The Sharing and Transfer of Context Specific Knowledge in a Product Support Environment

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The Sharing and Transfer of Context Specific Knowledge in a Product Support Environment

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ABSTRACT: Research on knowledge intensive services argues that service firms possess deeper expert knowledge which they co-produce and share with clients and which tends to result in context specific knowledge, (Nordin et al., 2011, Edvardsson et al., 2005, Freel, 2006, Wong and He, 2005). A key knowledge development capability is codifying this knowledge to enable its efficient transfer without losing the specialisation and context specific nature from which its value derives. A case study is presented of a knowledge intensive service company providing product support for business clients' technical hardware and software problems through codification of solution procedures within their applicable contexts. This paper examines the effects of codification on how service work is performed and how the client relationship is structured. It finds that increased codification resulted in workers engaging in a number of informal work practices that improved the re-use of codified service procedures, increased their problem-solving capabilities and made the service provision function more efficient for the firm.

KEYWORDS: Knowledge Intensive Firm, Product Support, Service Industry, Knowledge Sharing, Knowledge Transfer, Context Specificity.

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1 INTRODUCTION

This paper examines how technical, context specific knowledge was transferred and shared by product support workers to solve clients' problems. The next section argues that increasing knowledge intensity means that firms' value lies in their ability to manage knowledge and that for knowledge intensive service firms this requires a balance between engaging in co-production with clients to develop customised solutions and leveraging knowledge through standardisation. Section 3 examines knowledge transfer and knowledge sharing, firstly by outlining different applicable knowledge types, then considering the context specificity in which they may be re-used. It then examines how codification could be achieved for knowledge transfer before taking into account the actors involved and how the nature of their relationship might affect the degree to which knowledge is shared. A case study design was employed with data collected from multiple sources and analysed inductively, as outlined in section 4. Details of the case company and its knowledge intensity are outlined in section 5 while section 6 examines three work practices to gain an understanding of how context specific knowledge is shared and transferred. Though the firm used information systems to standardise and leverage codified client solutions, which had the potential to standardise work and deskill workers this research, by examining informal work practices found that employees engaged in actions that provided additional value to the firm while simultaneously making them more valuable to the firm. Finally, section 7 discusses the conclusions reached and outlined implications from the research.

2 KNOWLEDGE BASED THEORY AND SERVICE FIRMS

Firms exist, according to the knowledge based theory of the firm (Grant, 1996, Spender, 1996) because they possess specialised knowledge which they provide to a recipient firm. Knowledge transfer is not always necessary, not just because the knowledge is hard to transfer (Szulanski, 1996), but also because, due to specialisation it is more efficient to coordinate the use of knowledge than seek its transfer (Grant, 1996) so that decision rights are co-located with the individual possessing the required knowledge (Kogut and Zander, 1992).

As outlined by Alvesson (2000) knowledge intensive firms are companies where the majority of work is of an intellectual nature, with the majority of the workforce being qualified and well educated and though he admits (Alvesson, 2001) the concept is problematic and difficult to substantiate it is argued that the concept has enough 'heuristic value' to make it useful. This perspective has been used in a number of studies (Robertson and Swan, 2004, Robertson and Swan, 2003, Swart and Kinnie, 2003). Other authors consider the diffusion of knowledge with Starbuck (1992) arguing the firm should possess esoteric rather than common widely shared knowledge. Knowledge intensive firms have also been categorised by how they use their knowledge such as those that use knowledge to provide customised solutions to customer problems (Ditillo, 2004, Sheehan, 2005).

Knowledge is important in service firms in the form of expertise related to the technical and service characteristics of goods (Gallouj and Weinstein, 1997). Indeed when the service

provided involves 'customised solutions', services have been found to be more complex than the standard service offerings provided by firms (Nordin et al., 2011), similar to those who found service jobs were more qualified than those in manufacturing (Noyelle, 1986, Gadrey, 1996, Meisenheimer, 1998).   It is rare that firms organise service provision only in-house (Kowalkowski et al., 2011).   Thus, where a service requires specialist context specific knowledge for its delivery, it may be more efficient to outsource this to another firm. This is advocated in the services literature by (Zablah et al., 2005) who argues that one reason service firms are required is the efficiency and effectiveness of knowledge coordination. Companies providing a comprehensive service offering need to manage deeper technical knowledge and the ability to integrate systems both inter- and intra-organisationally (Nordin et al., 2011).

In the case of services, knowledge transfer enables professional and service firms with global networks to provide clients with an integrated set of services (Faulconbridge, 2006). For service provision the customer is no longer seen as passive (Tuli et al., 2007, Edvardsson et al., 2005) but seen as actively working with the service provider in an act of 'co-production' (Wong and He, 2005, Freel, 2006) making knowledge sharing within this service relationship fundamental. In addition the intangible character of services makes it a difficult but also a key capability for large scale semi-standardised services to 'scale and stretch' service operations (denHertog et al., 2010).

3 CONTEXT SPECIFIC KNOWLEDGE SHARING AND TRANSFER

It has been argued that knowledge transfer and knowledge sharing have often been misused and seen as substitutes (Antonova et al., 2011). A distinction they make, used in this paper is for knowledge transfer to be seen in terms of the role played by ICTs for knowledge transmission while knowledge sharing highlights the role of individual and organisational factors.

Important factors to consider when examining knowledge sharing and transfer are: (1) what is transferred- the knowledge types that comprise the message (2) the context of the knowledge (3) the transfer mechanism used to codify the exchange (4) the actors involved and their relationship (Hamel, 1991, Jasmuddin and Zhang, 2011, Nordin et al., 2011, Perez-Nordtvedt et al., 2008, Van Wijk et al., 2008). Another important factor is the degree of 'knowledge maturity' present (Schmidt et al., 2009, Kaschig et al., 2012). These will be examined in turn.

3.1 KNOWLEDGE TYPES

When knowledge is seen as an entity or object (Hislop, 2005, Schultz, 1998) representative of the world, awaiting discovery (Schultz, 1998), then the focus moves to processes whereby tacit knowledge can be made explicit, structured and shared (Hislop, 2005).

While tacit knowledge provides sustainable competitive advantage due to its inimitability

(Grant, 1996), its rareness (Barney, 1991) means that it needs to be 'scaled up' (denHertog et al., 2010) or 'leveraged' to meet the demands for it (Coff et al., 2006, Tsai, 2001). However the act of codification reduces inimitability opening it up to involuntary transfer (Schultz and Jobe, 2001). The sustainability of codified knowledge may be lengthened through the use of protective mechanisms such as patents (Liebeskind, 1996) or where the knowledge is firm specific (Coff et al., 2006).

