews with other stakeholders from the firm according to the emergent theories. Typically, these included members other than those that the researcher had been working alongside, e.g. the site manager, internal consultants, such as the company chemist, Health & Safety officer, or Design Engineer. Data collection during this phase focussed on ensuring that a state of theoretical saturation had been reached.

3.5.5.e. Querying the data

Throughout each of the analysis phases, much use was made of the querying functions within Nvivo. Simple querying of the data to search for particular key words in the literature or observational data was done to find specific items as for example in section 3.5.4.c above, but the practicality of this was limited to what the researcher already knew about the data. The more useful functions such as matrix queries, compound queries, scoped queries, and coding comparison queries helped to refine the queries by checking for gaps in the logic and identifying gaps in the data that needed to be filled.

3.5.5.f. Illustrating the findings

The final stage in the analysis of the data, before the case write ups could be completed, was to illustrate the findings. Nvivo has a modelling tool, which enabled the researcher to quickly draw diagrams to show relationships between concepts and categories. The value of this in the analysis phase was when the tool was used in conjunction with the querying function, and the researcher was able to turn to the raw data efficiently and effectively. Because the software keeps all data and nodes linked, it was possible to drill

down from theory, through category to concept to data very quickly, which again facilitated the development of theoretical saturation.

Other software packages were also used to illustrate the findings, including a visual communication tool called SmartDraw. Examples of diagrams created using this tool are included throughout this report. Other software tools included MindManager, a mind mapping tool, and CMaps, a concept-mapping tool.

3.5.5.g. Reporting the analysis in the case write ups

As was the case with the raw data, there were large volumes of text generated during the data analysis phase, far more than there was room for in this report so the next step of the analysis was to select the most appropriate representational data for inclusion in the case study write-ups. So for each the case's discussions, only that analysis that was most relevant was reported according to the following structure.

Research focus

The first section of the case write up briefly describes the research focus for this particular case including the research question and rationale for the case selection.

The context

The next section describes the location, workforce demographics, and other information about the site to provide a context for the next sections.

The researcher's daily reality

This section describes the case study site in further detail and the work that it does. It also indicates the importance of tacit knowledge in the context of this particular site, and describes the activities that the researcher took to build trust between himself and research participants.

Selected observations

This section provides examples of the theoretical samples of observed activities. Because of the sheer volume of data collected it is not possible to report every observation here, so a representative selection from the field notes are offered; these selected events were chosen because they best illustrated tacit knowledge as it was used in the various cases.

The reported observations include word pictures or vignettes of events and situations, verbatim quotes, summaries of conversations, and photographs (where appropriate) from the cases. In some instances participants were able to explicate or articulate their

tacit knowledge, but in many cases they were not and so the vignettes illustrated its practical outworking.

Table 5 below summarises the types of samples that were collected over the course of each observation, along with their associated illustrative data. The table also shows the analysis phase associated with the sample types and the literature that was relevant to that phase of data collection and analysis.

Sample type	Illustrative data	Analysis phase	Relevant Literature
Purposive	Rich descriptions of the site Identification of respondents Field study notes describing activities involving tacit knowledge phenomena Field study notes describing systematic application of tacit knowledge	Open Coding	Conceptual Framework
Theoretical	Tactically selected quality data	Descriptive Categorisation	Parent Theory
Saturation	Hypothesis testing	Abstraction and Theorising	Research Problem Theory

Table 5: Reporting the Analysis in the Case write-ups

For an example of how the field note data was analysed, i.e. coded and compared with the literature, see Figure 19 and Table 6 below.

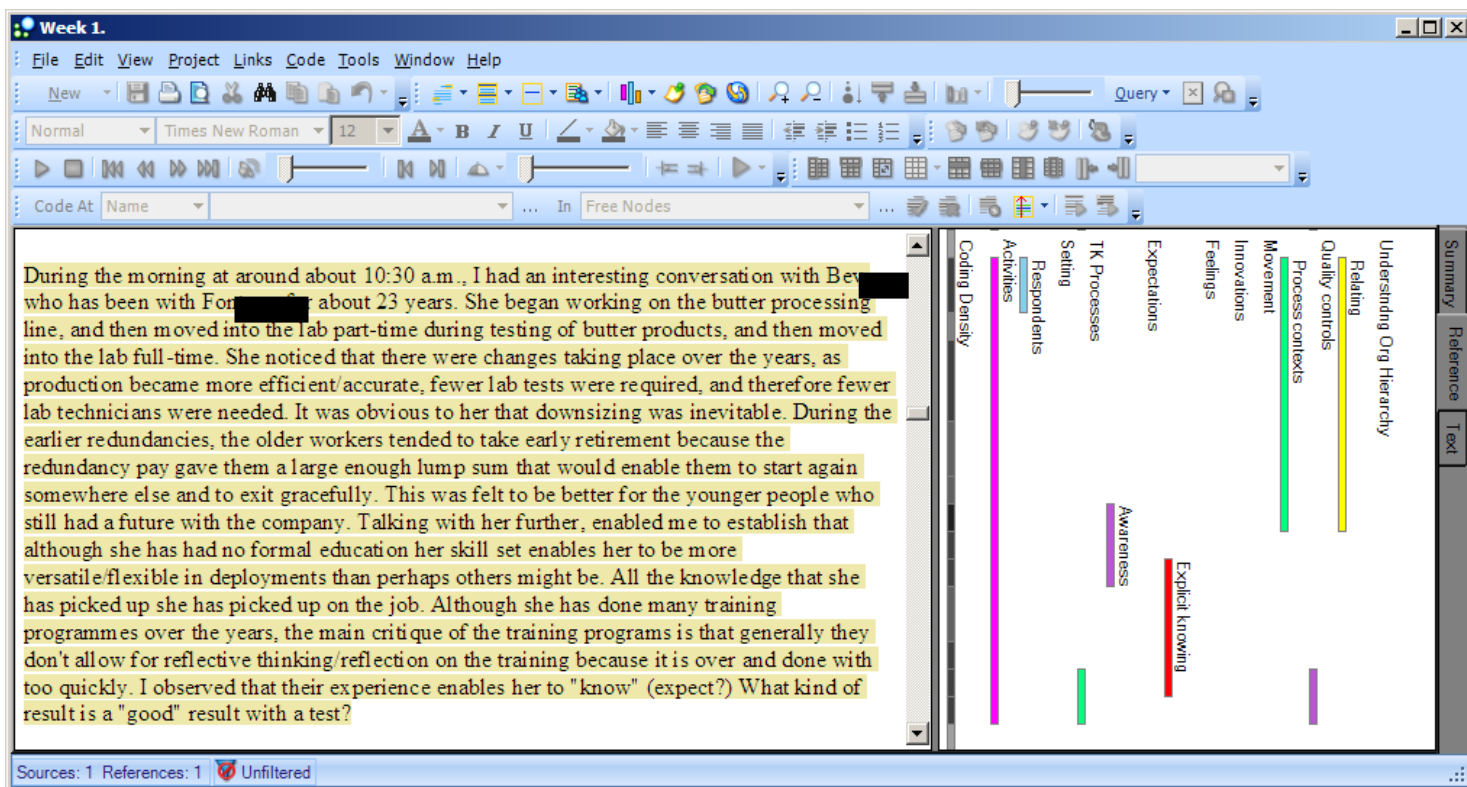


Figure 19: Screen grab from the Nvivo workspace showing an excerpt from the field notes, with highlighted text on the left, and coding on the right.

Purposive Sample	First open coding		Conceptual Framework
	Node	Description	
<p>During the morning at around about 10:30 a.m., I had an interesting conversation with [technician] who has been with [firm] for about 23 years. She began working on the butter processing line, and then moved into the lab part-time during testing of butter products, and then moved into the lab full-time. She noticed that there were changes taking place over the years, as production became more efficient/accurate, fewer lab tests were required, and therefore fewer lab technicians were needed. It was obvious to her that downsizing was inevitable. During the earlier redundancies, the older workers tended to take early retirement because the redundancy pay gave them a large enough lump sum that would enable them to start again somewhere else and to exit gracefully. This was felt to be better for the younger people who still had a future with the company. Talking with her further, enabled me to establish that although she has had no formal education her skill set enables her to be more versatile/flexible in deployments than perhaps others might be. All the knowledge that she has picked up she has picked up on the job. Although she has done many training programmes over the years, the main critique of the training programs is that generally they don't allow for reflective thinking/reflection on the training because it is over and done with too quickly. I observed that their experience enables her to "know" (expect?) What kind of result is a "good" result with a test?</p>	Awareness	Technician's awareness of a bigger picture than the task they were immediately engaged in. The awareness did not in and of itself help them perform their task better, but it gave them an idea of why the task was performed in the way that it was, and provided guidance for problem solving	<p>Tacit Knowledge is contextual</p> <p>Tacit Knowledge is both group and individual</p> <p>Tacit Knowledge is involved in decision making, shared values, strategy,</p>
	Explicit Knowing	Illustrations of specific teaching/training on a particular issue (typically between one technician and another), whether it was related to a task, or some other facet of their lived experience in the laboratory, e.g. about what went on in other parts of the factory.	
	Process Contexts	When a technician engaged in an activity for which there was no SOP, but which was nevertheless required to do their jobs.	
	Quality Controls	How technicians know when a thing is done "right".	
	Relating	When and how technicians related one idea to another, either about people or about processes.	

Table 6: First phase of grounded theory generation – Example of purposive sample with open coding and Conceptual Framework for comparison
 In this example the field notes were coded at either **Activities** or **Respondents** or **TK Processes**. Thus, solid arrows indicate underlined text coded at a node, and dotted arrows indicate comparisons with the literature.

3.5.5.b. Theoretical coding

The final phase of the analysis was the theoretical coding. This phase used Charmaz's (2006, p. 101) logic for theoretical sampling (see section 3.5.2.b Theoretical Sampling on page 106 above), which is not about representing a population or increasing statistical generalisability, but is about conceptual or theoretical development with the purpose of obtaining data to explicate categories, i.e. substantive theorisation leading to substantive theories (Urquhart, 2007; Urquhart et al., 2010). The analysis therefore focused on testing the thinking with a view to reaching a state of theoretical saturation as described previously (in section 3.5.2.c Theoretical Saturation). With the data collection clearly focussed on theoretical sampling, it was possible to ensure rigorous integrity of the data collected.

The case write up concludes with a brief summary of the findings, but the findings themselves are further explicated in Chapter 5.

3.6. Conclusion

This methodology chapter described how the primary research question, i.e. *How do supervisors effectively manage tacit knowledge and selected New Zealand firms?* was answered. The chapter explained how and why the research was situated within the Interpretivist paradigm as well as the reasons behind selecting a grounded theory methodological approach. It described the logic and processes of grounded theory and the theory's evolution before describing how the data was focused and bounded in such a way as to stave off criticisms over representativeness, reliability, or replicability, and participant reactivity and data trustworthiness.

The ethical considerations of the research were discussed and the chapter described how ethical approval for the research was obtained. This was done by providing information for participants and showing how confidentiality and participant and researcher safety would be maintained. The process of obtaining ethical approval also described how any potential conflicts of interest, or research sensitivity would be dealt with.

The chapter provided details of the method including descriptions of the data collection methods and instruments, and how the cases were accessed. It described how the data was sampled, initially through purposive sampling and then through theoretical sampling, until a state of theoretical saturation was reached. It described how the data was reported in the Case write-ups and gave an illustration of how handwritten field note texts were extended before analysis. A description of the application of a qualitative

research software tool (Nvivo) in the analysis was provided, along with an example of how insights from the data were arrived at.

The chapter concludes with an explanation of how the findings in Chapter 5 were developed using a grounded theory approach. It explains the open coding, memoing, descriptive categorisation, abstraction and theorising, and other analytical processes that were used in the development of the theoretical coding, and substantive theories and then describes how the analysis was reported in the Case write-ups.

The chapter provides a solid foundation and justification for the data collection in the field studies, for the data analysis, and ultimately for the research findings and conclusions.

Chapter 4: Case Studies

4.1. Introduction

4.1.1. Derivation of research questions and method

In Chapter 2: Conceptual Framework, the parent concepts, and research problem theory that underlie this project were discussed, and gaps in the literature around tacit knowledge management at the supervisory level were identified. These in turn gave rise to the research questions, and in Chapter 3: Methodology the rationale and method for answering those questions were presented.

This chapter builds on those previous two chapters by describing the four individual case studies that were conducted to answer the research questions. The four main sections describe the individual cases. In each case study, the rationale for the selection of that case is explained as well as the main purpose of the observation. Descriptions of the context of each case, and the daily activities experienced by the researcher as participant observer are provided. These are then followed by précis descriptions of the subsequent analytical processes that led to the findings. The findings from the cases are described in detail later in Chapter 5:

4.1.2. Findings from four cases evaluated in a cascading series

The literature review identified that before the primary research question (RQ_p) could be answered, i.e. *How do supervisors effectively manage tacit knowledge?* three supplementary questions had to be answered first. These included,

RQ_i - *What does tacit knowledge look like on the shop floor?*

RQ_{ii} - *How does tacit knowledge relate to Experience and Human Capital?*

RQ_{iii} - *What does ineffective tacit knowledge management look like on the shop floor?*

Although a specific research question guided the theoretical sampling in each individual case, the richness of the collection method meant that data pertinent to all the research questions was collected in all four cases. Thus the findings from one could be tested and evaluated in the context of another, and then again in a third. This complex interaction between the cases is illustrated in Figure 20 below, and is explained further in the rest of this section.

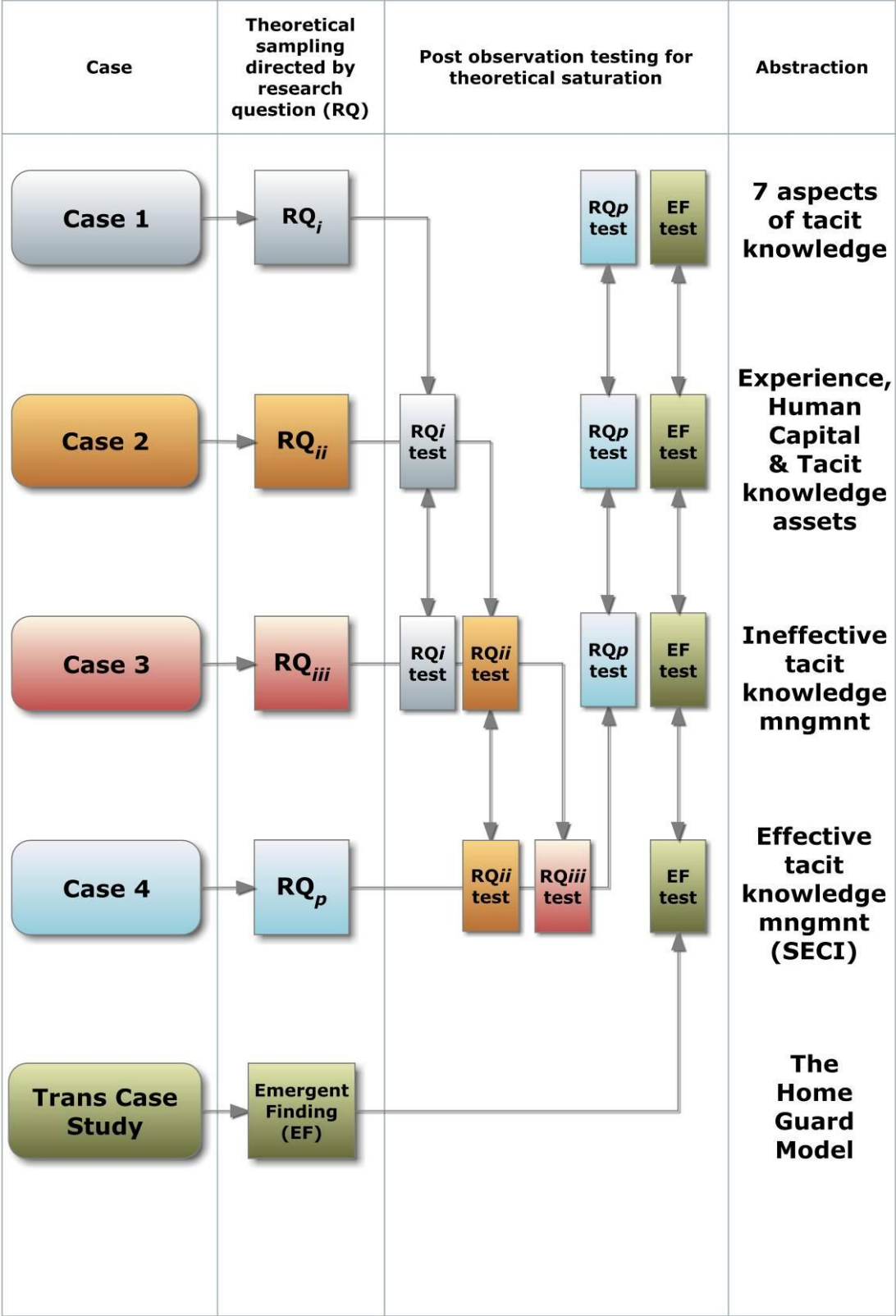


Figure 20: Flow chart illustrating how the cases were interconnected

The first case (Case 1) looked at the nature of tacit knowledge in a commercial laboratory, where laboratory technicians worked at well-documented tasks in a highly structured and regulated environment. The findings from this case answered RQ_i by

showing that there are seven aspects of tacit knowledge. These findings were tested in the second case and then again in the third.

The second case (Case 2) looked at tacit knowledge management in an electrical engineering workshop, where engineers relied on experience rather than documentation to perform their tasks. The findings from this case, which answered RQ_{ii}, showed that experience consists of a number of tacit knowledge assets. These findings were tested in the third and fourth cases.

Case 3 looked at tacit knowledge management in a manufacturing production line environment where there was very little explicit (documented) knowledge, and the average skill requirement was the lowest of all the cases. The findings from this case answered RQ_{iii}, by showing that tacit knowledge is developed as operators try to make sense of their environment regardless of managerial interventions (or the lack thereof). Case 3 findings were tested in the fourth case and then again retrospectively in Case 1.

Case 4, which sought to answer the primary research question (RQ_p), looked at how tacit knowledge was managed in a complex engineering environment, i.e. in a commercial aviation maintenance hangar. This case had characteristics of each of the previous three, i.e. a highly regulated operating environment, a high degree of reliance on experience, and processes akin to a production line, but it had an extra layer of complexity whereby the consequences of performance errors were potentially catastrophic in terms of risk to life and property. Findings from the fourth case were then retrospectively tested against the observations and data from the previous three cases.

Over the course of the four observations an interesting pattern of knowledge sharing behaviours was noticed that involved interactions between an individual's Power Distance – one of Hofstede's cultural dimensions (see section 2.3.2.f.1, on page 62 above), and Self Confidence (see section 2.3.2.f.2, on page 63 above) which led to an emergent finding that had not been anticipated. This finding is described in Chapter 5.

A summary table showing how the case study observations cascaded to support the findings is provided on Table 7 on page 130 below.

4.1.3. Structure of the case study descriptions.

The case descriptions are each presented in four parts. The first part describes the context of the case including its (i) industry, (ii) geographic location, (iii) workforce demographics, (iv) history and (v) the reason why it was selected.

The second part, which is written in the first person, describes the researcher's experienced reality as a novice yet privileged employee. This section provides support for the researcher's claim to "empirical literacy" (Miles & Huberman, 1994, p. 38), and provides evidence for his claim to having familiarity with the phenomenon and setting, a strong conceptual interest, a multidisciplinary approach, and good investigative skills.

The third part includes samples of observational data and is presented in the form of vignettes abstracted from the field notes. This important section presents support for the findings, and as with the second part is written in the first person.

The fourth part summarises the specific analytical thinking that relates to the case, which then leads on to the summary of the findings in the fifth part

The four cases are presented chronologically.

Case No.	Observational Data consisting of -	Cascaded data also supports	Findings
1	Vignettes illustrating tacit knowledge in the workplace. - Activity, Bodily, Community, Personal, Sound, Visual, and Word tacit knowledge.	findings from Cases 3, 4, & Trans case study	<ul style="list-style-type: none"> • Task related tacit knowledge has seven aspects
2	Vignettes illustrating - Contexts within which tacit knowledge is obtained/ learned/ garnered etc. - Human capital as a euphemism for decision making and problem solving, health and safety compliance, knowing customers, suppliers, and other stakeholders, managing workload and responsibilities, non standard procedures - Tacit knowledge assets as historical, stakeholder, legislative, complementary industry knowledge,	findings from Cases 1, 4, & Trans case study	<ul style="list-style-type: none"> • Experience can be thought of as tacit knowledge assets • Salient knowledge factors that affect worker performance are identified
3	Vignettes illustrating different levels of knowledge and providing reasons participants gave for why and how that knowledge was obtained	findings from Cases 1, 2, 4, & Trans case study	<ul style="list-style-type: none"> • Generic descriptors of tacit knowledge associated with five levels of competency
4	Vignettes describing facilitators of and barriers to effective tacit knowledge identification, acquisition, storage, retrieval and application according to Nonaka & Takeuchi's SECI spiral, i.e. in terms of - Socialisation activities - Externalisation activities, - Combination activities, - Internalisation activities	findings from Cases 2, 3, 4, and Trans case study	<ul style="list-style-type: none"> • Techniques enacted by supervisors that provide effective tacit knowledge management are identified. • Barriers to effective tacit knowledge management are identified.
Trans case	Vignettes from across all four cases that illustrate knowledge sharing behaviours in terms of self confidence, and power-distance	findings Cases 1 thru 4	<ul style="list-style-type: none"> • A model of tacit knowledge sharing behaviours

Table 7: Case Study Observations and Findings

4.2. Case study 1

4.2.1. Research focus

The research focus for the first case was to find an answer to the first supplementary research question, i.e. RQ_1 – *What does tacit knowledge look like on the shop floor?*

4.2.2. The context

Case 1 is a commercial laboratory situated within a milk-processing factory. The main purpose for visiting this site was to develop a greater understanding of what actually constitutes tacit knowledge in the context of a well-documented and highly regulated process oriented workplace – where to all intents and purposes all the knowledge required to do the work had already been made explicit in the form of accredited manuals. The observation period of eighteen days (approx. 160 hours spread over four weeks) coincided with the ‘off-season’ when the milk supply from dairy farms dries up according to the gestation cycle of the dairy herds.

The laboratory’s purpose is to provide on-site quality control to the dairy factory through specification testing (i.e. chemical, biological, physical, and sensory specifications) of the firm’s products. Since 96% of these are manufactured for export to customers with very particular specifications (Patrick, 2008), the role of the lab is crucial to the firm’s overall profitability and delays or inaccuracies in its processes can result in revenue losses of millions of dollars to the company. Apart from the market constraints placed on it the laboratory is also subject to audit by external accreditation agencies, which means that all tasks have documented procedures that must be followed.

Recently, within the twelve months prior to the observation period, the various laboratory services that support the factory had been amalgamated into the present facility as part of a firm wide rationalisation process.

The technicians who work in the lab are employed in shifts on a five on, three off schedule. The shift normally starts at 6:00am and ends at 4:00pm (with options for overtime when the plant is busy), which makes for a long working day. Although the full complement of staff included three supervisors (known as Team Leaders or TLs, one of whom was male) and 21 technicians (3 male, 18 female), only a skeleton staff of up to 14 technicians was on duty during the observation period. With the lab being not very busy, it was not possible to observe tacit knowledge phenomena in normal operational modes. However the flip side of that was that it gave the TL’s and technicians time to interact with the researcher in a more meaningful and valuable manner than would have been possible during the rest of the year.

The lab staff themselves ranged in age from recent school leavers to those nearing retirement, and several had been with the company for more than ten years. Most of the older members, and those who had been with the company for the longest, had gained their skills through On the Job Training (OJT), whereas the more recent employees tended to have educational backgrounds that were more formal. This reflected both the demographic in the local workforce (many of the townsfolk were retirees or young families), and a change in the lab's recruitment policies, which now preferred some level of tertiary science prior knowledge in candidates. Each technician was subject to an annual performance appraisal, at which he or she was assessed for competency at various laboratory tasks, and if warranted was awarded with a competency level promotion. The competency levels were described in a Dairy Workers' Union (DWU) handbook and ranged from Level I to Level 4 (See Table 8 below for the level descriptors)

Level Number	Level Descriptor
1	Introduced
2	Can complete under supervision
3	Competent to complete
4	Competent to trouble shoot and can train others, expert.

Table 8: Dairy Workers' Union Handbook: Levels of Competency

4.2.3. *The researcher's daily reality*

4.2.3.a. *The case study site*

The laboratory in which the observations took place is entered through a locker room, where the technicians store personal property and don their white knee length lab coats. A security door guards the lab and provides protection from both intruders and biohazards. The lab is well equipped with a number of work benches set up for particular types of tests; there is an environmentally controlled foreign matter testing bench, and a bench set up with computerised equipment, e.g. NIR (Near Infrared Red), autotitration and photospectrographic machines for measuring nutritional specifications, e.g. whey protein, lactose and casein levels. There is also a butter bench where tests on butter products e.g. for salt, fat, and moisture levels are conducted, and there is a cheese bench where tests similar to those for butter are done. A bench along the wall carries desiccating ovens and extraction hoods. There is a scullery with stainless steel sinks and dryers for washing equipment. Each bench also has a sink and a computer; the latter

accessed via a password and linked to a central database through an intranet and the internet.

Apart from the previously mentioned very sophisticated machinery, most of the equipment in the lab consists of everyday apparatus similar to the clamps, pipes, scales, test tubes, burettes and flasks that one might expect to find in any reasonably well equipped high school lab. An administration area is set up against a wall, where all the paper based records and manuals are kept; this is primarily where the TLs work.

Attached to the walls near the TLs' bench, are several display boards on which are posted the results of the previous day's test results giving information on lab performance. The rest of the walls in the lab are mostly bare. Next to the TLs' space is another laboratory, dedicated to analytical chemistry, and beyond that is a sensory lab. The analytical lab is equipped with similar equipment to the chemistry lab, but is dedicated to testing for other characteristics such as protein or vitamin levels. The sensory lab is fitted with equipment designed to measure product characteristics that the human senses are able to detect, such as milk powder particle size, fat separation (of reconstituted milk powder), or dispersability and bulk density.

4.2.3.b. The work of the case study

The daily activities of the technicians focussed on testing in-production, and post-production factory samples from the previous day's output. They would start work with general preparations for the day before the daily shift meeting started. These preparations might include removing clean glassware from the drying ovens, switching on water baths and other equipment, or returning sterilised equipment to their respective storage spaces. While some would be doing this, others would be at their usual workstations, logging on to their computers and downloading lists of samples and the corresponding tests to be done for the day. Still others would be locating and identifying the samples that had already been delivered to the laboratory by couriers from the various factory units. Once everyone had arrived, the shift meeting took place – usually led by one of the TLs. This 15 to 20 minute gathering at the beginning of the day was when information was provided to the shift members on a number of issues relevant to them, such as who was absent or on leave, quality reports, non-compliance reporting, or other work-related messages. Unless technicians already knew what their tasks were for the day, the TL would then also allocate and prioritise the tests or tasks to be performed. Occasionally there was some discussion about matters arising, but this tended to be the

exception rather than the norm. From then on, technicians would disperse to their allocated workspaces and begin work for the day.

Since all of the technicians who were on duty during the observation period were well trained and familiar with their work, usually they did not need to refer to their testing manuals for instructions or directions on how to perform their work. Occasionally if a technician was slightly unsure of what a precise specification might be, or needed to refer to a specific piece of information, they would refer to the laboratory manuals, but on the whole they were able to perform their tasks by rote. My initial impression as an observer was that most of the knowledge they needed to do the tests was tacit, because so few of them referred to the manuals. However as time went on, I was able to compare a technician's performance with the prescribed method, and in most cases I was unable to find any variation.

4.2.3.c. The importance of tacit knowledge in a highly documented environment

However, in spite of the level of training and the general need for compliance with documented processes, one of my own early experiences in the lab highlighted just how important tacit knowledge was for the performance of lab tasks, as the following excerpt from the field notes shows,

I was observing one of the technicians as she weighed samples after they had come out of a dryer, and I was curious. So I bent over, and picked up one of the flasks, and asked her what was in it. The response I got was not quite what I expected. The poor technician almost had an apoplectic fit, and in the most assertive tones asked me to put the flask down immediately. I had no idea what I had done wrong, but recognized that I had fluffed something up so I tried to make amends by using both hands to put the flask down quickly but gently, apologising profusely all the while. It only seemed to make the matter worse. After several very awkward moments, the technician (her routine completely interrupted) picked up the flask I had handled with her fingertips around the lip, and very carefully wiped off the fingerprints that I had left behind. She was very [angry or annoyed] at me and from that day on I felt that I had completely closed off any further communications with her. Apparently, that was not the case, because later on several people said to me that she often was not very communicative and that she had "got over it." I don't think I ever did though, and so probably missed out on some quite valuable insights from her.

Here was a classic example of complete ignorance, or "unconscious incompetence" at work. What I did not realise at the time was that the weight of the flasks, which had been weighed to four decimal places of a gram, would be affected by the residue from my fingertips and hands!

4.2.3.d. Building trust between the researcher and participants

In spite of the faux pas just mentioned, a crucial part of the observation was to gain the technicians' trust, in the hope that they would open up to me and share their experiences. It was obvious at the start of the observation period that the recent restructuring had made them all very nervous of changes in the lab, and there were some barbed comments at the start that suggested that I might be a management spy, sent to find out their secrets. I quickly identified that this might be a significant barrier to the data collection, so I made an effort to overcome the prejudice as the following excerpt shows,

The sense of mistrust was partially mollified, on the morning of the second day, when I started work at 6 a.m. with everybody else. I noticed several raised eyebrows looking at me as I joined the morning meeting. I was treated with some suspicion for most of the rest of the day, until the latter part of the afternoon. At that time, I noticed that there was some glassware that needed to be washed so I offered to do it.

I was shown how to do the washing according to the standard operating procedure, which was fairly simple and included a wash and a scrub with an industrial strength detergent, followed by a rinse in hot tap water, and then another rinse in ROI water, before placing the glassware in a metal rack and then into one of the drying ovens. This little task didn't take me longer than about 15 minutes, but when I went back into the laboratory, I noticed that there was an enormous pile of washing to be done on another bench. I asked, "Is there any more to be done?" and the response was, "That pile over there", indicating the huge pile that I had just noticed.

So I picked them up, took them into the wash room, and spent the next hour and a quarter washing dishes. By the end of it I was quite hot and sweaty but I thought I had done a good job. I went back into laboratory to say my farewells for the afternoon, but before I could leave I was given several compliments about the rate and amount of work that I had just completed and was thanked quite profusely by several of the technicians. I responded by telling them that I

was quite serious about my intention to help where I could, and that I was actually just grateful for the opportunity to show that I meant what I said.

This then developed into a general conversation about why and how I was doing what I was doing, and by the end of the conversation, another hour and a bit later, I felt I had turned a corner with regard to establishing a trust relationship.

As it turned out, that seemed to be the case because I hardly had to do any more work for the rest of my stay and in fact, on several occasions when I offered to do more dishes, I was told not to, but instead spend time in conversation with somebody with whom I had not yet had a chance!

Other conversations that I had with different technicians over the next four weeks enabled me to generate some deep insights into how things went on in the lab, and the following section describes a number of situations that were particularly relevant to the research questions.

4.2.4. Selected observations

As previously mentioned, the purpose of this case study was to develop an understanding of what tacit knowledge looked like in the context of a well-documented system. The initial phase of the data collection in this case focussed on purposive sampling (See section 3.5.2.a on Purposive Sampling on page 104 above), examples of which included the descriptions of the study site, daily work, and trust building exercises as provided in section 4.2.3 above. As the observation continued, the focus of the data collection shifted to theoretical sampling until the point of theoretical saturation was reached.

This section provides examples of the theoretical samples of observed activities. Because of the sheer volume of data collected it is not possible to report every observation here, so a representative selection from the field notes are offered; these selected events were chosen because they best illustrate tacit knowledge as it was used in the laboratory.

The recorded observations include word pictures or vignettes of events and situations, verbatim quotes, summaries of conversations, and photographs (where appropriate) from the lab. In some instances technicians were able to explicate or articulate their tacit knowledge, but in many cases they were not and so the vignettes illustrate the practical outworking of this tacit knowledge.

4.2.4.a. Tacit knowledge & the gap between manuals and practice.

As the days progressed, I watched the technicians and learned how they went about their tasks. Although they all had manuals from which to work, in the main these were hardly used. From time to time, when the opportunity arose I would ask a technician how a test should be performed. One day, I made an offer to assist a technician with the preparation for a test by weighing out some samples (see Figure 21); the following field notes record the event below -

Jane's* movements were sure and deft and consistent, whereas by comparison mine were fumbling, clumsy and inept. After watching me, painfully, for the better part of 20 minutes, and giving me some encouragement and constant corrections, it was time for [me to go to] a meeting, after which Jane took over and completed the rest of the weighing in very little time.



Figure 21: Weighing out samples of grated cheese in preparation for testing and showing the awkward access to the scale.

I noticed that Jane did not refer to any manuals when she was working, nor did she direct my attention to any as she was instructing. This was the general pattern within the lab; a technician would demonstrate a test without reference to manuals. Initially the question was whether they were just humouring me as an interloper, or whether they were actually demonstrating the approved methods. Later, after I was able to compare the teaching

* All names have been changed to protect the participant's identities.

with the approved methods, and it turned out the technicians were instructing according to the manual, and this method of 'show and tell' using non-standard language was the usual method of teaching the approved methods to others, as is described in the following excerpt.

Jane is teaching Susan how to do the cheese Salt test. When showing her how to liquidise the cheese using a homogeniser, Jane is using terms like, "it's a sucky feeling," to describe the sensation of the circulatory pump/feeder's tendency to "suck" onto the bottom of the flask if it is held too close to the bottom. Susan asks Jane about the residues/lumps stuck to the side of the beaker,

"Does it make a difference [to the test result]?"

Jane replies, "No, I have wondered that when I first did it, but it doesn't seem too."

I notice how a Level 3 (Jane) can remember and relate to the learning experience of a beginner, better than a Level 4 can. Jane is teaching by showing from memory (including the use of the *Autotitrator*) and there is no manual in sight!

It was obvious that Jane recalled the explicit knowledge i.e. the documented approved test methods, as she demonstrated the technique to Susan. However, what was interesting was that Jane identified and was able to convey knowledge about the technique that was not in the manual, but was nevertheless required for the task to be performed, e.g. the sucky feeling of the pump on the bottom of the flask. This was an example of the kind of tacit knowledge that I was looking for.

4.2.4.b. Tacit knowledge & the gap between instrumentation and practice

Once I had gained a degree of equilibrium in my own mind, and was over what I called the "Gee Whiz!" phase of discovery, surprise and occasional amazement at what transpired in the laboratory, it was possible to start making some sense of what was going on.

By the beginning of week two, familiarity with the environment enabled me to identify some of the tests that the technicians were conducting, and relate them to the manuals. As my own knowledge of the processes grew, I began to ask the technicians more focused questions about how they knew that they were doing the right thing. Even though the manuals had quite specific instructions about how to perform a task, it

became obvious in many cases that the accuracy of a test came down to knowledge the technicians had but which was not written down. The following description of a moisture test on the Butter Bench illustrates this well,

Kim was doing a Butter Moisture Test, and I observed the effect of temperature on the weight of the sample. Essentially the test is very simple, a small quantity of butter is placed into a metal beaker and weighed, then placed on to a hot plate and allowed to melt and boil. Once the melted butter has stopped boiling, and its colour has changed, it is taken off the hot plate, placed on to a marble slab, and allowed to cool down. Once the sample has cooled sufficiently, it is re-weighed and a moisture content can be calculated.

There is a standard process documented for this, which refers to the New Zealand Technical Manual (NZTM 3: Chemical Methods Manual, section 12: Moisture, Total Solids and Curd). This standard describes the scope, validation status, principles, apparatus and sample preparation procedures. It then describes the procedure in some detail along with the calculation, report, and definitions of precision. For example, steps five and six in the process read as follows:

5. When all the moisture has been driven off (i.e. bubbling has stopped, the froth has broken and precipitated curd is still and has turned a brown/light chocolate colour), remove the container from the hot plate and place on the cooling slab.
6. When the container has cooled to room temperature (generally a cooling time of 15 minutes is sufficient), re weigh to 0.001 g (W3)

At the first reading, the definition in the manual appears to be clear and unambiguous, but problems arise in the interpretation of a number of terms. Firstly, "bubbling has stopped" is very difficult to determine because of the froth that forms on top of the liquid butter. Secondly, the term "froth has broken" is subjective because it is difficult to tell when it has stopped breaking. Thirdly, it is difficult to see when the curd "is still", because convection currents in the melted butter cause it to move slightly. Fourthly, the colour description "brown/light chocolate" is again subjective, and what is more, it varies from butter type to butter type. For instance, salted butter will be darker than unsalted butter, and different again from other types of butter at the correct point in time when all the moisture has been driven out – for some people this is very difficult to determine. Finally, the term "room temperature" is also highly subjective because it is

measured by placing the metal container against the back of the technician's hand and determining its temperature (See Figure 22). Depending on how long the container has cooled, the room temperature can be either 'Hot', 'Warm' or 'Cold', according to the technician's perception of room temperature.



Figure 22: Measuring 'Room Temperature' using the back of a hand. A recorded temperature that is too "Hot" or too "Cold" will affect the test result.

This tacit knowledge is crucial for the accuracy of the test result, because it does affect the test outcome. In a sense, the technician is as much a part of the test as are the sample, the test equipment, and the approved manual. Because of these differences in subjective measurement, the butter may be "overcooked", "undercooked", or "just right". Over cooking can happen when the decision to remove the sample from the hot plate is delayed, as for example when what appears to be bubbling that has almost stopped, is actually bubbling that has just started again – this time of volatile oils inside the butter, which leads to too much weight being lost from the sample. If the sample is not stirred correctly or is allowed to boil too vigorously, hot melted butter can splatter out of the container creating an under reading, and thus indicating a higher moisture level than is accurate. The field notes describe a most significant effect of this subjectivity,

The most surprising thing for me though, was the effect of an incorrect temperature at the re-weighing. A test sample showed that the combined weight of container and melted butter weighed 31.602 g when it was Hot, a little bit more at 31.616 g when it was Warm, and astonishingly 31.619 g when it was Cold. Calculations comparing these weights with the original weight

gave the following moisture percentages, 16.08%, 15.94%, and 15.91% respectively; a difference of 0.17% between the highest and lowest readings.

Given that the Duplicate Tests Acceptable Variation for Repeatability (according to NZTM) is 0.08%, and the Reproducibility limit is 0.16%, it can be seen that in this case, it is entirely the technician's tacit knowledge that determines whether a test sample passes or fails to reach a standard.

This phenomenon was so intriguing that it remained front of mind for a considerable time. Later an opportunity arose to quiz a more senior member of the laboratory staff about this effect, and it was noted that it was relatively well known, and quite common. Although no definitive cause was attributable to the effect, the consensus seemed to be that it was caused by variations in air pressure in the microclimate above the container inside the balance cage. The sensitivity of the weighing equipment was such that it was able to measure these tiny differences.

4.2.4.c. Tacit knowledge & the gap between problem and solution

As the weeks progressed, more and more time was spent in conversation with the technicians, rather than simply observing what they were doing. It was fortunate that it was the off-season; otherwise it would not have been possible to enjoy the privilege. However, the favour was all mine, since there were times when my presence caused problems for them, as the following example of an informal chat with a technician in the Analytical lab illustrates.

A technician was analysing samples for protein. The test involved numerous steps, each of which required the addition of several reagents, then shaking to mix them, then centrifuging to separate out layers and finally decanting of the concentrate (See Figure 23). It was during the stage of adding some reagents to a Mojonnier (Mojo) flask, that ...

The technician got distracted when talking to me and forgot to add a second pump of a reagent into the Mojo flasks she was preparing. However, the moment she picked the rack up to begin the mixing process, she realised that it was underweight and began to reflect on what she had just done. She soon realised she had been distracted and hadn't added the extra pump that she should have, and promptly remedied that by adding the second pump. This required no supervision!

What I had stumbled on here was tacit knowledge that the technician had of the weight or heft of the rack of flasks. She had done this task so often in the past that she had

developed a sense of what the weight of the rack should be. When it was not what she expected, it was her own private knowledge base that alerted her to the problem and its solution. Nowhere in the manual was there any suggestion that the technician should weigh the rack of flasks to double check that the correct reagents had been added.



Figure 23: Decanting from a Mojonnier Flask – the skill of the technician lies in knowing how to pour off the surplus liquid accurately, leaving just the dark coloured layer behind.

