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Knowledge Management Initiatives in Offshore Software Development: Vendors' Perspectives

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Abstract: Offshore software development (OSD) is a leading business sector in the global IT marketplace, and vendors in different countries are opening software development centres to take advantage of new business opportunities. However, software development is both a technical and a social process in which various software modules are integrated, requiring ongoing interaction and synchronisation of activities between distributed stakeholders. Knowledge management (KM) strategies are applied to create knowledge consistent with client requirements, project specific features and chosen design methodologies. Building on existing KM theories with empirical evidence from ten case studies in the Asia Pacific region, within two country contexts (New Zealand and India), this research reveals the KM initiatives for enabling knowledge transfer in the OSD process at the operational, design and strategic level. The paper offers insights on how software vendors build organisational knowledge repositories as they streamline distributed tasks in different country contexts. Country-specific contexts reveal that New Zealand vendors are engaged more in project and product management and have further outsourced software development tasks to other low cost countries. The Indian vendors are involved in software construction, development of technical specialist skills and use of more formal processes. These findings emphasise implications of various sociological, cultural and technical perspectives of KM initiatives in OSD.

Keywords: Distributed knowledge management, Tacit, Explicit, Experience Capture, Software Development
Categories: D.2.7, D.2.9, M.8, M.9

1 Introduction

The current offshore outsourcing environment is re-structuring global society as new collaborative business ventures are being forged with free flow of knowledge between nations located across different time zones. The changing flow of knowledge in the field of information technology (IT) services due to offshore outsourcing (OO) has allowed both large and small organisations to establish business relationships in diverse economic, temporal and cultural locations. In the present offshore IT marketplace, businesses offering software application development and maintenance

lead the market, followed by data entry and data centre management businesses and lastly by the call centre management sector, though the picture may be changing [Gold, 05]. As offshore software development gains mainstream attention, organisations are still adopting new strategies to better manage their distributed operations, which will continue to evolve over the next decade [Eppinger, 06].

From a subject perspective, many researchers are questioning whether the association of OO lies more with economics or sociology. The emerging offshore market is blurring subject distinctions as economic processes are integrated with international federal law, geography, politics, history and other social sciences in the contemporary society. The primary motivation behind offshoring software development work for clients is cost. Based on lower per capita labour costs and available expertise in some countries, clients can benefit economically from moving as much development work offshore as possible [Gopal, 02]. However, Kaiser and Hawk argue that knowledge transfer in offshore software development (OSD) cannot be assessed as a purely economic decision [Kaiser, 04]. Both economic and social issues are associated with offshore outsourcing, which includes access to skilled personnel across the globe allowing for innovation and shared best practices, cross-site modularisation of development work and acceptance of diversity leading to bridging of gaps in internal capabilities within organisations ([Agerfalk, 06], [Gold, 05]). In emerging offshore markets, economic processes are integrated with international federal law, geography, politics, history and other contemporary social agendas. Negative issues too are associated with OO including costs related to infrastructural problems in developing countries, loss of control over intellectual property, threat of opportunistic behaviour by suppliers at the cost of clients, limited learning and innovation by clients, public relations mishaps and different legal systems of developing countries, amongst others ([Mol, 07], [Rai, 05]). Thus Ritzer and Lair have described offshore outsourcing as *"a sociology, rather than an economics"* [Ritzer, 07, page 325]. Mol notes that outsourcing described through an "economising perspective takes a static point of view" and a "dynamic picture" is needed as international outsourcing is context-dependent. Practitioners spend more time managing offshore projects and relationships with outside partners and clients. Hence, the complexity of knowledge transfer involves sociological, cultural and technological alignment across client and vendor boundaries which can be "best explained through a socialising perspective" [Mol, 07, page 167-71]. Recent work in OO indicates that globally distributed software development is undergoing continuous evolution associated with economic (cost-oriented), technical (process and design-oriented) and social (human-oriented) practices ([Smite, 10]; [Yu, 10]).

Literature presenting empirical evidence of vendor experiences in diverse national and organisational settings provides new lessons to understanding of knowledge sharing practices used and challenges faced in OSD processes [Mao, 08]. Recent studies have identified lack of empirical work addressing tactical approaches or real life processes used by practitioners (specifically vendors) to compete in the growing offshore software development sector ([Khan, 11], [Smite, 10]). Smite specifically, identifies a lack of empirical evaluation of engineering practice in industry environments pursuing distributed software development projects [Smite, 10].This study undertakes an empirical examination of distributed software development projects to investigate the key initiatives influencing knowledge

management from the offshore vendor (software provider) perspective. Researchers and policy makers have had a long fascination with the question of why certain national industries succeed: what led them to success, what factors will keep them successful and what prescriptive factors can be gleaned for other nations [Carmel, 03]. India and New Zealand are both ranked in top ten destinations as offshore service providers in the Asia Pacific region by Gartner in their 2010 survey [Longwood, 10], and are both compelling destinations for distributed software development operations.