Explicit knowledge is seen as declarative (Zack, 1999). This may take a number of forms, the following seen as most relevant to the study. There is 'know-what' which involves the development of categories and classifications (Kingston and Macintosh, 2000). Knowledge about 'know-how' provides an understanding of the current state or products and processes (Sanchez, 1997) and procedures about errors (Zack, 1999) as well as the actions to follow (Alavi and Leidner, 2001) which can be laid out as step-by-step procedures (Lee and Strong, 2003). Another category, 'know-when' (Alavi and Leidner, 2001) relates to the ordering or timing of events (Kingston and Macintosh, 2000). Authors may also refer to codified knowledge relating to causation (Zack, 1999) involving 'know-why' that involves theoretical understanding (Sanchez, 1997) about cause and effect (Alavi and Leidner, 2001) providing rationales and justifications for events (Kingston and Macintosh, 2000) and the principles governing them (Cheung, 2006).

3.2 CONTEXT SPECIFICITY

Situations requiring improvisation give rise to context specificity (Brown and Duguid, 1991). This is of particular relevance to professional services (Alvesson, 1993, Orr, 1996) where each service transaction may result in a particular set of circumstances, either in response to a specific client problem or through production on demand (Gallouj and Weinstein, 1997). For example, Morris (2001) found consultants had to recognise and signal context differences to reassure clients the service was customised to them. When this is the case the knowledge transferred must be adapted to suit a new setting (Szulanski and Jensen, 2006, Williams, 2007). When knowledge needs to be subsequently re-used in a new context problems may result from ambiguity which decreases knowledge transfer (Simonin, 1999).

(Nordin and Kowalkowski, 2010) point out that where solutions are 'inherently customised' the outcomes are unique to the context and not generic. (Nordin et al., 2011) quoting (Olivia and Kallenberg, 2003) argue that a balance needs to be struck between standardisation, where services are transferable across markets and customisation, where they are tailored to specific customers. Less complex services require exploitation while new process orientated solutions require exploration (Kowalkowski et al., 2011a). Nordin et al. (2011) posit that to suit customer needs a compromise is possible through 'modularity' where components can be reconfigured by assembling standard products and services. This modularity is made possible through codification of knowledge. While expected in the case of knowledge that is being developed it is argued that knowledge becomes more codified and standardised over time as it matures (Schmidt et al., 2009).

3.3 KNOWLEDGE CODIFICATION

The codification process incurs direct costs in terms of time, resources, managerial attention tools and indirect costs through inappropriate application (Zollo and Winter, 2002) both of which are positively related to knowledge intensity (Balconi, 2002). While costs are initially high the return depends on the degree of knowledge re-use which incurs a low marginal cost, (Prencipe and Tell, 2001).

A prerequisite for knowledge management is that the codes used to codify knowledge must be defined (Hall, 2006), involving work from those Tsoukas (1996) calls the 'taxonomic ' camp who seek to classify knowledge. This involves the development of mutually exclusive categories for everything under consideration, (Bowker and Star, 1999) this is at the core of the technological support for managing knowledge, (Sorensen and Lund-Snis, 2001) as well as being a way of managing complexity (Carstensen and Sorensen, 1996) by seeking to diminish ambiguity.

While taxonomic classification enables a model of interpretation to be developed and stabilised it suffers from indeterminacy because knowledge of the past is being constantly revised due to new developments, (Sorensen and Lund-Snis, 2001). Indeed (Michailova and Gupta, 2005) found databases too structured and slow to provide new knowledge. Tools around the codification process seek to support an understanding of the causal links between actions and outcomes forcing causal links to be made explicit (Zollo and Winter, 2002). The codification of a new service concept or formula is an important firm capability enabling its essential elements to be transplanted to other parts of the firm (denHertog et al., 2010). At this stage initial experiences and ideas used have become more formalised, (Schmidt et al., 2009).

Knowledge is collectivised through codification in information systems (Clergeau, 2005), such as intranets, databases etc. (Michailova and Gupta, 2005), expert systems, web pages (Schultz and Jobe, 2001), simulation and modelling techniques (Steinmueller, 2000). Experts' knowledge may also be captured via video recordings (Dow and Pallaschke, 2010). Non-ICT based mechanisms used to capture tacit and less structured knowledge involve mentoring (Simonin, 1999, Swap et al., 2001), including peer-to-peer (Kram and Isabella, 1985) as well as planned socialization activities (Easterby-Smith et al., 2008) and storytelling, (Jasmuddin and Zhang, 2011, Swap et al., 2001). In instances where knowledge is very difficult to transfer more extended periods of time may be necessary requiring the firm to recruit a person with knowledge (Rosenkopf and Almeida, 2003, Simonin, 1999), personnel transfer (Inkpen and Tsang, 2005) such as moving experienced personnel (Easterby-Smith et al., 2008). Hosting recipients (Zhao and Anand, 2009), enables transfer through people working together with an expectation of learning (Mason and Leek, 2008).

3.4 ACTORS AND THEIR RELATIONSHIP

Issues relating to knowledge sources include their level of expertise (Easterby-Smith et al., 2008, Lin et al., 2005) as well as familiarity with the particular problem (Nordin and

Kowalkowski, 2010). Possession of knowledge may be insufficient because of the higher cognitive level needed to codify it (Zollo and Winter, 2002). Even when possible knowledge may not be codified for fear among sources of losing power and prestige (Easterby-Smith et al., 2008, Morris, 2001). For recipients a key issue is how to use that knowledge (Lin et al., 2005). Absorptive capacity (Cohen and Levinthal, 1990) exists at organizational and individual levels (Zhao and Anand, 2009). At the organizational level it enables technological capabilities to be extracted from alliance partners (Mowery et al., 1996), facilitates inter-firm transfer (Lane et al., 2001) as well as contributing to the amount of knowledge learned from other organizational units (Gupta and Govindarajan, 2000, Szulanski, 1996). At the individual level it is required so that recipients have the ability to use the knowledge (Bhagat et al., 2002). A problem with the re-use of transferred knowledge objects is whether they will be equally understood by the individuals involved: the predominant way of handling this is through developing a scheme of vocabulary and syntax (Jastroch and Marlowe, 2010). Cowan and Foray (1997) found it was easier to codify and diffuse knowledge within a community that can all read such codes, for example, through possessing similar experiences (Hall, 2006). The desire of a recipient to absorb knowledge was increased when it was seen as valuable (Perez-Nordtvedt et al., 2008). Individual level absorptive capacity depends on employees existing knowledge structures (Zhao and Anand, 2009). Even those who apprehend the knowledge may not be motivated to use it due to a 'not invented here' view (Szulanski, 1996).