A little later during that same chat, this technician stopped in the middle of the conversation, and mentioned that the centrifuge was out of balance. I had not noticed anything out of the ordinary, but the technician was able to recognize the sound of flasks rattling inside where they had not settled into their racks properly. She stopped the machine, reached inside, made the necessary adjustments, and then started it up again. This time the rattling had stopped. Still later, when the Mojo flasks were being heated in a water bath, I was again chatting with the technician when she again interrupted the conversation to say that the current batch of flasks was ready to be removed for cooling. When I asked how she had known this – since there did not seem to be any timing device or other indication that the test was complete – her response was that her attention had been drawn to the sounds of the test. She knew the “trembling tinkle of [the] glass beads” in the bottom of the flasks meant all the excess moisture had evaporated. Again, there was no reference in the manual that this sound indicated the end of the test. Thus,

it was her tacit knowledge of the sound the test made when it was complete, that enabled her to stop it at exactly the right moment to ensure an optimal result.

4.2.4.d. Tacit knowledge & the gap between workplace culture and HR practice

Towards the end of the four-week observation, I had developed such a rapport with the technicians that many of them began to confide in me about some of their more personal issues. Many of these revolved around their relationships with other technicians, as well as with the lab supervisors, the TLs, and with management. As they told more and more of their stories, I realized that in spite of the explicit processes documented in the lab policy and procedures manuals and the DWU handbook, (and consistent with the literature – see section 2.3.2.b.1 on page 43 above) it was the organisational culture manifested in the technicians' shared values, beliefs, norms, and social relations which were not prescribed in the manuals that were relevant to the smooth functioning of the lab.

For instance late one afternoon, one of the female technicians complained about how she felt that she and others were being victimised by one of the TLs.

On the issue of workplace relationships, Christine said that there is a bit of bullying within the lab. Some from a Team Leader, and some from Valery. Apparently [this particular TL] tends to leave workbenches untidy with powder all over them, and leaves the mess for others to clean up afterwards. When Christine complained about it to her, there was no improvement [from the TL], and the effect seemed to be that Christine became victimised as a result. She has now learned not to “criticise” anyone, because it “always come back to bite you.”

This kind of personal knowledge about how to behave in the lab grew out of individual experiences of personal interactions and relationships. Similarly, in another conversation about absenteeism, and how different people coped with the pressures of the busy season another technician mentioned that ...

... even when he wasn't feeling well he "don't take time off if you can help it, especially when you're busy and there is only a few people on like when you are short staffed because of leave."

The field notes revealed that the technicians do not leave one another in the lurch when times are tough, but nowhere in the lab documentation could anything be found that suggested this was an expected attitude.

4.2.4.e. Tacit knowledge & the gap between standards and practice

Over the course of the observation period, an interesting phenomenon concerning standards became evident. Even though lab performance was monitored by external auditors (through an inter laboratory comparison process), it was obvious that much of the accuracy of many tests depended solely on the technicians' tacit knowledge, and even if a test was done exactly in accordance with its standard procedure it was still possible to produce results that were open to question.

For some technicians, particularly those who were very familiar with a test, it was possible to massage results to suit "special circumstances" and still have them done according to the manual. I put it to several technicians that there may be a temptation to massage results, especially when the occasional plant manager came by (Ostensibly, these lab visits were to check up on product testing procedures, but it was not unheard of for plant managers to pressure technicians to alter their findings to suit the plant's requirements). The response to the question was a resounding refutation of that possibility. Amy and Valery both emphasised that "you get what you get", and that ...

when under pressure from [the] factory for "good results", ... a similar attitude to [Dianne's] was revealed. [Dianne's response was], 'We do it how we do it'.
E.g. when demonstrating how a test is done to factory managers when trouble shooting.

It was a point of honour within the lab that in spite of pressures from the outside, the technicians maintained a sense of independent integrity and trust between themselves, which enabled them to stand by each other's work. In effect, the technicians' as a community were themselves the performance standard.

4.2.5. Analysis

Because the main purpose of this case study was to understand tacit knowledge in the context of a well-documented and highly process oriented environment, the goal of this phase of the research was to develop a theory of aspects of tacit knowledge. This next section then traces the data analysis and evolution of such a theory – from the initial open coding of the purposive sampling, through the theoretical coding of the theoretical samples to the subsequent theoretical saturation – where a model of seven aspects of tacit knowledge was developed.

4.2.5.a. *Open coding*

The first step in the development of the grounded theory of aspects of tacit knowledge was to collect purposive samples. The researcher asked questions about what was going on in the setting, and data – in the form of field observation descriptions or photographs of the setting, the people, and generic activities within the lab – was collected, with the focus on the undocumented processes, i.e. those processes that employed tacit knowledge. Thus, data was collected on

- Activities: about general activities that were happening at the time
- Respondents: about the people in the research setting
- Setting: about where and when the observation took place
- TK (Tacit Knowledge) Processes: about processes or tasks performed by the technicians for which there was no documentation such as in a Standard Operating Procedure or Manual

Since the literature describes tacit knowledge as being associated with behaviours, the first open coding conceptualised tacit knowledge phenomena in terms of how it was used by the technicians. The purposive data was therefore compared with a conceptual framework – derived from the literature review for the research – and then open coded in Nvivo into the ten descriptive categories listed below.

- Awareness: documenting technicians' awareness of a bigger picture than the task they were immediately engaged in. This awareness did not in and of itself help them to perform their task better, but it did contribute by giving them an idea of why the task was performed in the way that it was, and provided guidance for problem solving.
- Expectations: describing the awareness that technicians had about what could, should, or ought to happen, based on their past experiences.
- Explicit knowing: Illustrations of specific teaching or training on a particular issue (typically between one technician and another), either related to a task or some other facet of their lived experience in the laboratory, e.g. about what went on in other parts of the factory, but not necessarily documented in a manual.
- Feelings: where, when and how technicians' feelings impacted on, or were impacted by what they experienced at work.

- Innovations: where technicians' knowledge of processes etc. gave them insights into how things could be done differently/ better/ faster etc.
- Movement: situations in which technicians' bodily movements and how they used their body to do work were described.
- Process contexts: the contexts and activities for which there was no documentation, but which was nevertheless required for the technicians to do their jobs, including environmental, cultural, procedural contexts not written down, e.g. setting up in the morning.
- Quality controls: how technicians know when a thing was done “right”.
- Relating: when and how technicians related one idea to another, either about people or about processes.
- Understanding of Organisation Hierarchy: technicians' understanding of how they fitted into the organisation as a whole.

For an example of how the field note data from this case was coded and compared with the literature, refer to Chapter 3: in particular Figure 19 on page 122, and Table 6 on page 123 above.

Querying the data with Nvivo

The data was matrix queried, using an Nvivo8 function, to check for representativeness of the sampling. A feature of the Nvivo software is its ability to count references in the data that have been coded at a particular node. The number of references pertaining to a specific node does not by itself ascribe validity to the description, but it does give an indication of how often that particular category of phenomenon was observed.

A matrix query that intersected the purposive sampling data from the first week's observations with the first open coding resulted in Table 9 below. It shows the number of times that data was coded at Activities, Respondents, Setting and TK Processes, AND at the ten categories described above. It should be noted, that a single event in the data could be coded at any number of nodes, so the total number of references in the matrix table does not equal the number of data points collected.

By comparing references in the matrix query report and engaging theoretical sensitivity, the researcher was able to judge whether he had been suffering from researcher effects such as participant reactivity or biases such as a holistic fallacy.

One such bias was detected. Intuitively, the researcher knew that when a technician moved knowledge of how they use their body was involved. This was so obvious that it was overlooked in the first week's data collection. Indeed, analysis of the first week's data clearly showed a researcher bias against recording instances of how technicians moved as they conducted their daily tasks (only three references to Movement recorded over the entire week). Since the literature clearly identifies bodily tacit knowledge as an important element in tacit knowledge typologies, a memo was generated in Nvivo indicating that more attention needed to be paid over the following weeks to how lab technicians used their bodies.

Nvivo8 Matrix Query Result:

Intersect of Purposive sampling nodes AND open codes

	Activities	Respondents	Setting	TK Processes
Awareness	6	0	1	0
Expectations	1	0	0	0
Explicit knowing	15	3	0	2
Feelings	11	3	3	3
Innovations	9	5	0	3
Movement	3	0	0	1
Process contexts	11	4	2	0
Quality controls	13	5	1	6
Relating	3	2	0	1
Understanding of Org Hierarchy	3	0	1	0

Table 9: Matrix query result. Intersection of purposive data sample with first open codes.

Note to Table 9: Originally only three references were coded at Movement AND Activities, an oversight that was not apparent until it was highlighted in the matrix query.

Descriptive categorisation of the data

As the observation continued, further descriptive codes were developed, such the following,

- Problems and Solutions
- Previous Learning Experiences
- Personal Life
- Past Experiences
- New Experiences

- Helpfulness
- Health & Safety Issues
- Confidentiality issues

A novel approach needed to generate new insights

However, by the end of week two it became obvious that the constant comparisons between the literature and the data was guiding the analysis into conventional themes around tacit knowledge, but was not leading to any new insights about how tacit knowledge might be typed. This was a major concern because as was pointed out in Chapter 2, one of the problems with current models of tacit knowledge is that they do not provide useful metrics in terms of workplace competency, which was what this phase of the research was seeking in terms of aspects of tacit knowledge. At this point, it was realised that the analysis needed a fresh approach.

Fresh insights gained from the participants themselves

A review of the data gathered so far showed that technicians were able to tell who amongst themselves was most competent, so the data analysis began to focus on how they were able to do this. An insightful moment occurred during a discussion between some of the technicians, about a recently displayed skills matrix on the 'TLs' office wall, as the field notes explain,

There are several people gathered around the skills matrix which is now on display. Generally it seems as if there is a positive feeling towards the skills matrix and one quote was, "this is probably a good thing, they can see how well multiskilled we are." The only negative comment that I have heard so far is, "there's no time to do the dots." This is in reference to the requirement for every individual to place [a dot] at the intersection of the column that represents their name and the row that represents the test that they are capable of performing.

As part of a firm wide initiative towards visual displays of performance criteria, the company required each department to display a skills matrix, which showed each person's name and their competency at tasks performed in the laboratory (See Figure 24 below). The purpose of this display was to give supervisors and managers a quick overview of the levels of competency available during shifts so that they could make better judgments about resource allocations, e.g. who should be assigned to what task, why and when, as well as give some idea of relative manpower strengths from shift to

shift. The matrix was populated with coloured dots where each colour represented a different level of competency.

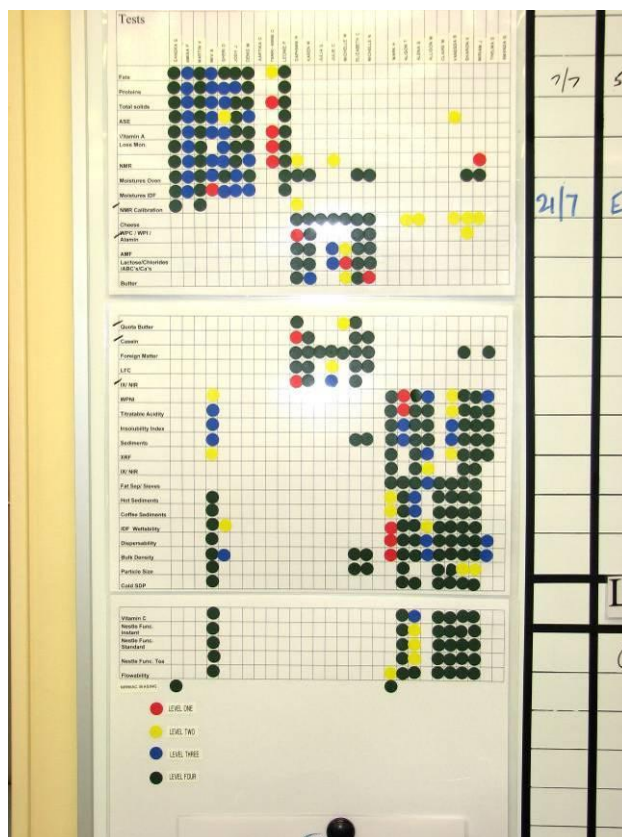


Figure 24: The completed skills matrix in the laboratory. The different colours indicate the range of the technicians' capabilities (rows), and their relevant competencies (columns).

The technicians were required to rate themselves against the DWU handbook's Levels criteria (Table 8 on page 132), and assign themselves a coloured dot against the tests that they performed. The method they used to assign their dots was to first assess themselves and then informally, to discuss each other's capabilities. After some discussion among themselves, they reached a consensus and assigned themselves colours. These assessments were then offered to the Tl's for their input, and in most cases, the Tl's accepted the technicians' judgements of themselves. As the matrix was being populated an interesting phenomenon occurred, and was described in the field notes thus,

The matrix is not yet complete but it is already quite apparent that there are distinct differences in the level of perceived competence between the various groups. For example, most of the dots that pertain to the technicians who work in the Functional department have given themselves a yellow dot, which represents level 4 competency, whereas most of technicians who work in the

Central Chemical Department, have given themselves only a red dot, which represents a level 3 competency.

The most interesting part of this process concerned the criteria that the technicians used for determining their individual abilities. Their self-assessments were not based around any objective descriptors such as those from the DWU handbook, but instead on -

- how well they felt they knew the processes, i.e. could perform it from memory without reference to the manuals
- how adept they believed they were at performing the test,
- how much they knew about the context of the test, and
- their own experiences of performing it, e.g. whether they found it difficult or easy

Most of them did not even refer to criteria such as “able to complete”, because, in the words of one technician,

"If you can bake a cake, you can work in a lab".

In other words, because the processes were so well documented the general feeling was - if a technician could read the manual then they were competent to perform the test. Furthermore it was noted, that just because a technician could perform a test “without supervision”, that did not automatically confer on them the ability to teach.

Later, another insight about the criteria the technicians used to assess themselves was gained,

In conversation with some of the Central Chemical technicians a little later in the day, it was noted by them that they tended to grade themselves more harshly than those who worked in the Functional Department. Interestingly though, [technicians in] both departments rate each other as equally competent within each other's groups, but the Central Chemical technicians are more reluctant to admit their own competency for fear of being found out that they might *not* know something when subjected to audit. Even though both departments have their own K'TP's (Key Technical Persons), who are deemed technically competent to grade and train others, there is a disparity between each department's K'TP's ability to assess others in the department. There are no objective standards by which to assess other technicians' capabilities.

The main criteria for being deemed competent among the technicians seemed to do with the degree of confidence that the technicians had in themselves, allied with the confidence that others had in them to test consistently to the required accuracy, i.e. test results compared favourably with the expected level of variation in repeatability and reproducibility as described in the manual. The competent technician knew what he or she was capable of doing, knew what the process steps were, knew what sensory cues could be used, and knew how to communicate their experiences of a test in the language of the laboratory. But, they also knew what the likely contextual influences could be, and depending on whether these were perceived as encouraging or threatening, they rated themselves in terms of how confidently they could defend their evaluations. The word they used to describe a competent technician was – intelligent.

This insight provided a persuasive reason to suggest that tacit knowledge – related to the performance of a task at least – could be viewed not only in terms of a competence, but also in terms of an intelligence. Thus, following Urquhart, Lehmann, & Myers' (2010) proposition that grounded theorists have an obligation to engage with theories outside their discipline, the literature on intelligence was scrutinised for further direction (see section 2.2.6: Tacit knowledge in terms of intelligence, on page 28 above). The investigation of the literature prompted the idea that tacit knowledge associated with the performance of a task may have attributes that correspond with intelligence, and more specifically with Gardner's theories on multiple intelligences.

The next phase of data collection then sought to identify whether the tacit knowledge brought to bear on laboratory tests and activities could be categorised using labels and descriptors that corresponded (even loosely) with Gardner's seven frames of mind. That is to say, were there any aspects of tacit knowledge that corresponded with the Visual/Spatial, Linguistic, Logical/Mathematical, Bodily/Kinaesthetic, Musical, Intrapersonal, and Interpersonal intelligences?

As it turned out, there were numerous examples of aspects of task related tacit knowledge that could be categorised according to Gardner's seven frames of mind (see page 291 in the Appendix for a subset of samples). The following section describes the grounded theory processes that led to an abstract understanding of tacit knowledge in the workplace.

4.2.5.b. Theoretical coding

Using Charmaz's (Charmaz, 2006, p. 101) logic for theoretical sampling, which is not about representing a population or increasing statistical generalisability, but is about conceptual or theoretical development, and has the purpose of obtaining data to explicate categories, a set of seven theoretical categories was devised, which aligned with Gardner's seven types of intelligence. These categories were,

- Activity Tacit Knowledge; making sense of events (in terms of e.g. logical processes, tasks, activities)
- Bodily Tacit Knowledge; making sense with one's body (in terms of e.g. movement, dexterity, exertion, balance)
- Community Tacit Knowledge; making sense of others (in terms of e.g. expectations, cultural and organisational norms, behaviours)
- Personal Tacit Knowledge; making sense of self (in terms of e.g. attitudes, motivations, emotional responses, values)
- Sound Tacit Knowledge; making sense of sounds (e.g. that are heard or created)
- Visual Tacit Knowledge; making sense with what is seen (in terms of e.g. colours, shapes, patterns, perceptions)
- Word Tacit Knowledge; making sense with words (having contextually specific meanings)

In the lab, all the tests are documented and have to be performed according to external auditing standards, but even within that constraint, a certain amount of tacit knowledge has to be brought to a task. The next phase of the data collection focused on those aspects of the performance of laboratory tests that required qualities of the technicians' experiences in terms of these seven categories.

4.2.5.c. Theoretical saturation

Back in the laboratory, the attention now focussed on the technicians' performances with particular note being paid to tacit knowledge as it was categorised according to the seven aspects. With the data collection clearly focussed on theoretical sampling, it became possible to ensure rigorous integrity of the data collected.

Technicians were observed as they conducted their tests, and at every stage, what they knew about the task was compared with the knowledge available in the manuals. They were also asked questions such as,

- How do you know that you've done it right?
- How do you know what a large/small sample size is?
- How are you able to tell whether the sample is thoroughly mixed?
- Why are you dropping drops [e.g. in a titration] that fast/slow?
- How do you know which is the biggest side?
- How do you know that the sample is completely dissolved?
- Why do you find that test easy/difficult?
- How do you know when the colour has changed?

In every test event, it was possible to identify tacit knowledge that matched one of the types in the list of tacit knowledge categories. For examples of the theoretical sampling that demonstrates this phenomenon, see Table 27: Theoretical samples illustrating the seven aspects of tacit knowledge in the Appendix on page 291 below.

By conducting further matrix queries with the data, it was possible to show that the data that had previously been coded at either the purposive or the open codes, could also be coded on at least one, often more, of the seven tacit knowledge types. This is clearly illustrated in Table 10 below, which shows the data at the purposive and open codes recoded at the seven types of tacit knowledge.

Theoretical codes	Purposive codes				Open codes																
Tacit Knowledge Types	Activities	Respondents	Setting	TK Processes	Awareness	Expectations	Explicit knowing	Feelings	Health & Safety Issues	Innovation and Thinking	Innovations	K Transference.	Movement	Pattern Recognition	Performance & Quality Measures	Problems and Solutions	Process contexts	Quality controls	Relating	SOP	Understanding Org Hierarchy
Activity	27	9	3	7	7	2	13	7	4	18	5	11	3	2	20	32	19	10	5	8	4
Bodily	14	6	0	6	3	0	0	1	0	1	2	3	5	0	4	5	4	2	2	4	0
Community	23	3	5	3	6	6	12	17	4	12	8	3	0	1	25	18	28	7	12	9	7
Personal	19	5	2	9	4	4	14	23	1	6	3	7	1	4	25	16	8	10	2	6	1
Sound	2	1	0	0	0	0	0	0	3	3	2	0	0	2	0	4	5	2	0	0	0
Visual	6	0	0	2	0	0	4	1	1	1	1	1	2	1	5	4	2	5	0	4	0
Word	12	3	1	3	3	1	10	10	0	4	0	3	0	0	13	7	9	9	1	3	3

Table 10: Matrix query result, intersection of purposive and open coding with the seven aspects of tacit knowledge

The analysis suggested that these seven aspects of tacit knowledge inform a technician’s awareness. It leads to them having expectations, enables them to make explicit what they know implicitly, impacts on their feelings, affects their bodily movements, helps them to make sense of events within their contexts, supports their commitment to quality and helps them to relate to their world.

4.2.6. Findings – Seven Aspects of Tacit Knowledge

As it became obvious that the theoretical codes of the seven tacit knowledge types could be sampled to achieve theoretical saturation, clearly delineated relationships between the phenomena and abstract concepts emerged. It was now possible to illustrate the conceptual categories, i.e. Substantive Theory (Urquhart et al., 2010) in terms of a generic laboratory test. The seven types of tacit knowledge that technicians use in a laboratory test, can be illustrated in two ways. The first is with a generic activity chart, and the second is with a table.

The substantive theory that emerged from this analysis is reported in section 5.2.3: A measure of task related tacit knowledge on page 248 below.

4.2.6.a. Generic activity chart

Since most manual test processes in the laboratory followed a basic sequence, it was possible to map a generic test process, and at each stage to identify the limits of the written procedure and where tacit knowledge took over. A form of activity chart adapted from Werner (1992) and Werner and Schoepfle (1987) was used to identify nine separate stages in a generic manual test. These stages included, preparation for work, preparation of test equipment, preparation of samples/ sub samples for testing, starting the equipment, doing the test, reaching the endpoint, removal of the samples/ sub samples, disassembly of the equipment, and then finally, recording of the results.

Generic Activity Chart of Lab Test Procedures, showing Knowledge Inputs (Adapted from Werner 1992, Werner & Shoepfle 1987)

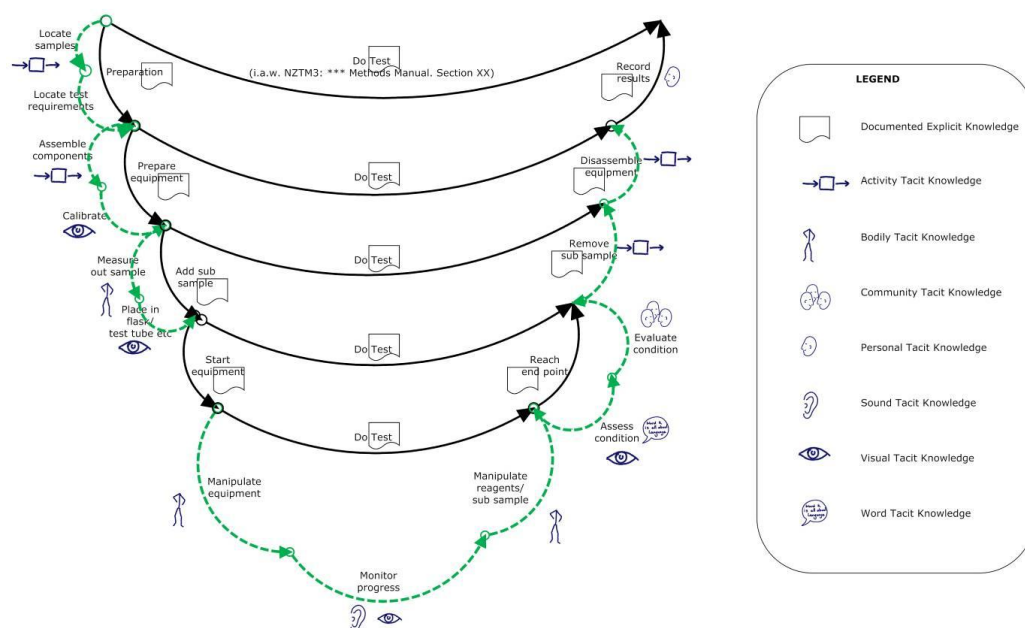


Figure 25: Generic activity chart of Laboratory tests

Illustrating where tacit knowledge takes over from explicit knowledge

Although the laboratory manuals describe in some detail how to perform each stage of a test, in many instances, even the use of explicit language and images was not enough for the technicians to perform the task to the expected standards of reproducibility or repeatability. With the use of an activity chart (see Figure 25 above), it is possible to illustrate the points where the explicit knowledge in the manual left off, and the tacit knowledge of the individual technicians took over.

Representations of seven aspects of tacit knowledge

In the activity chart, explicit knowledge, i.e. knowledge in the manuals, is illustrated with a solid black line and tacit knowledge is represented with a dotted green line. The arrows indicate the direction of the workflow. A standard document icon, as used in conventional process flow diagrams, is used to indicate explicit knowledge of the process as identified in manuals, and other icons (identified in the key) are used to illustrate the tacit knowledge applied. The placement of the tacit knowledge icons is indicative of applications of different types of knowledge at various stages in a test, but is not prescriptive of all the tacit knowledge types applied.

Not all aspects of tacit knowledge are equally important

Also, the seven types of tacit knowledge are not equally important in every test, and some tasks rely more heavily on one type of tacit knowledge than on another (for example titrations rely heavily on visual knowledge, but not at all on sound knowledge).

4.2.6.b. Table showing seven aspects of tacit knowledge

A table that used the same data as in the generic activity chart was constructed to illustrate the seven aspects of tacit knowledge. This is shown in Table 11 on page 158 below.

Event	Process	Tacit knowledge type	Description of tacit knowledge applied
Preparation	Locate sample	Activity	Technicians know where samples should be located in the laboratory, and in what form to expect them, e.g. sealed in a sterile sample bag, as a powder, liquid or solid. If a sample is not where it should be, they know where to start looking for it, and what the implications might be for the testing schedule (and the corresponding laboratory performance metrics).
	Locate test requirements	Activity	Technicians know which cupboards to look in, where components might be if they are not where expected, and who else might be using them.
Prepare equipment	Assemble components	Activity	Several pieces of equipment require assembly before they can be used. This might include labelling or numbering a series of flasks, which if not done correctly can lead to confusion as the test progresses. This is important since many tests require a control sample that must be treated in the same way as the test samples.

Event	Process	Tacit knowledge type	Description of tacit knowledge applied
	Calibrate	Visual	Some equipment requires calibration every time it is used, and technicians have found that for some equipment, the prescribed calibration technique can lead to inaccuracies, so have learned how to overcome the manual's shortcomings, e.g. by leaving probes to soak in saturated solutions for longer than the prescribed time.
Add sub sample	Measure out sample	Bodily	Some technicians are able to place a sub sample into the balance cage with deft movements, while others are clumsy and inept. Some are able to measure out an accurate sample size with just a few spatulas full, whereas others may take as many as seven or eight goes to get it right
	Place in flask/ test tube etc	Visual	As with the measuring out, some technicians can easily tell whether a sample has mixed completely, whereas others find this task difficult
Start equipment	Load sample, switch on etc	Visual and Bodily and Sound	As the technician loads test equipment, such as Mojo flasks into a centrifuge, he or she is able to tell whether the flasks are securely located, or the machine balanced etc, simply by observing their positions
Do Test	Manipulate equipment	Bodily	Turning taps on titrators, folding filter paper, shaking sieves, manoeuvring flasks in a hot oven etc., all call for a degree of knowledge about how quickly, slowly, carefully, firmly a piece of equipment needs to be manipulated to ensure optimal test results. For some technicians this is easy, for others it can be difficult
	Monitor progress	Visual and Sound	Observing when a permanent colour change happens, as for example in a titration, depends wholly on a technician's ability to recognise colour. Some find it easier if they use more indicator, some if they use less.
	Manipulate reagents/ sample	Bodily	Testing for temperature with the back of the hand for example, is totally dependant on a technician's perception of heat, or their tacit knowledge of the correct temperature.
Reach end point	Assess condition	Visual and Word	Colour matching or understanding the meaning of a descriptive word enables a technician to assess a test condition, all of which are dependant on their perception, e.g., what they know of colour.
	Evaluate condition	Community	Understanding when a test condition is in or out of specification relies of the technician's interpretation of communally agreed standards. This is particularly evident when describing e.g. the qualities of a film of reconstituted milk powder, or the elasticity of cooked cheese

Event	Process	Tacit knowledge type	Description of tacit knowledge applied
Remove sub sample	Remove sample from equipment	Activity and Visual and Community	As with placing a sample into test equipment, its removal and disposal are often not specifically described in the manual. The technician's knowledge of what to do with it is often informed by knowledge of who else is doing a similar test, who is testing similar samples, and what the organisation's policies are for disposing of waste, e.g. does the waste sample count towards the organisation's environmental footprint?
Disassemble equipment	disassembly of the equipment	Activity and Visual	Disassembling equipment for cleaning requires that the technician know where to put the used equipment so that it doesn't interfere with the work of others, when it should be cleaned to optimise the cleaning process (some reagents are harder to clean off than others if they are left to stand), and what can be cleaned with what – since some reagents may react with others in the cleaning process.
Record results	recording of the results	Personal and Word	When technicians are recording the results of tests, their experience (or lack thereof) can inform them about the validity of the results. For example, when operating an autotitrator, an experienced operator is able to tell whether the machine has malfunctioned by the quality of the results, are they consistent with past experience, do they show unaccountable aberrations to the norm, have they been produced in the expected time frame etc.

Table 11: Seven aspects of tacit knowledge in a generic laboratory test

4.3. Case study 2

4.3.1. Research focus

The research focus for this case was twofold. The main focus was to answer the second supplementary research question, i.e. RQ_{ii} – *How does tacit knowledge relate to Experience and Human Capital?* and the second was to triangulate the findings from Case 1, i.e. to see whether the conclusion that there are seven aspects to tacit knowledge could be substantiated

4.3.2. The context

Case 2 is a light to medium/heavy electrical engineering workshop that belongs to a global engineering conglomerate. The main purpose for visiting this site was to observe and describe ways in which the management of tacit knowledge as “intellectual working capital” (Ammar-Khodja & Bernard, 2008, p. 13) related to experience and Human Capital. Given that the term management has subtly different connotations in the Knowledge Management discourse, this meant that the focus was on how supervisors coached, cared for, coped with, and handled tacit knowledge (in terms of experience and human capital) on a day-to-day basis.

The workshop was chosen for two reasons. Firstly, because it provided a relatively unstructured, but competent and capable service oriented workplace context (as determined by the evident customer loyalty), where most of the knowledge required to provide the service resided in the persons of the engineers themselves. Secondly, the case had several demographic similarities with Case 1, e.g. with respect to age groupings, years of experience, qualifications and training, which it was felt provided sufficient points of congruency to mitigate the potential for analytical bias (Miles & Huberman, 1994, p. 263) during the process of triangulation of the findings from Case 1.

The workshop, which is one of several New Zealand business units operated by the participant company, is located at the branch premises in a major industrial estate in one of New Zealand’s five largest cities. The other business units on the site are also associated with electrical power, including a heavy maintenance unit that performs work on electricity generation infrastructure e.g. hydro-electricity generators, an electrical motor/generator rewinding shop, and diagnostic services such as heat signature analysis. The site also houses the administrative and Health & Safety support services for all of the business units associated with the branch.

Apart from the workshop manager; a tradesman himself who had been promoted from supervisor, the workshop staff consisted of a supervisor, ten engineers, and two

apprentices – one of whom had almost completed his time (3 years) and the other who was still fairly new (started within the last year). For a breakdown of the engineering staff age groupings and experience levels compared with the labour force in Case 1, see section 0: Appendix 3: Case study 2 - comparison demographic data in Cases 1 and 2 on page 292 in the Appendix.

Most of the engineers were fully qualified and certified, and between them they had over 100 years of experience in the trade, with the most experienced engineers having spent up to twenty five years in the industry. Most of this experience (certainly with regard to the older engineers) had been gained in what was the traditional way, i.e. through a hands-on apprenticeship augmented over the years by the occasional training course - some overseas and some local, and exposure to a variety of related tasks in the industry. The younger members of the workshop tended to have gained their working knowledge via a series of tertiary educational institute based courses, with added workshop experience to provide the practical application of the course based theory.

Over the course of the observation, an interesting tension was observed between those engineers who had gained their qualifications overseas, such as recently arrived immigrants, and those who had only worked in New Zealand. (It appeared that generally speaking, the value of the overseas qualification was not highly regarded by those who had gained their qualifications in New Zealand – for example, one engineer from Australia felt that his ideas were not valued because of where he hailed from. Another example related to an engineer from Fiji who was occasionally excluded from problem solving sessions, because it was felt by others that his qualifications were somewhat suspect).

4.3.3. The researcher's daily reality

Because the literature suggests that knowledge management is less about a formalised, hierarchical, bureaucratic approach to leveraging knowledge assets, than it is about caring, coaching, coping, and handling complex situations (see section 2.2.7: Knowledge management on page 29 above), the researcher's daily reality was focussed on trying to understand how a supervisor actually did these things, if he did them at all. With that in mind, this case provides descriptions and vignettes of observed activities to illustrate how a supervisor managed tacit knowledge i.e. experiences and human capital, on the shop floor.

4.3.3.a. The case study site

The workshop in which the observations took place is a substantial steel barn-like building, some 70 m long by 30 m wide, and approximately three stories tall. When it was first encountered, the first impression of the workshop was one of chaos. To the untutored eye, it appeared to be an eclectic collection of heavy and light manufacturing equipment, materials and parts scattered throughout in apparent confusion. However, over time it was possible to discern order in the apparent confusion.

The confusion resolved itself into the workaday tools and equipment of a well-resourced workshop, including numerous racks holding tools, work in progress, and a profusion of copper cable in coils of different thickness. There was a large apparatus used for balancing shafts, a set of workbenches containing the personal toolboxes belonging to the engineers, several small gantries used for managing smaller components, four lathes, and a washing bay. Immediately to the left of the main doorway were racks containing work cards for the jobs in progress, and beyond them were tall racks containing spare parts or pieces of equipment awaiting repair. There was also a small *portakabin* (portable building) to provide a relatively quiet, warm and dust free environment for storing records and doing paperwork. At the north end of the workshop there was a burn-out oven (used for burning insulation from motors or generators), a varnish vat, and more racks for holding lifting chains and spreaders. Overhead, a large gantry crane with a 25 tonne lifting capacity ran on rails along the length of the building.

4.3.3.b. The work of the case study

The workshop's primary purpose is to provide maintenance services for industrial electric motors and generators. The work ranges from general maintenance, such as performance testing or certification, through minor service work, such as troubleshooting and replacement of bearings or brushes, to major services such as refurbishment and rebuilding. The workshop can handle almost any kind of electrical motor or generator, and typical tasks include the service of flame resistant motors for the mining industry, or refurbishing industrial wind generators for an electricity supply company. A secondary service is the supply and installation of new motors and/or generators to industry.

The observation period of approximately 160 hours, spread over a four-week period occurred during the early spring period (August) of the normal annual business cycle. The regular working week of the workshop consisted of a normal 45 hours, i.e. 7:00am to 4:00pm (with a half hour for lunch), and when the observation period began the daily

routine started with the engineers all arriving sometime between 6:45am and 7:05am. On arrival, they would clock in at the front entrance, make their way to the locker room where they would collect a clean set of overalls (personalised with their own name) off the clean laundry shelf, don safety boots and then make their way into the workshop.

Once inside the workshop, unless they had an incomplete task from the day before, the engineers would loiter around the supervisor's office and wait for work to be allocated to them. If they did have an incomplete task, then they would simply pick up from where they had left off the day before. As soon as the supervisor had dealt with his immediate responsibilities such as assigning work, checking e-mails, checking in with the manager, and establishing progress on each of the jobs in hand, he was supposedly free to apply himself to his own task list, although this however tended not always to be the case.

Fairly frequently, sometimes as much as twice a day, customers would simply arrive at the workshop, drop a machine off and then leave without so much as an appointment, or conversation, or expectation about what work needed to be done. It seemed that the workshop had such a good relationship with its customers, and they felt so comfortable with the quality of service that was provided, that there was no need for the normal purchase ordering and quotations of a conventional business administration. In the main, customers were justified in their expectations because many of the engineers knew their customers' businesses so well they were able to identify to whom a stray motor belonged, what work it did, and what maintenance it needed, and therefore were able to perform the required maintenance without necessarily receiving any input from supervisor.

The routine also had monthly variations that incorporated site wide meetings on Health and Safety and on the corporate performance – including what was happening globally.

The organisation was well established within the local community (it had been on the site for more than 25 years) and had a good reputation for a high standard of workmanship; there was no shortage of work coming in the door. At first it appeared that to a large extent the engineers operated as a well coordinated team, probably because most of them were highly experienced. It seemed that work proceeded relatively smoothly throughout the day and when knock-off time came at four o'clock in the afternoon they simply cleared away their messes, packed up their tools and went home. This apparent calmness put the lie to the stress, busy-ness, frustrations, and confusions that the supervisor and several of the engineers actually experienced.

4.3.3.c. The importance of tacit knowledge in a highly experienced environment

Depending on their particular skill set, the engineers tended to focus on particular tasks such as dismantling for repair and reassembly, refurbishing components e.g. turning shafts, rewinding stators, cleaning components for spray-painting, testing for power output or short-circuits, or paperwork - e.g. writing up work cards.

Even though many of the motors, generators, spare parts or components, and the machinery with which to perform the work came with basic documentation, the sheer range of work done in the workshop made it impracticable to document every procedure, primarily because the majority of work involved one-off tasks. However in spite of that, within each task there were a number of distinct phases that were common to all tasks that included; initial inspection, dismantling, detailed inspection, return of components to within-specification – either through replacement or refurbishment, reassembly, and then final testing.

It was in this semi-structured framework of the task process that the engineers applied their tacit knowledge. What documentation was available was inclined to be very component specific, so engineers tended to use rubrics, rules of thumb or various hermeneutics (particular methods of interpretation – including sights, sounds, and smells) to identify and solve problems. If they didn't have the knowledge themselves they would either ask a colleague for assistance or, as happened as often as not, a colleague would notice them having difficulties and would volunteer to help.

This environment of somewhat ad hoc collegial challenge and solution finding made the site a useful case study in which to understand the role and function of tacit knowledge in terms of experience.

4.3.3.d. Building trust between the researcher and the participants

As with Case 1, it was important for me to establish a trust relationship with the research participants as soon as possible. Fortunately, the workshop manager provided an opportunity to do this on my very first day. I was given the chance to observe, and even help, one of the engineers (who I later found out was probably the most highly regarded and experienced of all of the engineers in the shop) to conduct a tap test, as the field notes describe.

I observed an engineer doing Tap Testing [see Figure 26 on page 164 below] on the wedges in a generator armature. This involved him using a small ball pein hammer to tap the wedges holding the windings in place inside the

armature. He would tap the wedge gently whilst placing his finger at one end and would listen for the sound and feel for vibrations. He was listening and feeling the amount of vibration to see whether a wedge was tight, slack or loose. As he made the judgement call, I made a note on the chart of the position and condition of the wedge. Later, he would then enter this information into an Excel spreadsheet, and produce a report for the client on the overall condition of the windings. Depending on the degree of looseness, some of the wedges would be tightened. (This particular generator had seven rows of wedges with 61 wedges in each row giving a total of 427 wedges, each of which was tapped probably on average eight to a dozen times.)



Figure 26: An engineer conducts a Tap Test on a generator armature

The engineer said that it was very easy to get lost or to lose focus when doing the work because it was very repetitive and he needed to stop every now and

then to "re-calibrate" himself. I asked him if he was mentally exhausted at the end of this and he said no not really because he was very used to it.

Once the engineer had completed the tap testing on the armature I felt that I had developed a level of rapport with him; I had managed to accurately record all comments he made about the wedges, and expressed an interest in him personally and engaged him in some personal conversation, all without slowing the job down. I felt that I had received his implicit approval, which seemed to have been communicated to the rest of the workforce because I did not experience any sense of resistance from the engineers for the whole time that I was there, and in many instances engineers would call me over so that I could learn something from them.

4.3.4. Selected observations

Following the same structure and rationale as for the previous case write-up, the following section provides examples of activities that illustrated how experience was gained and applied, or in other words, how Human Capital was developed.

4.3.4.a. Tacit knowledge & Intellectual Working Capital

Given the amount of documentation available, it was obvious that the engineers were using their Intellectual Working Capital, i.e. the workaday information of experienced workers to get the work done, and in this case the majority of that was tacit. I was able to observe how engineers added to this resource, i.e. gained experience, and how over time were able - through personal hermeneutics and rubrics – to discern patterns in it, which became in turn a form of received knowledge that was shared within the workforce. The following observations about the maintenance activity on wind powered generators shows this well.

During the second week of the observation, I was helping one of the engineers to strip down and troubleshoot a number of wind powered electricity generators that had failed. The generators had been seen in the workshop before, but no one there at the time knew exactly how they came apart. However because of the general knowledge that the engineers had about how generators were built in general, it was possible for them to develop a strategy for disassembling it. The field notes describe the situation as follows,

Raymond removed the pallet bolts and lifted one of the 660kW Wind Generators over to the service area with the overhead gantry crane. Before he did that though, he checked its weight on its label, and selected the correct chain from its label. Then he identified the generator's serial number and wrote

it on the job card that Charles had already prepared. Raymond then used a number punch to mark each component to identify from which machine it had come.

Once he was ready to start dismantling it, Raymond conferred with Brian and Geoff to identify how to pull the controller part of the generator apart. There were no notes or drawings available but Geoff said that he had had to put one back together previously, although he hadn't taken one apart. Furthermore, he said, the guy who had disassembled it was no longer there.