The degree of interaction between service provider and client has been identified as a key difference between services and manufacturing activities (Gallouj and Weinstein, 1997) with services, involving more interaction and feedback from customers than manufacturing (Kindstrom and Kowalkowski, 2009). Specialisation of knowledge may result in knowledge asymmetries, such as (Tuli et al., 2007) who argued that when customers have a limited understanding of their own needs that it makes it difficult for them to explain their requirements to a solutions provider. It is argued by (Freel, 2006) that knowledge intensity is a relative concept and involves an interplay between the knowledge provider and user that is central for client participation or co-production in services.

The quality of the relationship improves the economy of transfer (Perez-Nordtvedt et al., 2008). The interaction is facilitated when there is shared vision and values between actors (Van Wijk et al., 2008) as well as a shared language and common interests (Carlile, 2004) and source-recipient ties, both in terms of frequency and trust, are posited to improve transfer (Lin et al., 2005). However, interaction may also reflect issues around the balance of power between parties (Gallouj, 2002). It is also important to consider if the relationship is arduous (Szulanski, 1996). This is particularly of concern when there is a level of competition between sender and recipient which was seen to limit knowledge transfer by (Kachra and White, 2008).

Trust is a key determinant of organizational transfer (Szulanski and Jensen, 2004, Lane et al., 2001) with its presence enabling a common language to develop that aids transfer (Perez-

Nordtvedt et al., 2008). It is a key factor in an actor's willingness to share (Inkpen and Tsang, 2005) and increases the source's willingness to help the recipient comprehend what was transferred (Lane et al., 2001). Kachra and White (2008) found that requests for know-how were affected by sources expectation of reciprocity from the potential recipient, with a greater expectation when the latter was in the same firm. It was found that some actors' considered restricting access so that their knowledge was only shared freely with those whom they trusted, (Kaschig et al., 2012).

4 RESEARCH DESIGN

A case study design was employed (Yin, 2002). This was considered appropriate because the focus was on the dynamics of a single setting where the phenomena was to be examined in it natural context (Darke et al., 1998). Case studies have been used for knowledge management research to explore how knowledge was codified and disseminated (Hazlett et al., 2008), in the development of a knowledge classification system (Walters et al., 2007) as well as systems implementation in a call centre (Minami, 2009). They are also appropriate for an examination of human action and interpretations surrounding the use of information systems (Walsham, 1995), providing rich detail on how information systems are used (Howcroft and Wilson, 2003). They are thus appropriate for both technical, systems that codify knowledge for transfer and to aid understanding of behavioural issues around knowledge sharing. The focus on a single case company limits the generalizability of the results with further research needed to develop the concepts outlined in other contexts (Yin, 2002).

4.1 DATA COLLECTION AND ANALYSIS

The data for this study was collected using multiple sources and methods including: observation, semi-structured interviews, and corporate documents. Pilot interviews and access to organisational documents provided a context to develop a set of questions and probes for the interviews, which lasted from 30 to 90 minutes, and were recorded and transcribed. They took place over all levels of experience. Permission to record was sought and anonymity was assured before each interview. Organisational documents relating to formal work practices were made available and were compared with interviewees' accounts. Another valuable source of data was access to solutions in the knowledge repository, created and used by interviewees.

Inductive qualitative techniques were employed for data analysis similar to (Orlikowski, 2002). Data was iteratively coded as the research developed with a number of themes and concepts emerging (Silverman, 2000, Coffey and Atkinson, 1996, Klein and Myers, 1999, Walters et al., 2007).   As with (Riege and O'Keeffe, 2007:362) the author stopped interviewing when a *"stable pattern of clear agreements and disagreements on core issues"* was reached. This paper focuses on an examination of those themes and concepts relevant to knowledge sharing and transfer. While the use of a single case study is a limitation of the research it is hoped that the themes and concepts developed can inform work in other

settings.

5 THE CASE COMPANY AND KNOWLEDGE INTENSITY

Pi-Corp, the case company (a pseudonym) chosen was a multi-billion dollar corporation. It provided knowledge intensive technical product support for storage hardware and associated software to large corporate customers. Like more typical call centres the department had to process as many calls as possible with the minimum number of suitable qualified personnel (Graumann et al., 2003). The company was atypical being a business-to-business call centre, a category which was found to involve higher value-added products and services and were found to be more likely to focus on service quality and customer relationship management (Holman et al., 2007).

The product support department was organised hierarchically in terms of levels of expertise. Level 1, the focus of this study, was the first point of contact, resolving standard problems for which solutions typically existed with more difficult problems transferred to higher support levels. An essential feature of knowledge intensive firms is that they rely on professional knowledge or use knowledge to produce products for their clients (Miles et al., 1995). Technical support personnel need to be able to apply a body of knowledge broader and deeper than clients to problems, though this body of knowledge may be larger than one employees' memory, and where staff may have little understanding of the clients situation (Gray and Durcikova, 2005) so that knowledge is contextually bounded (Callaghan and Thompson, 2002). Anything beyond the limits of their knowledge should be escalated (Adria and Chowdhury, 2002).

Call centres have been found to control how employees act through 'scripting' for conversational control (Callaghan and Thompson, 2002) with employees being 'heavily normed following a deeply embedded script' (Houlihan, 2001). ICTs can act to structure and pace work, monitoring and measurement of output (Ellis and Taylor, 2006, Houlihan, 2001). The case company examined used a number of information systems to support knowledge transfer and sharing including (1) monitoring software, (2) a knowledge solutions repository. The monitoring software was installed on clients' systems using a taxonomy of error codes developed by the company to identify and report problems   The knowledge repository held all documented solutions, structured into a number of sections as outlined in Table: 1.

TABLE 1 HERE

This Repository was the main information system used to capture and transfer knowledge in the firm. While the fix section permitted long passages of text the other sections were used to record factual knowledge relating to the problem. While less structured, the fix section was designed to tell readers what specific set of actions to take. The firm's information systems were configured so that only one employee could access a problem at any one time.

6 ANALYSIS OF KNOWLEDGE SHARING AND TRANSFER IN WORK PRACTICES

The following sub-sections examine three particular work practices enacted by workers: (1) problem resolution (2) fix development and (3) solution codification. Each section first examines knowledge transfer and then, for (2) and (3) knowledge sharing practices that existed, both formally and informally in the product support department.

6.1 PROBLEM RESOLUTION

Knowledge transfer was most straightforward when a codified solution to a problem existed in the repository and could be re-used. This was an efficient transfer mechanism because clients tended to use the supported products in broadly similar ways resulting in recurrent problems arising within definable contexts. Taxonomies were used to define the problem in terms of the error codes it generated and the hardware and software environments in which it arose.

TABLE 2 HERE

There was no knowledge ambiguity (Alvesson, 1993, Orr, 1996) with actions guaranteed to achieve the same outcome (Zollo and Winter, 2002). The time constraints placed on workers by a productivity metric reduced the risk of a 'not invented here' syndrome (Szulanski, 1996) and encouraged the re-use of knowledge. Trust was also increased for recipients of knowledge as they were assured the solution had been quality checked and verified.