Raymond began disassembling the generator. He started by undoing a set of Allen screws and then noticed a couple of jacking screw points that had been plugged, possibly with putty, which I hadn't noticed. He cleaned the thread with a tap and an adjustable spanner and tap wrench. Once he had done that he tried to remove the controller with a crowbar and hammer, but that didn't work. Then he doubled up the nuts to remove some tie bars to remove the heatsink/ hub. He used CRC [a proprietary anti-corrosion formula] to loosen/dissolve some corrosion and then tapped the bar with a hammer and screwdriver but bent the bar. He replaced the bolts and then used a dot punch to lock the thread on the bolts that were too short otherwise. This seemed to work. As he was progressing he used a digital camera to record the process [see Figure 27 on page 168 below], and then made the comment, "the first thing I look for is the dots, and if they are not there I curse."

(This comment referred to a general practice at the firm, where the engineers would mark different ends of the generator with a different sequence of dots to identify which end they came from when they were being dismantled. This helped immensely in the reassembly process.)

Then together, we began setting up to pull the coupling off the shaft. We used a threaded rod and a puller. However before we could finish the task, Raymond was called away and I was left on my own. Whilst I was struggling with this, Mark came up and suggested that I use the pneumatic puller with spacers. He showed me how to do this, which was much quicker and easier than the manual method that I had been using.

Then Raymond came back and used a gas torch to heat the nut. He tested its temperature with a wet finger; the moisture sizzled when the nut was hot

enough, and then used a pair of cranked crowbars to lever the heated components off. After that it was straightforward to undo the bolts with a pneumatic impact wrench so that we could remove the bearings and bell housing/end shield. Once the bell housing was off we could see where the machine had been greased; there was a mixture of different colours - yellow in the grease nipple, then red under black under brown, which seemed to indicate that there was a problem with the grease itself. After that, we used a pair of winches and slings to remove the rotor, which was inspected for damage. Raymond noted some burn marks to the insulation on the stator windings. His comment was, "that's fucked" - which he humorously described as a technical term for the burn pattern that indicated where installation had broken down because of voltage spikes. There was corresponding pitting and molten spots on the rotor fan, which indicated arcing between the stator and the rotor, and a strong smell of burnt paint/varnish.

The following day I helped Raymond to prepare another wind generator for dismantling. Once we had prepared the bins and pallets to hold the dismantled parts we,

... continued disassembly according to yesterday's processes. It was easier this time because we remembered what worked last time and what didn't, so we didn't go down dead ends, and had the right tools ready, and knew what had to be done next.

The next day I was again working with Raymond,

Continuing to disassemble another 660kW wind generator, removing end caps same as previous methods. Brian came over to help without invitation when Raymond took off to do something else. After Smoko, I was still helping Raymond with the wind generators - removing the rotor to expose the windings in the stator when he said, "looks like the same problem with all of them" referring to the burn pattern we had previously observed. He described the location of the burn on the job card.

The next day I was again working with Raymond but getting faster with the dismantling of the wind generators, although on one occasion I missed out a couple of steps, possibly because I was thinking too far ahead. The following week during a meeting, Sean was "quite excited" to be talking with the owners of the wind generators about

them and putting together some prices for replacement stators and rotors, and Charles, describing his own work, provided some feedback on the customer's requirements.

What this story clearly shows is the intellectual working capital a.k.a. tacit knowledge, that an engineer uses and builds in the process of performing a challenging task is to all intents and purposes synonymous with experience, and shows how in the process, human capital is developed.



Figure 27: Using a digital camera to record stages in the disassembly of a generator supports the development of an engineer's personal experience

4.3.4.b. Tacit knowledge & Human Capital

Implicit in the literature's descriptions of human capital is that it incorporates tacit knowledge (see section 2.3.2.f: Human Capital on page 60 above), so I wanted to observe what human capital looked like in Case 2 and to see how it was managed. Consequently, I recorded a number of situations where human capital was deployed, although not necessarily always in the best interests of the company!

The following excerpt describes how human capital in the person of the workshop manager was used to develop and implement a business tactic that would help to maintain the company's competitive position in the market.

After lunch, I spent some time with Sean in his office. My purpose was to try to understand his quoting Excel spreadsheet, but in the end I got a lot more than I expected. He started off by showing me the Motor Bounty website, which is

an initiative by the government to industry to get inefficient electric motors off the national grid and replaced with more efficient ones. It seems that this as a government initiative with very strong environmental overtones, and as is typical with some of these government initiatives, hopelessly out of touch with the reality of commercial life. It seems that [the company] had the option of becoming a participant in this initiative or not. According to Sean, the initiative is only marginally feasible for them and not really worth their while economically, but the implications of not being part of it are probably more damaging from a marketing perspective, as he said, you "open yourself up to losing business," if you didn't participate because the competitors who did participate then had the opportunity to go into client's premises and on-sell their services, thereby cutting [his company] out of the loop.

An interesting facet of human capital I observed is that sometimes judgements are made with the best of intentions but can have detrimental effects on relationships within the workplace, as well as on the work to be done. The following excerpt describes a situation that was quite typical, where a lack of knowledge management led to less than optimal outcomes for the workshop and the client.

Raymond was telling me that he'd been told off by Sean for not letting Charles know that he had been taken off one urgent job, and put on to another urgent job. In consequence, Charles had to stop what he was doing to go and work on the first urgent job in order to have it completed by this morning for the customer to come and collect. Now, customer called (10:50am) to find out where the promised job is and Sean had to tell him that it still not ready because it needs a replacement fan.

This little incident, and the many others like it, caused me to do some reflexive thinking and I made the following note to myself about what I had just recorded,

There seems to be a norm that people don't tell others what and where they will be/are going. I wonder why. [This appeared to be] one of many expectations that are not articulated. Perhaps this is a key for [the supervisor] to consider?

I had a personal involvement in the small incident because I was involved peripherally, as the field notes describe,

[I had to make a] trip into town to collect a new fan for the urgently needed motor. Neil fitted the fan after lunch and at 2:00pm it's ready to go.

On another occasion, I had an interesting conversation with an engineer who had had broad experience overseas in Australia and Asia working in the mines and on large hydro generation schemes. He had been in the industry for nearly 30 years, and was able to point out that older electric motors tended to be much better built than modern motors, because in many cases they were built with better insulation and so were much more reliable than modern motors, which tended to be built with many shortcuts including inadequate insulation, and are prone to shorting out. In his experience, some modern motors have been known to have very short life spans. He mentioned a couple of very large and very expensive (approximately \$1 million) motors that he knew of in Australia, one of which lasted two weeks and another which lasted six months before they burnt out.

What was interesting about this conversation was how it pertained to the maintenance work that Raymond and I had done on the wind generators, because it seemed that exactly the same issue was manifested; it appeared that the modern generators were breaking down because the insulation couldn't cope with voltage spikes and hence were shorting out.

It seemed that not only did human capital relate to the work being done, but also to the consequences of work done, especially in a social behaviour sense. For instance, over the course of the observation, my attention was drawn to a number of health and safety incidents that seemed to have their origin in the social mores of the workplace. Even though the company had a dedicated health and safety officer, whose job was to support health and safety in the workplace, a number of injuries occurred in situations where it seemed that the social norms of the workplace were actually more important than any training, expertise, judgement, or intelligence. The following health and safety incident stood out clearly in that respect,

[I was working with Raymond when he] nipped his finger but with gloves on – [fortunately there was] no harm done. I said jokingly “you should write up an incident report.” [This was a comment made in response to the health and safety induction training that I had received, but] His response, “only if blood comes out” otherwise not worth it.

4.3.4.c. Tacit knowledge & Knowledge Assets

Because of the apparent lack of practically useful definitions of tacit knowledge in the literature, another focus of this case study was to try to understand exactly what constitutes a knowledge asset in practical terms. Obviously, because of the tacit nature of some of this knowledge, not all of it could be observed directly, but its use could. The following vignettes illustrate occasions when knowledge assets were important in the thought processes and decision-making of the participants.

During the first week that I was on-site, I observed an argument between one of the engineers and a visiting fire safety officer. The engineer was adamant that a fire extinguisher should be placed in a particular spot, but the Fireman was equally adamant that that was not the right place and the exchange became quite heated. It was obvious that the Fireman had a strong opinion about the placement of the fire extinguisher, but was completely unaware of the implications that that had for the company's processes and procedures. After a while, they agreed to disagree and the fire extinguisher was placed where the engineer wanted it. Later I had the opportunity to talk to the Fireman and discovered that he had recently been exposed to a major fatal fire that had occurred locally, and had an acute awareness of the need for easy access to fire extinguishers. It appeared that the engineer was completely unaware of that fact, and the incident highlighted to me the importance of the local environment context on decision-making; the Fireman was approaching the decision-making from the perspective of one environmental context and engineer from another.

On another occasion, I was talking with Brian, a trade certified electrician from overseas, about electric motors, specifically about the motor that he was working on that came from an underground coalmine. This particular motor had to be flame resistant because of the methane hazard, which can be found in the coalmines, and Brian was explaining how the motor was made flame resistant.

He also told me about a lifting arm that he used when he worked overseas, to insert rotors into their armatures. Apparently, it made the job very quick and easy because it only had a single lifting point, in contrast to the double lifting procedure, which was used locally. According to Brian, the overseas method was probably safer too, but when he mentioned it when he first arrived here some time ago, the idea was pooh-poohed and so he had not followed it up. He told me that his thinking was maybe it could be the cost of compliance (design and certification costs) combined with the management's apparent attitude toward not spending money on equipment, which was the reason for his idea

not being implemented. Another idea of his was the use of Markout Blue paint that was used to identify hot spots on the armature. Apparently, this idea was "rubbished" as well.

In another conversation I overheard, Geoff and another contractor were discussing a third contractor (chimney cleaner) who was not wearing appropriate PPE (no steel toecaps). The conversation moved on to overalls, the virtues of cotton vs. polycottons, (warmth, weight, shrinkage, fire resistance), the use of goggles (with regard to anti fog: "I've yet to come across safety glasses that don't fog" or, "sometimes they create a hazard" when they fog up), and inconsistent standards applied by management.

Later another engineer showed me some photographs of a little 2MW hydro generator that was being refurbished – it needed rewinding, and we were talking about the opportunities for micro power generation in New Zealand. He had also been involved in the practical/ conceptual design work on the rewiring of a generator, from 40MW to 48MW for a client, and had used his network contacts in Sweden to check their design work. It turned out that he had been considering going back to university to do engineering.

On yet another occasion, I was watching an engineer brazing joints. He could tell when it was safe to release a cramp by the colour change of copper after solder has melted; he needed to allow the work to cool until the copper turns blue.

In a separate quiet moment, another engineer showed me a workshop manual that he had written (when he came back to the workshop after an absence of some time). It seemed to me to be a very comprehensive document that consisted of a full lever arch file with approximately 15 different processes. Each process has between 8 – 10 pages of information documented. Apparently, he had done this because the manager of the workshop had recognised the value of the information that the engineer had, although the engineer's comment was "I still don't think this place recognises the value of QA [Quality Assurance]".

4.3.4.d. Tacit Knowledge & the Supervisor as a Knowledge Resource

By the end of the third week of the observations, I had noticed two very important factors that affected the smooth operation of the workshop. The first was that there was an enormous range of information and knowledge that engineers drew on as they went about their business, and secondly the supervisor was kept busy with constant interruptions. I made a point of observing these interruptions and noticed that he was expected to respond to a request for information, make a decision, or provide direction

as often as once every 10 min during the day. What was most interesting about these interruptions was that mostly the supervisor was able to respond to the request without having to resort to a diary, manual, or other form of documented knowledge, it was all "in his head". The constant interruptions however led to a situation where he said that he felt "out of control" and frustrated much of the time.

4.3.5. Analysis

In order to maintain consistency in the research, the data collection methods and stages for Case 2 were the same as for Case 1, i.e. they followed the same stages of purposive sampling (of activities, respondents, and the setting) and open coding, then theoretical sampling and finally theoretical saturation.

Since the purposes of this observation period were to answer RQii (*How does tacit knowledge relate to Experience and Human Capital?*) and to triangulate the findings for RQi (*What does tacit knowledge look like on the shop floor*), the observations had two foci. The initial focus was on collecting purposive samples to help make sense of the new case, but the secondary focus was on collecting theoretical samples according to the theoretical codes of the seven types of tacit knowledge described in the previous case study. Since the analytical focus overlapped, purposive samples for RQii could be treated as theoretical samples for RQi at the same time. The data was thus analysed with Nvivo using the same methods as in Case 1.

4.3.5.a. Triangulation of findings from previous case

The theoretical samples from Case 2 were coded at each of the seven aspects of tacit knowledge according to the theoretical coding developed in Case 1 and compared with that first case's coding. The data points were then compared and charted as shown in Table 12 below.

Aspects of Tacit Knowledge	A : Case Study 1	B : Case Study 2
1 : Activity Knowledge	76	50
2 : Bodily Knowledge	27	15
3 : Community Knowledge	90	45
4 : Personal Knowledge	55	47
5 : Sound Knowledge	8	7
6 : Visual Knowledge	16	14
7 : Word Knowledge	40	16

Table 12: RQ1 Theoretical Coding references for cases 1 & 2

The table shows that all of the seven aspects of tacit knowledge that were observed in Case 1 were also observed in Case 2, which suggests that the findings from Case 1 are supported in Case 2. When the number of data points at each aspect were shown in

terms of percentage of their total (see Table 13 below), further analysis of the theoretical coding showed that proportionally more Activity and Personal tacit knowledge was observed in Case 2 than in Case 1, but more Community tacit knowledge was observed in Case 1 than in Case 2. This seemed to correlate with the level of documented knowledge that was required to perform the work in either case, i.e. Case 1 had more detailed documentation than Case 2, and Case 2 relied more on experience than Case 1, which is consistent with the findings from Case 1 (see page 156: Not all aspects of tacit knowledge are equally important) that indicate that some tasks rely more heavily on one type of tacit knowledge than on another.

Aspects of Tacit Knowledge	A : Case Study 1	B : Case Study 2
1 : Activity Knowledge	29.94%	36.69%
2 : Bodily Knowledge	8.72%	7.1%
3 : Community Knowledge	29.92%	24.06%
4 : Personal Knowledge	17.54%	21.38%
5 : Sound Knowledge	1.87%	2.06%
6 : Visual Knowledge	5.81%	4.11%
7 : Word Knowledge	6.2%	4.61%
Total %	100%	100%

Table 13: Theoretical coding by proportion of data points for cases 1 & 2

What this suggested is that the seven aspects of tacit knowledge had indeed earned the status of category (in terms of grounded theory), because phenomena were repeatedly present and no new or relevant data had emerged regarding the categories' development, i.e. the category descriptions appeared to have accounted for all paradigm elements, variations, and processes, and the relationships between them seemed to be established and validated.

By the beginning of Week 2, theoretical saturation having been reached, the data collection focused more on the second purpose of this case i.e., to find out what constitutes tacit knowledge in terms of experience. Because of the great breadth of experience held by the engineers in the workshop, the case provided an opportunity to investigate what were subsequently identified as the tacit knowledge assets that comprise the “working capital”, or “workaday information” (Ammar-Khodja & Bernard, 2008, p. 13 ; Stewart, 1999) of experienced workers.

4.3.5.b. Open coding

Because the focus of this case was on how supervisors managed tacit knowledge in terms of experience and human capital, the first open coding in this case conceptualised tacit knowledge in terms of the supervisor's interruptions, because it seemed that they were key to how tacit knowledge as a whole was managed in the workshop. As with Case 1,

the data was coded at nodes that related to the setting, the various actors, at events that I observed, and at the processes that I observed or in which I took part.

The first cut open coding analysis led to the insight that the reason why the supervisor suffered so many interruptions was because of his own decision making, as is shown in the following diagram (See Figure 28 below). Firstly, although he did not overtly acknowledge it, the supervisor – being a relatively younger man, recognised the depth of experience of his workforce, and took the position that on the whole they were more competent than he to make decisions about the work they had to do. Thus, he preferred that they make decisions about the work first and then inform him later. However because there were always special customer requirements, or deadlines, or other kinds of special knowledge needs for each job, the engineers tended to require information from the supervisor, and when they decided they needed information they generally felt they needed it immediately.

Because of the busyness in the workshop, this immediacy placed pressure on the supervisor, who attempted to cope with it by giving answers as quickly as he could. Unfortunately, when he gave quick answers, the supervisor tended to speak very quickly and in consequence, some of his answers were either incomplete or not clearly articulated. However, being a conscientious supervisor he was aware that this created a propensity for error and so made a point of constantly checking up on progress. This constant checking up on them, often meant that engineers would end up conferring with the supervisor before implementing their decisions, thereby increasing the number of interruptions that the supervisor experienced. This set up a vicious circle, where the more freedom he gave to the engineers for making decisions, the busier the supervisor became. The busier he became, the less accurate his communications and the greater the number of jobs and tasks he had to keep track of, and thus the greater became the number of opportunities for error, and so on.

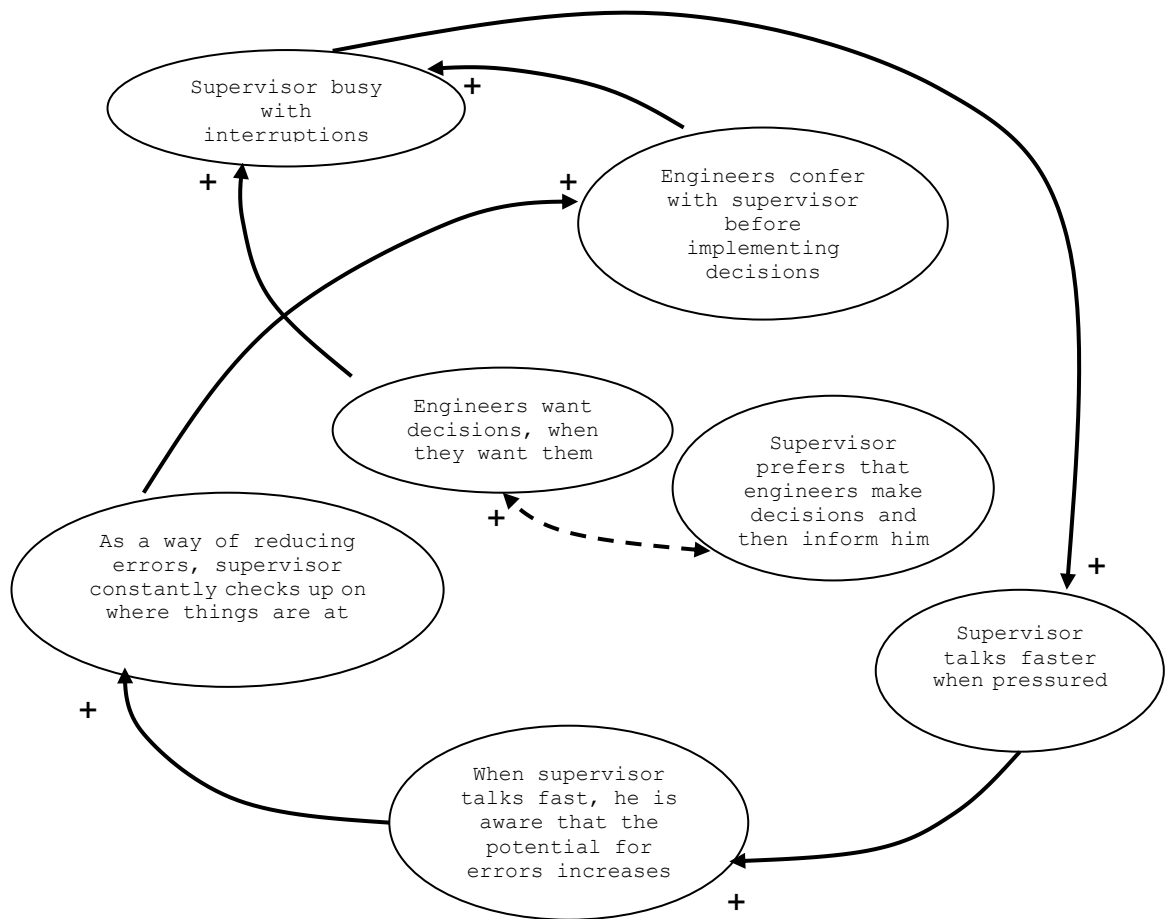


Figure 28: Causal Loop diagram of Supervisor's interruptions.

4.3.5.c. Theoretical coding

As the field notes from the first part of the observation clearly showed, the range of knowledge required to perform the work was extremely wide, and the supervisor was kept very busy providing answers to questions, so the next phase of conceptual development for this case study was to try and understand what tacit knowledge the engineers already had that enabled them to do their jobs, and to understand what new knowledge was created (with input from the supervisor) as they made make decisions about those jobs. In other words, an attempt was made to understand what constituted engineers' tacit knowledge in terms of their experience and how they applied it as human capital.

Starting with the concept of intellectual working capital, the theoretical coding began with categorisation of the supervisor's and engineers' workaday tacit knowledge that had immediate short-term value at the starting point of a task, i.e. their tacit knowledge intellectual working capital. This was followed by categorising the manner in which they,

as human capital, applied this knowledge, which in turn was followed by the parsing of their experiences into discernible tacit knowledge assets.

Tacit knowledge intellectual working capital

A closer look at the experience that engineers used as their starting points suggested that their knowledge falls into three broad categories; global knowledge, core industry knowledge, and local environmental knowledge. Which knowledge they drew on first, depended on the task they were performing at that moment.

Human capital

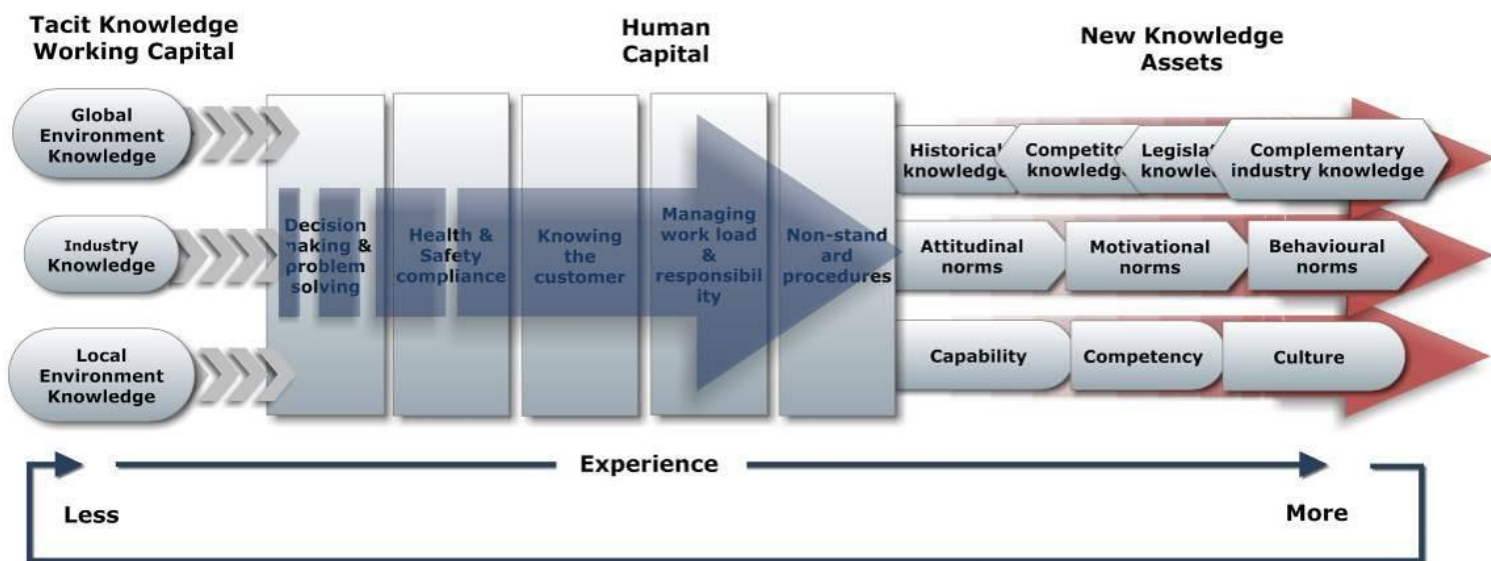
As the supervisors and engineers worked to complete their tasks, their activities (events and processes) were analysed and it was noticed that apart from standard procedures, there were also five categories of endeavour where they engaged their talents, relationships, personal attributes, judgements, and learning capabilities etc., i.e. their Human Capital. These categories included decision-making and problem-solving, health and safety compliance, knowing stakeholders (including customers and suppliers as well as management, government, etc), managing workloads and responsibilities, and performing non-standard procedures.

Tacit knowledge assets

Over time, as engineers completed tasks and overcame problems, they gained experience that enabled them to complete tasks more efficiently. This experience was specifically related to the firm and its activities and thus became a firm specific resource, i.e. a knowledge asset. Mostly engineers did not bother to document this knowledge because they were unlikely to come across an identical problem again and therefore any documentation would be redundant. So the experience they developed remained as part of the firm's tacit knowledge assets; created from the unique blend of each individual's tacit knowledge working capital, and their human capital.

These tacit knowledge assets were evaluated, and ten categories were identified. The first four, including Historical Knowledge, Stakeholder Knowledge, Legislative Knowledge, and Complementary Industry Knowledge, were identified as part of the individual's global tacit knowledge working capital. The next three described as norms, i.e. Attitudinal Norms, Motivational Norms, and Behavioural Norms, appeared to be subsumed into their industry tacit knowledge working capital, and the last three – personal capability, competency, and culture, were associated with their local environment tacit knowledge working capital.

It appeared that the more tacit knowledge assets an individual had the greater their intellectual working capital, and the more effective they became as employees. This complex interaction of working capital, human capital, and knowledge asset was conceptualised as a virtuous circle whereby tacit knowledge working capital provided the starting place for Human Capital to begin doing work. In the process of which, Human Capital develops new knowledge assets, which in turn become the tacit knowledge working capital for the next iteration of work as an Experience Cycle illustrated in the



following diagram (Figure 29: Experience cycle below).

Figure 29: Experience cycle

4.3.5.d. Theoretical Saturation

Once experience had been conceptualised and categorised (see Figure 29 above), the next phase of the data collection/analysis was test the theoretical coding to see if theoretical saturation could be reached. Further observations were conducted and coded against the theoretical coding, and then the analytical software was again used to test the idea.

The first cut analysis revealed that the theoretical coding appeared to be supported as is shown in Table 14 below. The table shows that the activities and processes in the workshop could be coded at all three of the Intellectual Working Capital categories, at five of the Human Capital categories, and at all ten of the Tacit Knowledge Asset categories.

Aspects of Tacit Knowledge	Intellectual working capital			Human Capital					Tacit Knowledge Assets									
	Global	Industry	Local	Decision making & problem solving	Health & Safety compliance	Knowing Stakeholders	Non-standard procedures	Self management	Global TK assets				Industry TK assets			Local TK assets		
									Complementary industry knowledge	Historical knowledge	Legislation knowledge	Stakeholder knowledge	Attitudinal norms	Behavioural norms	Motivational norms	Capability	Competency	Culture
1 : Activity Knowledge	2	23	21	11	2	3	12	1	5	4	1	2	3	2	0	3	6	3
2 : Bodily Knowledge	0	7	5	3	1	0	3	0	0	1	0	0	0	0	0	1	0	0
3 : Community Knowledge	0	8	21	4	4	1	4	4	1	1	1	3	8	5	3	0	6	5
4 : Personal Knowledge	1	11	19	7	4	1	3	4	4	1	1	1	10	2	1	1	5	7
5 : Sound Knowledge	0	4	2	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0
6 : Visual Knowledge	0	8	5	5	0	0	2	0	1	2	0	0	0	0	0	1	0	0
7 : Word Knowledge	4	8	6	1	2	1	1	0	3	0	2	1	1	1	1	0	0	3

Table 14: First cut - Theoretical Coding

However, this initial analysis and corresponding matrix query of the data suggested that Theoretical Saturation had not yet been reached, so further observations were made over the next few days, and then a second matrix query was performed on the updated data. The results of this subsequent analysis suggested that the conceptual categories were substantiated and that Theoretical Saturation had indeed been reached (as per section 3.5.2.c: Theoretical Saturation on page 107 above).

Observations in terms of aspects of tacit knowledge.	Intellectual Working Capital			Human Capital					Tacit Knowledge Assets									
	Global	Industry	Local	Decision making & problem solving	Health & Safety compliance	Knowing Stakeholders	Non-standard procedures	Self management	Global TK assets				Industry TK assets			Local TK assets		
									Complementary industry knowledge	Historical knowledge	Legislation knowledge	Stakeholder knowledge	Attitudinal norms	Behavioural norms	Motivational norms	Capability	Competency	Culture
1 : Activity Knowledge	2	24	21	11	2	3	12	2	5	5	1	2	3	3	0	4	6	3
2 : Bodily Knowledge	0	7	5	4	1	0	3	1	0	1	0	0	0	1	0	3	1	0
3 : Community Knowledge	0	9	21	4	4	1	4	4	1	2	1	3	8	5	3	0	6	5
4 : Personal Knowledge	1	11	19	7	4	1	3	5	4	1	1	1	10	3	1	3	6	7
5 : Sound Knowledge	0	5	2	2	0	0	1	2	0	2	0	0	0	1	0	3	1	0
6 : Visual Knowledge	0	9	6	8	1	0	3	1	2	2	0	0	1	1	0	4	3	0
7 : Word Knowledge	4	8	6	1	2	1	1	0	3	0	2	1	1	1	1	0	0	3

Table 15: Second cut - Theoretical saturation established.

4.3.6. Findings – Tacit Knowledge Management as it relates to Human Capital, Experience, and Knowledge Assets

There were two foci for this case, to triangulate the findings from Case 1, and to try to understand how tacit knowledge relates to experience and human capital.

The analysis showed that the assertion made in Case 1; there are seven aspects of tacit knowledge, was supported by theoretical saturation of the theoretical codes in Case 2, therefore the conclusion is drawn that the conclusions of Case 1 are valid.

By analysing the content and purpose of the interruptions that a supervisor experienced, it was possible to categorise experience in terms of Tacit Knowledge Working Capital, and Tacit Knowledge Assets. It seems that Human Capital experiences of decision-making and problem solving, complying with Health and Safety, getting to know stakeholders, managing their own workload and responsibilities, and engaging in non-standard procedures are the mechanisms by which engineers develop firm-specific tacit knowledge assets.

These tacit knowledge assets comprise knowledge of the company's and industry's history, its stakeholders, the law as it pertains to them, and of complementary industries. They also include behavioural, motivational, and attitudinal norms, as well as an individual's capabilities and competencies, all bound together in the firm's culture.

At this phase of the research, it was now possible to start seeing how supervisors managed tacit knowledge. In this case, the supervisor's management of tacit knowledge was synonymous with his management of Human Capital. He did this by providing engineers with a knowledge resource, and allowing them to use their own judgements and knowledge bases to make decisions. He encouraged them to make decisions and solve problems on their own, and ensured their compliance with Health and Safety requirements. He also enabled them to get to know the firm's customers by encouraging interactions between the two, and gave them all opportunities to try non-standard procedures so that they could develop self management skills, which was all consistent with the literature (for example see section 2.3.3: Facilitators of knowledge management on page 67 above).

4.4. Case study 3

4.4.1. Research focus

Like Case 2, there were multiple research foci for Case 3. The main focus was to answer the third supplementary research question, i.e. RQ_{iii} - *What does ineffective tacit knowledge management look like on the shop floor?* The other foci were to triangulate the findings from the previous two cases, i.e. (a) the seven aspects to tacit knowledge, and (b) experience can be expressed as tacit knowledge intellectual working capital, and tacit knowledge assets.

4.4.2. The context

Case 3 is an independent medium-sized manufacturing firm that manufactures windows and pneumatic doors for public transport systems, including buses, trains, and ferries. The main purpose for visiting this site was to observe and describe ways in which tacit knowledge was acquired, shared, and applied by workers in a situation where there were no specific knowledge management interventions or practices.

Of the four cases that were studied, this was the only one where the study site was proposed to the researcher from within his personal network. The network contact suggested to the researcher that it would be an ideal site because it was felt the firm was poorly served in terms of documented processes, policies, and procedures – there were none available on the shop floor. Furthermore, the contact believed that this lack of documentation was not counterbalanced by appropriate tacit knowledge within the workforce, but rather workers were creating their own tacit knowledge to help them make sense of their roles, but which was not necessarily in the firm's best interests.

4.4.3. The researcher's daily reality

As with the previous two cases, my purpose in this case was to become a part of the workforce so that I could observe from an insider's point of view what happens when knowledge, and tacit knowledge in particular was not effectively managed. I wanted to see whether the seven aspects of tacit knowledge (identified in Case 1) were manifested in this kind of environment, and to see what tacit knowledge intellectual working capital existed in an eclectic workforce, and what kind of tacit knowledge assets were generated as a result (compared with Case 2).

Insofar as I was able, I was less successful at becoming part of the workforce in this case than I had been at either of the previous two. Mostly this was because of the pressure of the workload (which will be explained later), but also because I found that my presence on the shop floor acted as a kind of catharsis for many of the workers, who would

(ironically given the previous comment) take time off from their work to share their concerns and burdens with an interested but non-affiliated third party. As a result, I didn't do as much participating in this case, but did much more observing. I was also given the privilege of being invited to attend most meetings, including workshop staff meetings, supervisors' meetings, and engineering meetings.

4.4.3.a. The case study site

The factory was located in a major industrial area in one of New Zealand's largest cities. It was housed in a small industrial-property development, and occupied three of the seven available premises. Two of the three premises were adjacent to each other but the third was separated by another business sandwiched between them, which led to some interesting workflow and personnel dynamics. The first premise contained a reception area, an engineering design office, administrative offices, and a cutting and welding shop. The second premise contained a grinding and sanding shop, and the door assembly shop, whilst the third premise contained the window assembly shop.

The workforce of approximately 40 comprised two groups, an office group and a factory group. The office group included two design engineers who had their own separate office space, and an accountant, procurement officer, administrator, general manager, and managing director who all shared a common office space. The factory group consisted of four supervisors, a storeman, and approximately 30 process workers who were more or less equally spread across the remaining premises.

Although the workforce was predominantly male (only one of the design engineers and the administrator were female), it comprised a motley collection of ethnicities. There were Englishmen, one of whom was a recent immigrant and one who had been in the country for many years, there was a Russian, a Pole, a South African, a Chinaman, a Filipino, and a few New Zealanders, but the majority of the workforce were Pacific Islanders including Fijian Indians and Samoans. They ranged in age from young school leavers through to a 65-year-old who was about to retire. A very few of the workforce had been with the company for more than just a few years, and only one fitter and turner had been there more than 10 years. Skill levels in the workforce were equally broad, ranging from very highly skilled design engineers and a welder who was City and Guilds qualified, through to some of the process workers who were illiterate and could not speak English. This miscellany of skills, experiences, and languages meant that there were significant communication difficulties anyway, which exacerbated the lack of knowledge management initiatives.

4.4.3.b. The work of the case study

The work of manufacturing windows and doors was supposed to start at 7:00 am and continue through the day until 5:00pm, with 15 minute breaks for morning and afternoon tea, and a half hour for lunch at midday. The process began in the cutting and welding shop, where raw materials in the form aluminium extrusion profiles were cut to length, machined, bent and welded to form window and door frames (see Figure 30 below). As the frames were fabricated they were passed through a doorway into the adjacent premises, the grinding and sanding shop, where the welds were cleaned up and the frames trimmed and levelled, and any dents, scratches, dings, or nicks were sanded out.



Figure 30: Even without an effective knowledge management strategy, skilled welders still produce excellent work

After a cursory quality inspection, the sanded frames were passed outside and loaded on to a utility vehicle and sent off site to be powder coated. Once they were returned, the door frame components were sent to the door assembly shop, whilst the window frames and components were sent around the corner to the window assembly shop.

In the door assembly shop, the pneumatic door opening and closing mechanisms were attached to the various door components, which were in turn assembled into the door units, then finally packed and sent off to customers. Similarly, in the window assembly

shop, glass was bonded to the window frames, the completed windows were water tested to ensure they were weatherproof, and then packed and delivered.

Upstairs in the parts storeroom, the storeman was kept busy assembling door mechanism kits, whilst the design engineers drew up customers' designs. These were then costed out and the parts procured by the procurement officer who was (supposed) to coordinate their delivery with the production schedule that was driven by the managing director, who doubled as the salesman.

There were a couple of salient characteristics about this site that made it especially challenging from a data collection point of view. Firstly the environment was exceedingly noisy from the cutting, grinding, and sanding machinery, as well as from a stereo that was turned up very loudly. Secondly, it was also very untidy, dirty, and unkempt, which made it difficult sometimes to determine what was work-in-progress, and what was rubbish! It was only after I had been there for a week or so that I had developed sufficient tacit knowledge to be able to tell clutter from scrap (See Figure 31 below).

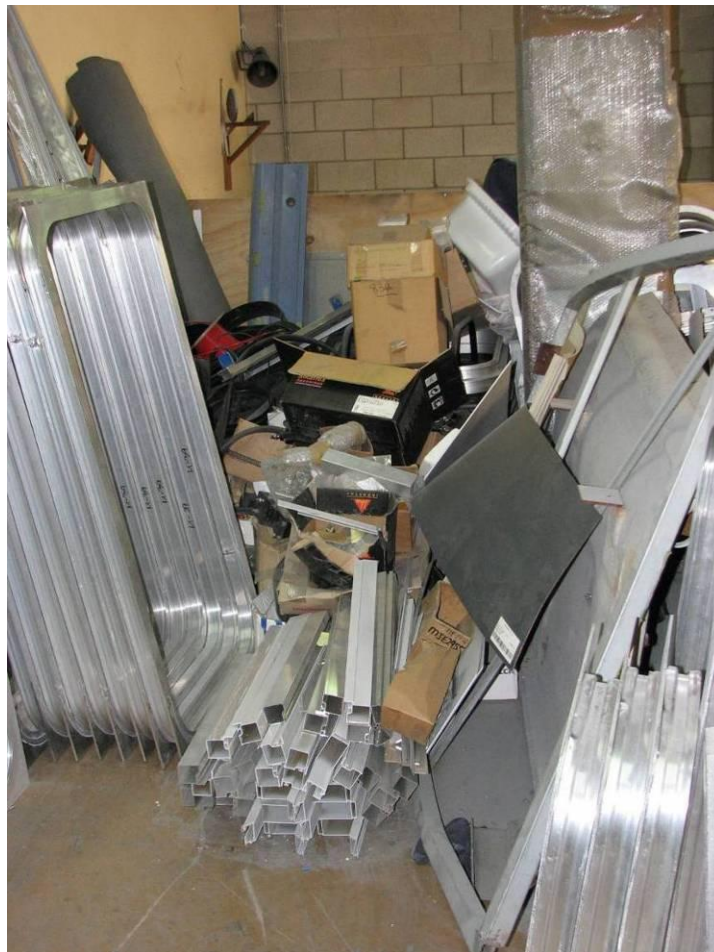


Figure 31: Sometimes it was difficult to tell the difference between clutter and scrap!

4.4.3.c. The importance of tacit knowledge in a poorly structured environment

According to my contact, the company had been very effective in marketing its products and in consequence demand for them had grown. However, this appeared to have been a double-edged sword because growth had caused cash flow problems, and according to the contact, over the past few years a management culture of shortcuts had developed as a way of overcoming cash flow difficulties and of meeting increasingly demanding customer expectations.

Prior to this study, a stable core of skilled, qualified, and experienced trades people who knew how to manage production had been able to work around those shortcuts to produce the required results. However, with the growth in staff numbers and a corresponding staff churn over the last few years, this strong core competency had been diluted to the point where the firm's ability to deliver what customers expected had eroded, and could no longer be met by the now predominantly untrained, unskilled, unqualified, semiliterate, multicultural, and uncommunicative labour force.

4.4.3.d. Building trust between the researcher and the participants

As with the previous two cases, once I had been shown around and introduced to each of the supervisors, and then to the workforce in general, I attempted to develop a rapport in much the same way as I had before. Again, I was fortunate as one of the supervisors gave me the opportunity to help him and another worker to take a bundle of surplus frames up to a mezzanine floor to make some space in the workshop. The frames were stacked in no particular order and were all mixed together on the shop floor, so I took the opportunity to sort them into types according to size and shape as they were being moved. I checked with the supervisor before doing this to make sure that it would be helpful for him, which he replied it would be, and so established for myself a reputation for being useful.

As it turned out, this was one of the very few chances I had to actually do something constructive around the factory, because I quickly discovered that work carried on at a somewhat frenetic pace and there were few opportunities to help out – since that required somebody to stop what he or she were doing to teach me what to do. Although having said that, the few opportunities I was given proved to be extremely worthwhile from a participant observer's perspective.

4.4.4. Selected observations

According to my first impressions of the site, my contact's assessment of the firm seemed to be accurate in that there were apparently no documented standard operating procedures, policies, or standards available either in the administrative areas or on the shop floor. Over time, I was able to find several kinds of documentation that were related to the work of the factory, but in the main they were either incomplete, out of date, or entirely ad hoc as in the illustration of an order form (See Figure 32 below). The field notes from my first day's observation immediately suggested that there was something amiss,

I arrived at about 6:56 a.m. and there were about eight others already here. We waited for a supervisor to arrive and one did at exactly 7 a.m. who opened up. Workers went inside and signed in on the log sheet. [There was] No checking! I stood around for the next 15 minutes having a look at notices and wandering around the workshop. A few people said "Hi", but it was not until Douglas arrived that it felt like I was taken in hand. Douglas showed me around, then at about 7:50 a.m. introduced me to Strickland in the window grinding/sanding bay [and without any explanations basically left him to look after me].