This situation affects both level one work and client interaction. The ability to use information systems to identify and re-use explicit knowledge of a procedure had the potential to reduce the problem solving skills required as employees did not require as detailed an understanding of the knowledge domain. This could lead to a reduction in their absorptive capacity in the long term. This level of codification also meant that the 'problem resolution' portion of the service could be completed by clients. This did not reduce Pi-corps competitive position as the firms advantage was in creating the knowledge and codifying it as a solution for transfer and apprehension with solutions being made available through a customer support website. This had implications for the level one product support department. With customers now receiving the knowledge necessary to resolve their own technical problems the number of recurrent cases handled by the department decreased providing staff with proportionately more difficult, ambiguous, knowledge intensive cases.

6.2 FIX DEVELOPMENT

The introduction of new hardware & software versions led to new problems and problem contexts arising for which no solutions existed. While error code and client environment taxonomies could be used to search for and identify solutions to similar contexts knowledge ambiguity (Zollo and Winter, 2002) was present here as the actions outlined in similar solutions may not result in the required outcomes.

"*You may resolve an issue today that's unique to the customer and write out a* [repository solution] *on it but it may … manifest itself differently and your solution may not apply…you can't say oh try this, it worked for me yesterday.*" Product Support Manager

Employees at level one product support were primarily expected to close standard cases. When similar solutions made it possible to quickly resolve a new problem this was allowed. Employees were expected to escalate more difficult problems to the next support level. Thus, where the problem required specialised difficult to transfer knowledge, the work was transferred to where the knowledge resided consistent with (Kogut & Zander 1992). Escalation could occur where there was a lack of absorptive capacity or motivation on the part of the employee. Their productivity metric motivated workers to escalate difficult cases. However this research identified that some employees defined their work not in terms of the number of cases they closed in a day but rather by the depth of their problem solving skills: this motivated them to attempt to solve those problems. Where a set of actions developed by an employee resolved a problem this might remain tacit. Thus while knowledge was created, it could remain in a tacit format being, as (Alavi and Leidner, 2001) put it 'embedded in context specific actions'. Developing a fix could also require a degree of improvisation with existing solutions procedure needing to be recreated for the new context (Birkinshaw et al., 2002, Williams, 2007). If the procedure documented in a solution worked in the new context than the taxonomy could be modified thus allowing solutions to be developed in conjunction with emerging problems.

An employee could also possess the motivation to develop a fix but lack (1) the ability (Zollo & Winter, 2002) to codify a successful fix once developed (2) lack sufficient expertise (Easterby-Smith et al., 2008, Nordin & Kowalkowski, 2010) in sufficient detail. There also existed a risk that the knowledge codified in a solution could be re-used inappropriately (Lin et al., 2005) in a different context to implement a fix where employees had the motivation to develop knowledge but lacked sufficient understanding.

Formal and informal knowledge sharing mechanisms were used to support fix development. Formal mentoring (Swap et al., 2001) and staff rotation were used to develop the skills of novice employees. Novices with problems could approach their mentors who would question how they had tried to solve the problem, allowing the mentor assess the development of their skills and absorptive capacity. This enabled novices to differentiate the context specificity of solutions: when an existing solution could be used or when the context

necessitated different actions, as well as developing basic problem solving skills. Additionally, mentoring enabled novices to begin building strong ties with experienced staff members. Novices were also rotated through a number of specialist teams in their first 18 months. This provided them with a broad as well as deep understanding similar to (Liedtka et al., 1997).

While the firm expected difficult problems to be escalated this did not always happen. Within the level one department there were informal experts, prepared to share their knowledge on particular types of problems from whom employees sought help. Due to the option and expectation of escalation employees only engaged in this when sufficiently motivated. Due to the system only allowing one employee access to a problem at any time the person seeking help and the informal expert tended to work physically closely together, around a single workstation, enabling informal knowledge sharing to occur.

Two types of expert were identified during this research: those who were able to solve difficult problems, possessing know-how and know-when as well as those 'stars' who, in addition understood and could explain the underlying cause and effect relationships i.e. the know-why behind actions. Due to the voluntary nature of this knowledge sharing interaction the expert could decide the volume and difficulty of knowledge to impart. This depended on identified factors in the literature such as: recipients' absorptive capacity (Lane et al. 2001), willingness to learn (Zhao & Anand, 2009); identifiable through a series of sharing episodes where trust could be developed. For the expert there were a number of motivations. They felt an obligation to the department similar to (Coff et al., 2006) as they had been helped when they were new to the firm. Another motivation was that by being known to willingly share their knowledge less experienced employees brought the difficult problems in that area to a relevant expert. This provided experts an effective mechanism to increase their own skills by providing access to problems that would otherwise have been escalated. Though informal this practice was of value to both the firm and level one employees. For the firm, problems were solved at the lowest, and cheapest level of support. For employees it increased their problem-solving skills.

6.3 SOLUTION CODIFICATION

The objective of the repository was to initially codify a set of actions and the context in which they were applicable, augmenting contexts as new instances presented themselves. Therefore knowledge codification focused on the service to be performed rather than seeking to develop a customised solution for a unique client problem, similar to Nordin et al. (2011).

Stars, the most valuable category of worker to codify knowledge at level one were those with both know-how, know-when and know-why. The possession of know-why provided them with the ability to specify the context precisely, increasing their confidence the

solutions would not be re-used inappropriately. This increased their reputation as an informal expert gaining peer-recognition. Making their knowledge explicit was not a threat as their informal help giving practice enabled them to deepen their knowledge at a faster rate than others in their team.

> *"if you read the case you will find out who was full of bluster, and then who is the* [star] *with the punchy stuff that got it (the answer/solution) … you know and you remember them."* EXPERIENCED EMPLOYEE

Other informal experts, who could develop a fix with know-how and know-when but possessing limited know-why were reluctant to make their fix explicit in a solution. One possible explanation was that they had developed peer recognition as possessing problem-solving expertise and felt that making their knowledge explicit had the potential to reveal the limits on their knowledgability, both to other experts and to less experienced employees. As well as affecting their reputation it could reduce the difficult cases they were brought.

Stars enacted an additional informal sharing practice when it came to documenting solutions: they included a rationale that made their additional know-why about service actions explicit. While solutions were highly structured, the fix section was configured to take large amounts of text to outline the procedure. A set of comments were included in that section that explicitly outlined know-why relating to the appropriateness of context specific actions. This informal practice helped subsequent users identify the applicability of a solution to new contexts and aided subsequent modification of the procedure when necessary.

TABLE 3 HERE

This practice was another way for stars to show their depth of knowledge, not only by the act of creating a solution for knowledge transfer but, even in a very structured system, using system attributes to indicate additional depth of knowledge. Though informal it was beneficial for the firm as it increased efficiency in identifying a suitable solution, decreasing reuse errors. Rationales also aided recipients with a willingness to learn as they provided additional details not strictly needed to resolve the problem specified. It was a more efficient way than constantly updating taxonomies, given the pace of change of product development, thus avoiding the problem identified by (Sorensen and Lund-Snis, 2001) of having to constantly revise knowledge.

7 CONCLUSIONS AND IMPLICATIONS

In line with the knowledge based theory of the firm (Grant 1996) solutions were developed by those possessing specialised knowledge. This enabled them to capitalise on economies of scale in codifying solutions, which while costly, could be leveraged over their client base enabling them to stretch and scale. The recurrence of client problems enabled service procedures to be codified a priori. The explicit nature of the service provided and the ability to specify a reuse context made it possible to transfer solutions not only to Pi-Corp employees but also to clients. This was achieved using a customer self-service website. Though codification increased knowledge imitability Pi-Corp's competitive advantage was protected by two factors: (1) the web-site was only made available to customers (2) the codified knowledge was specific to the firm's products, making any involuntary transfer of little value to competitors.

This way of managing knowledge in the firm gave rise to a number of implications. There was the potential to restructure the service provider-client relationship. As the codified knowledge was firm-specific there was no risk of involuntary transfer. The codified nature of the knowledge used had the potential to deskill Pi-Corps technical support workers. By removing knowledge ambiguity, making it easier to share with clients, the firm decreased the importance of the standard support service activities, increasing the importance of its capabilities of developing and codifying new knowledge (activities taking place at a higher support level). This had the potential to reinforce and increase knowledge asymmetries between customer and service provider as well as between support levels within the service provider.

The standardisation of level one work, due to knowledge codification and transfer was further circumscribed in the case of fix development due to productivity metrics and escalation. The only formal knowledge sharing mechanisms were designed to train novice employees. However, when informal work practices were examined it was clear that employees were engaging in knowledge sharing practices that enabled more knowledge intensive services to be offered at a lower, more cost effective organisational level and reducing the risk of inappropriate knowledge re-use, benefitting the service provider. While the repository structure was designed for formal, codified knowledge transfer the lack of simultaneous access to problems or of a shared virtual workspace resulted in an environment that enabled informal person-to-person knowledge sharing. These practices were also of value to all levels of employees. They improved the problem solving skills of newer employees while developing a number of experts who were willing to share their knowledge.

Inappropriate re-use was reduced while the ability to resolve more difficult cases at the lowest level possible and employee learning were increased by the informal practice of including a rationale to codify additional know-why. While this addition reduced short-term productivity, on which employees were measured, it increased the departments (and firms) long-term efficiency. It also provided a way for employees to enhance their reputations by illustrating the depth of understanding of an area, thus increasing the likelihood their help

would be sought for difficult cases, helping to deepen their expertise. In addition the pace of change of the underlying knowledge base meant that such expert employees were not afraid that codification of their know-why would decrease their personal 'competitive advantage'. A negative consequence found was that employees who had developed a set of actions but were not confident of the depth of their understanding chose not to codify their knowledge into a solution. Thus were managers interested in increasing the number of employees codifying knowledge it would be necessary to develop interventions such as extending mentoring from novice staff to more experienced staff lacking the confidence to codify their fixes.

These findings emphasise the agency exhibited by service workers when faced with job standardisation and deskilling as service procedures became more explicit and transferable. While the actions they took benefitted both them and the firm they were surfaced by an in-depth examination for informal as well as formal work practices.

REFERENCES

Adria, M. & Chowdhury, S. D. (2002) 'Making Room for the Call Centre', *Information Systems Management,* Vol. 19**,** No. 1, pp. 71-80.

Alavi, M. & Leidner, D. E. (2001) 'Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues', *MIS Quarterly,* Vol. 25**,** No. 1, pp. 107-136.

Alvesson, M. (1993) 'Knowledge-intensive firms and the struggle with ambiguity', *Jounal of Management Studies,* Vol. 30**,** No. 6, pp. 997-1015.

Alvesson, M. (2000) 'Social Identity and the Problem of Loyalty in Knowledge-Intensive Companies', *Journal of Management Studies,* Vol. 37**,** No. 8, pp. 1101-1123.

Alvesson, M. (2001) 'Knowledge Work: Ambiguity, Image and Identity', *Human Relations,* Vol. 54**,** No. 7, pp. 863-886.

Antonova, A., Csepregi, A. & Marchev, A. (2011) 'How to Extend the ICT Used at Organizations for Transferring and Sharing Knowledge', *The IUP Journal of Knowledge Management,* Vol. IX**,** No. 1, pp. 37-56.

Balconi, M. (2002) 'Tacitness, codification of technological knowledge and the organisation of industry', *Research Policy,* Vol. 31**,** No. 3, pp. 357-379.

Barney, J. B. (1991) 'Firm Resources and Sustained Competitive Advantage', *Journal of Management,* Vol. 17**,** No. 1, pp. 99-120.

Bhagat, R. S., Harveston, P. D. & Triandis, H. C. (2002) 'Cultural Variations in the Cross-Border Transfer of Organizational Knowledge: An Integrative Framework', *Academy of Management Review,* Vol. 27**,** No. 2, pp. 204-221.

Birkinshaw, J., Nobel, R. & Ridderstrale, J. (2002) 'Knowledge as a Contingency Variable: Do the Characteristics of Knowledge Predict Organization Structure?', *Organization Science,* Vol. 13**,** No. 3, pp. 274-289.

Bowker, G. & Star, S. L. (1999) *Sorting Things Out: Classification and its Consequences,* MIT Press, Cambridge MA.

Callaghan, G. & Thompson, P. (2002) ''We Recruit Attitude': The Selection and Shaping of Routine Call Centre Labour', *Journal of Management Studies,* Vol. 39**,** No. 2, pp. 233-

254.

Carlile, P. (2004) 'Transferring, Translating and Transforming: Knowledge across Boundaries', *Organization Science,* Vol. 15**,** No. 5, pp. 555-568.

Carstensen, P. & Sorensen, C. (1996) 'From the social to the systematic: mechanisms supporting coordination in design', *Computer Supported Cooperative Work: Journal of Collaborative Computing,* Vol. 5**,** No 4, pp. 387-413.

Cheung, W. M. (2006) 'Ontological Approach of Organisational Knowledge to Support Collaborative Product Development', *Journal of Advanced Manufacturing Systems,* Vol. 5**,** No. 1, pp. 3-25.

Clergeau, C. (2005) 'ICTs and Knowledge Codification: Lessons from Front Office Call Centres', *Knowledge and Process Management,* Vol. 12**,** No. 4, pp. 247-258.