Although this was a somewhat inauspicious start, I made a point of maintaining an appropriately impartial and unbiased approach to the observations, and it did not take long to gather data to suggest that a lack of effective management and tacit knowledge management in particular was the cause of some poor performance issues for the company. This assertion is supported by the following series of selected observations.

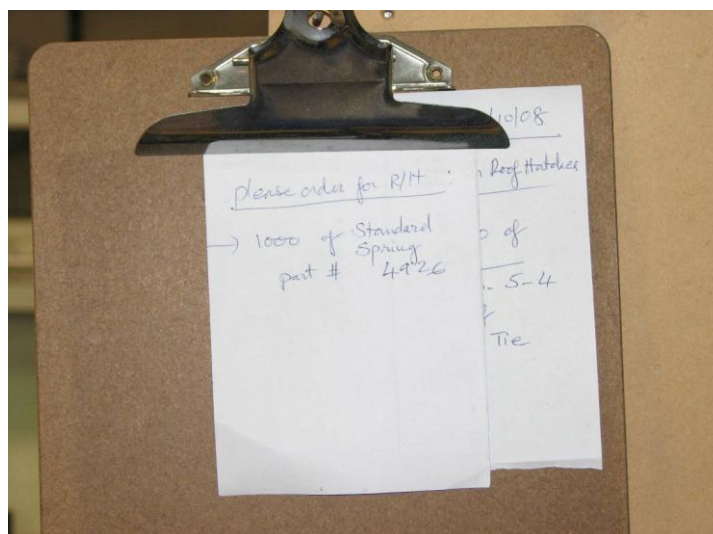


Figure 32: Example of an ad hoc order form that served as a kind of knowledge management tool between the factory and the stores.

4.4.4.a. Tacit knowledge hoarding

My early efforts to establish a rapport with the workforce seemed to pay off because as early as the second day the supervisors began to open up and share with me their thoughts about how knowledge was being managed on the shop floor. For example, on day two of my observation I was speaking with the supervisor of the door assembly shop about some of the problems he faced; the field notes recall,

[We were talking] about Beamish, an older fellow, who'd been here for 12-13 years and was due to retire soon. He used to be involved in production, but now it is mostly prototyping and R&D and troubleshooting. Beamish is the 'go to' guy according to Jock who "really" runs the place. But according to Rodney, Beamish is "ready for retirement" because he is a knowledge hoarder. Apparently he will respond to requests for information, but if you don't do what he suggests he won't help again. According to Rodney, Beamish used to "know everything," but as the designs have changed he doesn't seem to be keeping up with the times.

A little later in the day, Rodney told me that Beamish,

... tends to keep information to himself about changes that need to be made to drawings when they are wrong or have errors. He (Rodney) cited an example of some work that he had had to do when Beamish had been away. The work had been done according to the drawing but was wrong because the drawing was inaccurate, yet Beamish always did the job right, which meant that he knew where the errors were...

I discovered it was widely recognised in the door assembly shop that the drawings they received from the engineering design office were not always accurate – but as the field notes recorded,

... it seems that although others might have known that the drawing was wrong, they didn't know what was wrong where.

4.4.4.b. Tacit knowledge is not always best practice

The literature frequently refers to tacit knowledge as if it is synonymous with best practice (see section 2.2.7: Knowledge management on page 29 above), but what the observations showed is that in the absence of any concerted effort to identify it, the tacit knowledge that workers' develop may not always be best practice, and on occasion may actually be harmful to the firm's overall goals, as the following observations illustrate.

4.4.4.c. Tacit knowledge can lead to errors and workarounds

There were a number of occasions when I was talking with participants, or watching what they were doing when I noticed errors were made and workarounds used. I mentioned this to Jock.

[Jock and I were] talking about quality control issues when the pressure is on. [He noted that] unskilled workers take shortcuts and miss out steps or don't know what the process should be. They only find out if things, like missing primer, have not been done according to the SOP [sic] when they come back for warranty work.

On another occasion, I observed some workers using a circular saw. The field notes report,

A lack of knowledge of process and procedure is everywhere! Rasta, Mane, and Murphy were setting up the circular saw to split a couple of lengths of timber down the middle. Mane had a go at setting up the saw but Rasta got Murphy to come and do the job. There was no blade guard on the saw. Nor were there any push sticks and the guide rail was set up on the wrong side of the blade. i.e. set up on the same side as the operator. There seems to be an expectation that all workers have a basic amount of prior knowledge of how to use the equipment and technology (some people might call this common sense) but there is no standard set.

This was obviously not a unique instance, because I recorded another instance of inappropriate use of a machine -

Jock and Murphy working on circular table saw. Only Murphy was using a push stick. Jock had his hand over the top of the blade – a lack of awareness of safety or a norm perhaps?

4.4.4.d. Tacit knowledge can drive health and safety, poor maintenance, and scheduling

Not only was machinery used incorrectly, so were materials. And perhaps somewhat alarmingly, health and safety procedures were also often not observed either. For instance, I watched one of the participants gluing some rubber doorsill corners together.

[He was using] Loctite 770 Activator plus Loctite 406 Cyano Acrylate Super glue plus 'Blast' Cyano Acrylate accelerator. Tino pointed out that there are a number of problems with this solution. These include,

(a) The glue sets rigid and on the flexible rubber seal – this is not good because the joint doesn't last very long which leads to complaints.

(b) The superglue seeps out of joints when they are pressed together and sticks to fingers, which is a potential health hazard. Tino had asked for gloves once. The first lot came and were used up. He has since asked for more but none have been forthcoming.

This lack of knowledge management was not confined purely to the shop floor. It appeared to be endemic throughout the organisation as the following illustration of a communication/knowledge sharing breakdown between the administration and the shop floor shows.

Ling showed me an outsourced component, a "Door Shaft Mount." The drawing in the manual on the shop floor/factory showed a major outside dimension as 35 mm but the component measured 40 mm. He had to mill 5 mm off each component to make it fit. He indicated that he was feeling frustrated - "not good" and "why this?" [were the words he used]. In fact Ling had told Rodney and Beamish and Douglas, but according to Ling, nothing happened. He didn't know what was going to happen. I bailed up Douglas a little bit later in the morning and showed him the problem. He knew about it and knew how the problem had been caused - an error from the design office to the supplier, the design office had overwritten the correct design measurement somehow. Douglas knew about this - had informed Chris of the issue but because Chris had been away, this information hadn't got to Ling! (See photos)

A lack of active knowledge sharing impacted on the health and safety workers in several ways too;

[I watched a] young fellow cleaning components in the solvent wash, and not using gloves. I asked him if he had ever considered using gloves. He said that he had every time he did the job. I asked him if he had ever asked for gloves. He said no. He had tried to use the thin latex gloves [that were available] but they just broke and were no good. I suggested that he try to ask for gloves at tomorrow morning's meeting and I would see what happened to the request.

Later, when I had had the chance to check up on this request, I noticed that it was not forwarded from the supervisor. Unfortunately, I did not get to follow this particular

incident up any further, but there were others that I did. It seemed that the procurement of safety equipment was ad hoc at best – with no particular rationale why some equipment was ordered, and some was not. There did not seem to be any pattern to how requests were communicated since all levels in the organisation failed at one time or another to pass these kinds of requests on. I eventually surmised that this kind of request was only forwarded if people were of a mind to remember, since the ordering was done by people who were not directly affected by the lack of equipment.

The lack of any communication or knowledge sharing activity impacted on the maintenance of machinery as well, as this instance of a problem with a stamping machine shows;

Jock came over to the office and asked to show me something. There were gaps in the doors due to the stamping machine not removing material accurately. He said the machine needs adjusting. According to Jock, the problem has been around for 3 years. When it first appeared, Papa John saw the problem and growled everyone. This meant the problem was solved temporarily but it had now come back. Jock wanted to know why there was no standard produced and why problem is re occurring. Of the five who were working in the shop when the problem originally appeared, only two are left - Jock and Beamish. So none of the new ones know about the problems

Problems with scheduling also tended to affect how tacit knowledge was developed, as Rodney pointed out,

The [factory's] biggest problem is the lack of materials [and] incorrect components in the BOM, [he was constantly] running out of stock/profile, and suffered a lack of drawings. He asked a not-so-rhetorical question "How many times have we finished a job before we get the drawings?"

To make sure that I was not getting a biased opinion from Rick, I followed up on this issue of scheduling and got talking with Chris, who was just back from three days holiday.

I asked him about what it was like to work here. He said they were good people to work for but disorganised. According to Chris, production information is not passed to the shop floor, neither is scheduling, e.g. he got "told off" for not knowing that he was supposed to be going to see a customer one morning at 10 a.m., or that he was to fly to Wellington "this evening."

4.4.4.e. Tacit knowledge as a resource

In this somewhat chaotic environment, many of the workers tended to develop their own private knowledge resources. I observed where several participants had developed personal rubrics to help them manage their own tasks in the absence of any other effective management. Since very little if any of this knowledge was documented, it was manifestly tacit, but as I discovered this did not necessarily lead to best practice, nor did it always work in the company's best interest. For example,

Murphy who has been working here for a year and eight months has an encyclopaedic knowledge of the aluminium profiles that are used, and can recite the profile code number for every profile that he uses. In discussions with him it turned out that he planned his own work schedule based on his knowledge of,

- His own work rate.
- Recognition of patterns of orders.
- A desire to make the workload easier for himself.

He knows how fast he can work and how fast he likes to work so he plans his workload so that he can work at a steady pace and not have to do overtime.

He recognises patterns of orders and notes that some orders are consistent on a weekly or monthly basis. Murphy asks for and receives copies of the work schedule so that he can plan his own work schedule for the week.

Knowing that, when he receives an order for a single unit or single set, he might make up the components for up to six or eight units or he might cut up an entire consignment of lengths of extrusion in preparation for future orders [and store them according to his own logic – See Figure 33 on page 192 below]. By making up multiple units or sets he will reduce set up times for the order by setting up economically. He will bundle components into kits for future orders. It seems that no one else knows that that is what he is doing, not his supervisors and not management, and certainly not the stores man. He does this because it makes him feel safe and in control.



Figure 33: Apparent confusion obscures a sophisticated but tacit planning schedule devised by a worker in the cutting and welding shop.

Once I had noticed it as a phenomenon, I began to actively seek instances of how people managed their own time. It was not too hard to find. For example, Damien referred to his own to do list, which was almost complete by lunchtime, saying, "I don't like to put too much on my list otherwise I swamp myself with work". In another situation when,

Tiso was asking Jock about what material to use for a "Plug Door Bracket Flat Bar", Jock asked how many he needed. "Only two" was the response, so Jock said to him to cut a whole lot for himself because the piece of metal/flat bar that would be left would be too small to find next time he needed it.

In the same way that individuals developed tacit knowledge to help them make sense of their environment, communities or groups of individuals also developed tacit knowledge resources as they tried to make sense of the somewhat chaotic workplace.

In situations where there were no standard operating procedures, it was the knowledge created and shared within ad hoc groups that helped individuals to for example, overcome surprise, manage stress, or deal with unspoken expectations, as the following few examples show.

Strickland comes back and is surprised that the truck is not there. He has a purchase order for some powder coating. Laurence goes to him and reassures Strickland that Karl is coming back and points to other frames that are due to be taken. The load limit of the truck appears to be limited to the height of the truck sides!

Other group tacit knowledge related to motivations and attitudes, e.g. the predominantly Samoan workers in the window shop seemed to be the only group that spent any time together. Rasta noticed that they were “more friendly” than in the door shop where he worked before, which was “why he wanted to move out of there”.

This lack of knowledge about equipment or processes was endemic and had the effect of increasing stress levels within groups. For example, I was having a conversation with some of the workers in the cutting and welding shop about the state of their equipment.

The bending machine is worn and slow and it is difficult to do a proper job. This makes it stressful because the welders tell them off if they are too slow or are not accurate enough. Vaughn had asked Rowan to fix it. But that hadn't happened. All that had happened was that he had been given an old second hand part to affect a repair but that had not fixed the problem. Young Samoan had asked Mitchell for maintenance to be done, but nothing had happened yet.

These kinds of resourcing, scheduling, and process issues resulted in unexplicated but perhaps somewhat justified true beliefs in the minds of workers that led to tensions between them and sometimes almost erupted into physical violence. During one afternoon meeting that I attended, the discussion revolved around how people related to one another. The supervisors were sharing problems about,

one worker nearly punching another because they had dropped an item onto a workbench with the expectation that the work would get done. It turns out the one who did the dropping was Nonne (Chinaman) and the one who did the ‘nearly punching’ was the head Samoan.

4.4.4.f. Tacit knowledge and training

Perhaps one of the greatest ironies I came across in this case related to training. Contrary to what might have been expected in the circumstances, the will to train and share knowledge with others was there, as the field notes record,

Damien used to do the training of new storemen when he worked for [a previous employer] even though in his own words he wasn't the best. He ... enjoyed doing the training, saying that it made him feel important and valued.

In another conversation,

[the topic was around problems] that the company was experiencing with regard to quality. Mitchell said he and the other trades people were more than happy to train or teach others, but they were getting tired of teaching people because of the high turnover of staff. Yesterday Rodney told me that he had asked Beamish how many people had come though since he had been here, and the response was too many to remember.

4.4.5. Analysis

4.4.5.a. Triangulation of findings from previous cases

To test the validity of the findings from the previous two cases, the data from Case 3 was coded at the theoretical codes from Cases 1 and 2, and then analysed using the matrix query function in Nvivo. As the following tables illustrate, the findings from the first two cases were supported in the data from Case 3.

Table 16 on page 194 below shows the presence in Case 3 of data coded at the seven aspects of tacit knowledge, which provides further support for the findings from Case 1 that were of course supported in Case 2.

	A : Case Study 1	B : Case Study 2	C : Case Study 3
1 : Activity Knowledge	Yes	Yes	Yes
2 : Bodily Knowledge	Yes	Yes	Yes
3 : Community Knowledge	Yes	Yes	Yes
4 : Personal Knowledge	Yes	Yes	Yes
5 : Sound Knowledge	Yes	Yes	Yes
6 : Visual Knowledge	Yes	Yes	Yes
7 : Word Knowledge	Yes	Yes	Yes

Table 16: Theoretical sampling of data from Cases 1, 2, & 3 support RQi

In spite of a lack of active tacit knowledge management in Case 3, Table 17 on page 195 below shows the presence in Case 3 of data coded at the theoretical codes developed in Case 2. This suggests that Human Capital will develop tacit knowledge assets regardless of any managerial input. What Case 3 shows though, is that these tacit knowledge assets may not always be leveraged in the company's best interest, but will certainly be used in the individual worker's best interests.

Theoretical code	A : Case Study 1	B : Case Study 2	C : Case Study 3
1 : Global	No	Yes	Yes
2 : Industry	No	Yes	Yes
3 : Local	No	Yes	Yes
4 : Decision making & problem solving	No	Yes	Yes
5 : Health & Safety compliance	No	Yes	Yes
6 : Knowing Stakeholders	No	Yes	Yes
7 : Non-standard procedures	No	Yes	Yes
8 : Self management	No	Yes	Yes
9 : Complementary industry knowledge	No	Yes	Yes
10 : Historical knowledge	No	Yes	Yes
11 : Legislation knowledge	No	Yes	Yes
12 : Stakeholder knowledge	No	Yes	Yes
13 : Attitudinal norms	No	Yes	Yes
14 : Behavioural norms	No	Yes	Yes
15 : Motivational norms	No	Yes	Yes
16 : Capability	No	Yes	Yes
17 : Competency	No	Yes	Yes
18 : Culture	No	Yes	Yes

Table 17: Theoretical sampling of data from Cases 2 & 3 support RQii

4.4.5.b. Open coding

Since one of the purposes of this case study was to try to understand what happens in situations where tacit knowledge is not actively managed, the goal of the analysis was to try to evaluate the consequences of a lack of managerial intervention.

Following the by now familiar processes for developing a grounded theory, the first data that was collected was both purposive (for answering RQiii), and theoretical (for triangulating the answers to RQi and RQii).

The purposive sample was collected according to the usual criteria, i.e.

- Activities: about general activities that were happening at the time
- Respondents: about the people in the research setting
- Setting: about where and when the observation took place
- TK (Tacit Knowledge) Processes: about processes or tasks performed by the technicians for which there was no documentation such as in a Standard Operating Procedure or Manual

4.4.5.c. Theoretical Coding

The data was then open coded in Nvivo into two main descriptive categories encompassing Communications and Implementing Ideas. After further consideration, it was thought that these two ideas were not sufficiently descriptive of the emerging

concepts, so the data was then on-coded into six further descriptive categories that described the consequences of poor or inadequate tacit knowledge management. These included,

- Disorganisation and Miscommunications
- Errors and Work-arounds
- Personal Rubrics
- Poor Maintenance
- Relationships Issues
- Scheduling Issues

4.4.5.d. Theoretical Saturation

The six theoretical codes were tested in the latter part of the data collection period for theoretical saturation, and the analysis software was used to check for data integrity. A matrix query revealed that the six categories of poor performance appeared to be related to the activities performed by the respondents and their tacit knowledge processes in all but two of the intersections (see Table 18 below). The two intersections where there was no apparent relationship were where the Work-arounds and Personal Rubrics concepts intersected with the Setting category of sample data, which is consistent with their category descriptions. That is to say work-arounds and personal rubrics, which are performance categories, would not expect to be associated with descriptions of the case setting *per se*.

Theoretical codes	A : Activities	B : Respondents	C : Setting	D : TK Processes
1 : Disorganisation & Miscommunications	Yes	Yes	Yes	Yes
2 : Errors & work arounds	Yes	Yes	No	Yes
3 : Personal Rubrics	Yes	Yes	No	Yes
4 : Poor maintenance	Yes	Yes	Yes	Yes
5 : Relationship issues	Yes	Yes	Yes	Yes
6 : Scheduling issues	Yes	Yes	Yes	Yes

Table 18: Matrix query showing intersection of Open Coding with Theoretical Coding of Purposive sample data in Case 3.

One of the primary assumptions of the data collection was that the researcher would treat all data consistently. From a practical standpoint, this meant that all observations were written up in a similar style, using equivalent elaboration of the raw field notes in the final versions. The value of this method was that when it came to coding, it was possible to make the reasonable assumption that the frequency of an observed

phenomenon was related to the number of words that were coded at any particular descriptive category.

Based on this assumption, matrix query analysis of the number of words coded (See Table 19 below) in the data revealed that Disorganisation and Miscommunications, Relationship Issues, and Scheduling Issues in the firm were frequently related to the respondents themselves, while Errors and Work-arounds were related to the Respondents, their Activities and their Tacit Knowledge Processes. Poor Maintenance, and (as was mentioned earlier) Errors and Work arounds, and Personal Rubrics on the other hand, were not frequently related to the setting.

Theoretical codes	A : Activities	B : Respondents	C : Setting	D : TK Processes
1 : Disorganisation & Miscommunications	550	1239	323	722
2 : Errors & work arounds	767	711	0	658
3 : Personal Rubrics	187	166	0	211
4 : Poor maintenance	259	210	85	162
5 : Relationship issues	400	943	517	361
6 : Scheduling issues	728	982	335	525

Table 19: Matrix Query showing words coded at the Theoretical codes in Case 3.

4.4.6. Findings – Tacit knowledge develops irrespective of managerial interventions but is not synonymous with best practice.

The analysis suggested that the findings from Case 3 support the earlier findings from Cases 2 and 3 and provided answers to RQ_{iii} - *What does ineffective tacit knowledge management look like on the shop floor?*

Essentially, with respect to RQ_{iii}, this case revealed that when tacit knowledge is not effectively managed, workers as Human Capital still have experiences of decision-making and problem solving, complying with Health and Safety, getting to know stakeholders, managing their own workload and responsibilities, and engaging in non-standard procedures, and do develop firm-specific tacit knowledge assets.

However, instead of contributing to the benefit of the firm, these assets become liabilities because they lead to Disorganisation and Miscommunications, Errors and Work-arounds, Personal Rubrics, Poor Maintenance, Relationships Issues, and Scheduling Issues. These findings are discussed further in the next Chapter.

4.5. Case study 4

4.5.1. Research focus

Being the last of the four case studies, Case 4 was probably the most important insofar as its primary focus was on the main research question – how can supervisors effectively manage tacit knowledge on the shop floor? However, the case was also important for triangulating the findings from the previous two cases. Consequently, the site was selected because anecdotal evidence from the researcher's personal network suggested it would provide the most appropriate context for the culminating data collection phase.

Apparently, the site's operations were very well documented and had excellent systems for sharing explicit technical knowledge, but still required experienced engineers to be able to comply with mandated service and performance levels. The challenge this provided for the supervisors was that they had to use their own judgements and initiative to manage their human capital, because even though the site documentation was comprehensive, that comprehensiveness did not extend to this area of operation. The site was reported to be very successful at achieving its performance goals of safety and reliability, so it was axiomatic that the engineers were doing a good job, but the question then was how did they do that?

4.5.2. The context

Case 4 is a civil aviation aircraft maintenance hangar that provides engineering maintenance services to a regional airline. The main purpose for visiting the site was to observe and describe how supervisors managed tacit knowledge in the context of a highly regimented and high-risk environment, where in spite of all the best intentions, the documented, i.e. explicit knowledge available to engineers was not totally sufficient for the effective running of the hangar. The site had several features in common with all three of the previous case study sites. For example, as with Case 1, the work of Case 4 was carried out in an exacting environment where all work had to be done in accordance with strict policies, procedures, processes, and guidelines established by legal bodies such as the CAA (Civil Aviation Authority), and by aircraft engine and airframe manufacturers. Similarly as with Case 2, the operational exigencies of its customer meant that work priorities for Case 4 could change at a moment's notice, which required that its engineers be able to problem solve and self manage with a very high level of expertise. And finally as with Case 3, in spite of the complexities associated with its industry, the work of Case 4 was primarily process based, revolving as it did around regular, minutely specified routines. A difference here was that whereas in Case 3 the routines were

around production and manufacturing, the routines in Case 4 were around regular maintenance programs.

4.5.3. The researcher's daily reality

Of all of the four cases, this case was the one where I felt most comfortable as a participant observer. This was because I had had the opportunity to work here prior to the data collection period, which gave me more theoretical sensitivity to the nature of the work than at any of the previous three sites. It also meant that I did not have to undergo a "gee whiz" phase of orientation. By this stage of the research project too, I was also sufficiently sensitised to the preliminary findings from the previous three cases that my purposive sampling had a more theoretical slant right from the start. This in turn enabled me to reach theoretical saturation relatively quickly by comparison with the other three cases. For those reasons, the selected observations that follow are possibly the richest of all in this report in that I was more sensitive to the nuances of the situations than at any time previously, and was therefore more assiduous in recording details of relevant phenomena.

4.5.3.a. The case study site

For reasons of commercial sensitivity it is not appropriate to describe the context in any detail, because given the nature of the aviation industry in New Zealand, to do that would be to breach the confidentiality agreement between the researcher and the participants. Suffice it to say that the hangar was well-established and staffed by a stable workforce of engineers, some of whom had been with the industry in excess of 40 years.

Like many aviation maintenance service providers around the country, all the Case 4 engineers and supervisors were males ranging in age from school leavers (with the occasional schoolboy on work experience), through to those who were contemplating retirement shortly at 65. About half of the workforce were LAMEs (Licensed Aircraft Maintenance Engineers), with the rest being AMEs (Aircraft Maintenance Engineers) or Aircraft Detailers (whose main responsibility was cleaning the aircraft – both inside and out). An AME is a person having a designated role within the industry, with responsibility for carrying out tasks i.a.w.⁴ the documented standard procedures but under the supervision of a LAME, but a LAME is an engineer who is both qualified and licensed by the CAA to carry out those procedures under his (or her) own cognisance.

⁴ i.a.w. – An industry wide acronym standing for “in accordance with”, used widely on maintenance reports to assert that work was done according to the certified Maintenance Manual (MM).

In spite of the high level of documented processes required by law, the importance of experience (or tacit knowledge assets) to the aviation sector is implicitly recognised in its accreditation systems. This is reflected in the somewhat arduous journey required to become a LAME, which requires a five-year apprenticeship and then nine exams to obtain the basic license, with type approvals after that. Interestingly this system does lead to the somewhat anomalous position where an engineer can be qualified but not licensed, i.e. recognised as having the theoretical knowledge to complete a task, but not necessarily the skill, or experience, or competence, or other form of tacit knowledge to complete it to the required standard.

For some of the engineers the difference between being licensed and unlicensed was not a hardship, either because they did not want the extra responsibility that came with the license, or because the remunerative differences were more than made up through overtime. As far as the site was concerned, it appeared to the participants there was little difference between the two, other than an AME could not become a supervisor. However as far as compliance with the industry competency standards is concerned, licensing and type approvals are an extremely important tool for establishing work performance levels – as will be described shortly.

4.5.3.b. The work of the case study

Because of the highly regulated nature of the aviation industry, the work in Case 4 (according to the participants that I interviewed) is almost generic in that it follows a pattern that can be found at almost any equivalent aircraft maintenance facility around the world; most of the work is the routine inspection and servicing of aircraft according to a predetermined schedule.

This schedule is determined by CAA regulations and/or manufacturers' requirements and consists of specified checks on specified parts of the aircraft at specified service intervals, such as an A check on basic systems at 50 hours, a B check on engines at 100 hours, a C check on the airframe at 200 hours, and so on. The schedule also has to cope with "defects", which are reported instances of equipment that is perceived to be either un-serviceable (U/S), or operating outside of its design parameters. In a generic industrial sense, this requirement is understandable with respect to equipment that is obviously broken or damaged, but within the aviation sector it has greater import, because it is incumbent on engineers to report anything they believe to be suboptimal. Likewise, pilots are also required to report anything that they think is not functioning correctly. The subjective nature of these perceptions can lead to perplexing challenges

for the maintenance engineers – some serious and some not so, as the following account from the field notes describes.

Chris and Laurie are reading the NCR's [Non Conformance Reports] from [an aircraft's] defect book. A pilot had written up 11 consecutive NCR's including "sensitive knobs" (which elicited ribald laughter from the LAMEs) on a piece of equipment. The engineers "knew" this pilot as being nit-picky from all his previous reports. He had a reputation for being overly critical of system performance and the tone of voice used by the AMEs indicated little respect for the person, yet their discussion about why the aeroplane's steering should be "shimmying slightly" on takeoff was professional; considering slight wear on a front gear component as a possible cause.

The maintenance schedule is also complicated by the need to account for operational cycles, such as engine run cycles, or landing gear extension and retraction cycles, as well as aircraft locations and service routes. Indeed, the scheduling of aircraft maintenance is so complex that the case study site has a separate Maintenance Watch operation that manages aircraft movements just to ensure that the appropriate maintenance is done. Maintenance is scheduled every day of the year regardless of external environmental influences, such as inclement weather or public holidays, and there are two shifts – a day shift and a night shift. Maintenance Watch therefore also has to coordinate closely with hangar operations to ensure that the scheduled maintenance can actually be performed, since most of the work happens at night when passengers are not travelling (see Figure 34 below).



Figure 34: Most of the maintenance occurred at night when the passengers were not travelling

During the day shift, a skeleton crew of engineers is available for the regular routines like wheel or engine servicing, or any emergency work that the customer may need, but it is during the night shift when most of the engineers are on duty. The engineers themselves follow a four nights on, four nights off schedule, but because of variations to individual routines (for sickness, leave, training etc) it was highly unusual to have exactly the same crew mix every night. In consequence, on some nights the crew could consist mostly of experienced engineers whereas on other nights the crew could consist of mostly inexperienced engineers. Naturally, this provided some challenges for the supervisors when it came to allocating work. However, this was one of the features of the site that made it so useful from a research perspective, because it gave me the opportunity to see how supervisors coped with this extra demand on their ability to manage tacit knowledge assets.

My observations took place during the night shifts over a four week period and I elected to work a Monday through Thursday routine because that enabled me to experience working with the widest variety of supervisors and engineers. The night shift started at 7:00pm and finished at around 5:00am. Generally, preparations for the shift would begin

with the engineers arriving and having a look at the work schedule to familiarise themselves with the work to be done. Then they would wheel their personal toolboxes out of secure storage to where they anticipated they would be working, and then finally they would congregate in the supervisors' office; know colloquially as the Dog Box, for the shift meeting at 7:15pm.

At the shift meeting, the supervisor on duty would inform the crew of the events planned for the shift, allocate tasks, and generally bring people up to speed on the goings-on of the hangar. This was important given the changeable nature of the crew, and helped to keep everyone informed of new Engineering Notices, NOTAMs (Notices to Airmen), Staff Memos, and so on. (Interestingly, even though not all supervisors were equally adept at running the shift meeting, and was there no uniform approach to knowledge sharing, on most nights the crew were informed of all of the items on the checklist of important knowledge factors that had been identified in Case 2, albeit not always directly. For example, information about Annual Leave and Training was published on a large display on one of the walls, rather than mentioned in the supervisor's comments.)

4.5.3.c. The importance of tacit knowledge in a high risk industry

There are high risks associated with poor maintenance performance in the aviation industry, so it is vital that it has a credible measure of engineering competency. Irrespective of the licensing process described above, where this becomes an issue is in situations where an engineer might consider himself to be more competent than what his peers or supervisors think.

I encountered such an instance in a conversation with Beamish. Apparently one of the other engineers had a license but had had his type approval withheld because he "lacked experience". I knew from conversations with him, that this other engineer was somewhat upset by this situation and was considering exiting the industry because he felt he was not being recognised appropriately. But according to Beamish, this two tiered system is designed to prevent the "runaway accreditation" that could result from too great an emphasis on paper qualifications without congruent experience, and as such is an important factor in the trust relationships that exist between engineers.

I had a salutary example of how important this experience is, as the following story from the field notes explains.

Rupert (a LAME) tells me a story about a lucky escape that he had when he had to bail out of an aircraft when he was doing some test flying. The aircraft, a small single-engine eight seater, was in an experimental stage and developed an out-of-control horizontal stabiliser flutter, which caused the tail to break off. The aircraft flipped over onto its back, the main wings broke off, and the aircraft fell into a flat spin. As he attempted to bail out, Rupert's parachute harness caught on a projection in the cockpit hatch. He had the presence of mind to not struggle, but released himself and was able to fall away from the aircraft before opening his parachute. He told me that as he descended gently under the canopy, he was able to watch the aircraft spiralling down, and burst into flames when it struck the ground. A lucky escape!

At first reading, the preceding story is entertaining in and of itself, but of somewhat dubious relevance to the case. However, there was more to it than that. Later on, as we were cleaning up at the end of a shift one morning, I noticed ...

The team members (especially the older ones with more experience) tend to stick around and make the effort to do the last bits, e.g. the RTS (Return to Service) inspection where the aircraft is given a final once over to check for loose panels, cowls, missing or loose fastenings, furniture not right, cockpit not right, tools left behind etc.

Rupert was having a look, (because no one had been allocated at the start of the night) and noticed a "sloppy" aileron – one of the critical control surfaces on a wing. He mentioned it to Skyler, who is the supervisor for tonight, who investigated the spares inventory and noticed that no spare was available.

A little later that same shift, my field notes recall,

Skyler tells Rupert that he has reported the sloppiness to Maintenance Watch.

The following night, shortly after the supervisor arrived,

... the guys gather in the Dog Box and Skyler begins allocating tasks. Most of the guys already know pretty much what they are required to do and have the paperwork in their hands. There is some general chitchat about priorities and the subject turns to [the aircraft that was serviced last night], which is coming in again to have the ailerons checked and repaired. This is a direct consequence of Rupert's observation last night that the aileron shows excessive play. The conversation turns to defects and whether the aircraft should even have been

allowed out of the hangar last night. Skyler calls it a bit of "engineering licence" to have let it go, but it should have been defected.

What this story illustrates is a remarkable confluence of incidents. If Rupert had not been diligent and checked the ailerons when no one had been allocated to the task, would they have been checked? If Rupert had not had the experience of having to bail out when he was test flying, would he have been sufficiently sensitised to have recognised that the aileron was worn beyond its operational parameters, and would he have recognised the potential dangers? If he had not shared his concerns with the supervisor, how long would it have been before the defect was reported? How responsible was it of the supervisor to allow "a bit of engineering licence" and release the aircraft to service, and how did he know that the defect that Rupert had noticed – in the greater scheme of things – was deferrable until the following night?

The consequences of a failed aileron on a commercial passenger carrying aircraft are almost unbearably severe, but these engineers took cognisance of the risks, and yet carried out their work with aplomb, dealing with decisions like this on a daily (or rather nightly) basis. They based their decisions in large part on their experience, and regardless of any criticisms to the contrary that a layman such as myself might level, they knew from their deep well of accumulated tacit knowledge that they had indeed done the right thing.

4.5.3.d. Subsequent visits to Case 4

As the last of the four cases to be studied, Case 4 proved to be useful not only as an appropriate context for the culminating data collection phase, but also for testing some of the findings from the previous cases. The most interesting of these findings resulted from a trans case analysis of the interactions between supervisors and their subordinates.

What the analysis revealed is that there seems to be a correlation between a person's individual Power Distance and Self Confidence, and the knowledge sharing behaviours they exhibit. The finding is described in detail in the next chapter (see section 5.2.2: Knowledge counter agent archetypes – The Home Guard Model, on page 242 below) and is consistent with what the literature says about the characteristics of Hofstede's Power Distance cultural dimension, and an individual's self-confidence.

The participants in Case 4 were extraordinarily accommodating in testing this model, and subsequent visits to the site suggested that it was useful for depersonalising the behaviours of what were labelled Knowledge Counter Agents, i.e. people whose

knowledge sharing behaviours run counter to organisational objectives (Compare with section 2.3.2.e.2: Knowledge agents and knowledge agency, on page 54 above).

4.5.3.e. Building trust between the researcher and the participants

Fortunately, as mentioned previously, I had had the opportunity to do work at Case 4 before the participant observation so I had already established a trust relationship with the engineers I was observing. The difference that this made was that I was able to very quickly re-establish a rapport with my research participants who were almost without exception happy to share their stories.

4.5.4. Selected observations

Because the main focus of this case study was to observe how supervisors effectively managed tacit knowledge on the shop floor, the field study notes concentrated on the interactions of Human Capital resources, i.e. the maintenance crew. Thus, the purposive sampling for this case was designed to record examples of Human Capital as defined in Case 2, so the selected observations below provide examples of decision making and problem solving, health and safety compliance, knowing stakeholders, managing workload and responsibility, and non-standard procedures. The theoretical sampling that followed was focused on specific supervisory behaviours identified in the purposive samples that facilitated knowledge management. As a corollary to that, the theoretical coding also described instances where tacit knowledge management was hindered, which were identified as barriers.

4.5.4.a. Tacit knowledge & decision-making and problem solving

I had the opportunity on many occasions to observe the social interactions between supervisors and engineers as they engaged in problem-solving activities as the following story about an aeroplane's landing performance problem illustrates.

After Smoko, I went with Skyler across the apron to [a recently arrived aeroplane], which has a problem with yaw on landing. Skyler fires up the engines and plays with throttle and propeller settings. He discovers that the Left prop is lagging. He surmises it is a problem with the pitch control and not the engines. He drives the a/c back to the hanger – just like a car, and parks it in front of the hangar saying that he is, “not really supposed to do this”. He finds Adrian and discusses with him possible causes and solutions to the problem. Earlier I had asked Skyler if they were able to work on the prop, or whether they would have to do a prop change. He thought it would need to be changed because they are not allowed to work on props here. After discussions

with Adrian, Skyler makes some adjustments to the mechanical linkages between the cockpit and the propeller, takes it out to the engine bay, and runs the engines up. (I make some notes of the cockpit instrument readings for later comparison with specifications in the maintenance manual). He makes some further changes, runs them again and finally is satisfied that the problem is fixed and tows it back into the hangar.

4.5.4.b. Tacit knowledge & health and safety compliance

Even in such a high risk and highly regulated environment as the aviation sector, there are still people who fail to manage their own health and safety appropriately, which was quite a revelation for me personally. The observations suggest that health and safety compliance is as much as, if not more than, an outcome of personal tacit knowledge as it is of corporate policies and procedures, as the following couple of stories show.

... [We were sitting around the Smoko room table sharing] stories about events at work, e.g. someone got drenched with fuel in a recent shift because of incorrect procedures, apparently someone was being overzealous and refusing help and ended up getting wet while draining fuel from underneath a wing fuel tank. It could have been potentially very dangerous if not fatal.

Or,

I arrived a few minutes after 7 PM to find a stranger hanging around the Dog Box. After Simon had completed allocating work packs, the stranger introduced himself as the [Corporate] Health and Safety officer from head office. He was here to investigate what the nightshift members knew of a prohibition notice that OSH⁵ had placed on a temporary painting booth that was housed in an old shipping container. A fire had occurred previously, during which a painter had been burnt. The OSH investigation that followed showed that the ventilation system was substandard for use with isocyanates. None of the nightshift engineers indicated that they were aware of the prohibition notice and only a few were aware of a red folder that documented the incident. The detailer Richie was the only one who said that he had actually read the folder and no one knew of its current whereabouts. Skyler pointed out that there were three formal channels of communication which could have been used to disseminate the prohibition notice as well as the red folder, i.e.

⁵ Occupational Safety and Health – a government department.

Supervisor's Reports, Staff Memos, and Engineering Notices, none of which he pointed out had been used.

4.5.4.c. Tacit knowledge & knowing stakeholders

An aspect of effective engineering practice in the aviation sector is knowing when to defer to the requirements of stakeholders in complex situations. In the main, the experienced engineers relied on their own tacit knowledge as well as the company's documentation to resolve problems, but from time to time they would look beyond these knowledge resources to those of other stakeholders. It seems that it behoves the engineers to know their stakeholders in order to know when to defer to them as the following story illustrates.

On further inspection of [an aeroplane], Duncan discovers a series of cracks in the exhaust port of the RH engine (see Figure 35 below). There is some discussion around what to do. According to the Maintenance Manual, there are some limits in cracking that can be deferred, but these ones are larger and need a second opinion. Adrian sends photos and email to [the engine manufacturers] in the US for a decision about Go/No Go, but in the meantime, the inspection continues. In the Dog Box, some discussion between Skyler and Adrian about whether to change the motor now, or wait for a decision from [the manufacturers]. The argument is that if they give the go ahead (unlikely, but possible, given that they have given permissions in the past for similar issues) then the aircraft can be put into service and have the damage repaired some other time, so as not to disrupt schedules. On the other hand, Skyler knows that the crack is not going to go away, they have the time, manpower and a spare engine, and considers so why not do it now? There is no right or wrong decision, because both are correct courses of action. It seems that the decision comes down to a judgement call based on precedent and the supervisor's personal choices and character.



Figure 35: The decision to change out an engine is based on everyone's experience

4.5.4.d. Tacit knowledge & non-standard procedures

From time to time engineers would be confronted with problems for which there was no formally documented solution. Typically, these were problems that were infrequently encountered in the hangar; however there was usually somebody on duty who knew about them, or had experienced them or something similar in the past. Diligent engineers tended to make personal notes to themselves, which they would record in their own personal notes folder for future reference. It was not a foolproof system since it did not always provide all of the answers, but it usually provided a jumping off point for some collegial problem solving as the following illustration shows.

... Standish and George are investigating parts availability and test procedures for the faulty engine relay. All the required information doesn't seem to be available on the computer. Standish asks, "Do you want to see my really bad diagram?" Standish had made a diagram [of a solution to a similar problem he had arrived at previously] and was trying to make sense of the instructions, but he didn't really understand his own drawing because it was done about three

years ago. He introduced his solution to George by saying, "What we found when we first got the aircraft is they wouldn't accept that GPU..."

There was more conversation that I couldn't follow about the technical nature of ground power supplies. Eventually, they both realised that neither of them had the solution, so Standish calls out to another engineer asking, "Hey, Harry, have you ever adjusted a PCB GPU?" Harry says "No". Standish explains to me that the reason he asked Harry is because he says everyone has a folder that they keep their tacit knowledge in.

4.5.4.e. Tacit knowledge & managing workload and responsibility

Perhaps an important characteristic of experienced engineers is their ability to manage their workload, and to take responsibility for their own work and all of its consequences as they pertain to a wider context. I had the extraordinary privilege to observe one of the more senior engineers as he demonstrated these characteristics to me. An aeroplane had suffered a broken cable in the pilot's seat, for which there was no deferral procedure, and therefore the aeroplane was grounded at a distant airfield. This meant that an engineer had to travel to another centre to repair it.

It turns out that a second person is needed for health and safety reasons to go down to [the other centre] so I am selected. We prepare tools for the away visit and Rupert makes the comment, "I get laughed at because my toolbox is too heavy", but he justifies himself by saying he is just being prepared. He tells a story about de-icing, where he used a windscreen demister to melt the ice that had frozen in a component. Now he always takes a hot air gun with him.