Coff, R. W., Coff, D. C. & Eastvold, R. (2006) 'The Knowledge-Leveraging Paradox: How to Achieve Scale Without Making Knowledge Imitable', *Academy of Management Journal,* Vol. 31**,** No. 2, pp. 452-465.

Coffey, A. & Atkinson, P. (1996) *Making Sense of Qualitative Data,* Sage Publications, London.

Cohen, W. M. & Levinthal, D. A. (1990) 'Absorptive Capacity: A New Perspective on Learning and Innovation', *Administrative Science Quarterly,* Vol. 35**,** No. 1, pp. 128-152.

Cowan, R. & Foray, D. (1997) 'The Economics of Codification and the Diffusion of Knowledge', *Industrial and Corporate Change,* Vol. 6**,** No. 3, pp. 595-622.

Darke, P., Shanks, G. & Broadbent, M. (1998) 'Successfully completing case study research: combining rigour, relevance and pragmatism', *Information systems Journal,* Vol. 8**,** No. 4, pp. 257-272.

Denhertog, P., Aa, W. V. D. & Jong, M. W. D. (2010) 'Capabilities for managing service innovation: towards a conceptual framework', *Journal of Service Management,* Vol. 21**,** No. 4, pp. 490-514.

Ditillo, A. (2004) 'Dealing with uncertainty in knowledge-intensive firms: the role of management control systems as knowledge integration machanisms', *Accounting, Organizations and Society,* Vol. 29**,** No. 3, pp. 401-421.

Dow, R. M. & Pallaschke, S. (2010) 'Capturing Tacit Knowledge for Spacecraft Operations in ESOC', *Systemics, Cybernetics and Informatics,* Vol. 8**,** No. 6, pp. 1-5.

Easterby-Smith, M., Lyles, M. A. & Tsang, E. W. K. (2008) 'Inter-Organizational Knowledge Transfer: Current Themes and Future Prospects', *Journal of Management Studies,* Vol. 45**,** No. 5, pp. 677-690.

Edvardsson, B., Gustafsson, A. & Roos, I. (2005) 'Service portraits in service research: a critical review', *International Journal of Sercice Industry Management,* Vol. 16**,** No. 1, pp. 107-121.

Ellis, V. & Taylor, P. (2006) ''You don't know what you've got till it's gone': re-contextualising the origins, development and impact of the call centre', *New Technology, Work and Employment,* Vol. 21**,** No. 2, pp. 107-122.

Faulconbridge, J. R. (2006) 'Stretching tacit knowledge beyond a local fix? Global spaces of learning in advertising professional service firms', *Journal of Economic Geography,* Vol. 6**,** No. 4, pp. 517-540.

Freel, M. (2006) 'Patterns of Technological Innovation in Knowledge-Intensive Business Services', *Industry and Innovation,* Vol. 13**,** No. 3, pp. 335-358.

Gadrey, J. (1996) *Services: la productivite en question,* Desclee de Brouwer, Paris.

Gallouj, F. (2002) 'Innovation in services and the attendant old and new myths', *Journal of*

Socio-Economics, Vol. 31**,** No. 2, pp. 137-154.

Gallouj, F. & Weinstein, O. (1997) 'Innovation in Services', *Research Policy,* Vol. 26**,** No. 4, pp. 537-556.

Grant, R. M. (1996) 'Toward a Knowledge-Based Theory of the Firm', *Strategic Management Journal,* Vol. 17**,** pp. 109-122.

Graumann, M., Arnold, H.-J. & Beltjes, M. (2003) 'Call Centres: A Case Study on the Interplay Between Organization and Information Technology', *The Geneva Papers on Risk and Insurance,* Vol. 28**,** No. 1, pp. 111-126.

Gray, P. H. & Durcikova, A. (2005) 'The Role of Knowledge Repositories in Technical Support Environments: Speed Versus Learning in User Performance', *Journal of Management Information Systems,* Vol. 22**,** No. 3, pp. 159-190.

Gupta, A. K. & Govindarajan, V. (2000) 'Knowledge Flows within Multinational Corporations', *Strategic Management Journal,* Vol. 21**,** pp. 473-496.

Hall, M. (2006) 'Knowledge Management and the Limits of Knowledge Management', *Journal of Knowledge Management,* Vol. 10**,** No. 3, pp. 117-126.

Hamel, G. (1991) 'Competing for competence and inter-partner learning within international strategic alliances', *Strategic Management Journal,* Vol. 12**,** pp. 83-103.

Hazlett, S. A., Mcadam, R. & Beggs, V. (2008) 'An exploratory study of knowledge flows: A case study of Public Sector Procurement', *Total Quality Management,* Vol. 19**,** No. 1-2, pp. 57-66.

Hislop, D. (2005) *Knowledge Management in Organizations: A Critical Introduction,* Oxford University Press, Oxford.

Holman, D., Batt, R. & Holtgrewe, U. (2007) The Global Call Centre Report: International Perspectives on Management and Employment. www.callcenter.org.

Houlihan, M. (2001) 'Managing to manage? Stories from the call centre floor', *Journal of European Industrial Training,* Vol. 25**,** No. 2/3/4, pp. 208-220.

Howcroft, D. & Wilson, M. (2003) 'Participation: 'bounded freedom' or hidden constraints on user involvement', *New Technology, Work and Employment,* Vol. 18**,** No. 1, pp. 2-19.

Inkpen, A. C. & Tsang, E. W. K. (2005) 'Social Capital, Networks, and Knowledge Transfer', *Academy of Management Review,* Vol. 30**,** No. 1, pp. 146-165.

Jasmuddin, S. M. & Zhang, Z. (2011) 'Transferring Stored Knowledge and Storing Transferred Knowledge', *Information Systems Management,* Vol. 28**,** No. 1, pp. 84-94.

Jastroch, N. & Marlowe, T. (2010) 'Knowledge Transfer in Collaborative Knowledge Management: A Semiotic View', *Systems, Cybernetics and Informatics,* Vol. 8**,** No. 6, pp. 6-11.

Kachra, A. & White, R. E. (2008) 'Know-How Transfer: The Role of Social, Economic/Competitive, and Firm Boundary Factors', *Strategic Management Journal,* Vol. 29**,** pp. 425-445.

Kaschig, A., Maier, R., Sandow, A., Lazoi, M., Barnes, S.-A., Bimrose, J., Bradley, C., Brown, A., Kunzmann, C., Mazarakis, A. & Schmidt, A. (2012) Technological and Organizational Arrangements Sparking Effects on Individual, Community and Organizational Learning *In:* Ravenscroft, A., Lindstaedt, S., Kloos, C. D. & Hernández-Leo, D., eds. 7th European Conference on Technology-Enhanced Learning, 18-21 September 2012 Saarbruken (Germany), Springer, pp. 180-193.