We climb aboard the specially chartered 'plane, and as we prepare to fly down to [our destination]... I listen to the pilots chitchat over the intercom. It is a mixture of professional jargon and formal communications with each other and the tower in preparation for the takeoff. Once they have completed the climb out and we are on the way (the aircraft is configured for Cruise) the pilots relax into conversation and talk about house renovations, fishing and diving, buying a boat, family.

Flying over the [countryside] in the moonlight, I can see the fog lifting off from the ground and as we fly past, I can see [the mountain] off to the west with clusters of lights up the slopes showing the ski lifts and chalets and restaurants.

The valleys are filled with mist and in the distance, I can see what must be the lights of [a large town].

... We crossed the coastline about five minutes ago, and I can see the cloud cover beginning to thicken, and I realise just quite how high we are. The chartered aircraft cruises at 18,000 feet. The pilots are chatting about their flying experiences, sharing stories of places they have been to, aircraft they have flown or would like to fly, gossip about who is arguing with whom, and what is happening around the hangar/flight line.

... We are now flying through high cloud and all the chitchat and conversation from the cockpit has stopped. There is a bit of turbulence and the only voices I can hear are the faint calls of other aircraft and the tower at [our destination].

We arrive amidst a downpour at approximately 11:05 PM and taxi straight to the [stricken aircraft] that has parked up for tomorrow. [Our chartered aircraft] pulls up ... the door is opened by the co-pilot and Rupert and I jump out, just as if we had arrived by ute. Rupert immediately grabs the tools and makes a beeline to the passenger door. I follow, feeling a little bit as if I am missing out somewhere – it is as if there should be a fanfare of some sort like, "Da da! We've arrived!" Rupert immediately opens his toolbox, selects a screwdriver, and begins removing the pilot's bulkhead so that he can begin the process of removing the seat to repair the broken cable, whilst the pilots supervise the refuelling (see Figure 36 below).

The repair is carried out in what I can only describe as the usual manner; thorough, methodical, no corners cut. In spite of the rain, Rupert carries out the repair with the same degree of professionalism I have seen him demonstrate in the hangar. I want to fudge the minor details, like leave the pilot's seat slightly damp (from the rain that landed on it as Rupert was working), or take a piss against the main gear because the terminal bathroom facilities are closed, or chuck the cast-off trimmings of a tiny split pin on to the tarmac (it would have caused FOD – Foreign Object Damage – if it had been sucked into an engine), but I am shamed by this 68-year-old's attention to detail. We pack up and Rupert does the paperwork. We climb back into the [charter], which feels more and more like the company ute and take off into the murk. Fortunately, it has not been cold [at our destination], but it has been wet, and we are both damp and chilled from the thighs down. The air-conditioned

and pressurised cabin of the [charter] soon begins to warm us up and dry us out, and I settle down to write up my observations.



Figure 36: Pilots supervise the refuelling on an away trip that feels like a jaunt in the company van - somewhat anticlimactic!

4.5.5. Analysis

4.5.5.a. Triangulation of findings from previous cases

Following the now standard processes of coding, on coding, and triangulation in Nvivo, the analysis quickly showed that the findings from all three of the previous cases are supported in Case 4. That is to say, all seven aspects of tacit knowledge identified in Case 1 were present in Case 4 (see Table 20 on page 213 below), all of the tacit knowledge assets and tacit knowledge working capital identified in Case 2 were identified in Case 4 (see Table 21 on page 213 below), and consistent with expectations, very few of the problems associated with the mismanagement of tacit knowledge as identified in Case 3 were observed in Case 4.

Tacit knowledge aspect	Case Study 1	Case Study 2	Case Study 3	Case Study 4
Activity Knowledge	Yes	Yes	Yes	Yes
Bodily Knowledge	Yes	Yes	Yes	Yes
Community Knowledge	Yes	Yes	Yes	Yes
Personal Knowledge	Yes	Yes	Yes	Yes
Sound Knowledge	Yes	Yes	Yes	Yes
Visual Knowledge	Yes	Yes	Yes	Yes
Word Knowledge	Yes	Yes	Yes	Yes

Table 20: Matrix query solution in Nvivo shows presence of theoretically coded data supporting findings from Case 1.

Theoretical coding	Case Study 2	Case Study 3	Case Study 4
Tacit Knowledge Working Capital			
Global	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Local	Yes	Yes	Yes
Human Capital			
Decision making & problem solving	Yes	Yes	Yes
Health & Safety compliance	Yes	Yes	Yes
Knowing Stakeholders	Yes	Yes	Yes
Non-standard procedures	Yes	Yes	Yes
Self management	Yes	Yes	Yes
Global Tacit Knowledge Assets			
Complementary industry knowledge	Yes	Yes	Yes
Historical knowledge	Yes	Yes	Yes
Legislation knowledge	Yes	Yes	Yes
Stakeholder knowledge	Yes	Yes	Yes
Industry Tacit Knowledge Assets			
Attitudinal norms	Yes	Yes	Yes
Behavioural norms	Yes	Yes	Yes
Motivational norms	Yes	Yes	Yes
Local (workplace) Tacit Knowledge Assets			
Capability	Yes	Yes	Yes
Competency	Yes	Yes	Yes
Culture	Yes	Yes	Yes

Table 21: Matrix query solution in Nvivo shows presence of theoretically coded data supporting findings from Case 2.

4.5.5.b. Open Coding

Because the main focus of this case study was to understand *how* supervisors effectively managed tacit knowledge, the analysis concentrated on identifying and categorising specific behaviours of supervisors that were consistent with knowledge management behaviours alluded to in the knowledge management discourse, e.g. coaching, coping with, and handling complexity associated with human capital.

4.5.5.c. Theoretical Coding

Analysis of the purposive samples suggested that the knowledge life cycle would be an appropriate framework for the theoretical coding phase of this case study, since it has

much to do with knowledge creation in organisations. Therefore, by using Nonaka and Takeuchi's SECI spiral as a starting point, it was possible to categorise supervisors' individual and communal knowledge management behaviours in terms of formal and informal Socialisation, Externalisation, Combination, and Internalisation activities. It was also possible to describe categories of workplace factors that acted as barriers to effective tacit knowledge management. Table 22 below shows the number of instances of observed behaviours the corresponded with these categories in Case 4 over the four week observation period.

Knowledge Life Cycle stages	Informal Activities	Formal Activities	Barriers
Socialisation	28	16	7
Externalisation	14	19	3
Combination	30	18	6
Internalisation	18	13	1

Table 22: First Cut Theoretical Coding of purposive samples based on SECI spiral.

4.5.5.d. Theoretical Saturation

By the time the observation was in its fourth week, it appeared that a state of theoretical saturation had been reached, and the data collection focused on seeking exceptions to the category descriptions. As it turned out, no exceptions were encountered, and the categories were deemed to have theoretical relevance.

This categorisation was well illustrated in section 4.5.4.d above, where Standish and George were problem solving. To begin with, knowledge of a problem was shared (socialisation) as George explained to Standish that he was having problems because of the non-availability of a spare PCB (printed circuit board) that he needed to repair a GPU (ground power unit). Together they had identified that the information required to effect a repair did not seem to be available on the computer (externalisation), but Standish had previously had experience with this problem and made notes about his solution. He offered to show George what he had done before (to get around the problem caused by lack of a spare PCB) to see if there were any commonalities between the two problems (combination). After further discussion, they both realised that neither of them had the solution (internalisation), so Standish turned to another engineer, Harry, to ask him if he had had experience with the problem (socialisation), and so the virtuous cycle began.

The part that Standish the supervisor played in this began with him encouraging George to engage in conversation, a socialisation activity, which provided opportunity for some opportunistic question and answering. In the process of the conversation, Standish

facilitated knowledge sharing and between them, he and George externalised the problem by identifying that no solution existed for it in the existing database. The conversation segued very naturally to the combination phase when Standish shared his experience and offered to show George his notes from the previous occasion. After some further discussion, both George and Standish internalised their combined knowledge and recognised their limitations in that they were still unable to find a solution, so Standish then reached out to a third engineer and asked him if he had a solution, thus moving smoothly into the next iteration of a socialisation phase. Together all of these behaviours on the part of the supervisor resulted in the rapid resolution of what could have been a potentially crippling problem with the aircraft.

The behaviour of the supervisor in this scenario was crucial to the rapid solution of the problem, because if he had so desired he could have completely blocked any knowledge sharing and possibly affected the performance of the airline by stymieing the repair. He could have discouraged the initial conversation or demanded that George conference with him formally. Alternatively, once he had realised that George was unable to fix the problem himself, he could have reallocated the task to someone who could, e.g. Harry, thus minimising and disabling George's efforts and putting more pressure on Harry. He could also have teased or otherwise ridiculed George for not having a solution, or he could have lorded it over George and been miserly with his own experience or solutions. Finally, he could have deferred the problem altogether until such time as there were more experienced crew on duty. In all of these other possible scenarios, the supervisor's behaviour could have resulted in a sub optimal solution for the organisation as a whole.

Even though as would be expected, many of the knowledge management behaviours within Case 4 facilitated the development of tacit knowledge assets and contributed to the effective application of human capital, the theoretical sensitivity engendered in Case 3 enabled the researcher to also identify barriers to effective knowledge management in Case 4 that may have been overlooked otherwise.

For example, the nature of the shift work meant that the crew was constantly changing and there were several occasions when information that had been made available to one crew was not brought to the attention of another, as in the issue of the red folder in section 4.5.4.b above. Sometimes this was because supervisors forgot to pass things on, or had assumed that things had been passed on when in fact they had not.

Another barrier to effective knowledge management concerned the psychological and financial costs of learning. There was an incident when,

... an SOP called for a duplicate inspection to have been done but had not.

The problem was compounded because the duplicate inspection should have been signed off by a LAME, and the supervisor was that LAME.

There was much consternation over the issue with the crew as a whole and as far as some of the more senior engineers were concerned, there should have been "some serious arse kicking" over it. Quite apart from the financial cost to the airline for the error, there was a considerable psychological cost to the crew, particularly to the culprits, in terms of lost credibility, lost trust, and a sense of failure that they had let themselves and each other down.

Other barriers included a lack of social spaces within which socialisation activities could occur – the Smoko room was really too small for the engineers to all fit in during break times, or because of personal characteristics of the supervisors themselves. For instance, some supervisors were more self-confident than others were and would take "engineering licence" in decision-making when others might not, with all the accompanying stress and pressures that that put on staff and resources.

4.5.6. Findings – Tacit knowledge management techniques used by Supervisors

Analysis of the data from Case 4 suggests that effective tacit knowledge management implementations by supervisors at the shop floor can be described in terms of four categories, somewhat analogous with Nonaka and Takeuchi's SECI cycle (Nonaka et al., 2000), as has been alluded to by Marwick (2001). Activities in each of the categories can occur independently, but typically they flow on seamlessly from one category to another in a virtuous spiral as described in the previous section.

The findings show that even though knowledge management activities can flow seamlessly from one category into another, they are discrete and can exist independently. What the activities in Case 4 suggested is that the more the four phases are integrated, the more effectively knowledge is managed in the organisation as a whole. The findings also showed that each of the four phases have both formal and informal enablers, as well as barriers that prevent effective knowledge management.

Informal enablers are described as those behaviours that workers engage in spontaneously as they interact with each other during the course of the day, but upon which supervisors have an influence. Formal enablers are those behaviours that

supervisors can overtly encourage and/or stipulate workers engage in by building them into the organisation's normal systematic processes.

The barriers to effective knowledge management at the supervisory level are those kinds of organisational or contextual factors that influence workers in the course of their day, but over which supervisors typically may only have partial control. However, because of their unique position in a firm (notwithstanding the organisational structure of the firm itself), supervisors may have the potential to directly or indirectly manage these barriers by making suggestions, or offering solutions on how to overcome them to other stakeholders who may be in a better position to deal with them.

4.6. Reflections on the immersion data collection method

4.6.1. An effective method of data collection

As a data collection method, the total immersion data collection design was successful in so far as it enabled the researcher to collect large volumes of data⁶. But apart from this, the method was also considered successful in terms of the expected outcomes and the unexpected insights that were gained.

Apart from the incident of the fingerprints mentioned in Case 1, there were no other incidents that he was aware of, of the researcher compromising the work that the participants had done. On a few other occasions the researcher did distract the participants from their work, which caused them to either make errors (that were quickly identified and resolved), or be slowed down. But in these instances, once the researcher had been made aware of the distraction that he was creating he withdrew to let the participants carry on with their tasks. In the main, by showing sensitivity to the participants' work and the overall business goals of the cases, the total immersion method appeared to create very few difficulties for the participants. As it turned out, in all four cases the participants behaved much like partners in the research rather than simply subjects of it. Perhaps the reason for this lay in the prior efforts that were taken to communicate with prospective research sites about the purpose and value of the research. That is to say, the research initiative was effectively "sold" to the participants and the invitation to participate appears to have been the correct approach to take as far as gaining access to the sites was concerned.

⁶ More than 24 GB of digital data were collected from the four sites over the period of the observations, but it was the combination of this and the application of dedicated, modern IT resources i.e. the Nvivo software, that enabled the sophisticated analysis and deep insights that further justified the total immersion method. There is no doubt in the researcher's mind that without the Nvivo tool he could not have sensibly managed all this volume of data in the timeframe available

Although there was some initial concern by some parties, for instance the Dairy Workers Union, that the research might be a management ploy to spy on workers, or that workers may be disadvantaged by the research findings, the researcher felt that by taking a sympathetic ethical approach to their concerns, their fears would be allayed.

The enthusiasm, openness and honesty with which participants engaged with the researcher suggest that this was an effective approach, and the quality and number of insights that the researcher gained, which quite probably may not have been gained with a different data collection, further attest to the effectiveness of the method for studying tacit knowledge.

4.6.2. Expected research findings

As far as expected outcomes are concerned, there was always a high probability that the researcher would be able to identify quite specific categories of tacit knowledge management activities that supervisors engaged in. The literature signposted that these categories might be consistent with previously identified typologies, e.g. Nonaka and Takeuchi's SECI knowledge life cycle, and Gardner's theory of multiple intelligences. Similarly, Polanyi's insights into the tacit dimension clearly indicated elements of tacit knowledge would be both explicable and ineffable, and that is indeed what the data showed. Another outcome that was expected was the identification of categories of tacit knowledge asset, although what the descriptions of those categories might be was not clear to begin with. The suggestion is made here that they might not have even been identified and described if the researcher-as-instrument had not actually experienced them for himself, simply because the participants themselves were unaware of them.

4.6.3. Unexpected research findings – The Home Guard Model

As far as the discovery of unexpected insights is concerned though, the research method was also highly successful. Although it was not mentioned in the individual case write-ups, one of the most interesting and unexpected findings that resulted from a trans case analysis of the interactions between supervisors and their subordinates, was the discovery of a heretofore unrecognised relationship between power distance and self-confidence as factors in knowledge sharing behaviours (that was later dubbed the Home Guard Model). Initial insights into these behaviours were gained in Case 1 and then subsequently fleshed out in Cases 2 and 3, and then in the intervening period before the final case were worked up into a coherent model.

The usefulness of the model, which is described in detail in the next chapter (see section 5.2.2: Knowledge counter agent archetypes – The Home Guard Model, on page 242

below) was trialled in subsequent visits to Case 4, and proved to be a boon to supervisors in so far as it provided them with a tool that helped to depersonalise antisocial knowledge sharing behaviours.

4.6.4. Risk mitigation

As far as risks to the research were concerned, the efforts that the researcher took to assimilate into the workforce were by and large very successful as was explained in the case write ups. However this success was also predicated to some extent on the pre-existing human resource management practices at the case sites themselves. For example, in Cases 1, 2, and 4, the researcher was required to undertake formal introductory training in the form of Site Inductions, and Health and Safety briefings, which served to break the ice with the existing workforce and immediately provided a common platform on which to begin building relationships; in two cases he was issued with ID cards that provided site access, and in the third he was provided with overalls with his name on them. In Case 3, the only site that did not provide any formal introductory training, it proved to be quite difficult to establish relationships with the workforce, and it took several weeks before participants began opening up to the researcher.

The value of the extended immersion period also meant that any observed reactivity effects became quite obvious over time, and could be discarded as not being representative. One unexpected side-effect of the total immersion method as far as relationships with participants was concerned, was that the researcher quite unwittingly became a kind of Confessor to a number of them, particularly to those who were feeling somewhat disenfranchised – either through a combination of their own personal character traits, or because of the organisation's managerial structures and processes.

Another of the previously identified risks, i.e. that of becoming so identified with a workforce that objectivity was lost, was not encountered. The reason for this was probably that the observation period was long enough to develop appropriate relationships with the participants, but not so long that the researcher lost sight of what he was there for. It is surmised that the processes of the grounded theory research method contributed to this by keeping the researcher's observations focused on the task in hand; there was always an agenda behind the personal interactions between him and the participants, which helped to keep his emotions at least one step removed from the context.

The other previously identified risk of actual physical harm was also not realised, although (as was mentioned in section 4.2.3.c: The importance of tacit knowledge in a highly documented environment, on page 134 above) there were one or two awkward moments where the researcher's presence caused some disruption to the participant's work. One of the outcomes of that particular incident was that the researcher learned very quickly not to touch anything, at any time, without specific permission. This was both good and bad. The good was that after the fingerprints issue, there were no other problems with the researcher interfering with the results of participant's work, but the bad was that he felt somewhat constrained in using his initiative to help in some situations. The effect that this had on participants was that the researcher was in danger of developing a reputation for being standoffish, until he explained why he was somewhat reticent about volunteering.

4.6.5. Data trustworthiness

As was pointed out in (section 3.3.3.f: Trustworthiness, on page 92 above), the issue of the quality of the data presented in this research needs to be addressed. This section presents an argument for the trustworthiness of the data and subsequent reconstructions by addressing each of Lincoln and Guba's (1985) quality criteria. The evidence is presented in tabular format in Table 23: Evidence for the trustworthiness of the data in this research below, where the first column lists the quality criterion, and the second column describes how that criterion was fulfilled.

Quality criterion	Evidence
Credibility	
Prolonged engagement	Four weeks of total immersion were spent each in four separate case study sites, comprising more than 600 hours of participant observation, and more than 100,000 words of expanded field study notes.
Persistent observation	A set of staged observations was used consistently across all four sites based initially upon sensitising questions that lead to purposive sampling, then theoretical questions that lead to theoretical sampling and then finally guiding questions, which led to theoretical saturation.
Triangulation	Different sources included observations of multiple supervisors, observations of multiple participants, collections of supporting documentation, e.g. laboratory procedures and/or aircraft maintenance manuals. Different methods included observations by the researcher-as-instrument, reference to in situ documentation, interviews. Different investigators and different theories were not relevant to this enquiry.

Quality criterion	Evidence
Peer debriefing	All through the process I had the good fortune of being able to expose my thinking to a disinterested peer; a fellow study colleague who was deeply interested in the topic. He acted as a sounding board, challenged my hypotheses, allowed me to vent, and generally helped to keep me honest by making me fully aware of my own posture and processes. My debriefer is recognised in the acknowledgements.
Negative case analysis	The use of qualitative analysis software enabled me to code every line of my field study notes according to each stage of the observation, and to check for exceptions ex post facto using the matrix query functionality.
Referential adequacy	Because of the sheer volume of data collected, it was possible to archive significant portions of it for later analysis after each observation period. This was a particularly important aspect of the subsequent staircased evaluation of the findings as described in section 4.1.2 earlier in this chapter.
Member checks	<p>This was done informally during the observations in a fairly ad hoc manner when I shared insights, asked probing questions, and reflected on observations with participants.</p> <p>Subsequent to each observation, I made formal member checks via either a return visit to the site, or by sending of a copy of the appropriate case study to my contacts on site for their input. In each case, participants had the opportunity to challenge my thinking, provide further insights, and/or affirm the veracity of my reconstructions.</p> <p>Only one respondent had an issue with one of my case study reconstructions, and that was with Case 1 where the site manager had an issue with my reconstruction of how the skills matrix was populated. It turned out that the manner in which that was done, i.e. by the technicians reaching consensus amongst themselves, was not actually how it was intended to be done, and he was concerned that I had misreported what I had observed. However, I was able to assure him through a variety of sources, including photographs and verbatim quotes from my handwritten field notes that my construction was an accurate reflection of reality.</p>
Transferability	
Contextual similarity	As was described in Chapter 3, the four case studies were selected for their value as instrumental cases (Cases 1, 2, 3) and as an intrinsic case study (Case 4), and each case is written up according to the same format which enables the contexts to be rendered quite similarly.
Dependability	
Audit items	
Raw data	Digital recordings, written up field notes, and unobtrusive records such as copies of pages from manuals were collected, digitised, and stored within the Nvivo database.
Data reduction and analysis products	Field study notes were written up and loaded into the Nvivo database, and summaries in the form of node descriptions were developed, while theoretical notes, working hypotheses, and hunches were written up in memos.
Data reconstruction and synthesis products	The Nvivo software was used to create and manage themes in the form of nodes, and query definitions were provided to describe relationships and findings. Conclusions were written up in the final report.

Quality criterion	Evidence
Process notes	Methodological notes were captured in the memoing process in Nvivo.
Intentions and dispositions	The enquiry proposal, personal notes, and expectations were first developed in the original research proposal that was submitted for ethical approval and then subsequently incorporated into the project file in Nvivo.
Instrumentation	No forms, schedules, formal observational formats, or surveys were conducted.
Reflexive journal	Reflexive journal notes were kept in the form of memos and managed in Nvivo.
Confirmability	
Axiological objectivity	The ontological and epistemological objectivity (i.e. the nature and truth) of the observations have been attested to in the previous section on dependability, but the axiological objectivity (value) was only partially confirmed by the member checking, although subsequent anecdotal evidence suggests that the findings are useful to supervisors. Full confirmation will probably only come over time as the results are published in appropriate academic and/or practitioner journals.

Table 23: Evidence for the trustworthiness of the data in this research

On the whole, the total immersion data collection method was considered extremely successful, and could be used as a model for similar future research into tacit phenomena.

4.7. Conclusion

This chapter discussed and described the cases that were studied over the course of this research project. The chapter was introduced with a brief description of how the research questions and method were derived and an explanation how the findings from the four cases were evaluated in a cascading series of triangulations. Explanations of how trust was built between the researcher and the participants were also given. The four cases were written up according to a consistent format that explained the research focus, context, and researcher's daily reality. In each case write-up, a number of observations were selected to provide background illustrations for the grounded theory processes of open coding, theoretical coding, and theoretical saturation that led to the findings from that case.

Case 1 was set in a commercial laboratory where the researcher was able to observe the technicians as they went about the process of testing milk products for conformity with customer specifications. A feature of this case was the importance of tacit knowledge in a highly documented environment. Out of the analysis of the data collected from this case came the finding that regardless of the amount of explicit knowledge provided to

complete a task, seven aspects of tacit knowledge are associated with a successful performance.

Case 2 was set in an electrical engineering workshop where engineers serviced and maintained electric motors and electricity generators. Triangulation of the data in this case supported the findings from Case 1. A feature of this case was the importance of tacit knowledge in a highly experienced environment. The analysis of the data from this case also showed how tacit knowledge management relates to human capital, experience, and tacit knowledge assets.

Case 3 was set in a factory that manufactured automatic doors for public transport systems, including buses, trains, and ferries. A feature of this case was the importance of tacit knowledge in a poorly structured environment. Triangulation of the data in this case supported the findings from both Case 1, and Case 2, and the findings revealed that tacit knowledge develops irrespective of managerial interventions but is not necessarily synonymous with best practice.

Case 4 was set in an airline hangar that provided aircraft maintenance services to a fleet of commercial airliners. A feature of this case was the importance of tacit knowledge in a high-risk industry. Triangulation of the data in this case supported the findings from all three previous cases, and the findings showed that the tacit knowledge management techniques used by supervisors can be categorised according to formal and informal enablers and barriers that correspond with Nonaka and Takeuchi's SECI knowledge creation spiral.

The four cases also provided the context for a trans-case study of the interactions between supervisors and their subordinates, which led to the discovery of an apparent relationship between an individual's Power Distance and Self Confidence, and their knowledge sharing behaviours.

This chapter provides the foundation and justification for the findings and discussion that are presented in the following chapter.

Chapter 5: Findings and Discussion

5.1. Introduction

5.1.1. *Topic and scope of the chapter*

This chapter reports on and discusses the findings about tacit knowledge management practices as abstracted and synthesised from the analysis of the data collected in the case studies, which were described in detail in the previous chapter.

What the research shows is that supervisors manage tacit knowledge as they apply management practices to knowledge assets and tacit knowledge phenomena, and this happens whether they do it intentionally or not. What's more, they manage tacit knowledge in spite of, rather than because of the various drivers for knowledge management identified in the literature, since typically much of their knowledge management praxis happens unwittingly or serendipitously without reference to either the organisation's strategic plans, human resource management initiatives, or training programs.

A model of tacit knowledge management based on Nonaka and Takeuchi's widely recognised SECI knowledge creation cycle has emerged from the analysis. This model may provide insights into what Gertler (2003) describes as the "original tacit knowledge problem" of the recursive looping that allows "tacit knowledge acquired ... by shop floor workers to feed back to ... engineers, designers, and managers" (p. 82).

The findings were developed from a grounded theory analysis of field data, and have been abstracted from the theoretical interpretations of observed phenomena. These findings provide answers to the research question, "How do supervisors effectively manage tacit knowledge?"

5.2. The findings

The findings are divided into five sections. The first describes effective knowledge management activities that supervisors can implement, along with descriptions of barriers that they might encounter (section 5.2.1). The second describes a model of knowledge sharing behaviours that confound productive knowledge sharing within organisations (The Home Guard Model). Supervisors are able to use the model as a diagnostic tool for developing and implementing solutions to knowledge management problems at an individual level (section 5.2.2).

The third section describes seven aspects of task specific tacit knowledge, and provides a metric for measuring task specific tacit knowledge (section 5.2.3). The fourth section

identifies a list of knowledge factors that affect worker performance on a daily basis (section 5.2.4), and the fifth illustrates a model of tacit knowledge assets, which empirical evidence suggests is how experience is gained (section 5.2.5).

5.2.1. How supervisors manage tacit knowledge

This section builds upon what is known of tacit knowledge, knowledge assets, knowledge management, the contextual nature of tacit knowledge, and the role of trust in knowledge management, and shows that both managing tasks and managing people are equally important for effective tacit knowledge management at the supervisory level.

5.2.1.a. Knowledge management activities implemented by supervisors

Consistent with the findings in the literature (Choi & Lee, 2003; Eraut, 2004; Lam, 2000), this research shows a supervisor can have a significant impact on tacit knowledge management depending on their management style. However what this research also shows is there does not seem to be one single style that is particularly effective at either actively encouraging or discouraging tacit knowledge phenomena. For example, a supervisor with an authoritarian attitude can encourage beneficial behaviours by establishing expectations during staff meetings, and a laissez-faire supervisor can allow fruitful discussions to flourish outside of the normal operating functions of the business, by simply not stopping them. On the other hand, an authoritarian manager can block or prevent spontaneous, creative, informal interactions by forbidding them, and a supervisor with a more laissez-faire attitude can have a deleterious effect on knowledge sharing if they let these behaviours spiral out of control into time wasting chitchat.

What this research does show is that there are a number of activities that supervisors engage in or promote that have an effect on how tacit knowledge is identified, captured, stored, retrieved, and applied in either an individual's or a group's experience. This research proposes the substantive theory that supervisors' activities regarding tacit knowledge management can be categorised into four classes synonymous with Nonaka and Takeuchi's (1995) SECI knowledge creation spiral and can be described as both formal and informal enablers of, and barriers to effective tacit knowledge management.

The following section describes the characteristics of each of these classes of tacit knowledge management activities along with their enablers and barriers.

5.2.1.b. Socialisation activities

5.2.1.b.1. Characteristics:

The Socialisation class of activities is roughly akin to Nonaka and Takeuchi's Socialisation stage in their SECI knowledge creation cycle (Nonaka & Takeuchi, 1995), and involves the ad hoc sharing and creating of knowledge, new ideas and/or insights in an often chaotic and unstructured manner. These socialisation activities usually occurs in small groups or within single individuals (although they can occur within larger groups depending on how they are led) and can be considered analogous to the fertile "ba" (Nonaka & Konno, 1998) where new knowledge and insights are generated.

Socialisation activities are triggered by anything novel or new that engages the interest or curiosity of a worker, and include not just work-related problems, but any kind of life experience that engages a worker's attention. These run the gamut from private fishing expeditions over the weekend, through their children's school results, to relationships with their significant others (including their supervisors) - all of which impact upon their work life experience. For example, a socialisation activity might include an apprentice or inexperienced worker struggling with a particular task, and either discovering the solution for him/herself or being shown the solution by a more experienced worker – as when Raymond was being helped in Case 2 (see section 4.3.4.a on page 165 in the Case Studies)

This research identified that when properly managed, these verbalised and non-verbalised thoughts and actions of socialisation activities result in the development of the Human Capital (e.g. Javalgi et al., 2009; Teigland & Wasko, 2009) associated with decision-making and problem solving in four domains, i.e. (1) Health and Safety compliance, (2) learning and knowing about customers, (3) managing workers' own workload and responsibilities, and (4) engaging in non-standard procedures.

The role that the supervisor plays in socialisation activities is to encourage and optimise opportunities for this kind of social interaction, and to do what they can to mitigate any barriers to those interactions. They can also act as intermediaries between the shop floor and management by identifying and explaining problems to management and seeking resources and/or input from higher up the organisational hierarchy.

5.2.1.b.2. Formal Enablers:

Formal enablers that supervisors implemented as socialisation activities included,

- Initiating brainstorming at shift meetings to solve problems. It is during brainstorming sessions that workers have opportunities to express concerns, highlight items of interest, or otherwise draw attention to matters about which others may not be aware. These may include problems that require solutions, but may also highlight deficiencies in the organisation's existing knowledge base, for instance with documented standard operating procedures that are outdated or inaccurate.
- Ensuring that sufficient debriefing and sharing of anecdotes occurs after unusual or abnormal events. A certain amount of knowledge creation takes place during non-standard events, but empirical evidence from the field studies suggests that unless deliberate attempts are made to disseminate this learning, it tends to remain with the people who were directly involved with the experience. By scheduling appropriate debriefing and encouraging the sharing of anecdotes (perhaps around the Smoko table), a supervisor can significantly enhance the learning opportunities for those who were not directly involved in the incidents, but may nevertheless apply the learning to their own tasks.
- The establishment of café style knowledge sharing. Evidence from the field studies suggest more often than not that the problems workers encounter involve departments within the organisation other than their own. By having regular interdepartmental meetings where supervisors can meet to share items of concern, opportunities for a more holistic approach to optimising organisational performance are created. It is not unusual to find that a problem, such as a lack of materials in the workshop is not related to incompetence on the part of a particular department, e.g. stores, but to a breakdown in communication systems, i.e. knowledge sharing, between the departments themselves, or between the organisation and external service providers. Having opportunities to share their own experiences enable supervisors to become more reflective about how they "know" things about the rest of the organisation.
- Allocating tasks in such a way that either less experienced workers have the opportunity to learn, or more experienced workers have the opportunity to extend their knowledge base and/or share their existing knowledge with others. By sharing the learning experiences around the workforce, supervisors can play an active part in encouraging workers to remain engaged with their jobs and thus enhance competency and capability.

5.2.1.b.3. Informal Enablers:

Informal enablers that supervisors implemented as socialisation activities included,

- Encouraging social interactions during "Smoko" breaks. Supervisors can do this by being inclusive in their conversational gambits, and by simply making sure that all workers have equal access to staff/crew room facilities such as seating, or hot water for coffee etc.
- Encouraging rather than shutting down opportunistic question and answer sessions that occur between workers as they interact socially with each other during the normal course of their day-to-day work.

5.2.1.b.4. Barriers:

The barriers to socialisation activities that supervisors faced (which may have been outside their immediate control, but which they nevertheless influenced to some extent depending on the organisational structure) included,

- Changing shift members. In organisations that operate shifts, problems can arise with knowledge sharing when the staff make-up of the shifts change frequently, such as in a laboratory or aircraft maintenance hangar where the facility operates on a 24/7 basis, but where the workers operate on a days on/ days off basis. What happens in this instance is that knowledge that is shared or created on one shift, for instance during a brainstorming session, is not necessarily passed on to incoming shift members in the following period. Over time this leads to problems; what happens is the supervisor who oversaw the brainstorming session tends to remember that a problem has been encountered and solved, and therefore be of the opinion that the solution has been disseminated to all members of the shift. But what he or she forgets is that because of the changing/rotating shifts, not everybody on the shift that they are currently responsible for actually attended that particular brainstorming session, and so not everybody is aware of the problem and its solution. The next time a similar problem arises, the expectation in the supervisor's mind is that everybody in the shift is aware of the solution, which of course is incorrect. Thus when that technician/worker who is not aware of the problem/solution seeks resolution from the supervisor, the impression is created in the mind of the supervisor that this particular worker is either slow to learn, or does not pay attention, or is just plain incompetent - all of which may be inaccurate.

- Cliques. The problem with cliques occurring in the workplace is that small groups of people form their own micro cultures within the workplace, possibly according to language, ethnic groupings, job descriptions, smokers v. non-smokers, etc. and begin to develop their own norms. These norms can lead to the group taking shortcuts, or developing their own solutions to problems but which may not be in the organisation's best interests, as well as the development of a form of “siloining” of shared experiences - none of which are conducive to organisational learning as a whole.
- Inadequate social spaces. If the organisation does not have sufficient space for informal socialising to take place, for example if the "Smoko" room is too small to fit everybody during break times, then the potential for cliques to form is exacerbated. Similarly, it becomes very difficult for a supervisor to be inclusive, and depending on the organisational culture, access to the "Smoko" room can become a privilege that is accorded to the "in" group, so that once again a siloining of shared experiences begins to take place.
- Personal characteristics. As is consistent with the literature, this research showed the individual personal characteristics of supervisors themselves have an impact on the "ba". For example, supervisors who lack self-confidence, or have low emotional intelligence (EI) (see section 2.3.2.f.3: Emotional Intelligence and Human Capital, on page 64 above). can have a negative effect on socialisation activities, because they may lack the personal authority required to guide and lead informal social interactions. Their own social status and relationships can lead to the formation of cliques and the corresponding knowledge siloining that takes place within them.

How organisations could overcome these barriers will depend on individual circumstances, but suffice it to say that once a barrier to knowledge sharing has been identified, the first step in overcoming that barrier has been taken.

5.2.1.c. Externalisation activities

5.2.1.c.1. Characteristics

The externalisation activities are roughly akin to the Externalisation phase in Nonaka and Takeuchi's SECI cycle, and are a much more organised process of sharing and creating knowledge. As with socialisation activities, externalisation activities occur within individuals as well as within groups, and although there is some degree of spontaneity in the kinds of activities that take place, they are generally more structured. Externalisation activities result in the development of what the literature calls Intellectual Capital (e.g.

Ammar-Khodja & Bernard, 2008; Johannessen et al., 2005; Mouritsen et al., 2001) or tacit knowledge assets, and include externalising knowledge in the form of notes, sketches, shared heuristics, and formal communications about the tasks being performed in the workplace. For example, an externalisation activity could include the generation of a staff memo or an engineering notice developed from a socialisation activity, like the defect notice that was created for the sloppy elevator in Case 4.

The role the supervisor plays in externalisation activities is much more about engaging the workforce in processes to identify, capture and share new knowledge than it is about the creation of new knowledge, which is more the focus of the Social phase .

5.2.1.c.2. Formal Enablers:

Formal enablers that supervisors implemented as externalisation activities included,

- Supervisor reports. At the end of every shift, the generation of a comprehensive report that captures events of that shift provides a useful tool for knowledge sharing at the handover to the next shift. Depending on whether the shift changeover is immediate or delayed, i.e. shifts run back-to-back as in a 24-hour a day operation or run on consecutive days, the supervisor report can be a list of bulleted items, or it can be more prose like. The optimal format for the report would depend on individual organisational circumstances, but in any case it is suggested they should include all of the items that are referred to in the findings discussed later in this chapter in Section 5.2.5 - Knowledge factors affecting worker performance on page 268 below.
- Notices. In the case of an engineering workshop these could be Engineering Notices, or in the case of a laboratory they could be Laboratory Notices, etc. As with the supervisor reports these notices could be either bulleted items or prose. Again, the purpose is to capture specific learnings associated with tasks performed during the shift with a view to highlighting the new knowledge generated and that things may be done differently in the future, e.g. possible changes to the standard operating procedures. Notices can form the basis of discussion documents, or they can be a way of ensuring that debriefings and/or anecdotes are a formally captured for later dissemination. These reports play an important part in combination activities, which are described in the next section.
- Staff memos. As with supervisor reports and notices, staff memos are about capturing knowledge of events that occurred during the shift. However, unlike either supervisor reports or notices, staff memos are about the softer aspects of managing

the workplace, i.e. the human dimension. Staff memos are about clarifying expectations of staff and about recognising achievements, and thus are very much associated with establishing the organisation's behavioural culture and its norms. From time to time, workers will explore the boundaries of acceptable or appropriate behaviour within the workplace. These behaviours may be associated with a task but are more typically associated with activities beyond the expectations outlined in the organisation's policies and procedures manuals. These behaviours could be completely innocuous, or they could be quite destructive, or they could be ambiguous and open to interpretation, as in the case of a worker bringing a toy from home to play with during a meal break in the middle of a night shift. In any case, supervisors who are at the front line to observe these exploratory behaviours may or may not encourage them depending on their individual management approaches. Unless there is consensus within the organisation as to what kinds of behaviour are appropriate and what are not, unfair and unrealistic expectations about acceptable behaviour arise of the minds of both workers and supervisors, which lead to the "knowledge" that some workers are unreliable and/or some supervisors are unreasonable. As with the notices, staff memos play an important part in combination activities.

- Accreditation authority notices. Typically, a large amount of new knowledge associated with tasks is generated outside the organisation, but needs to be incorporated into the organisation's standard procedures in order for it to comply with external standards, e.g. Health and Safety regulations, Food Safety Authority requirements, Civil Aviation Authority NOTAM (Notices to Airmen), etc. It is not unheard of for this kind of formal notification to be disseminated only down through the organisation as far as the supervisory level but not down to the shop floor itself where the work actually happens. The research suggests there is a need for supervisors to disseminate this kind of information right down to the lowliest member of the shop floor workforce so that all members of the workforce can be made equally aware of the importance that external influences play in their daily jobs. Evidence from the field studies shows that when a worker's mental schema enables them to situate their own jobs within a wider context, they tend to ascribe greater importance to their responsibilities than they might do otherwise. For example, a bottle washer in a laboratory who understands the importance of ISO accreditation to the laboratory is more likely to understand the significance of their job in terms of ensuring that glassware is appropriately sterilised, than one who does not. Similarly, a

fitter in a factory that produces doors for public transport who is unaware of the firm's obligations to public safety, may not appreciate that the prescribed torque setting for a bolt is there for a reason. This lack of appreciation of the greater scheme of things can (and in some cases does) lead to a sense of complacency about the importance of e.g. a sterilised flask or a calibrated torque wrench, towards getting the job done properly.

5.2.1.c.3. Informal Enablers:

Informal enablers that supervisors implemented as externalisation activities included,

- White boarding. This describes the activity of sharing ideas, or articulating thoughts to others using the medium of a whiteboard and dry erase marker, and then leaving the results of the ensuing conversation out on display for others to comment on, or to learn from.
- Personal folders. Similar to white boarding, personal folders provide a means for individuals to capture their own thought processes on paper and then save them in some kind of folder, e.g. a ring binder, for reference later. Problem solving that happens during socialisation activities such as opportunistic Q&A (Question and Answer) sessions results in solutions that may be relevant to others at some later date, but unless the results of the conversations are captured it is quite possible for the lessons that were gleaned from the Q&A session to be lost.
- Annotations. In organisations that have well documented procedures, it is not uncommon for experienced workers to discover workarounds or shortcuts that either speed up or otherwise enhance the process. Quite often, a supervisor will notice the experienced worker taking the shortcut. Depending on his or her personal style, they may either admonish or praise the worker for the workaround, discuss it, or ignore it. Depending on whether the alteration to the standard procedure complies with the relevant regulations, it may be very useful for either the experienced worker or the supervisor to add an annotation to the documented procedure describing the workaround or shortcut. Over time, as others refer to the documentation to perform the task, the annotation is added to and refined until the point is reached where the annotated procedure is actually the standard procedure. Once this happens, the documentation is then ready for a combination activity.