Kindstrom, D. & Kowalkowski, C. (2009) 'Development of industrial service offerings: a process framework', *Journal of Service Marketing,* Vol. 20**,** No. 2, pp. 156-172.

Kingston, J. & Macintosh, A. (2000) 'Knowledge management through multi-perspective

modelling: representing and distributing organizational memory', *Knowledge Based Systems,* Vol. 13**,** No. 2, pp 121-131.

Klein, H. K. & Myers, M. D. (1999) 'A Set of Principles for Conducting and Evaluating Interpretative Field Studies in Information systems', *MIS Quarterly,* Vol. 23**,** No. 1, pp. 67-93.

Kogut, B. & Zander, U. (1992) Knowledge of the Firm. Combinative Capabilities, and the Replication of Technology. *In:* Prusak, L. (ed.) *Knowledge in Organizations (1997).* Butterworth-Heinemann, Newtown MA.

Kowalkowski, C., Kindstrom, D. & Witell, L. (2011) 'Internalisation or externalisation? Examining organisational arrangements for industrial services', *Managing Service Quality,* Vol. 21**,** No. 4, pp. 373-391.

Kram, K. E. & Isabella, L. (1985) 'Mentoring alternatives: the role of peer relationships in career development', *Academy of Management Journal,* Vol. 28**,** No. 10, pp. 110-132.

Lane, P. J., Salk, J. E. & Lyles, M. A. (2001) 'Absorptive Capacity, Learning, and Performance in International Joint Ventures', *Strategic Management Journal,* Vol. 22**,** pp. 1139-1161.

Lee, Y. W. & Strong, D. M. (2003) 'Knowing-Why About Data Processes and Data Quality', *Journal for Management Information Systems,* Vol. 20**,** No. 1, pp. 13-39.

Liebeskind, J. P. (1996) 'Knowledge, Strategy, and the Theory of the Firm', *Strategic Management Journal,* Vol. 17**,** Winter Special Issue, pp. 93-107.

Liedtka, J. M., Haskins, M. E., Rosenblum, J. W. & Weber, J. (1997) 'The Generative Cycle: Linking Knowledge and Relationships', *Sloan Management Review,* Vol. 39**,** No 1, pp. 47-58.

Lin, L., Geng, X. & Whinston, A. B. (2005) 'A Sender-Receiver Framework for Knowledge Transfer', *MIS Quarterly,* Vol. 29**,** No. 2, pp. 197-219.

Mason, K. & Leek, S. (2008) 'Learning to build a supply network: an exploration of dynamic business models', *Journal of Management Studies,* Vol. 45**,** No 4, pp. 759-784.

Meisenheimer, J. R. (1998) 'The services industries in the 'good' versus 'bad' jobs debate', *Monthly Labor Review,* Vol. 22**,** pp. 22-47.

Michailova, S. & Gupta, A. (2005) 'Knowledge Sharing in Consulting Companies: Opportunities and Limitations of Knowledge Codification', *Journal of Information & Knowledge Management,* Vol. 4**,** No. 3, pp. 201-212.

Miles, I., Kastrinos, N., Flanagan, K., Bilderbeek, R., Denhertog, P. & Bouman, M. (1995) Knowledge Intensive Business Services: Their Role as Users, Carriers and Sources of Innovation, *In:* Eims Publication No. 15, I. P. (ed.). Luxembourg: DGX111.

Minami, C. (2009) 'The role of call centres for manufacturers', *The Marketing Review,* Vol. 9**,** No. 2, pp. 115-126.

Morris, T. (2001) 'Asserting Property Rights: Knowledge Codification in the Professional Service Firm', *Human Relations,* Vol. 54**,** No, pp. 818-838.

Mowery, D. C., Oxley, J. E. & Silverman, B. S. (1996) 'Strategic Alliances and Interfirm Knowledge Transfer', *Strategic Management Journal,* Vol. 17**,** Winter Special Issue, pp. 77-91.

Nordin, F., Kindstrom, D., Kowalkowski, C. & Rehme, J. (2011) 'The risks of providing services: Differential risk effects of the service-development strategies of customisation, bundling and range', *Journal of Service Management,* Vol. 22**,** No. 3, pp. 390-408.

Nordin, F. & Kowalkowski, C. (2010) 'Solutions offerings: a critical review and reconceptualisation', *Journal of Service Management,* Vol. 21**,** No. 4, pp. 441-459.

Noyelle, T. (1986) *New Technologies and Services: Impact on Cities and Jobs,* University of

Maryland, College Park.

Orlikowski, W. J. (2002) 'Knowing in Practice: Enacting a Collective Capability in Distributed Organizing', *Organization Science,* Vol. 13**,** No. 3, pp. 249-273.

Orr, J. E. (1996) *Talking about machines: An ethnography of the modern job,* ILR Press/Cornell University, Ithaca, NY.

Perez-Nordtvedt, L., Kedia, B. L., Datta, D. K. & Rasheed, A. A. (2008) 'Effectiveness and Efficiency of Cross-Border Knowledge Transfer: An Empirical Examination', *Journal of Management Studies,* Vol. 45**,** No. 4, pp. 714-744.

Prencipe, A. & Tell, F. (2001) 'Inter-project learning: processes and outcomes of knowledge codification in project-based firms', *Research Policy,* Vol. 30**,** No. 9, pp. 1373-1394.

Riege, A. & O'Keeffe, M. (2007) 'Intra-Organisational Knowledge Drivers in the INPD Process: The Case of Watty Limited', *Journal of International Innovation Management,* Vol. 11**,** No. 3, pp. 349-378.

Robertson, M. & Swan, J. (2003) ''Control- What Control?' Culture and Ambiguity Within a Knowledge Intensive Firm', *Journal of Management Studies,* Vol. 40**,** No. 4, pp. 831-858.

Robertson, M. & Swan, J. (2004) 'Going Public: The Emergence and Effects of Soft Bureaucracy Within a Knowledge-Intensive Firm', *Organization,* Vol. 11**,** No. 1, pp. 123-148.

Rosenkopf, L. & Almeida, P. (2003) 'Overcoming local search through alliances and mobility', *Management Science,* Vol. 49**,** No. 6, pp. 751-766.

Sanchez, R. (1997) Managing Articulated Knowledge in Competence-based Competition. *In:* Sanchez, R. & Heene, A. (eds.) *Strategic Learning and Knowledge Management.* John Wiley & Sons Ltd, New York.

Schmidt, A., Kinklemann, K., Ley, T., Lindstaedt, S., Maier, R. & Riss, U. (2009) Conceptual Foundations for a Service-Oriented Knowledge and Learning Architecture: Supporting Content, Process and Ontology Maturing. *In:* Schaffert, S., Tochtermann, K. & Pellegrini, T. (eds.) *Networked Knowledge Networked Media: Integrating Knowledge Management, New Media Technologies and Semantic Systems.* Springer, Heidelberg.