5.2.1.c.4. Barriers:

Barriers to externalisation activities over which supervisors had an influence included,

- Lack of opportunity. The lack of opportunity for workers to engage in white-boarding activities, or to make annotations on documentation, or to take time out to record personal insights is perhaps the biggest barrier to effective tacit knowledge management, because it prevents reflective thinking, learning and sharing activities that are needed for knowledge to grow.
- Lack of materials. By simply making a whiteboard and markers, or paper, pen and folders available to workers, supervisors encourage the externalisation of thoughts, which are the precursors to knowledge growth in the organisation. Knowledge growth is stifled without access to these kinds of resources, i.e., tools that all workers are able to use spontaneously and intuitively without the need for high levels of ability or technology.
- Lack of reflexive thinking. Along with of a lack of opportunity and a lack of materials with which to explore ideas, a lack of reflective thinking about the task in hand prevents innovative ideas from developing within the workforce. If workers are pressured to keep "doing" their work, the chances for the opportunistic Q&A sessions that are such important socialisation activities are reduced. Supervisors who monitor the social interactions of their workforce intervene appropriately when they are aware of conversations that are merely shooting the breeze and wasting time, compared with when they involve reflective thinking about work.
- Poor literacy skills. Because the written word is a key link (although by no means the only one) between socialisation and externalisation activities, workers who lack effective writing skills, perhaps because of language difficulties as in Case 3, are prevented from documenting their good ideas, so effective knowledge sharing beyond the immediate conversational circle is confounded. This prevents workers from contributing meaningfully to white-boarding activities, to capturing their thoughts in personal folders, and to annotating documented procedures. Empirical evidence from the field notes suggests that because of this lack of contribution, perceptions can arise in the minds of more literate co-workers that less literate individuals have nothing to contribute or are somehow less worthy, and a knock-on negative effect begins to occur. Cliques can begin to form between those who do contribute to the knowledge pool and those who do not, and the insights of the less competent writers tend to be ignored or belittled. In spite of New Zealand having a high literacy rate, the lack of competent writing skills amongst the workforce is quite apparent to an astute observer. The problem is particularly noticeable in situations

where there is a high percentage of workers from lower socio-economic groups, or immigrants for whom English is a second language.

- Inconsistent treatment of instances. Supervisors are constantly faced with behaviour or circumstance that require them to make managerial decisions. Because many of these behaviours or circumstances challenge a supervisor's worldview (based on his or her own personal experiences), they often lead to learning opportunities and chances for new knowledge to grow. Depending on how a supervisor treats these events, they can become sources of tremendous frustration for themselves and for their workers, or they can become learning opportunities that enable everyone to grow. If every instance of a behaviour, e.g. a customer complaint or a worker shortcut, is treated in the same way by every supervisor within the organisation, then norms are established and the workforce as a whole develops consistent expectations. If on the other hand, supervisors do not treat every instance similarly, then inconsistencies are established in the collective minds of the workforce and a door is opened to the kinds of knowledge confounding behaviours that are discussed in the second part of this discussion (see Knowledge counter agent archetypes on page 242).
- Incomplete or inadequate sharing. Consistent with the barriers to socialisation activities, if the externalisation activities mentioned previously are not sufficiently comprehensive nor sufficiently widely disseminated, then a barrier to knowledge sharing is erected - more through omission, than commission. For example, if shift handover documentation does not adequately capture the events of a shift, then effectively a series of macro cliques are formed between the shifts themselves. This leads to the same kind of siloing in the workforce that happens between cliques as a result of socialisation activities, but on a larger scale.

Supervisors have perhaps the greatest opportunity to overcome barriers to externalisation activities than at any other stage, because these barriers are the most susceptible to supervisory interventions since they relate directly to the immediate day-to-day tasks in the workplace.

5.2.1.d. Combination activities

5.2.1.d.1. Characteristics

Combination activities are roughly equivalent to Nonaka and Takeuchi's Combination phase in their SECI cycle. These occur when the recorded knowledge that has accumulated as a result of the externalisation activities is aggregated and integrated with

other prior knowledge. This aggregation and integration is both a collecting and a disseminating process, and occurs as supervisors and workers combine their individual learning into a collective whole. Combination activities are about taking the intellectual capital that was developed in the externalisation activities, and integrating it seamlessly into the organisation's normal operation. As with the previous two types of activity, there are both formal and informal enablers that supervisors encouraged, and barriers that they needed to overcome.

5.2.1.d.2. Formal Enablers:

- Compilations of notices. As notices are generated from externalisation activities, their compilation into a form of compendium facilitates easy reference to past learning. Compilations include paper-based files and/or digital media, such as databases or hyperlinked Web files.

If not managed appropriately, the notices generated from externalisation activities can quickly develop into a chaotic mass of unrelated information, which can in turn breed confusion in the minds of workers since it is no longer possible to link learning with events. For example what can happen is a worker, e.g. an engineer, comes across a particular problem, resolves the problem, reports it to a supervisor and between them, they generate an engineering notice to capture the learning. Some time later, a different engineer encounters a similar problem, and recalling that an engineering notice had previously been generated around the issue, tries to find the solution. Unless he knows where to look for that particular engineering notice, the second engineer can spend an inordinate amount of time looking for the document.

If the document cannot be found quickly one of two things tend to happen, either the engineer loses interest in trying to find the document, returns to work irritated and frustrated that he hasn't found a solution, and ends up "reinventing the wheel" as he re-discovers the solution. Or, he spends so much time looking for the missing documents that he ends up spending more time seeking answers than fixing the problem. It is therefore important that notices are reviewed periodically and compiled into meaningful collections

This problem of locating previously derived solutions is often the focus of information technology-based knowledge management systems (e.g. Javalgi et al., 2009; Srdoc et al., 2005; Teece, 2000; Yakhlef, 2005), and is therefore an important driver for the establishment of a workplace taxonomy or other similar tool for cataloguing information. In the aviation sector, this problem is largely overcome

with the use of the ATA Chapter system - an internationally recognised method for organising engineering maintenance information into coherent chapters - and an excellent model for other industries to emulate perhaps.

- Updating folders and Standard Operating Procedures. It is not sufficient that notices and other externalisation activity documentation be merely compiled, they must also be kept up to date with relevant changes. This crucial, though somewhat overlooked, detail ensures that the most recent learnings are presented for the problem solver. It is possible for a solution to one problem to become the cause of another and hence require revision. Unless a knowledge seeker retrieves the most current version, problem situations can be compounded instead of alleviated.
- Record keeping. Another obvious, but often-overlooked enabler of tacit knowledge is effective record keeping. Records need to be kept of changes to standard operating procedures, new notices and staff memos and accreditations. The significance of this enabler has been widely recognised for some time, and indeed many accreditation agencies such as ISO, NZFSA, CAA, etc require accurate record keeping. The value that good record keeping has as far as workers are concerned is that it provides an audit trail of learning. At the shop floor, it is important that records be kept of who knows what - particularly in relation to the generation of new notices - so that supervisors maintain an accurate picture in their minds of the competency and capability levels of the workers in their shift.
- Authorisations. There are several kinds of authorisation (to perform tasks) that workers can be given, such as licences, formal permissions, type approvals, and exams. These are important in the social fabric of the workforce because they are public recognitions of individual competency within the firm. When a worker is given an authorisation, they are given a responsibility to perform certain tasks to an expected standard because they have been able to demonstrate that they have the know-how. Authorisations therefore become a measure of workplace competency (and a proxy measure for tacit knowledge) and go a long way to helping to break down cliques that cause knowledge siloing. Authorisations can also be aspirational in that they can provide a reason for workers to upskill.

5.2.1.d.3. Informal Enablers:

The informal enablers of combination activities are very similar to the opportunistic Q&A activities of the Social phase. The difference here is that whereas socialisation Q&A activities tended to be around novel or new situations, the opportunist teaching

and sharing of combination activities is around the "how to's" of extant situations. For example, it might be a tradesman explaining to an apprentice how to use a particular tool or software application, or it might include two trades people exchanging tips and tricks that each has learned in the course of events.

In general, informal combination activities are still around the aggregation and dissemination of prior knowledge.

5.2.1.d.4. Barriers:

The enablers of combination activities can be encouraged by supervisors, but since they invariably require support from higher up the organisational hierarchy, the barriers to these types of activities are primarily managerial, and include,

- Lack of management commitment. Perhaps the single greatest barrier to combination activities is a lack of management commitment to ensuring that supervisors are able to make them happen. If management is not sufficiently committed to the organisation's learning, then its knowledge management activities suffer from the following,
- A lack of resources. For example, where supervisors are unable to make notices publicly available.
- A lack of controls. For example, where supervisors are unable to award or withhold authorisations.
- A lack of accountability. For example, where supervisors have no records of what learning has taken place, nor of standards to which workers are expected to perform.

5.2.1.e. Internalisation activities

5.2.1.e.1. Characteristics

Internalisation activities correspond roughly with Nonaka and Takeuchi's Internalisation phase in their SECI spiral. They are less obvious to the observer than the other three classes of activities described, because they require the observer to interpret the workers' behaviours to some degree. However, this research has found that they form a vital link in the spiral of knowledge management. It is in the internalisation activities that the organisational knowledge conceived and created in socialisation activities, clarified and communicated in externalisation activities, and collated and codified in combination activities is finally committed to practice. Internalisation activities as much about the mental models and schema that inform the behaviour of individual workers as they are about observable behaviours themselves.

5.2.1.e.2. Formal Enablers:

Consistent with the literature (e.g. Alvesson & Karreman, 2001; Ramesh & Tiwana, 1999; Thompson et al., 2001), this research has shown that the formal enablers supervisors can leverage to influence internalisation activities depend on the degree to which they hold workers accountable for the work that they do. In a sense, the supervision of internalisation activities focuses on establishing and maintaining expectations, and reinforcing behavioural norms so that the knowledge that workers have expended time and effort in creating and absorbing in the previous three stages is actually embedded in the work done.

- **Supervisor sign off.** An effective way to ensure that workers apply what they know is to require any work done by any individual to be formally recognised as having been done to the requisite standard, e.g. signed off. If work is not done to the appropriate standard, it is not acceptable and therefore should not be signed off. The observations from the Field studies suggest that a task is only performed correctly when the right knowledge has been brought to bear upon it. The significance that this has for knowledge management at the supervisory level is that it is incumbent upon them to ensure that the right knowledge resources are available to workers so that they can learn how the job should be done properly.
- **Accountabilities.** Along with the supervisor sign off, those workers who have been given the authority to perform certain tasks, through licensing, accreditation, permissions etc, must be held to account. If an authorised worker produces work that does not match up to expectations, then the supervisor must hold that worker accountable for either the slip, mistake or violation that resulted in the substandard performance. The significance of this from a knowledge management perspective is that it sets up and establishes behavioural norms in the minds of all workers, that knowledge learned must always be applied.

5.2.1.e.3. Informal Enablers:

The most significant informal enabler of internalisation activities is the example that supervisors themselves set for the workers. Supervisors who demonstrate commitment to the task, who encourage, guide, and lead their workers to excellence provide the most persuasive reason for workers to apply the knowledge that they have to the task. Supervisors who themselves are poorly managed by their superiors can buffer their workers from the effects of that poor management by demonstrating a commitment to

apply what they know to the job, without letting the effects of the poor management compromise the quality of their own outputs.

5.2.1.e.4. Barriers:

As with the informal enablers, the barriers to the internalisation activities depend largely on the character of the supervisors themselves. Consistent with the enablers previously mentioned, the barriers to internalisation activities are predicated on how much workers are allowed to get away with sub-par performance. For instance, if supervisors are disengaged or tolerate disengagement, or if they engage in satisficing behaviour, then they do not provide the leadership that is required to overcome a lack of motivation (either extrinsic or intrinsic), a lack of self-confidence, and a fear of failure that inhibits many knowledge sharing activities in the workplace.

To a large extent, internalisation activities are influenced by culture; the organisation's own culture as well as the culture within which the organisation is immersed. In that regard, it is no longer the supervisors' management style that tends to influence the activities, but their leadership style.

5.2.1.f. Summary

The results suggest that Nonaka and Takeuchi's SECI cycle provides a useful model for understanding the knowledge life cycle. Empirical evidence from the multiple case studies offers insights into the day-to-day activities that supervisors can engage in that actively enable or inhibit effective knowledge creation/sharing/growth/implementation, and which correspond loosely with the SECI cycle.

There are four classes of activity that supervisors can engage in that support tacit knowledge phenomena in the workplace. Socialisation activities involve the conception and creation of new knowledge, externalisation activities involve the clarification and communication of new knowledge, combination activities involve the codification and collation of new and existing knowledge, and internalisation activities involve the commitment of knowledge to work. Although the activities can be divided into four distinct phases, they do not necessarily exist independently of each other, but can and do interact seamlessly in the workplace.

These four types of activity have both formal and informal enablers that need to be implemented, and barriers that need to be overcome to establish effective knowledge management. Formal enablers include systemic processes embedded within the

organisation's day-to-day business activities that support knowledge management activities, while informal enablers relate to the way supervisors model behaviour in the workplace. Barriers to effective knowledge management also include behaviour modelled by supervisors, but may be more related to the organisation's culture and resources.

This research also suggests that even though managers play an important part in supervisory tacit knowledge management in their role as providers of resources, the supervisors themselves have a large impact on how knowledge at the shop floor is managed.

The following table, *Barriers and Enablers of Tacit Knowledge at the Supervisory Level* on page 241, provides a summary of the findings in this section.

Table 24: Barriers and Enablers of Tacit Knowledge Management at the Supervisory Level*

Stage	Enablers	Barriers
Socialisation	<i>Informal</i> – Smoko, Opportunistic Q&A	Changing shift members Cliques Inadequate social spaces Personal characteristics EQ Social status, Relationships
	<i>Formal</i> – Brainstorming at shift meetings, Debriefs & Anecdotes Knowledge Cafés Task Allocations	
Externalisation	<i>Informal</i> – White boarding Personal folders Annotations	Lack of opportunity Lack of materials Lack of reflexive thinking Poor writing skills Inconsistent treatment of instances Incomplete or inadequate sharing Missed opportunities
	<i>Formal</i> – Supervisor Reports Engineering Notices Staff Memos Accreditation Authority Notices, e.g. CAA, NZFSA,	
Combination	<i>Informal</i> – Opportunist teaching & sharing of “how to’s”, e.g. software, tips ‘n tricks	Lack of management commitment Lack of resources Lack of controls Lack of accountability
	<i>Formal</i> – Compilation of Engineering Notices Updating Folders/ SOPs Record Keeping Licensing Permissions Type Approvals Exams	
Internalisation	<i>Informal</i> – Personal commitment	Disengagement, Satisficing, Lack of motivation (extrinsic or intrinsic) Lack of leadership Lack of self confidence, Fear of failure
	<i>Formal</i> – Supervisor sign-off, Accountabilities, e.g. licensing, accreditation, type approvals etc	

* adapted from (Nonaka & Takeuchi, 1995)

5.2.2. Knowledge counter agent archetypes – The Home Guard Model

The second set of findings from the research concerns supervisor/subordinate interactions in the four case studies. As was mentioned previously in the literature review, effective knowledge sharing happens between knowledge agents (see section 2.3.2.e.2: Knowledge agents and knowledge agency), and is a product of the organisational context (see section 2.3.2.b: Contexts) and individual levels of trust. However, the evidence from the field studies suggests that effective knowledge management is both more and less complex than that.

What the field studies showed is that on the one hand, the organisational context can go a long way to providing the environment within which individuals develop trust, but because people bring their own personalities, quirks and foibles to every context, trust building is to some extent independent of the organisational culture. On the other hand, because tacit knowledge sharing happens between individuals in a deeply personal manner depending on their environment, effective tacit knowledge management at the supervisory level can be completely dependent on the organisation's culture and/or contextual influences on personal relationships.

Furthermore, depending on the quality of relationships between individuals, not all knowledge sharing supports the organisation's goals. For instance, during the course of the research numerous constructive and productive knowledge exchanges occurred between individuals; many contributed to the overall knowledge base of the organisation and resulted in consistent or improved outputs (consistent with what is implicit in the literature, that individuals referred to as Knowledge Agents typically engage in this kind of constructive activity – see section 2.3.2.e.2: Knowledge agents and knowledge agency, on page 54 above). However, during the same observations, knowledge exchanges occurred between individuals that were decidedly destructive and non-productive; knowledge was either not shared or it was actively hidden, false information was passed, or knowledge in the form of caustic gossip was bandied about. Because this kind of knowledge did not contribute to positive organisational outcomes, and in some cases led to quite detrimental results, the term Knowledge Counter Agents was coined to identify those individuals who do not contribute positively to organisational learning.

5.2.2.a. The Home Guard Model

Further analysis of the observations revealed five sets of archetypical behaviours associated with knowledge sharing activities that occurred consistently across all four case studies. Further analysis of these archetypes showed that organisational, social, and

societal contextual influences appear to be less important to knowledge sharing than Hofstede's (1983) Power-Distance cultural dimension (see section 2.3.2.f.1: Power Distance and Human Capital on page 62 above), whilst the various levels of trust between workers seem to be predicated on an individual's self-confidence (see section 2.3.2.f.2: Self Confidence and Human Capital on page 63 above). This observation led to the insight that the quality of tacit knowledge sharing activities by workers can be described in terms of the intersection between their self-confidence and power-distance. If self-confidence is conceptualised as an axis on a plane, with low self-confidence at one end and high self-confidence at the other, and intersecting that at right angles is another axis representing power-distance, then a two-dimensional plane results that represents the context of an individual's knowledge sharing behaviours.

This power distance/self-confidence plane provided the foundation for another major finding of this research, i.e. the development of a model of knowledge sharing behaviours. The model was tested in the field in Case 4, and preliminary results suggest that it has construct validity, since it made intuitive sense to supervisors. Originally it was called a Model of Knowledge Counter Agency Archetypes, but the Field tests showed that this name was inappropriate because (a) the terminology was too highbrow for practical application in the workplace, and (b) it had negative connotations for what turned out to be a tool with very practical and positive implications for supervisors. The supervisors who trialled it in the field study came up with the name, *The Home Guard Model*, because they felt this more accurately reflected in the way that they used the model in their desire to see all members of the workforce engaged in positive knowledge building behaviours.

The following sections describe in further detail the second substantive theory arising from this research, i.e. the Home Guard Model.

5.2.2.b. The five knowledge sharing archetypes

Analysis of field study data suggested that behaviours in the self-confidence/power-distance plane could be divided into five zones. Individual behaviours in four of the zones (high power-distance/high self-confidence, low power-distance/high self-confidence, high power-distance/low self-confidence, and low power-distance/low self-confidence) tended to result in sub-optimal knowledge sharing or knowledge sharing that was counter-productive to the organisation's goals. Whereas individual behaviours in the fifth zone at the intersection of the two axes tended to result in optimal knowledge sharing and an innovative, problem-solving,

stimulating, learning environment in the organisation (see Figure 37: The Home Guard model on page 249 below).

Since the observed behaviour in four of the five zones tended to be destructive, a militaristic metaphor was used to name the five zones. The terms Saboteurs, Guerrillas, Collaborators, and Prisoners were used to label the four types of knowledge *counter* agents, whilst the name the Home Guard was given to knowledge agents. The following sections describe the typical characteristics and behaviours of individual knowledge agents who operate in each of the five zones in the Home Guard model.

5.2.2.b.1. Saboteurs (high power-distance/ high self confidence)

Characteristics and threats

In the Home Guard model, knowledge Saboteurs are dangerous to organisations, because they undermine opportunities to learn new ways of doing things. Saboteurs may be workers or supervisors, and are characterised by having high levels of self-confidence and a high power-distance. They are destroyers hidden in plain sight. Quite often, saboteurs are workers who have been with the company for a considerable length of time and have developed such a deep level of expertise and corporate knowledge that they consider themselves invulnerable to disciplinary procedures. In many cases, they are older workers who are reluctant or resistant to change. Because of their entrenched position within the company they tend to undermine initiatives for learning and change and thus prevent growth while arguing that they have seen it all before.

The danger that saboteurs present to the company is that they will typically pay lip service to change initiatives, and then because of their extensive corporate knowledge will find loopholes around the proposed change to circumvent or prevent the change from taking place. They may be seen to be doing the right thing, whereas in fact they may be doing the wrong thing altogether simply to prevent the change from taking place. The problem is compounded because of their influential position in the workforce, particularly in the eyes of less experienced workers who may tend to look up to them. The saboteur will subtly undermine the change initiative by sharing confidences with and manipulating the less experienced workers, teaching them the workarounds or shortcuts that will guarantee the change initiative's failure, thus enhancing their own reputation for knowledge and wisdom.

5.2.2.b.2. Guerrillas (low power-distance/ high self confidence)

Characteristics and threats

Like the saboteurs, guerrillas are dangerous to organisations because they too undermine opportunities to learn or grow. They are more typically subordinates than supervisors, and are characterised by low power-distance and high self-confidence. However, unlike the saboteurs, guerrillas are hidden and function below the radar. In many cases they have come to the organisation with a strong egalitarian outlook on life (perhaps nurtured within the union movement or within very liberal social contexts), which possibly accounts for their low power-distance, and a strong sense of self worth. Because their positions are not as entrenched as the saboteurs are, they tend to function far less overtly, but just as destructively.

Guerrillas resist change by constantly harassing and undermining change initiatives through gossip or an unwarranted outrage at proposed changes to the status quo. They are frequently disengaged workers who feel disenfranchised by management because they have not been consulted about new ways of working or thinking. The danger that guerrillas present is subtle because, like the saboteurs, they will pay lip service to new initiatives or will respond to new initiatives only whilst they are under direct supervision. However, the moment the supervisor's eyes turn away from them, they will revert to previous behaviours and "mouth off" to anyone who will listen about the perceived injustice or inappropriateness of the new idea. The pernicious negativism of guerrillas becomes a constant drain on the rest of the workforce, who either isolate themselves from the noise (resulting in knowledge siloing) or succumb to the negativity and thus become barriers to change themselves.

5.2.2.b.3. Collaborators (high power-distance/ low self confidence)

Characteristics and threats

The next group of knowledge counter agents, the collaborators, are quite often obvious to the workforce on the shop floor, but almost invisible to management. Collaborators are characterised by a high power-distance and low self-confidence, and can often be found in positions of some authority. This means they are occasionally supervisors, but more likely to be people with specific but minor authorities, e.g., in charge of a particular piece of equipment or process. Their high power-distance can result from the authority that has been placed in them by management, who typically perceive that the collaborator's own self-confessed competency is an accurate reflection of their capability. Unfortunately, the collaborator typically has low self-confidence, which means that they lack a certain amount of personal authority.

The danger that this knowledge counter agent archetype presents to the organisation is that they are often appeasers when dealing with authority figures, but accusers and blamers whose personal interactions with subordinates are self-serving. The overall effect that collaborators have on the knowledge environment is that they tend to communicate misinformation upwards in the hierarchy if that will protect their self-image, and will hoard knowledge from others lower in the hierarchy to reinforce their vicarious authority.

5.2.2.b.4. Prisoners (low power-distance/ low self confidence)

Characteristics and threats

The fourth of the knowledge counter agent archetypes are the prisoners. Prisoners are characterised by a low power-distance and low self-confidence. They are typically ordinary workers from possibly dysfunctional home, school, or work backgrounds, and may be new to the company or even the country. This results in them feeling they have no authority within the organisation to speak out on anything, and neither do they have the self-confidence to make their voices heard. As a consequence, prisoners feel disempowered and fearful about the value of their contributions, and their behaviour is characterised by silences. The danger that prisoners present to the organisation is that although they may be hugely competent, their reticence to speak out means that their wisdom may never be applied during opportunities to learn, and so their experience is lost.

5.2.2.b.5. The Home Guard (moderate power-distance/ moderate self confidence)

Characteristics and benefits

The fifth of the knowledge counter agent archetypes are the Home Guard, but unlike the other four types, this type contribute positively to the organisation's goals. The home guard are characterised by moderate power-distance and moderate self-confidence. This means they feel sufficiently empowered to speak up against perceived injustices or errors, but do not feel so empowered as to circumvent organisational processes or hierarchies. Similarly, they have sufficient self-confidence to stand up for what they believe is right, but are not so arrogant as to believe that they are not open to correction. As the name implies, the Home Guard are the protectors of the organisation's tacit knowledge assets. They are usually engaged workers, who are committed to the organisation's welfare and are sufficiently self-disciplined to take part in mature discussion and dialogue. They can be relied upon to implement change in good faith, and

are keen to learn new ways of doing and being. The Home Guard are the powerhouse of the organisation's learning capacity and are a valuable repository of productive tacit knowledge resources.

5.2.2.c. Supervisor Interventions

The value of the knowledge counter agency model is that it provides a simple and intuitive tool for supervisors to understand why their subordinates may be engaging in knowledge sharing behaviours in the way that they are. Coincidental with that understanding comes the knowledge that because a worker may be engaging in counter productive knowledge sharing activities, that does not mean that they will always do so. In fact, observations at Case 4 suggest that gaining an understanding of the reasons why workers behave in the way they do can be the first step supervisors take to develop appropriate knowledge management interventions at the individual worker level., which may then turn a knowledge counter agent into a member of the Home Guard.

Because the model describes observable behaviours in the workforce that do not rely on subjective interpretations of actions, evidence from Case 4 suggests that supervisors can use it to easily categorise individuals according to a knowledge counter agency archetype. Because the categorisation depends on typical, rather than atypical behaviours, supervisors who have shared their conclusions about individuals with each other are able to test the accuracy of their evaluations. The model has been tested in the field and shown that once an individual's counter-productive knowledge archetype has been identified with some confidence, it is possible to develop successful strategies to bring that individual into the home guard.

Successful strategies include, bringing a saboteur into the home guard by reducing their power distance through holding them to account for non-conformance with an engineering notice, or increasing a guerrilla's power distance by a making them accountable for specific responsibility. Other strategies could include boosting a collaborator's self-confidence with a combination intervention such as a licence to operate a particular machine or process, and a prisoner's self-confidence may be enhanced by a socialisation activity such as engaging them in opportunistic questions and answers in the Smoko room.

5.2.2.d. Summary

Analysis of the observations suggests that knowledge sharing in the work place includes activities that are both productive and counter-productive to the organisation's objectives. Consistent with the literature, the analysis suggests that two main factors

affecting knowledge sharing activities are the organisational context and the personal characteristics of the workers themselves. However, a new insight from the research is that it is the workers' own self-confidence and power-distance, manifested in their knowledge sharing behaviours that affects and is affected by supervisory activities.

A model of five knowledge counter agent archetypes is proposed; Saboteurs, Guerrillas, Collaborators, Prisoners, and the Home Guard, who exhibit behaviours unique to particular combinations of self-confidence (high/low) and power-distance (high/low). Four of the five archetypes exhibit knowledge activities that are counter-productive to the organisation' goal, whilst the fifth - the Home Guard - are the guardians of the organisation's tacit knowledge assets.

The model has been shown to be useful in understanding worker knowledge sharing behaviours, and provides insights to supervisors on how they can effectively manage knowledge agents. When the model is used in conjunction with the knowledge management activities identified in the previous section, knowledge counter agents can be moved into the Home Guard and become useful contributors to the organisation's learning.

5.2.3. A measure of task related tacit knowledge

The literature has identified that although tacit knowledge is a strategically important resource in a firm and the basis for competitive advantage (Ambrosini & Bowman, 2001; Teece, 2000) it has resisted operationalisation as an asset. Because there a commensurate need to know more empirically about the nature of tacit knowledge (Jensen, 1993), one of the goals of this research was to investigate methods of tallying tacit knowledge assets to overcome the inefficiencies in the knowledge market (Johannessen et al., 1999; Teece, 2000).

5.2.3.a. Seven aspects of task related tacit knowledge

The analysis and subsequent theory generation suggested a third substantive theory in the finding that there are seven aspects of tacit knowledge that inform a worker's awareness and hence performance of a task. This awareness leads to them having

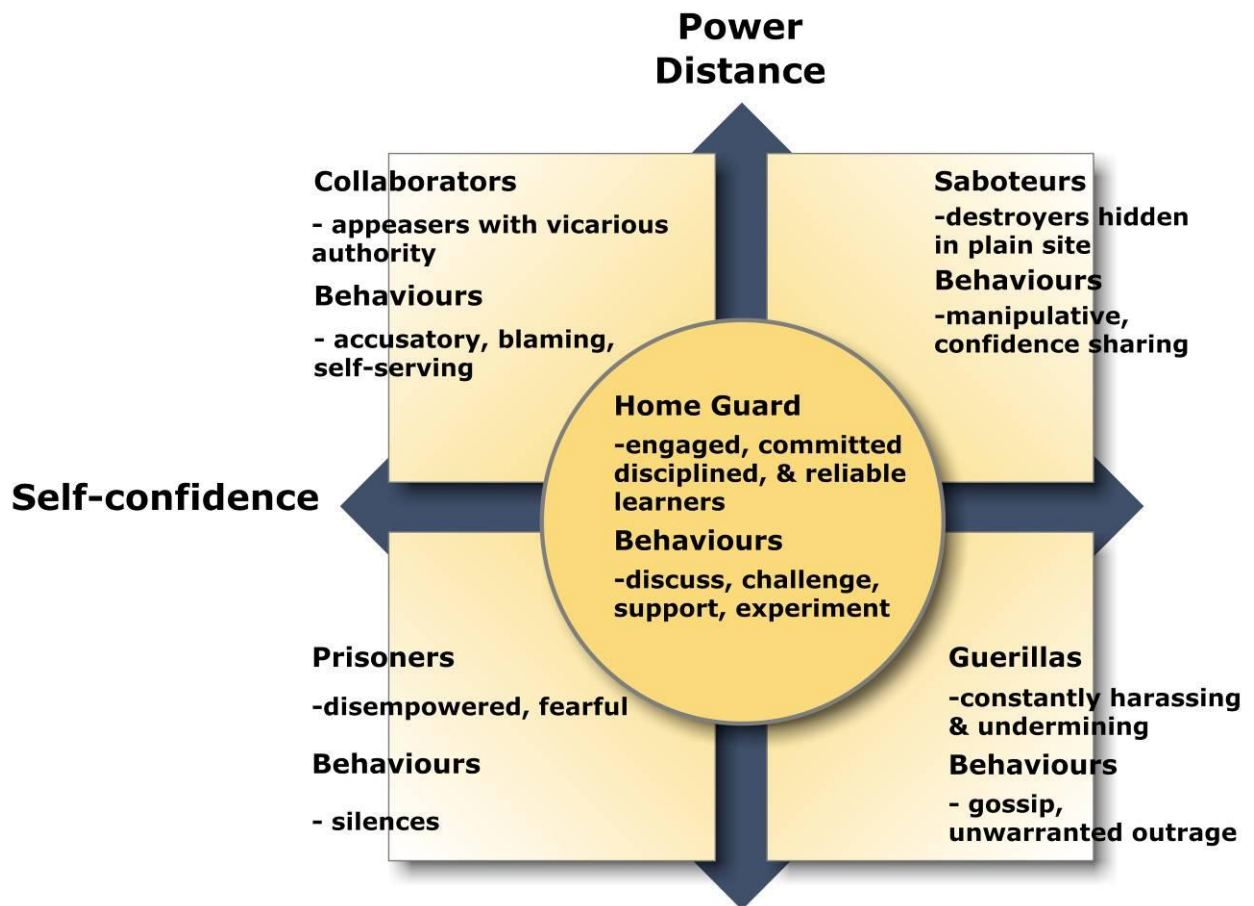


Figure 37: The Home Guard model

expectations, enables them to make explicit what they know implicitly, impacts on their feelings, affects their bodily movements, helps them to make sense of events within their contexts, supports their commitment to quality and helps them to relate to their world as they perform a task.

Because this study focused on task related tacit knowledge, generic activity charts were used to demonstrate task related knowledge use. The activity charts were used to show how explicit knowledge (often in the form of Standard Operating Procedures) does not go far enough in capturing all the nuances of "knowledge" and "knowing" that workers need for them to complete a task to a satisfactory level of performance, and that this knowledge gap is closed with a worker's individual tacit knowledge. The analysis showed that this task related tacit knowledge can be viewed as an asset with seven aspects.

These seven aspects of tacit knowledge are identified as activity, bodily, community, personal, sound, visual, and word tacit knowledge. In several respects, these labels could be construed as being layman's terms for a mere relabeling of some of the existing typologies. However, to do that would be to misconstrue the value of lay terms as they

apply in the workforce. Remembering that the purpose of this research was to learn how supervisors manage tacit knowledge in the workplace, it is consistent with the Interpretivist approach taken with this study to use a vocabulary that applied to the organisations being studied (Alvesson & Deetz, 2000), and so the labels used for these seven aspects of tacit knowledge reflect this, which makes them far more accessible as operationalised constructs than if more esoteric academic terms were used. Having said that though, the following explanations do refer to those aspects of tacit knowledge that have already been identified in the literature.

5.2.3.a.1. Activity tacit knowledge

Activity tacit knowledge is equivalent to Aristotle's *phronesis*, or what some writers refer to as know-what (e.g. Capurro, 2002), or procedural memory (Sternberg et al., 2000). It is the knowledge that an individual has with which they make sense of task related events. Activity tacit knowledge is about the logical step-by-step processes involved with tasks or activities, and includes what a worker knows about how to perform a task.

At the most basic level, activity tacit knowledge includes knowing the steps involved in performing manual tasks such as for example, mixing a dye in a laboratory, or grating and weighing a sample etc. At more complex levels, activity tacit knowledge includes knowing what steps to combine in a procedure to speed things up, what to do to trace back to solve a problem, and remembering things that have gone wrong previously.

5.2.3.a.2. Bodily tacit knowledge

Bodily tacit knowledge is roughly equivalent to Aristotle's *aisthesis* (Capurro, 2002) and also perhaps to his *techné* (Johannessen et al., 2005), or to Polanyi's processes in the operation of perception (1966), and is the knowledge that an individual has with which they make sense of their own body and environment in terms of their physiology. More commonly recognised as a skill (Leonard & Sensiper, 1998). Bodily tacit knowledge includes movement, dexterity, exertion, or balance and is the knowledge that a person has about his or her own body and how they use it, or how it can be used.

In the most fundamental and naïve sense, bodily tacit knowledge is simply knowing how to manipulate materials or equipment. But more complex bodily tacit knowledge involves knowing and/or recognising and/or sensing with their body physical phenomena related to a task, such as measuring temperature, or recognising heft, or applying effort.

5.2.3.a.3. *Community tacit knowledge*

Community tacit knowledge is equivalent to the Aristotelean *episteme* (Johnson et al., 2002), Cook and Seeley Brown's (1999) group knowledge (or *genre*), and to Lam's (2000) Collective knowledge. It is the knowledge that individuals have in the context of making sense with others about their tasks. It is about the expectations, cultural and organisational norms, or other behaviours that are unique to a particular group of people, and is both dependent on and independent of the individual group members. This aspect is particularly noticeable in organisations where members from an immigrant community are employed, since their experiences are so different from those of the locals. (For a further discussion of the characteristics of experience, see section 5.2.4, Tacit knowledge aspects of experience, on page 261.)

Community tacit knowledge also relates to group attitudes to aspects of work, for example towards safety management. It also relates to how people validate each other, by comparing results, or sharing standards, and for expressing feelings, e.g. about management decisions. It also includes group awareness, such as of the reputation of others (even when that person has never been met), and it includes collegial concerns e.g. about external audits, or gaining consensus, e.g. about new initiatives.

5.2.3.a.4. *Personal tacit knowledge*

Personal tacit knowledge is the knowledge that an individual has to make sense of their task, and similarly with community tacit knowledge is about personal expectations, personal norms, and other behaviours unique to the individual. In that sense it is akin to Aristotle's *aistheseis* (Capurro, 2002), or *individual* knowledge as other writers aver (e.g. Cook & Seely-Brown, 1999; Lam, 2000)

Personal tacit knowledge involves attitudes, motivations, emotional responses, personal values and belief systems. It is involved with recognising when a result is good, or when a task is boring. It is about having pride, such as in following a process, or feeling undervalued, e.g. when work is not recognised. It is about self-awareness, such as recognising when one has been distracted, and about trusting in one's self, and it is about being able to qualify a judgement.

5.2.3.a.5. *Sound tacit knowledge*

Unlike the previous four aspects of tacit knowledge, Sound tacit knowledge has no direct analogy in the literature. However because of its embedded nature, the fieldwork in this research yielded sufficient opportunities to identify it as a theoretical category, so the concept was developed as an aspect of tacit knowledge based on Gardner's work on

multiple intelligences as described in section 2.2.6: Tacit knowledge in terms of intelligence on page 28. Examples of Sound tacit knowledge were found throughout the study, from the “trembling tinkle” of glass beads in the laboratory, to the sound of insufficiently lubricated aeroplane wing flap bearings in the aircraft maintenance hangar, and were about how people made sense of the sounds that are heard or created in the process of doing work.

Sound tacit knowledge includes being aware of a sound, as well as recognising it and evaluating it in terms of a problem or diagnosis, e.g. too loud, not loud enough, expected or atypical, and so on. As an example of an atypical sound, Figure 38 on page 252 below shows the waveform of a recording of an aeroplane flap motor that an engineer was able to identify as being U/S (unserviceable).

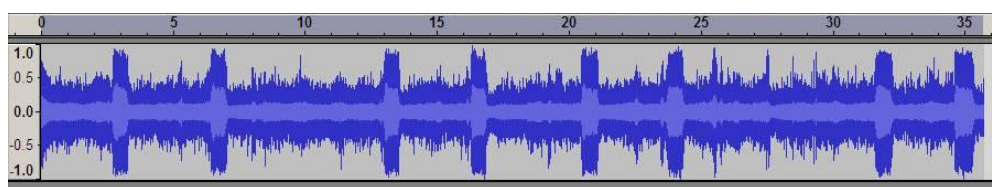


Figure 38: Wave form of the sound of an unserviceable flap actuator.

5.2.3.a.6. Visual tacit knowledge

Like Sound tacit knowledge, Visual tacit knowledge does not have a direct analogy in the literature, but it too was developed as an aspect of tacit knowledge observed in the field and is based on Gardner’s work. Visual tacit knowledge is about making sense of what is seen in terms of colours, shapes, patterns, and visual perceptions related to a task.

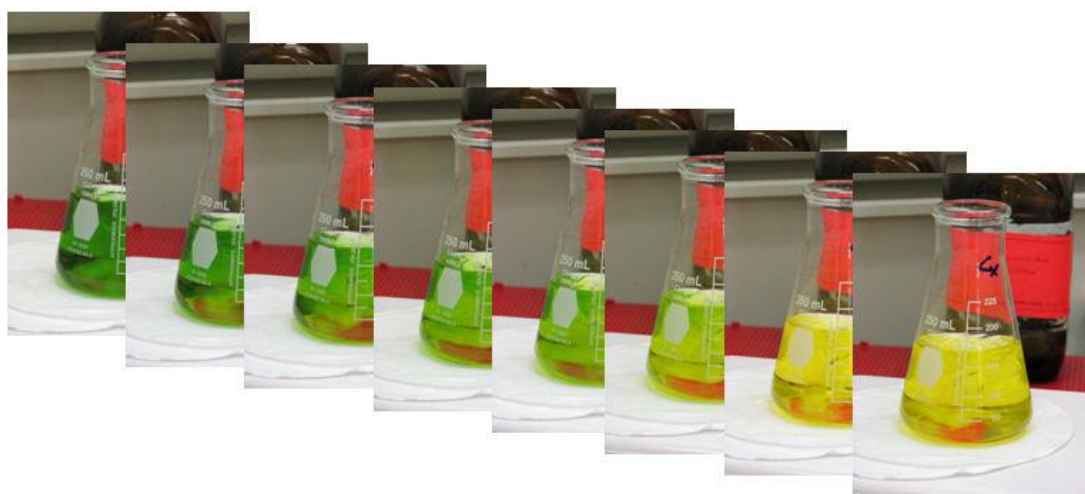


Figure 39: An operator's visual tacit knowledge enables her to identify the incremental changes in colour in a titration

As with Sound tacit knowledge, there were numerous opportunities to observe Visual tacit knowledge, and a good example is provided in Figure 39 above from Case 1, where the visual tacit knowledge of a technician was used to determine the point at which a colour change took place in a titration.

Visual tacit knowledge enables the recognition of colour or colour changes and provides meaning to patterns. It enables the finding of visual matches, for example between a sample and a standard, and enables size comparison, for example when using measuring devices.

5.2.3.a.7. Word tacit knowledge

Although words are inherently explicit, the field studies revealed that individuals and groups used words in ways that were unique to their specific context. In many cases words were used or made up to try to capture the essence of a shared experience, so in that sense Word tacit knowledge has some correspondence with *episteme* or group knowledge, or even genre in the literature. But what this research showed is that sometimes the meanings that are ascribed to some words could not be articulated but only experienced by the users. For example, words like “sucky feeling” in Case 1, or “beer’ o’ clock” in Case 2, or “fish eye inclusion” in Case 3 had meanings that were difficult if not impossible to articulate outside of their contexts, but which had specific meanings within them. In that sense, Word tacit knowledge is about making sense with words, particularly those that have contextually specific meanings.

Word tacit knowledge is used to interpret documented definitions, or to make up words or phrases specific to the context. It is involved with the use of common terms as metaphors in cases where there are no other appropriate terms, and is developed in the sharing of experiences and in the agreement on meaning for a word to describe those experiences.

5.2.3.b. Characteristics and interactions of task related tacit knowledge

Analysis of the seven aspects of task related tacit knowledge shows that even though they are distinctly different from each other, they are not necessarily independent of each other, and neither are they present in equal amounts for every task. For example, to do a titration in a laboratory, a chemistry technician needs specific visual knowledge but little or no sound knowledge related to the task, whereas to perform a tap test in an engineering workshop, an engineer does not require specific visual knowledge but does need very specific sound knowledge related to the task.