Schultz, M. & Jobe, L. A. (2001) 'Codification and tacitness as knowledge management strategies: An empirical investigation', *Journal of High Technology,* Vol. 12**,** No. 1, pp. 139-165.

Schultz, U. (1998) Investigating the Contradictions in Knowledge Management. *In:* IFIP WG 8.2 & WG 8.6 Joint Working Conference on Information Systems: Current Issues and Future Changes, 1998 Helsinki, Finland: Omnipress, Wisconsin, USA.

Sheehan, N. T. (2005) 'Why old tools won't work in the 'new' knowledge economy', *Journal of Business Strategy,* Vol. 26**,** No. 4, pp. 53-60.

Silverman, D. (2000) *Doing Qualitative Research: A Practical Handbook,* Sage Publications, London.

Simonin, B. L. (1999) 'Ambiguity and the Process of Knowledge Transfer in Strategic Alliances', *Strategic Management Journal,* Vol. 20**,** No. 7, pp. 595-623.

Sorensen, C. & Lund-Snis, U. (2001) 'Innovation through knowledge codification', *Journal of Information Technology,* Vol. 16**,** No. 2, pp. 83-97.

Spender, J. C. (1996) 'Making Knowledge the Basis of a Dynamic Theory of the Firm', *Strategic Management Journal (Winter Special Issue),* Vol. 17**,** pp. 45-62.

Starbuck, W. H. (1992) 'Learning by Knowledge-Intensive Firms', *Journal of Management Studies,* Vol. 29**,** No. 6, pp. 713-740.

Steinmueller, W. E. (2000) 'Will New Information and Communication Technologies Improve the 'Codification' of Knowledge?', *Industrial and Corporate Change,* Vol. 9**,** No. 2, pp. 361-376.

Swap, W., Leonard, D., Shields, M. & Abrams, L. (2001) 'Using Mentoring and Storytelling to Transfer Knowledge in the Workplace', *Journal of Management Information Systems,* Vol. 18**,** No. 1, pp. 95-114.

Swart, J. & Kinnie, N. (2003) 'Sharing knowledge in knowledge-intensive firms', *Human Resource Management* Vol. 13**,** No. 2, pp. 60-75.

Szulanski, G. (1996) 'Exploring Internal Stickiness: Impediments to the Transfer of Best Practice within the Firm', *Strategic Management Journal,* Vol. 17**,** Winter Special Issue, pp. 27-43.

Szulanski, G. & Jensen, R. J. (2004) 'Overcoming Stickiness: An Empirical Investigation of the Role of the Template in the Replication of Organizational Routines', *Managerial and Decision Economics,* Vol. 25, pp. 347-363.

Szulanski, G. & Jensen, R. J. (2006) 'Presumptive Adaptation and the Effectiveness of Knowledge Transfer', *Strategic Management Journal,* Vol. 27**,** pp. 937-957.

Tsai, W. (2001) 'Knowledge Transfer in Interorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance', *The Academy of Management Journal,* Vol. 44**,** No. 5, pp. 996-1004.

Tsoukas, H. (1996) 'The Firm as a Distributed Knowledge System: A Constructionist Approach', *Strategic Management Journal (Winter Special Issue),* Vol. 17**,** pp. 11-25.

Tuli, K. R., Kohli, A. K. & Bharadwaj, S. G. (2007) 'Rethinking customer solutions: from product bundles to relational bundles', *Journal of Marketing,* Vol. 71**,** pp. 1-17.

Van Wijk, R., Jansen, J. J. P. & Lyles, M. A. (2008) 'Inter- and Intra-Organizational Knowledge Transfer: A Meta-Analytic Review and Assessment of its Antecedents and Consequences', *Journal of Management Studies,* Vol. 45**,** No. 4, pp. 830-853.

Walsham, G. (1995) 'Interpretive case studies in IS research: nature and method', *European Journal of Information Systems,* Vol. 4**,** No. 2, pp. 74-81.

Walters, R., Jaselskis, E. J. & Kurtenbach, J. M. (2007) 'Classification of Knowledge within the Electrical Contracting Industry: A Case Study', *Leadership and Management in Engineering,* Vol. 7**,** No. 1, pp. 11-17.

Williams, C. (2007) 'Transfer in Context: Replication and Adaptation in Knowledge Transfer Relationships', *Strategic Management Journal,* Vol. 28**,** pp. 867-889.

Wong, P. K. & He, Z.-L. (2005) 'A comparative study of innovation behaviour in Singapore's KIBS and manufacturing firms', *The Services Industries Journal,* Vol. 25**,** No. 1, pp. 23-42.

Yin, R. K. (2002) *Case Study Research: Design and Methods,* Sage Publications, London.

Zablah, A. R., Johnston, W. J. & Bellenger, D. N. (2005) 'Transforming partner relationships through technological innovation', *Journal of Business & Industrial Marketing,* Vol. 20**,** No. 7, pp. 355-363.

Zack, M. H. (1999) 'Managing Codified Knowledge', *Sloan Management Review,* Vol. 40**,** No. 4, pp. 45-57.

Zhao, Z. J. & Anand, J. (2009) 'A Multilevel Perspective on Knowledge Transfer: Evidence from the Chinese Automotive Industry', *Strategic Management Journal,* Vol. 30**,** pp. 959-983.

Zollo, M. & Winter, S. G. (2002) 'Deliberate Learning and the Evolution of Dynamic Capabilities', *Organization Science,* Vol. 13**,** No. 3, pp. 339-351.

Table 1: Sections of a Repository Solution

Section	Description	Knowledge Type
Goals	The actions performed and documented in the fix	Know-what
Facts	Clients configuration using terms in the 'environment tree' to specify the case context	Know-what
Symptoms	Describe problem characteristics and are objective statements detailing occurrences	Know-what
Changes	Changes instituted or attempted by the client	Know-what
Cause	Links symptoms (effects) to actions (changes)	Know-why
Fix	Outlines the procedure to follow and involves explicitly documenting the sequence of actions taken	Know-how

Table 2: Examples of Typologies in the Environment Section

Environment:	Product: PI CORP Hardware PX4 Series
Environment:	Product: PI CORP Hardware PX3 Series
Environment:	PI CORP Firmware: FLARE Release 19 and later

Table 3: Rationale as part of a Solution Fix Section

Fix:	...As long as the correct VERITAS ASL packages are installed, VERITAS VxVM should know how to handle this anomaly and function as normal. The key to failover mode 1 is that when an I/O request is sent to the passive path the PI-CORP Hardware array ...