Some aspects of tacit knowledge, such as activity, sound, visual, and word are more susceptible to explication than other types, whereas others such as bodily are almost impossible to explicate. Other types such as community and personal tacit knowledge are often hidden, in the sense that they are so embedded within an individual's mental models that in Polanyi's (1966) words, they do not “attend” to them. However, evidence from the field study suggests that if people are given the opportunity to do some reflective thinking, they are able to uncover some of their community or personal tacit knowledge and explicate it.

Evidence from the field studies also suggests that the seven aspects of tacit knowledge interact with each other and a person's individual schema are constantly being built and rebuilt in response to new experiences or stimuli. For example, community knowledge developed during one shift in a workshop (such as external training provision about the safe use of oxyacetylene gas cutting equipment) affects an individual's personal knowledge (I was doing that wrong). This in turn affects their activity knowledge (I need to turn the gas off properly next time), bodily knowledge (this is how firmly to turn off the gas taps), sound knowledge (that hiss is what gas turning off sounds like), visual knowledge (the dial in the green indicates safe), and word tacit knowledge (Gas Off, means gas at the bottles not just gas at the torch has been turned off).

Similarly when more personal knowledge – such as when a worker discovers the solution to a problem – is shared with others (through modelling, explaining, pointing out, etc. either formally or informally), it becomes subsumed into the community tacit knowledge base.

This model suggests that the seven aspects of task related tacit knowledge are separate, yet at the same time combined, as illustrated in Figure 40 on page 255, and to perform a task properly, a combination of all seven aspects is required to produce an expected or desired outcome.

5.2.3.c. A problem with the list of seven aspects of tacit knowledge

At first glance, it appears that the seven types of tacit knowledge simply mirror the five senses, and include elements of emotional intelligence. If that were the case, then the question arises of why are the senses of smell and taste not included in the list? The response to this query is based around the definition of a frame of mind, or an intelligence, and its associated knowledge content.

The characteristics of a frame of mind, which identify an intelligence and give rise to the aspects of tacit knowledge, have been identified previously in Chapter 2: section 2.2.6 on page 28. Although there is evidence that the senses of smell and taste can potentially be isolated in the event of brain damage, and there is probably an evolutionary plausible reason for these senses, according to Gardner (2004) there is insufficient evidence as yet to support the other criteria. For instance, there is not yet sufficient evidence for the existence of *idiots savants* or prodigies who exhibit exceptional abilities to taste or smell, nor is there an identifiable core operation which can deal with specific kinds of taste/smell inputs – it is axiomatic that they are related, but quite how is still open to question. There does not appear to be a distinctive developmental history with expert end-state tasting or smelling performances, and finally, neither the senses of taste nor smell are susceptible to encoding in a symbol system. At best, there is a tendency to use metaphorical or descriptive language to describe tastes and smells, but these are highly subjective and open to interpretation.



Figure 40: Seven aspects of task related tacit knowledge

Because these senses fall short of being capable of full description as a frame of mind or an intelligence, the best fit for tacit knowledge of smells and tastes is probably in the bodily tacit knowledge type simply because of their natures, which are fundamentally embodied.

Having said this though, should sufficient evidence be found to categorise the senses of taste and smell as intelligences, then the previous set of seven aspects of tacit knowledge may have to be expanded to include taste and smell tacit knowledge aspects as well.

5.2.3.d. Measuring tacit knowledge according to 5 levels of competency

The literature clearly identifies that competency is closely related to tacit knowledge (e.g. Cogburn, 2004; Evans et al., 2004; Kruger & Dunning, 1999; Levina & Vaast, 2005), but apart from allusions to a worker's ability to "act in a wide variety of situations" (Mouritsen et al., 2001, p. 737), or the development of very specific tacit knowledge inventories (e.g. Hedlund et al., 2003; Leonard & Insch, 2005) little or no work appears to have been done on generic descriptors for levels of task related tacit knowledge.

This research attempts to fill that gap with the suggestion that the seven aspects of task related tacit knowledge can be generically described at each level of competency as the following sections explain. However, a cautionary note is sounded here. Given that there is such debate in the industrial relations literature around problems associated with efforts to improve performance (see section 2.3.2.f: Human Capital, on page 60), it should be noted that these descriptors do not in and of themselves predicate performance, but are rather expressions of tacit knowledge in the performance of a task.

Observations from the field studies showed that the seven aspects of tacit knowledge develop in workers through a progression of five stages. This is consistent with Polanyi's (1966) ideas of emergence and a hierarchy of comprehensive entities, and corresponds with Dreyfus and Dreyfus' (1986) competency levels (See the Appendix 4: Summary of Dreyfus & Dreyfus' (1986) Levels of Competency in the Appendix on page 293).

At their least developed stage, a worker has tacit knowledge consistent with a *novice's* level of competency. As they develop, the novice progresses through the *familiar* (or *advanced beginner*), *competent*, and *proficient* levels to finally reach the level of an *expert*. The following sections describe these generic levels of task related tacit knowledge in further detail.

5.2.3.d.1. Five levels of activity tacit knowledge

At the novice level of activity tacit knowledge, a worker knows how to apply rules to perform procedural steps in a task, e.g. you undo a bolt this way, and by the time they

have achieved familiarity with the task, they are prepared for the next step, e.g. undo the bolts and then the clamps. By the time a worker has achieved competency in a task, they are able to consider process steps in the light of other contexts or tasks. For example, bolts and clamps are disassembled in accordance with a Standard Operating Procedure. At the proficient level of competency, a worker comprehends work in the context of longer timeframes than merely the task in hand, e.g. what else do they have to do today, and is able to work from memory and envisage time savers. An expert's level of activity tacit knowledge enables him/her to anticipate future processes, develop innovations, and consider options that are not available to others less competent.

5.2.3.d.2. Five levels of bodily tacit knowledge

At the novice level of competency, a worker's bodily tacit knowledge results in body movements that are awkward and clumsy, or otherwise demonstrate poor motor skills. They are at the point where they are still learning how to use their body, e.g. how to hold tools correctly. By the time they have achieved a familiar level of bodily tacit knowledge they are able to wield tools correctly, although they may be somewhat methodical or animated, and when they reach the competent level of bodily tacit knowledge their actions are deliberate and confident, and they are able to wield tools effectively. By the time they have become proficient, a worker is able to use their body in alternative ways, e.g. is able to use tools in an atypical fashion, and movements are swift, quick and efficient. By the time a worker has developed an expert's level of bodily tacit knowledge they exude confidence, their movements are unthinking and flowing, and they are unconscious of their own methods, to the point where they may find it difficult to explain how they do what they do.

5.2.3.d.3. Five levels of community tacit knowledge

For the novice, their community tacit knowledge is limited to knowledge of instructions, and the situational elements of the task are defined without reference to the overall situation within the workplace, i.e. are context free, so they can perform a task according to an instruction, but not be able to determine whether they have performed it to the appropriate standard. As the worker becomes familiar with their community, task elements are considered in the context of the workplace and they begin to be incorporated into their own decision-making, for example, they can anticipate when others need help. As the worker becomes competent in the task, their mental models begin to include a non-critical adoption of organisational norms, whether they are positive or negative, and they become perpetuators of the organisational culture, e.g. in a

positive sense they may begin arranging and working in with others. In a negative sense they may begin arranging and working independently of others. As the worker becomes proficient, they are able to identify the salience of their own and others' performance to the context of the organisation as a whole, e.g. are able to identify the importance of their work to the rest of the organisation's activities, and by the time they are an expert, the worker's performance is established as an organisational model, either unconsciously or consciously.

5.2.3.d.4. Five levels of personal tacit knowledge

At the novice level, the worker applies the rules of the task unambiguously, however as they become familiar, they are able to recognise elements when they are present, and for example, are able to begin to estimate the time taken to perform a task. By the time they are competent, the worker is engaging in satisficing rather than optimising performance, and their self-assessment of the performance is relative to their own personal hierarchies. Once a worker has reached a proficient level of personal tacit knowledge, their behaviours and performance are triggered without deliberation, and they are able to recognise influences on themselves, for example, when they should not rely on memory for critical information. By the time they are expert, the worker has developed their own value system for the task in hand and is able to incorporate their own, organisational, and external hierarchies in their decision-making, or task execution.

5.2.3.d.5. Five levels of sound tacit knowledge

For a novice, task related sounds are basically meaningless because of their unfamiliarity. As they become familiar to the worker, sounds become associated with a task, but it is not until the worker is competent that they are able to recognise and anticipate typical sounds associated with the task (although they are unable to discern abnormalities yet). Once a worker has developed a proficient level of sound tacit knowledge they are able to recognise atypical instances of sounds, but it is not until they become expert that their level of familiarity with the task enables them to use sounds as diagnostic tools, e.g. operational duration of a noise as an indicator of the condition of a piece of equipment.

5.2.3.d.6. Five levels of visual tacit knowledge

A novice in the workplace is able to recognise elements of a task only by the application of holistic templates or through ostensive definition. Otherwise, they are confused and unable to visualise or locate components, or tools, or equipment. As they gain familiarity, the worker is able to recognise object types and can differentiate components. It is not until they are competent that the worker has sufficient visual tacit knowledge to be able

to itemise components, for example to be able to tell handedness, and to be able to mentally transform and/or depict objects. As a worker develops proficiency they are able to discern similarities with instances in other domains or contexts, and to be able to recognise deficiencies, for example during test conditions. It is not until they reach an expert level of competency that a worker has sufficient visual tacit knowledge to be able to sense lines of force with respect to the task in hand and can offer visual cues, for example pre-and post test conditions, as rationales for understanding situations.

5.2.3.d.7. Five levels of word tacit knowledge

The novice uses generic or context free language and terminology to name tools or parts and to understand instructions, and can for instance recognise a square panel at the back of an aeroplane fuselage, but not a moisture trap access port in the same place. It is not until they have reached familiarity with the task that they are able to name details, or describe processes using generic nomenclature. As a worker achieves competency with a task, they are able to name items using contextually accurate language and are able to identify and name atypical instances. A worker has not developed proficient word tacit knowledge until they are able to understand acronyms, historical and/or technically accurate terms, and groupings of terms, but they have achieved an expert level when they are able to borrow language from other domains, and build metaphors to talk about the task at hand.

5.2.3.e. Asymmetry of aspects of tacit knowledge

An important feature of task related tacit knowledge is that a worker can come to a new task already having various levels of tacit knowledge relevant to the task. Some of this tacit knowledge may have been gained from prior experience in the industry, or through formal training. However in spite of this, their competency may not be recognised in the workplace because they lack other aspects, such as appropriate levels of community tacit knowledge (particularly in relation to age, or ethnicity), or word tacit knowledge (particularly in relation to nationality, e.g. some words mean different things to different people, depending on whether they are New Zealanders, Americans, or South Africans). Similarly, the development of a worker's tacit knowledge does not typically happen symmetrically across all seven aspects. This can lead to some awkward anomalies. For example, an engineer could have a proficient level of activity tacit knowledge about a particular task (such as having a good understanding of a maintenance task in the context of a maintenance regime), and even be accredited (through exam results) as having that level of competency, but be entirely inept (a complete novice) in the way that they handle

tools to perform that task. The result being that although the engineer knows what to do and is accredited to do it, because he lacks bodily tacit knowledge (e.g. manual skills), he is unable to perform a task to the required level of performance. This kind of anomaly presents difficulties for a supervisor, because it makes it difficult for them to accurately assess a worker's suitability to perform a task.

A summary view of the generic knowledge descriptors associated with five levels of competency in the seven aspects of task related tacit knowledge is shown in Table 25: Level descriptors for seven types of tacit knowledge, below.

Competency Level		TK Type						
Level	Behavioural descriptors	Activity	Bodily	Community	Personal	Sound	Visual	Word
Novice	Rigid adherence to taught rules or plans Little situational perception No discretionary judgment	Applies rules to perform procedural steps, e.g. undo bolt this way	Movements awkward, clumsy, poor motor skills, e.g. learning to hold tools correctly	Instructions, elements are defined without reference to the overall situation, i.e. context free	Applies rules unambiguously, via information processing	Sounds basically meaningless, unfamiliar	Recognises holistic templates, but otherwise confused, unable to visualise or locate	Can name parts, tools, steps in generic terms, e.g. tap, shutoff
Familiar	Guidelines for action based on attributes or aspects (i.e. global characteristics of situations recognizable only after some prior experience) Situational perception still limited All attributes and aspects are treated separately and given equal importance	Prepared for next step, e.g. undo bolt then clamps	Wields tools correctly, is methodical, animated.	Elements being considered in context, e.g. can anticipate when others need help	Recognises elements when present, e.g. begins to estimate time to perform task	Sounds are familiar but not associated with task.	Recognises object types, can differentiate components	Can name details, describe processes using generic nomenclature, e.g. sensor valve

	Competency Level	TK Type						
Level	Behavioural descriptors	Activity	Bodily	Community	Personal	Sound	Visual	Word
Competent	<p>Coping with crowdedness</p> <p>Now sees actions at least partially in terms of longer term goals</p> <p>Conscious and deliberate planning</p> <p>Standardised and routinised procedures</p> <p>Adopts hierarchical procedures for decision making</p>	<p>Considers steps in light of other contexts/tasks, e.g. disassembly i.a.w. SOP</p>	<p>Actions are deliberate and confident, e.g. wields tools effectively,</p>	<p>Non-critical adoption of organisational norms, whether positive or negative, e.g. arranging and working in with others</p>	<p>Satisficing rather than optimising performance, e.g. self assessment of performance relative to own hierarchies</p>	<p>Recognises and anticipates typical sounds but unable to discern abnormalities</p>	<p>Able to itemise components, e.g. handedness, can transform, and depict objects,</p>	<p>Name items with contextually accurate nomenclature, e.g. quartz sensor bypass/thru valve, can name atypical instances</p>
Proficient	<p>See situations holistically rather than in terms of aspects</p> <p>See what is most important in a situation</p> <p>Perceives deviations from the normal pattern</p> <p>Decision-making less laboured</p> <p>Uses maxims for guidance, whose meaning varies according to the situation</p>	<p>Comprehends work in context of longer timeframes, works from memory, envisage time savers</p>	<p>Uses alternative methods, movements are swift/quick, e.g. wields tools efficiently.</p>	<p>Identifies salience of own and others' performance to the context as a whole</p>	<p>Behaviours and performance triggered without deliberation, can recognise influences on self, e.g. when not to rely on memory for critical info.</p>	<p>Recognises atypical instances</p>	<p>Discerns similarities with instances in other domains or contexts, and recognise deficiencies, e.g. during test conditions.</p>	<p>Understands acronyms, historical and/or technically accurate terms, groupings of terms, e.g. electro pneumatic valves</p>
Expert	<p>No longer relies on rules, guidelines or maxims</p> <p>Intuitive grasp of situations based on deep understanding</p> <p>Analytical approaches used only in novel situations, when problems occur or when justifying conclusions</p> <p>Envisioning of what is possible</p>	<p>Anticipates future processes, develops innovations, considers options.</p>	<p>Consciousness of own methods not front of mind, exudes confidence, movements are unthinking, flowing</p>	<p>Performance established as an organisational model – either consciously or unconsciously</p>	<p>Developed own value system for task in hand, incorporating own, org., and external hierarchies.</p>	<p>Uses sounds as diagnostic tool e.g. familiar with operational duration</p>	<p>Sense lines of force with respect to the task in hand, can offer visual cues, e.g. pre and post test conditions.</p>	<p>Borrows language from other domains, builds metaphors</p>

Table 25: Level descriptors for seven types of tacit knowledge

5.2.4. Tacit knowledge aspects of experience

Consistent with the literature (see section 2.2.5: Tacit knowledge and experience, on page 26, and section 2.3.2.b: Contexts, on page 43 in the literature review), the data suggests that the lived experience (verb use) of workers results in experience (noun use)

that is highly dependent on an individual's life contexts. However, analysis of the data suggests that there are three distinctly different contexts (global, industry, and local workplace), which inform the individual's unique tacit knowledge, as illustrated in Figure 41 on page 262 below⁷.

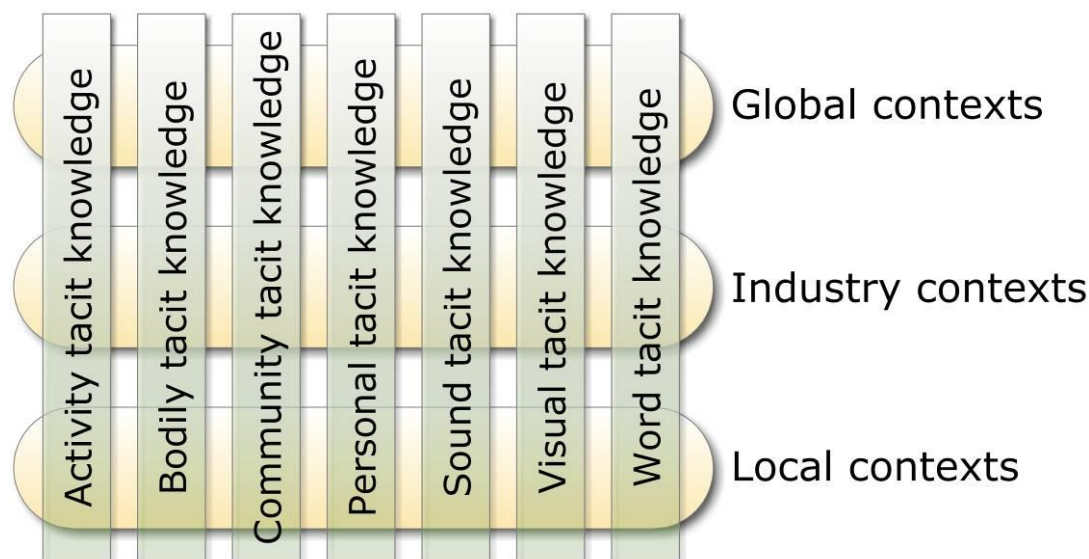


Figure 41: Contextual influences on experience (or workplace tacit knowledge).

The following section describes the contexts extrapolated from the field note data that influence a worker's experience – in the senses of both verb and noun – and suggests that workplace experience is the application of their tacit knowledge content at the intersections of three contexts.

5.2.4.a. Workplace knowledge contexts

There are three macro contexts that inform an individual's experience; their global environment, their industry environment, and their local (workplace) environment. The union of these three contexts comprise an individual's total life experience, whereas the intersections of these contexts comprise their workplace experience. The intersections of the three macro contexts result in three learning environments, identified as the external learning environment, the internal learning environment, and workplace norms.

The research shows that it is the intersection of these three that informs an individual's workplace knowledge, as illustrated in Figure 42 on page 263 below.

⁷ References to tacit knowledge in the diagram refer to the aspects of tacit knowledge described in section 5.2.3 A measure of task related tacit knowledge on page 250

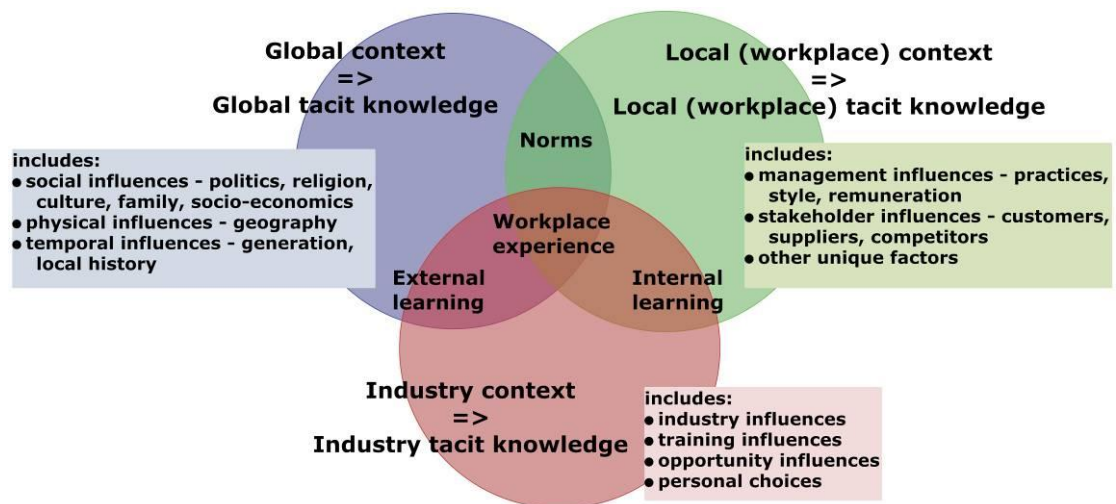


Figure 42: Workplace experience (or workplace tacit knowledge) is at the intersection of three macro contexts.

5.2.4.a.1. Three macro contexts

The three macro contexts of an individual's experience, i.e. the global, the industry and the local workplace, provide them with what is defined here as their *global tacit knowledge*, *local (workplace) tacit knowledge*, and *industry tacit knowledge*.

The global context includes the larger world experience, and is the source of an individual's global tacit knowledge, informed by the societal contexts that they have lived through. These include social influences such as politics, religion, culture, family, and socio-economics, physical influences such as geography, and temporal influences such as generational identity or local history. This global tacit knowledge is gained through the process of subception - "the principal mechanism by which knowledge is tacitly acquired" - and is proximal to the individual (Polanyi, 1966, p. 7). Because individuals are immersed in their global environment, they are typically unaware of the experience and knowledge that they are gaining, i.e. it is hidden, until they are confronted with alternative global tacit knowledge, such as might happen when they emigrate from one country to another, or meet someone from a different culture.

It is the industry context that gives rise to a worker's industry tacit knowledge, which pertains to their work experience informed by less general contexts such as the industry in which they work, their education and training, opportunities they have had, and their personal choices or expectations associated with the conditions of their work. Because this knowledge is distal (Polanyi, 1966) to the individual, it is close to their consciousness, usually because they have made a conscious decision to engage in a particular experience, whether that is through choosing a career, or undergoing training, or applying for a specific job based on an employer's reputation.

The local (workplace) context gives rise to local (workplace) tacit knowledge, which pertains to an individual's life experience informed by the immediate context of their workplace. It includes for example, management practices and style, remuneration, the customer and supplier base, and all the other unique factors that distinguish one workplace from another. The lived experience of the individual results in them "dwelling in" the local environment, and in the process of making sense of the circumstances within which they find themselves, they *interiorise* (Polanyi, 1966) the local environment's knowledge, combining it with their global and core knowledge. It is this characteristic of experience (verb) that makes workplace tacit knowledge unique, because individuals connect knowledge in ways that cannot be defined (Polanyi, 1966, p. 24).

5.2.4.a.2. Three micro contexts

As far as workplace tacit knowledge is concerned, the intersections of the three macro contexts result in three different types of learning as experienced by workers. At the intersection of the global context and the industry context, an individual experiences external learning, which refers to the knowledge gained as a result of external forces on them. At the intersection of the industry context and the local (workplace) context, an individual experiences internal learning, which refers to the knowledge gained from their own personally directed learning. At the intersection of the global context and the local (workplace) context, an individual learns knowledge that they are unaware of in the form of norms.

5.2.4.a.3. Workplace knowledge application

The significance of this model for supervisors is that it highlights some of the difficulties they face in the course of their daily knowledge management. This study suggests that any given worker's workplace experience will be manifestly different from another's, which makes a one-size-fits-all approach to knowledge management by supervisors somewhat of a fraught strategy, because a tactic that might work well for one worker, may not work with another.

What the Field studies showed though is that effective supervisors take cognizance of these different levels of workplace experience and adjust their knowledge management praxis accordingly. What was interesting was that few if any of these supervisors were able to clearly articulate why they differentiated their strategies from worker to worker, but to do so most appeared to draw on what the literature describes as their emotional intelligence (see section 2.3.2.f.3: Emotional Intelligence and Human Capital, on page 64 above).

Consistent with what the literature has already identified (see section 2.3.3.a: Learning and training), this research showed supervisors who are effective tacit knowledge managers appear to have an intuitive ability to take into account the complexity of contextual factors that obfuscate or confound performance in the workplace (compare with section 2.3.2.b.3: Boundary and geographical contexts), and instead are able to allocate tasks and resources to their subordinates in a way that leverages their subordinates' experience. Sometimes this leveraging meant giving workers an opportunity to learn something new, whilst other times it might mean using their pre-existing experience to achieve a particular result, whether that be the rapid turnaround of a customer's order, or a task to be performed to an exacting standard.

This section of the findings describes how these effective supervisors managed their human capital and knowledge assets to achieve the best results for the firm

5.2.4.b. Experience in terms of tacit knowledge working capital, human capital, and knowledge assets

Analysis of the data suggests that not only can experience be thought of in terms of learning processes, as mentioned in the previous section, but it can also be thought of as classes of tacit knowledge asset. This section describes the development of this experience, from tacit knowledge working capital use by human capital through to tacit knowledge assets (see Figure 43: A model of experience as tacit knowledge assets, on page 267 below).

5.2.4.b.1. Tacit knowledge working capital

Consistent with the literature (see sections 2.3.3.c: Saliency, on page 71 and 2.3.3.d: Absorptive capacity, on page 72), observations in the field suggest that an individual begins the process of developing experience (noun) from the starting place of knowledge that has immediate relevance or saliency to them. For the purposes of this study, this knowledge with immediate saliency is referred to as “tacit knowledge working capital”, a term derived from Ammar-Khodja and Bernard's (2008, p. 13) label *intellectual working capital* (see the discussion on Intellectual Capital in section 2.3.2.f.4 on page 65 above) that they use to identify workaday information and knowledge that has short-term value as the starting point for work activities that follow. Tacit knowledge working capital is therefore identified as having been derived from either *global, industry, or local (workplace)* contexts and has immediate saliency to human capital.

5.2.4.b.2. Tacit knowledge and human capital

The literature almost universally uses the term human capital as a euphemism for people at work (see section 2.3.2.f: Human Capital, on page 60), but in the context of this study,

the term is used as a noun for people's *application of knowledge* as they go about their work. In that sense, human capital is both the tacit know-what and know-how used in work activities.

There were five distinct categories of work activity identified in the data, i.e. Decision-making and problem solving, Health and safety compliance, Getting to know customers and suppliers or other stakeholders, Managing individual workloads and responsibilities, and Performing non-standard procedures. (n.b. in this context, human capital is not used to refer to people engaged in performing standard operating procedures. This is primarily because as a standardised process it is implicit that knowledge associated with the procedure has been made explicit to some degree – notwithstanding an earlier finding, which suggests that every standard operating procedure requires a certain amount of tacit knowledge for its performance).

5.2.4.b.3. Tacit knowledge assets

The field studies suggest that the tacit knowledge assets (i.e. experience – noun form) that workers accumulate through their learning (i.e. experience – verb form) can be divided into three classes that correspond with the three kinds of knowledge contexts described in the previous subsection. Tacit knowledge assets that correspond with global contexts include,

- Historical knowledge of the firm and the industry within which it operates. This includes knowledge of for example, previous firm initiatives, successes and failures, or changes over time to the way the work is done in response to new technologies.
- Knowledge of industry forces that correspond with Porter's five forces model (Hill & Jones, 1999, p. 81) of suppliers, competitors, rivals, substitutes, and customers.
- Knowledge of legislation that pertains to the industry. This especially includes knowledge associated with licensing and accreditation rules, e.g. NZFSA, ACC, CAA, etc.
- Knowledge of complementary industries. This includes knowing how a worker's own work relates to the work of other industries, e.g. how an electrical pump relates to water in a coalmine, or how a moisture level in powdered milk relates to the shelf life of a retail food product.

Tacit knowledge assets that correspond with industry contexts include,

- Attitudinal, motivational and behavioural norms, such as standards of effort, quality, throughput, etc that a worker in any particular industry might be expected to demonstrate. For example, regardless of their workplace, a qualified electrical engineer would be expected to demonstrate greater awareness of electrical safety procedures than would a laboratory technician in a chemical laboratory.

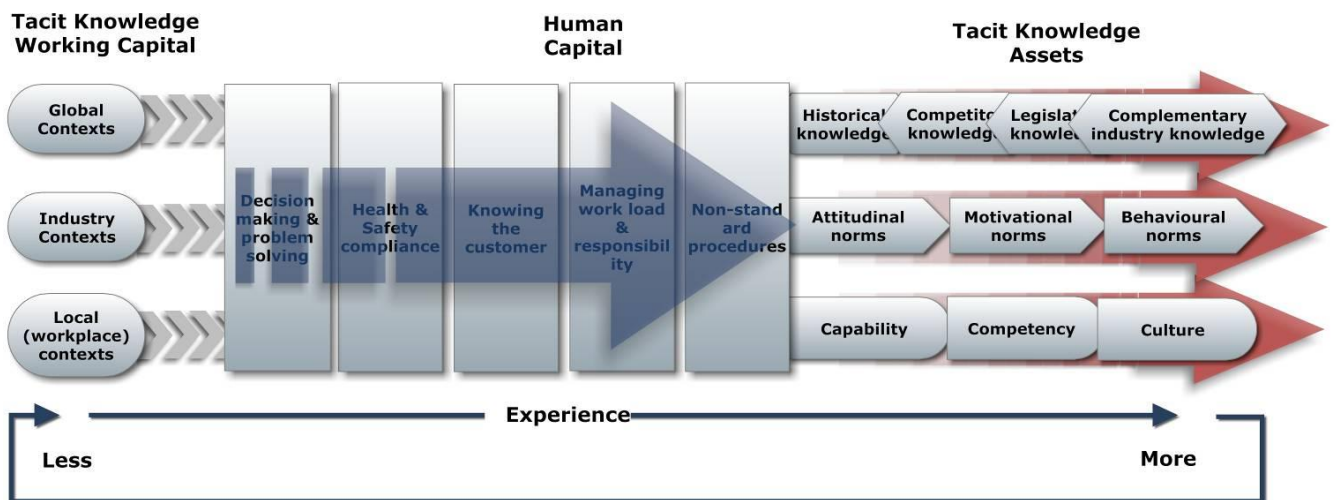
Tacit knowledge assets that correspond with local (workplace) contexts include,

- Capability, which refers to the range of skills that a worker is able to demonstrate.
- Competency, the level of performance that a worker is able to demonstrate in each of these skills.
- Culture, the degree to which a worker adopts and complies with the organisation's way of doing things

As workers build their tacit knowledge asset base, i.e. their experience (noun), the new knowledge becomes subsumed into their respective global, industry, and workplace knowledge bases, ready to be retrieved as tacit knowledge working capital for the next time human capital is applied to the job.

Once a supervisor is able to think of their workers' experience in terms of three learning contexts, i.e. external learning, internal learning, and norms, and in terms of their tacit knowledge assets, they are in a better position to evaluate both long and short term knowledge requirements, so as to optimise organisational performance. Long-term requirements include individual competency or training needs, and short-term requirements include daily inputs to the day's activities.

Figure 43: A model of experience as tacit knowledge assets



5.2.5. Knowledge factors affecting worker performance

As described in the previous chapter (Chapter 4: The case studies), three of the four cases demonstrated reasonably effective knowledge management practices on the shop floor, but the fourth demonstrated very little knowledge management praxis. However, in spite of this discrepancy all workers in all four cases appeared to require the same type of knowledge inputs on a daily basis.

Workers use their tacit knowledge working capital as the starting point for their application of human capital (see section 5.2.4.b.1: Tacit knowledge working capital, on page 265 above) to make decisions, comply with health and safety regulations, get to know customers, etc. According to its salience, this tacit knowledge working capital seems to establish the direction that a worker takes with respect to how they solve problems, or how they manage their workload and responsibilities, etc. This means that when a worker starts their shift, the decisions that they make as they begin work are made according to what knowledge appears most relevant to them at that moment. If their supervisors do not specifically provide this tacit knowledge working capital, workers will look to their own experiences/tacit knowledge assets for starting points. Obviously because each one of these is unique, the resulting directions that individual workers take can be radically different from the direction that the organisation wants them to take.

5.2.5.a. Lack of shop floor tacit knowledge management leads to inefficiencies

Evidence from the field studies suggests that in the absence of appropriate knowledge management practices on the shop floor, eventually individual worker activities become not only counter-productive to the firm's overall direction, but also counter-productive to the efforts of fellow workers. The overall result is one of ineffective and inefficient firm performance, regardless of the level of individual competency and/or capability of the workers themselves.

For example, if a worker knows that an order has been placed for a particular product, they may set themselves up to produce that product according to the global, industry and local knowledge they hold at that time. If that worker also has knowledge of previous similar orders and their frequency (industry knowledge), they may elect to set their workstation up to produce not only the immediate order (workplace knowledge), but in anticipation of subsequent orders too. As far as the worker is concerned, they may be optimising their output in the long term (global knowledge), but in doing so may be

delaying their immediate output with its corresponding implications for other workers associated with that order.

Another example includes the situation where a business needs to reduce the turnaround time for the servicing of a customer's order. If this is not made known to the worker who is actually doing the work, then it is unlikely that the worker will make efforts to reduce the turnaround time. Furthermore, because of the worker's own experience, they may actually exacerbate the problem should they decide to spend extra time on the job to ensure that it is done to a particular standard - a real problem in situations where individual workers have higher performance criteria than the company!

In order then to ensure that all workers are working towards the same goal, i.e. the organisation's optimal performance, they need the same starting points and directions - in spite of their individually unique experience/tacit knowledge assets. One of the supervisor's knowledge management roles is thus to ensure that all workers have the same tacit knowledge working capital.

5.2.5.b. A daily checklist of knowledge factors

Further evidence from the field studies also suggests that because of workplace habits, it is not always obvious to either workers or supervisors exactly what tacit knowledge working capital is actually required on a daily basis. As an example, in organisations where the workflow is highly routinised, such as in a laboratory, certain aspects of activity tacit knowledge become so deeply embedded in the daily routines that they become norms, and workers no longer recognise them as steps in a task, but rather cultural expectations of workplace behaviour. Thus, when changes to work flow patterns are mandated by management, they are perceived not as changes to the job, but rather as threats to the organisation's culture.

The data suggests that there are a number of knowledge factors that all workers on the shop floor need to know about on a daily basis, which help them and the organisation to perform optimally. The knowledge factors include,

- big picture items that help workers to understand where their work fits in to the rest of the organisation's goals,
- self-management and/or cooperation items that help workers to factor into their own work plan how they can help others or could be helped by others
- workplace safety factors that workers need to be aware of so that they can complete shifts safely

- personal/professional development factors that workers use to plan their own personal or professional growth
- performance standards that workers need to be aware of, over and above standard operating procedure requirements, to help them produce good work.

Thus, a worker's tacit knowledge working capital includes knowing about not only their own immediate task but also about other tasks that they and/or others will be expected to perform in the course of the day, and about upcoming work or events. This knowledge helps them in their own planning and self-management so that they can fit their tasks in with the rest of the organisation's goals. Since workers typically work in with others, it is also useful for them to know who is present at work on a daily basis, who is away on leave or absent, and who is going off site perhaps to do a pickup or a drop off. Similarly, they need to know about visitors or contractors who may be on site, to be aware of health and safety, and environmental issues to keep themselves and others safe at work.

Since people are usually interested in their own personal and/or professional development, it is also useful for them to know what training is about to be provided, or what training they can avail themselves of. Along with training opportunities it is also important that workers be recognised by supervisors for their successes and achievements, which not only helps to build individual self-esteem and self-confidence, but also tends to encourage similar behaviours. Since a goal of knowledge management is to ensure consistently high standards of performance, it is also useful for workers to know about upcoming inspections and audits that they or the organisation may be subject to, and to know about deadlines or extra customer requirements, which helps to set performance expectations. These knowledge items are summarised in Table 26 on page 272 below.

The research shows that when supervisors routinely incorporate all of these knowledge items into their daily briefings to the workforce, then work generally proceeds more smoothly than if they do not. Furthermore, when supervisors have changed the content of their daily briefing to include all of these items, they have noticed improvements to their own workload and stress levels. This improvement is attributed to reduced interruptions from individual workers who are looking for direction, and fewer interventions into situations where workers were not performing optimally.

What is interesting about these items is that quite often much of the information is already published in some form or other in the workplace. For example, upcoming work or events may be routinely displayed in the form of charts, and health and safety information may be routinely published in in-house magazines or newsletters. However the research shows that even though this information is available, not all workers routinely take note of it, and therefore do not incorporate it into their own tacit knowledge bases, hence the reason why supervisors need to make it salient by pointing it out.

Experiments show that if the information mentioned above is not already published in some form, then it is relatively easy for supervisors to draw attention to it through the use of graphic organisers or *aides memoir* such as a supervisor's daily to do list, an example of which is illustrated in Figure 44 on page 273 below. This single page of A4 paper captured all the salient information that a workforce needed on a daily basis, providing its tacit knowledge working capital. The sheet of paper was divided into four sections, and folded into quarters so that it fitted comfortably into the top pocket of a pair of overalls for easy reference during the day. Furthermore, at the end of every day the supervisor was able to file each day's sheet and thus begin a collection of information that could be mined, e.g. for repeated patterns of absenteeism, or typical extra customer requirements.

Table 26: Factors of daily tacit knowledge working capital

Knowledge factor	Tacit knowledge working capital	Rationale
Big picture	Tasks for today	Helps workers to know how their task fits in with the rest of the organisation's obligations
	Upcoming work/events	Helps workers to plan their own output, and set up expectations for the future
Self-management/cooperation	People present today	Lets workers know who they can work in with and helps them to manage their own workload
	Absentees/On leave	Lets workers know who they can't work in with and helps them to manage their own workload
	People off-site	Lets workers know who is going where and why
	Pick-ups/drop-offs	Lets workers know about interactions with the world outside the workplace
Workplace safety	Visitors/contractors on site	Lets workers know about (possible) strangers who they may be required to interact with
	Health and safety issues	Keeps workers aware of how they can keep themselves safe at work
	Environmental issues	Keeps workers aware of how they can protect the environment around them
Personal/professional development	Training	Lets workers know who is receiving training (aspirational for those workers who are keen to up skill)
	Recognitions	Recognises individual contributions to the organisation's goals, builds self-esteem, self-confidence, and encourages similar behaviours.
Performance standards	Inspections and audits	Encourages compliance with organisation's or external standards
	Deadlines	Provides expectations of when tasks need to be completed by
	Extra customer requirements	Lets workers know about non-standard performance criteria

5.3. Discussion of the contributions and findings

This section contains a review of how this research confirms what has previously been published and reviewed in Chapter 2, and explains how the work extends what is already known on the topic. It also introduces an entirely new contribution to the academic literature.

5.3.1. From section 5.2.1: How supervisors manage tacit knowledge

Considering this was the primary focus of the research, this finding is entirely consistent with what the literature says about human capital as a knowledge management enabler (see sections 2.3.2.f: Human Capital and 2.3.3: Facilitators of knowledge management). The finding identifies that there are both formal and informal enabling activities (compare with section 2.3.4: Barriers and Limitations of knowledge management) that supervisors can engage in and furthermore these are consistent with the Knowledge Creation Spiral of Nonaka and Takeuchi. How this research extends the knowledge creation spiral is that it provides explicit details of the kinds of activities that supervisors can engage in, but which those writers allude to yet do not mention specifically. Similarly, this research also identifies a number of specific barriers to effective knowledge management related to the SECI spiral, several of which have not been identified previously in the literature. For example, the changing nature of shift work crews has not been previously identified in the literature as a barrier.

The value that this finding has for future research is that each one of these individual enablers and barriers can now be specifically tested for their relative efficacy or importance.

5.3.2. From section 5.2.2: Knowledge counter agent archetypes – The Home Guard Model

The development of the Home Guard Model, the finding in section 5.2.2 is an entirely new contribution to the literature. Although the possible influences that Hofstede's Power Distance dimension (see section 2.3.2.f.1) combined with Self-confidence (see section 2.3.2.f.2) have on individual knowledge sharing behaviours is implicit in the writing on those two topics, there is little, or nothing published on their effects within the knowledge management discourse.

The model was tested in one of the cases and the empirical evidence suggests that it provides an intuitive and effective tool for helping supervisors to understand why certain people in the workforce exhibit the kinds of knowledge sharing activities that they do. With the insights gained from the model, supervisors are able to accommodate and/or modify their own and others' behaviours to achieve desired goals.

The Home Guard Model is therefore an entirely new contribution that appears to have construct validity, but does need further evaluation to test for credibility, transferability, dependability, and confirmability.

5.3.3. From section 5.2.3: A measure of task related tacit knowledge

From a managerial perspective, as opposed to a supervisory perspective, the finding in this section is probably the most useful, although it may prove to be somewhat controversial over time because of the arguments in the literature over the nature of tacit knowledge *per se* (see section 2.2.1.a: The debate over the nature of knowledge). By taking a fresh look at what the literature has to say about knowledge typologies (see section 2.2.1.c: Contemporary descriptions of knowledge), and combining that with what it has to say about work performance in terms of competency (see section 2.3.2.e.3: Knowledge measures or levels), this finding has provided a tool for evaluating worker competency in any generic task.

What this research has found is that there are distinct categories of knowledge associated with various combinations of aspects of tacit knowledge (i.e. activity, bodily, community, personal, sound, visual, and word) and levels of competency (i.e. novice, familiar, competent, proficient, and expert). Each of these knowledge categories can be described in such a way that it is now possible to objectively assess and evaluate a worker's competency to perform a task, whereas previously much of this evaluation has relied on the subjective assessments of supervisors and/or frontline managers.

5.3.4. From section 5.2.4: Tacit knowledge aspects of experience

Although this section does not provide anything startling or particularly esoteric, it does confirm what has previously been published about the importance of context (see section 2.3.2.b) and the value of knowledge assets (see section 2.3.2.e). That is to say this research acknowledges the importance of both macro and micro contexts and offers (perhaps somewhat simplistically) suggestions of how supervisors might conceptualise the experiences of their subordinates' knowledge assets in terms of these contexts. The value that this rather simple model has for supervisors is that it provides a readily accessible conceptual framework upon which to hang the findings from the research, i.e. the five categories of human capital, and ten categories of tacit knowledge asset.

The value to the literature that this finding has is that it provides an operationalised conceptual explanation of the term *experience*, which is a commonly misconstrued construct (see section 2.2.5: Tacit knowledge and experience). The findings also suggest that with the previously mentioned set of five categories of human capital, and ten

categories of tacit knowledge assets, organisations now have a metric around which they can build a strategy to develop knowledge assets.

5.3.5. From section 5.2.5: Knowledge factors affecting worker performance

This finding is perhaps the least controversial of all the findings from this research in that it identifies a number of knowledge factors that affect worker performance. These are all consistent with what the literature has already identified, see section 2.3.1: Factors affecting knowledge management. Intuitively, most of these factors would probably be readily identifiable through a process of reflective thinking about work, but what is important is that they have now been specifically identified, which could provide the basis for a new approach to the training of supervisors.

Furthermore, perhaps as a result of the situated nature of the participant observations, these findings have a particular significance because the data shows that if these knowledge factors are not actively managed by supervisors then organisational performance is compromised. Further research would need to be conducted to evaluate the relative importance of each of these knowledge factors, but it is axiomatic that if they are not managed then organisational performance will suffer.

5.4. Summary of Findings and Discussion

This chapter described the findings that resulted from analysis of data collected at four Case study sites with the application of a unique embedded researcher-as-instrument participant observation method.

The first finding that was that knowledge management activities implemented by supervisors were consistent with the findings in the literature and suggests that supervisors can have a significant impact on tacit knowledge management depending on their management style. However, regardless of their style, their facilitation of formal and informal socialisation, externalisation, combination, and internalisation activities was how they managed knowledge. The characteristics of each of these classes of activities were described and a list of enablers, as well as barriers was identified.

The second of the findings described a completely new insight, which identified that it is an individual's Power Distance and Self-confidence that underpin their knowledge sharing behaviours. This insight, labelled the Home Guard Model, identified four behavioural archetypes; saboteurs, guerrillas, collaborators, and prisoners who engage in knowledge sharing behaviours that are contrary to the organisation's goals, but also

identified the Home Guard as a fifth archetype that exhibits the kinds of behaviours that support the organisation's goals.

The third of the findings described a measure of task related tacit knowledge comprised of seven aspects and five levels of competency. These seven aspects, which are by and large consistent with the literature, include Activity, Bodily, Community, Personal, Sound, Visual, and Word tacit knowledge. The finding suggests that there are generic descriptors of the tacit knowledge associated with novice, familiar, competent, efficient, and expert levels that can be applied to any task.

The fourth finding was again consistent with the literature and identified three micro and three macro contexts that inform a worker's experience. The findings showed that experience can be considered as the application of human capital to tacit knowledge working capital which results in the generation of ten classes of tacit knowledge assets. These ten classes include knowledge of (1) the company's and industry's history, (2) its stakeholders, (3) complimentary industries, and (4) the law as it pertains to them. They also include (5) behavioural, (6) motivational, and (7) attitudinal norms, as well as an individual's (8) capabilities and (9) competencies, all bound together in (10) the firm's culture.

The fifth finding identified knowledge factors that affect worker performance. It also identified that a lack of shop floor tacit knowledge management leads to inefficiencies that can be obviated with a daily checklist of knowledge factors. The knowledge factors that were identified include big picture items, self-management and/or cooperation items, workplace safety factors, Personal/professional development factors, and performance standards that workers need to be aware of on a daily basis.

The implications of these findings for policy and practice are discussed in the next chapter, which provides the conclusion to this research report.

Chapter 6: Conclusions and Implications

6.1. Introduction

This research has considered the problem of how supervisors effectively manage tacit knowledge in selected New Zealand firms. The project had two particular problems to deal with. The first was with the nature of tacit knowledge and the corresponding problems associated with how it can be managed. The second dealt with an appropriate method of how to collect data about this enigmatic construct. This section presents the conclusions to the research and summarises how these two problems were resolved.

6.2. Conclusions about the research issues

Although there is considerable literature about knowledge management, including tacit knowledge, that goes back to the 1960s, the majority of the literature has been about the management of explicit knowledge and the information technologies associated with its management. Although there have also been attempts in recent times to develop technologies to manage tacit knowledge, there is still very little understanding of and/or agreement about the nature of tacit knowledge itself. There have been numerous attempts to understand tacit knowledge constructs, but on the whole these have tended to be pitched at a very high level and do not provide clear direction about how they could be operationalised, for instance by supervisors on the shop floor.

Closely related to the problem of a lack of operationalisation of tacit knowledge constructs has been the dearth of research into the topic that used appropriate methods, i.e. structurally embedded within the research context. The resultant tautology of a lack of operationalised constructs resulting from a lack of appropriate methods has contributed to the lack of operationalised constructs.

By beginning from first principles and developing working definitions of knowledge, tacit knowledge, and knowledge management, and then situating the researcher-as-instrument within a number of case study sites, this research was able to collect data in a way that has not been done before. The resulting analyses and insights have generated a number of findings that contribute to both the theory and to the policy and practice of tacit knowledge management.

6.3. Conclusions about the research problem

The findings that resulted from analysis and insight into the data collected by the researcher-as-instrument revealed that there are a number of techniques that supervisors employ to effectively manage tacit knowledge assets. In spite of their lack of theoretical

knowledge about the topic, it appears that supervisors who effectively manage tacit knowledge engage their emotional intelligence to identify and incorporate a number of factors, and then subsequently modify their tacit knowledge management activities according to principles previously identified in the literature, including Nonaka and Takeuchi's Knowledge Creation Spiral among many others. The research showed that these tacit knowledge management activities comprise both formal and informal enablers, and also identified a number of barriers to effective knowledge management over which supervisors may have some influence.

Furthermore, the findings from this research suggest that a dichotomous view of tacit knowledge is inappropriate, which ironically is consistent with Michael Polanyi's seminal work, *The Tacit Dimension*. The research showed that a tacit knowledge metric that recognises a typology of aspects of tacit knowledge (see Figure 45 below),

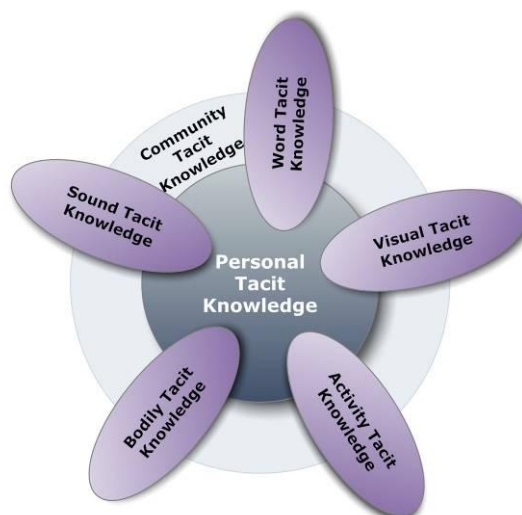


Figure 45: Seven aspects of Tacit Knowledge

and takes into account Polanyi's proximal and distal terms of tacit knowledge in a hierarchy of competencies, can be developed to produce generic descriptors of tacit knowledge assets that do not rely on a supervisor's subjective assessment of a worker's ability.

Furthermore the research has shown that the term experience, which is difficult to define in terms of task competency, can be deconstructed into a number of tacit knowledge assets, which human capital can then employ in the process of performing non-standard tasks (illustrated in Figure 46 below). The research also revealed that there

are a number of salient knowledge factors that workers need to be made aware of on a daily basis that contribute to the development of organisational tacit knowledge assets.

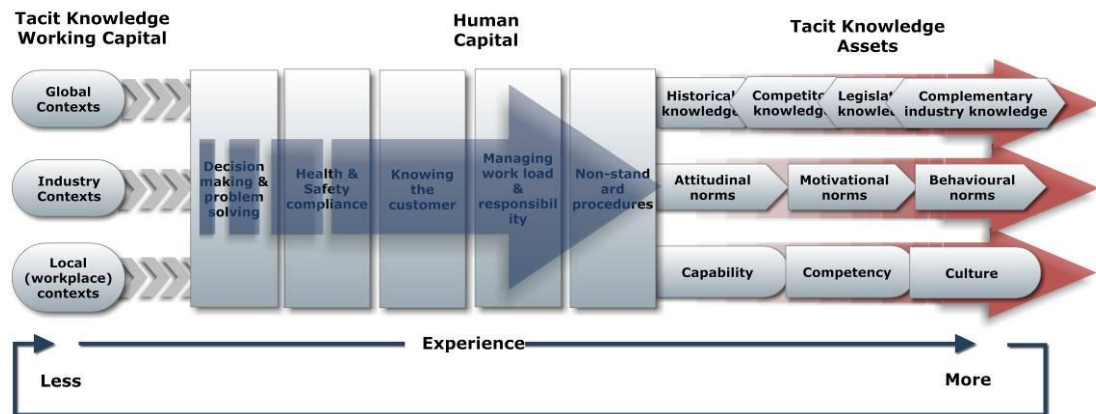


Figure 46: The experience continuum in terms of tacit knowledge and human capital

A feature of this research is the somewhat unexpected finding that an individual's knowledge sharing behaviours are related to their Power Distance and Self-confidence. That these two characteristics of human capital are mentioned in the literature is not surprising, but the suggestion is made here that the connection between them and knowledge sharing activities could not have been made without using the research method that was structurally and contextually embedded within the participant cases. The resulting Home Guard Model (illustrated in Figure 47 below) has proved to be an intuitively useful tool that supervisors can use to help understand counter-productive knowledge sharing activities by subordinates.

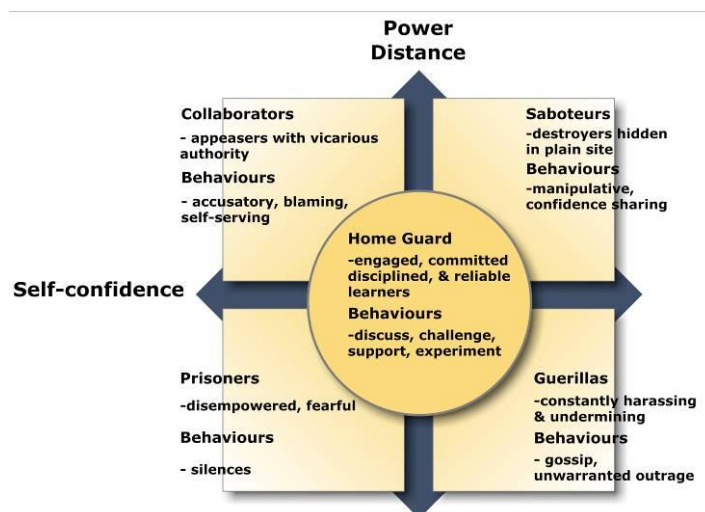


Figure 47: The Home Guard model

6.4. Ten knowledge management interventions

A synthesis of all the findings suggests that a useful audit tool for evaluating tacit knowledge management techniques on the shop floor can be developed that has implications for theory, policy, and practise. The findings suggest that there are at least ten knowledge management interventions that need to be deployed consistently to establish effective tacit knowledge management. This section speculates on these ten interventions and concludes with a suggestion for a knowledge management audit tool that could be developed and trialled in future research.

6.4.1. Consistent application of rules, policies, and procedures

What the research has shown is that as workers experience (verb form) their local environment, they are affected by management decisions. Over time, this experience builds expectations of management, expectations of themselves, and expectations of their fellow workers. These expectations develop into a justified true belief, i.e. tacit knowledge, of the workplace that workers use as they go about their daily business. Because the workplace is social, people talk to each other and share experiences, including their experiences of interactions with management. It is not uncommon for workers to discover discrepancies in the way situations are handled by management compared with the organisation's published rules, policies, and procedures. More often than not, this leads to dissatisfaction and allegations of unfairness directed at management. Unless workers have sufficient personal resources of self-confidence and appropriate levels of power distance to deal with the situation, dissatisfaction can turn a willing worker in the home guard into a knowledge counter agent (see section 5.2.2 Knowledge counter agent archetypes on page 242 above).

It seems that the most important intervention that management can support in terms of effective tacit knowledge management is a consistent application of the firm's rules, policies and procedures, which need to clearly outline expectations of behaviour - especially around knowledge activities.

6.4.2. Use of feedback mechanisms

Because new knowledge is constantly being developed in socialisation activities through opportunistic questions and answers, brainstorming etc, it is vitally important that mechanisms are established to capture where possible this new knowledge. Externalisation methods such as white boarding and personal folders are very important at an individual level, but it is probably more important that management allocates resources (such as time, or attention) to ensuring that feedback mechanisms are

implemented that will channel innovations or solutions to problems further up the organisational hierarchy.

Effective ways of doing this include regular supervisor reports that describe events and learnings from the shift, notices and memos. These need to be compiled into useful folders or incorporated into standard operating procedures through update mechanisms. It is only in this kind of formal process that insights from experienced workers can be routinely incorporated into organisational performance optimisation. An important by-product of this formal process is that it encourages innovative thinking in the minds of workers as they constantly manage their own work or solve their own problems, because they recognise that the effort that they put into the task over and above what is required in the standard operating procedures is valued.

6.4.3. Maintenance of histories and memorabilia

One of the characteristics of experienced workers is that they have historical knowledge of their industry and/or workplace. Since it takes time to develop this knowledge through personal experience and it is becoming increasingly uncommon for workers to stay for extended periods within either a single workplace or even an industry, it is extremely important that firms establish a repository for their own history. The significance of this in terms of effective tacit knowledge management is that it provides background to current work practices for inexperienced workers, which helps them to understand why particular things are done in particular ways. This can be extremely important in helping to prevent lessons having to be re-learned, or the wheel having to be re-invented.

To highlight the significance of this, an anecdote from the aero industry is pertinent. Some years ago, well before the current fleet of aircraft was commissioned, an incident occurred that resulted in a wheels-up emergency landing that could have caused many deaths. What happened was that an engineer inadvertently left a tool in the retractable undercarriage wheel well of an aircraft. The aircraft took off and as the undercarriage retracted, the tool was dislodged in such a way that it locked the landing gear up and prevented it from being extended when the aircraft next approached landing. The resultant crash landing could have been fatal but for the pilot's skill. In order to prevent such an occurrence from ever happening again, it is now standard procedure for all tools in the airline's maintenance hangar to be stored on shadow boards, which are checked before the aircraft is allowed to leave the hangar after maintenance.

For a newcomer to the airline's maintenance crew who has no knowledge of this incident, the regular and somewhat time-consuming routine of checking the shadow boards can be seen to be a waste of time. The temptation exists to cut the procedure out to save time at the end of the shift, particularly if the shift has been arduous or long. However, the story and the mangled tool serves as a salutary reminder to all newcomers of the significance of the shadow board, and helps to prevent complacency towards good housekeeping from creeping in.

6.4.4. Understanding of organisational naming systems

An important element of any firm's knowledge management system is a universally recognised naming system. Because of increasing globalisation, more and more firms are finding that the workforce is more cosmopolitan and less homogenous than ever before. Because of the resulting diversification in individual's global tacit knowledge, word tacit knowledge becomes a casualty in efforts to communicate effectively. Numerous arguments and differences of opinion can be traced back to the different understandings of words between people from different backgrounds.

Having a universal naming system enables people from different backgrounds to communicate effectively, and helps in searches to retrieve information from data banks or other knowledge repositories, e.g. compilations of engineering notices. Several industries have internationally recognised naming systems and the aviation industry's ATA Chapter system is a good example of this. The ATA chapter system enables aviation engineers anywhere in the world to quickly locate relevant service information regardless of aircraft type or where the aircraft is located.

6.4.5. Use of licensing and accreditations

It has been shown that self-confidence is an important element in knowledge sharing and creating activities, and evidence from the research suggests that workers who are licensed or accredited are more likely to speak out about issues than if they are not. Licensing or accreditation sends a message to those who are not similarly recognised that the licence holder has achieved a level of competency; meaning that they can speak on relevant topics with some degree of authority.

Typically it takes some effort for a worker to gain a licence or be accredited, and in some industries limits are placed on the amount of responsibility that those who are not licensed may exercise. Similarly, a degree of trust is placed in those who have been accredited and they are expected to exercise that trust by for example, signing off that work has been completed in accordance with established procedures. Evidence from the

field studies suggests that in general, workers who have been accredited jealously guard their accreditation and have the confidence to stand up to pressures to compromise standards, which is an important factor in ensuring that organisational performance is not compromised.

6.4.6. Maintenance of open communication channels

Consistent with formal feedback mechanisms, it is also important that organisations maintain open communication channels that allow non-threatening, opportunistic question and answer sessions between supervisors, managers, and subordinates.

The main reason for this requirement for open channels of communication is that it facilitates the sharing of tacit knowledge working capital, which does not need to be disseminated in the form of formal feedback mechanisms.

6.4.7. Visible organisational charts

An interesting characteristic of competent workers is that they will often try to find solutions to problems without going through their supervisors. The reasons for this are many and varied, but include for example, the worker knowing that the supervisor is unlikely to be able to answer the question anyway, or the worker having a poor relationship with the supervisor, which precludes any meaningful knowledge exchange.

When a worker does try to find the knowledge that they are seeking, they tend to first approach people that they know, asking them for the knowledge directly or for directions about from whom or where that knowledge can be obtained. Almost invariably, the worker seeking knowledge is directed to someone else within the firm who is likely to have that knowledge. However, because this direction giving is mediated by the quality of relationships between the seeker and the solution, it is not uncommon for the quest to be confounded. The situation is exacerbated when more experienced workers, or those with wider social networks engage in knowledge hoarding, i.e. do not share their knowledge.

A way to streamline this knowledge sharing is to publish organisational charts that list personnel in the company, along with their responsibilities, job title and contact details. In large organisations, where personnel are widely distributed geographically, this kind of information is invaluable to newcomers and old hands alike. For newcomers, the benefit is obvious but for the more experienced worker the charts can often be of benefit in that they help to identify the achievements of fellow workers, and helps to keep them abreast of changes.

6.4.8. Published skills matrices and training programs

Along with visible organisational charts, published skills matrices and training programs are extremely important for helping to identify capabilities and competencies. From the supervisor's perspective, the skills matrix provides several insights into the workforce. The matrix helps to track individual worker skills development, and to identify training needs. In situations where the personnel make-up of shifts changes over time, it is useful for supervisors to see how individual skills are developing, which helps them to make decisions around task allocation. For example, if a task with critical constraints such as quality or time criteria needs to be performed, a supervisor can use a skills matrix to identify who should do the task. It may be appropriate to assign an experienced worker to the task if there are important time constraints, but it may also be appropriate to assign an inexperienced worker who could use the opportunity to develop their own skills if time is not of the essence.

The skills matrix is also important to the general workforce. It provides a visual cue to everyone about where they fit within the wider context. For the aspirational worker, the matrix shows directions where they could look to develop new skills, and for the more complacent worker it shows who the up and coming newcomers might be.

Another useful aspect to the skills matrix is that it helps to overcome potentially damaging attitudinal norms in the relationships between workers. An example of this is the situation where an apprentice was treated appropriately as a junior when he first began. Over time the apprentice developed greater and greater levels of capability and competency, and achieved a limited accreditation, to the extent that he was outperforming older, supposedly more experienced workers. However, because of his "junior" social status, he was never consulted in problem-solving brainstorming sessions, which caused a considerable degree of angst until a new apprentice was taken on. It was only then that the social norms of the workforce changed to recognise his experience status; his insights were valued and he began to be involved in new knowledge generation.

6.4.9. Opportunities for debriefing and reflective thinking

In the busyness and hurly-burly of operational life, complex situations are constantly being encountered and overcome in the workplace, contributing to the body of experience or tacit knowledge assets. Similarly, there is a constant coming and going of people into the workplace, and from time to time existing members of the workforce receive training, all of which bring fresh insights into organisational norms.

Unfortunately, for most organisations little or no time is made available for debriefing and reflective thinking about these insights.

On those occasions where debriefing or reflective thinking does actually occur, it tends to happen in an ad hoc fashion around the Smoko room table during coffee or lunch breaks. The only people who benefit from the session tend to be the cliques who gather in social groups around the person or people who are sharing.

It seems that another problem associated with the busyness of life is that very few workers develop the necessary metacognitive skills to support reflective thinking. The practical outworking of this is that workers often do not learn from previous mistakes, and end up repeating them to the detriment of both themselves and the organisation.

By providing opportunities for debriefing and reflective thinking, organisations help workers to develop critical thinking skills and provide opportunities for learning that might otherwise be lost.

6.4.10. Effective updating of standard operating procedures

Although feedback mechanisms are useful for passing new knowledge back up the organisational hierarchy, the knowledge creation loop is not closed unless new knowledge is fed back into standard operating documentation. A problem with documented standard operating procedures and/or maintenance manuals is that they can become fossilised, i.e. dead documents that no longer have relevance to the day-to-day tasks because of new technologies, new equipment, new standards, or new knowledge.

It is important that documented procedures are seen to be living entities that grow and change over time. Workers should be encouraged to challenge the standardised procedure if they can find faster, cheaper, better ways of doing things, and the new ways need to be included in the documentation in such a manner that they effectively capture the new knowledge.

Updates to standard procedures must be written up in such a way that the workers who use them can actually make sense of the changes. In organisations with a high literacy rate it makes sense that changes are made using appropriate written jargon, but in organisations where there is a high degree of illiteracy then updates need to be made with the use of photographs, diagrams, colour coding or other graphic organisers that do not require reading or writing skills.

6.5. Further research

6.5.1.a. A knowledge management audit tool

An audit tool such as the example in the Appendix could be developed (see; Appendix 5: A shop floor knowledge management audit tool on page 295 in the Appendix) to evaluate the degree to which managers implement the ten knowledge management practices outlined above.

A prototype tool was tested in two of the cases, and results compared with the subjective assessments of both the research participants and the researcher. It appears that a score of less than 60% indicates *ad hoc* or serendipitous knowledge management interventions, and a score of 90% or greater is a desired level. Scores between 60% and 90% seemed to indicate some degree of knowledge management activity, but with plenty of room for improvement.

Further testing and evaluation of the tool needs to be carried out before it can be considered a reliable instrument, but the evidence suggests that even without this, an audit tool could be a useful checklist that firms can use to evaluate their tacit knowledge management practices.

Appendices

Appendix 1: Methodology – invitation to participants

This is the invitation that was sent to participants, outlining the research.

Tacit Knowledge Management at the Supervisory Level in Selected New Zealand Industries

Waikato Management School
Te Raupapa



Research Information Sheet for Participant Firms.

This is an invitation to firms to participate in important Knowledge Management research conducted by David Williams of the University of Waikato, Management School, Management Systems Department.

The purpose of the research

The purpose of the research is to investigate how tacit knowledge can be effectively managed at the supervisory level in selected New Zealand firms, with a view to improving productivity, performance, and worker conditions.

The background of the research

If one considers organisational knowledge to be of two types, tacit and explicit, Explicit Knowledge is all the knowledge in an organisation that is documented in the form of formal procedures, policies, manuals, software, and photographs etc. Tacit Knowledge on the other hand, is all the other knowledge. Tacit knowledge therefore includes experience, on-the-job learning, attitudes, motivations, and skills, i.e. all the knowledge that is in workers' heads, the knowledge that is actually used to create value.

There are many problems associated with effective tacit knowledge management (TKM), including the problems of

- ✦ identifying it (e.g. what is it),
- ✦ accessing it (e.g. who has it),
- ✦ measuring it (e.g. how much of it have they got),
- ✦ sharing it (e.g. how do you let others know it), and
- ✦ applying it (e.g. how to use it to increase productivity, reduce errors, develop new ideas, improve worker conditions, etc).

New Zealand has a reputation for having an innovative, No.8 fencing wire/can-do attitude, and a great lifestyle. However, these are under threat from a number of directions. Firstly, over the next 15 to 20 years we are likely to lose a considerable amount of tacit knowledge as the Baby Boomer generation moves into retirement. Secondly, the advent of global markets and the globalisation of technology is threatening our innovative point of difference, and thirdly we are losing a lot of young bright talent overseas in the infamous brain drain.

New Zealand desperately needs to develop a way to leverage the experience of its more experienced workers, and to integrate it with the emerging skills and talents of the upcoming techno-savvy generation, so that the country can maintain its distinct reputation and regain its position as having one of the highest standards of living in the world. One of the ways that this can be achieved, is to manage our tacit knowledge more effectively.

It has been long recognized in Academic Theory, that the effective application of tacit knowledge is key to organisational success, but little if any work has been done to understand how it can best be managed by those at the supervisory level. This research aims to help fill that gap.

□ Who is associated with the research: researcher, supervisors, sponsors, funding agencies, and institutions

David Williams – Researcher (PhD Candidate)

The lead investigator in this research is David Williams, a PhD candidate at the University of Waikato School of Management, Department of Management Systems. David is a boat builder by trade, and has many years of experience in that industry in Europe and in New Zealand, (e.g. large Super Yachts and America's Cup boats here in New Zealand). He is also a qualified teacher and manager, and currently operates his own business consultancy, specialising in knowledge management. As a result of his previous life experiences, David has developed a passionate interest in encouraging the best from people, which has resulted in his interest in research in tacit knowledge. David's research is funded mainly by the University of Waikato, through its Doctoral Scholarship program.

Contact Email: info@mwal.co.nz

David is supervised by two eminent Waikato lecturers, Professor Bob McQueen and Dr Peter Sun.

Bob McQueen – Chief Supervisor

Bob is Canadian by birth (Toronto area), and New Zealander by choice. He completed a BAPSc in Electrical Engineering from the University of Waterloo in 1969, an MBA from the Harvard Business School in 1974, and a PhD (Computer Science) from the University of Waikato in 1992. He is presently a Professor of Electronic Commerce Technologies in the Department of Management Systems, University of Waikato in Hamilton, New Zealand. Previous experience with IBM in Toronto, DEC in Vancouver, and the MBA led to the founding in 1976 of McQueen Technology, a small business in Guelph, Canada which designed and installed specialised microcomputer based data acquisition systems for six years in the packaging industry. After a stint at the University of Guelph, working on electronic group communication (the CoSy system) and the inauguration of the Bitnet/Internet extension into Canada in 1984, the McQueen family visited New Zealand for a year in 1985, fell in love with it, returned briefly to Canada for two years, and emigrated to New Zealand permanently in 1988. He started at the University of Waikato in 1988 in the Department of Computer Science, and was Chairman of the Department during 1989-90. In 1994, he transferred "across the road" to the Department of Management Systems, in the Waikato Management School. Teaching and research is in the area of electronic commerce, information technology in organisations, and knowledge management.

Contact Email: BMCQUEEN@mngtwaikato.ac.nz

Peter Sun – Second Supervisor

Peter has extensive experience in organisational management. He started his career with Coopers & Lybrand as a technical consultant and did several World Bank projects valuing assets of government owned enterprises. The privatisation of Sri Lanka's extensive tea plantations was one such project. After spending two years with Coopers & Lybrand, Peter moved to Unilever (Ceylon) Ltd as a Plant Engineer and had stints in several management positions. He worked as Unilever's Industrial Engineer, Quality Assurance Manager and finally as the head of Information Technology. After spending many years with Unilever, Peter joined MAS Holdings, a large apparel manufacturing group with operations world wide. He was the CEO for one of their manufacturing operations and later headed the diversification of MAS into information technology. Peter has a first degree in mechanical engineering, a Masters Degree in industrial engineering, and a PhD in management. His primary research interests are in the areas of organisational learning/learning organisation, and knowledge management.

Contact Email: petersun@waikato.ac.nz

□ How to contact the researcher or his supervisors.

The researcher and supervisors can be contacted at:

University of Waikato,
School of Management,
Department of Management Systems,
Private Bag 3105,
Hamilton 3240,
New Zealand.
Ph: (07) 838 4477

□ What's involved for your firm

The proposal is that the researcher will conduct a Four Phase (Participant Observation/ Data Analysis/ Action Research/ Evaluation) research program in your firm. In return, your firm will receive 4 to 6 weeks free skilled labour and the opportunity to implement cutting edge TKM techniques.

Phase 1: Participant Observation.

In the first phase, your company is invited to provide the opportunity for the researcher to engage in participant observation on the shop floor. Specifically this means that the firm will provide an appropriate employment opportunity to the researcher for a period of four to six weeks, during which he will work for you (on a voluntary basis) whilst observing tacit knowledge utilisation in your firm. The researcher has a broad range of practical and technical skills that he can apply to add value for the duration of this phase. Whilst he is working for you, he will be journaling, i.e. making notes, recording observations, (and if permission is granted, taking photographs and video) of tacit knowledge phenomena, to collect data for the research. Individual employees will be asked to participate in the research, and if they do, they will be asked to sign a consent form that will allow the researcher to collect data from them.

Phase 2: Data Analysis.

After the work period has ended, which will be determined by mutual consent, the researcher will analyse the data collected. It is expected that the analysis will reveal tacit knowledge resources, and suggest ways that tacit knowledge may be leveraged.

Phase 3: Action Research.

In the second phase, the findings from the Phase 2 Analysis will be shared with your organisation, and you are invited to collaborate with the researcher to develop appropriate tacit knowledge management interventions applicable for your situation. Your company will work with the researcher to apply and monitor these experiments over whatever timeframe is suitable to you, possibly for a period of up to twelve months. It is important during this phase that the researcher and the firm collaborate closely to design interventions that are appropriate, cost effective, and well thought out to reduce the potential for unwanted or unexpected outcomes.

Phase 4: Interventions Analysis.

At the end of the Action Research period, the researcher will evaluate the effectiveness of the interventions, and use whatever lessons have been learnt to inform future participant observations and action research in later iterations of the cycle at other participant firms. Lessons learnt will be published in suitable journals.

□ What are the benefits?

What your firm will gain	What the researcher will gain
Four to six weeks of free skilled labour	Opportunities for observations, interviews, and other data collection, as appropriate
Analysis and findings from the data	Data on organisational tacit knowledge
Development of tacit knowledge management (TKM) interventions	Collaboration from the firm to develop tacit knowledge management techniques
Training (as appropriate) and monitoring of interventions	Support for the implementation and monitoring of appropriate tacit knowledge management techniques
TKM integration with other firm initiatives	Data on the effectiveness of interventions
Report back on the effectiveness of interventions	New knowledge in the field of tacit knowledge management

Appendix 2: Subset of theoretical samples from Case 1

Theoretical Samples	Categorisation		Research Problem Theory
	Saturated Category	Category Description	
Mixing dyes, grating and weighing cheese samples, washing beakers, combining steps in a procedure to speed things up, tracing back to solve problems, remembering things that have gone wrong previously.	Activity Tacit Knowledge	making sense of events (in terms of e.g. logical processes, tasks, activities)	<p>Knowledge is tacit and explicit</p> <p>Tacit Knowledge is embodied and embrained</p> <p>Tacit Knowledge is individual and group</p> <p>Tacit Knowledge is the content of a frame of mind/ intelligence</p> <p>Tacit Knowledge is contextual</p>
Loading samples onto a weighing scale, dropping drops of reagent in a titration, measuring temperature with the back of the hand, recognising incorrect heft, kneading samples to break them up	Bodily Tacit Knowledge	making sense with one's body (in terms of e.g. movement, dexterity, exertion, balance)	
Group attitudes to safety management, comparing results with someone else for validation, sharing standards, group feelings about management decisions, group awareness of the reputation of others even when that person has never been met, collegial concerns about external audits, reaching agreement or gaining consensus about new initiatives	Community Tacit Knowledge	making sense of others (in terms of e.g. expectations, cultural and organisational norms, behaviours)	
Recognising when a result is good, or that a task is boring, having pride in following a process, feeling undervalued, recognising a distraction, trusting self, qualifying a judgement call	Personal Tacit Knowledge	making sense of self (in terms of e.g. attitudes, motivations, emotional responses, values)	
Recognising flasks rattling in a centrifuge, recognising that a noise is too loud and devising measures to reduce it	Sound Tacit Knowledge	making sense of sounds (e.g. that are heard or created)	
Recognising colour changes in a titration, when butter is sufficiently cooked, the meaning of scorch patterns in cheese in terms of fat or moisture content, finding visual matches to illustrate standards, reading a micrometer accurately, size comparisons	Visual Tacit Knowledge	making sense with what is seen (in terms of e.g. colours, shapes, patterns, perceptions)	
Interpreting documented definitions, making up words or phrases specific to the laboratory, using common terms as metaphors in cases where there are no other appropriate terms, sharing experiences and agreeing on a meaning for a word to describe that experience	Word Tacit Knowledge	making sense with words (having contextually specific meanings)	

Table 27: Theoretical samples illustrating the seven aspects of tacit knowledge

Appendix 3: Case study 2 - comparison demographic data in Cases 1 and 2

For a breakdown of the engineering staff age groupings and experience levels (compared with the labour force in Case 1), see the figures below.

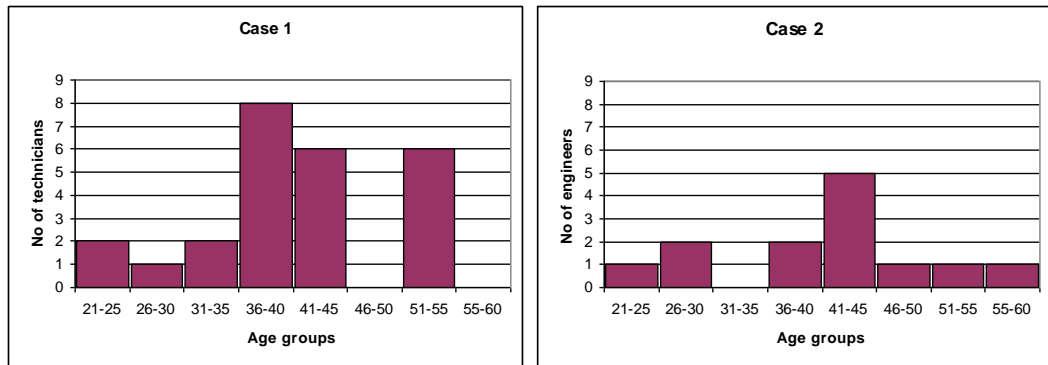


Figure 48: Age groupings at Case 2 compared with Case 1

As the charts show, the workforce age groupings for both Cases 1 and 2 had a similar spread, with the majority of the workforce in the 36 to 50 age bracket and comparable average ages, i.e. 40.7 years old for Case 1 and 40.8 years old for Case 2. The average experience with the firm was 7.8 years for the technicians in Case 1, and 8.2 years for the engineers in Case 2.

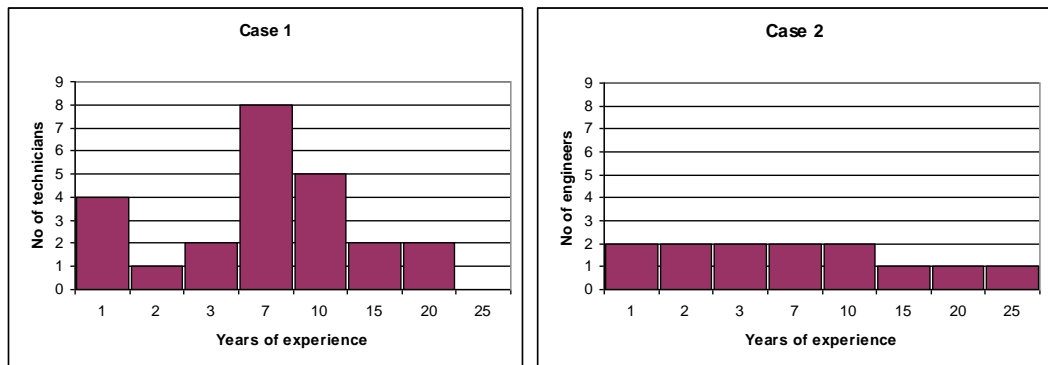


Figure 49: Years of Experience groupings at Case 2 compared with Case 1

Appendix 4: Summary of Dreyfus & Dreyfus' (1986) Levels of Competency

Five levels of competency

This section briefly reviews the generic behavioural descriptors of the five levels of competency as described in Dreyfus & Dreyfus's (1986) *Mind over Machine*, Chapter 1: Five Steps from Novice to Expert. The equivalent levels of the seven aspects of tacit knowledge are described in Table 25: Level descriptors for seven types of tacit knowledge, on page 261 above.

6.5.2. Novice

At the novice level the rules and elements of tasks are context free, which means that the novice interprets them absolutely literally. The novice recognises these elements and rules by information-processing or holistic template matching, i.e. consciously pattern matching the new with what they know already, and they feel little sense of responsibility for the outcomes because they lack a coherent sense of the overall task. The novice judges their own performance based on how well they followed rules, and unfortunate outcomes are viewed as the result of having been provided with inadequate elements or rules.

6.5.3. Familiar (Advanced beginner)

At the familiar (or advanced beginner) level, new elements related to the task are recognised as situational, but rules are both situational and still context free. At the familiar level of competency, decision-making moves away from conscious access to facts, i.e. via information-processing or template matching as at the novice level, but little responsibility is still felt for outcomes, and unfortunate outcomes are still viewed as the result of inadequate elements or rules.

6.5.4. Competent

At the competent level of performance, the worker becomes overwhelmed in their awareness of the number of context free and situational elements associated with the task, which is not helped by the lack of a sense of what is important. Because of this, the worker begins to develop hierarchical procedures for decision-making, which include planning and development of schema - mental models - and the adoption of organisational norms.

As far as task performance is concerned, the worker gives attention to the selected goal over the presence of other facts, and analytical reasoning is trumped by other goals, for example personal desires or other interests. It is at this level that a worker's psychological

conditioning comes into play as they can only pay attention to a limited number of facts. A worker begins to lose objectivity about procedures, and organising plans are chosen (either consciously or unconsciously) which crucially affect behaviours. A competent worker feels responsible and emotionally involved in outcomes.

6.5.5. Proficient

A proficient worker is deeply involved with the task, and experiences it in the context of recent events. For this reason, certain features of the task acquire salience, whilst others recede into the background as the flow of events modifies salience and triggers memories of previous successes or failures. At this level, a worker applies holistic similarity recognition, i.e. unconscious pattern recognition, to problem solving, which gives rise to intuition or intuitive behaviour (but does not preclude analysis).

6.5.6. Expert

An expert knows what to do based on a mature and practised understanding of the situation in hand. Experts are deeply involved in the task and do not make conscious plans or decisions, but just do what normally works. Their performance is ongoing and nonreflective, and only atypical circumstances draw on critical reflection or intuitive thinking. To an expert, all situations are evaluated as similar to prior instances -simultaneously with their associated decisions, actions or tactics, and are "chunked". This chunking is done through the recognition of functional equivalents of configuration, and attempts to justify an intuition are rationalised by trying to find a valid explanation or by inventing a reason. Overall behaviour, particularly in atypical circumstances, is arational, i.e., neither rational nor irrational, and performed without reference to conscious analytical decomposition and recombination of rules and/or elements.

Appendix 5: A shop floor knowledge management audit tool



Shopfloor Knowledge Management Audit

Please indicate how often the management team* applies the following -

Management Intervention	Never	Rarely	Sometimes	Mostly	Always	
Survey Date: ____/____/____	1	2	3	4	5	
1. Consistent Application of Rules, Policies, Procedures						
2. Use of Feedback Mechanisms (e.g. Supervisor Reports, Engineering notices, Staff Memos, meeting agenda)						
3. Maintenance of Histories & Memorabilia (e.g. record of things that brought us Fame or Shame)						
4. Understanding of organisational naming systems (e.g. ATA Chapters, Parts Inventory,)						
5. Use of Licensing and Accreditations (e.g. Licences, Certificates, Type Approvals)						
6. Maintenance of Open Communication Channels (e.g. access to Supervisors/ Management by workers)						
7. Visibility of Organisational Charts (e.g. lines of authority, accountability, responsibility, shift planning)						
8. Publishing of Skills Matrices & Training Programs						
9. Opportunities for debriefing/ reflective thinking (e.g. after training, or post extra-ordinary events)						
10. Effective updating of Standard Operating Procedures/ Maintenance Manuals (e.g. documents kept current, effective and relevant)						
Total (out of 50)						
% (Total x 2)						

* includes supervisors, team leaders, forepersons, etc. (i.e. anyone in a managerial role)

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