This study explores the widespread adoption of offshore outsourcing from the Indian and New Zealand software provider perspective. It examines the strengths and challenges associated with OSD in these two countries, to bring together a comparison of the knowledge management (KM) practices for development of software projects. The research question posed in this study is: *"How do vendor organisations in different global environments (New Zealand and India) manage knowledge-based activities in offshore software development projects to be successful?"*. The aim of this study is to investigate vendor experiences and identify KM initiatives used to capture the interrelated but fragmented knowledge spread across distributed sites involving multitudes of software platforms, tools and methodologies into a common knowledge repository. The knowledge repository is continuously updated as the project evolves, and management needs to create an environment that supports mechanisms to collaborate effectively, review tasks, track progress and selectively apply changes [Lohmann, 09].

The paper is structured as follows: This section has introduced the background of the study and posed the research question. The next section reviews literature relating to the offshore software industry sector in the context of New Zealand and India, and knowledge management processes in software application development. Next, the research methodology used to answer the research question is explained. The adoption of a logical positivist lens with multiple case study design to interpret the vendors' knowledge processes with existing theory is discussed. A brief background of the ten cases from New Zealand and India are provided next. Practices associated with KM processes in ten different social and cultural settings are described. Using a cross-case analysis, the next section evaluates the key initiatives for knowledge management in ten organisational and two national contexts to interpret the vendor practices for successful project implementation. The last section summarises the findings and discusses the KM initiatives for building and sharing knowledge in offshore software development projects.

2 Current Research on Outsourcing in Asia Pacific Region

The current outsourcing environment has clients situated mostly in North America, Western Europe and Japan in which US accounts for 40% of the market, followed by Japan with 10% [Mao, 08]. To service the overseas clients, the Asia Pacific region is emerging as an alternate provider destination for niche IT services and the demand for software providers offering new technology services is expected to increase here [Longwood, 10]. Gartner's 2010 release of top ten leading locations in the Asia/Pacific region lists three regions – leaders (India and China), mature (Australia, Singapore and New Zealand) and emerging (Malaysia, Indonesia, the Philippines, Thailand and Vietnam) – as attractive destinations for offshore services [Longwood,

10]. Thus India and New Zealand are both aspirant producer nations of the emerging offshore software provider market, but differ in many respects, providing an opportunity for meaningful comparative research. Carmel and Abbot label India as a "farshore" destination based upon its distance from all major client nations, while New Zealand is identified in a "nearshore" cluster comprising of New Zealand, Australia and Singapore which cater to regional client nations. For Indian firms, nearshoring destinations represent one of the competitive threats, hence many top Indian firms are expanding their global presence by having development centers in nearshore locations (e.g., Hungary, New Zealand, Australia) ([Bradley, 09], [Carmel, 06]).

Indian software exporters presently lead the offshore outsourcing marketplace and software development represents approximately one-third of India's service exports [Eppinger, 06]. The present market shows Indian suppliers have shaped some of that market's methodologies and processes with many software organisations having adopted the Software Engineering Institute's Capability Maturity Model (CMM) and are certified at highest maturity levels (i.e., level 5) [Ramasubbu, 08]. The Indian government has introduced Software Technology Parks (STPs), which offer benefits of reduced customs regulations and levies. The STPs located in the export zones are geared towards exporting their own products and, to take advantage of these benefits, many software firms have established their own STPs [RajKumar, 98]. But as demand for Indian software professionals is increasing, their wages are also increasing, so profit margins are shrinking and outsourcing in India is now becoming susceptible to global competition [Farrel, 06]. Research shows that attrition rates in Indian IT facilities have risen to 30% [e.g., Mehta, 09].

New Zealand (NZ) offers a mature IT business environment and is often used as a testing ground for new technologies, for multi-nationals to prototype, trial, prove and test solutions and business models before mass roll-out to the United Kingdom, European or US markets [O'Neil, 04]. Gartner reports that New Zealand could be a potential provider for OSD jobs in some niche IT disciplines, but businesses will have to change their business methods and models to succeed [Greenwood, 04]. O'Hara states that New Zealand software development businesses lack export commercialisation strategies and labels them as "technology–enthusiasts" who "fail to understand the difference between a product and a business" [O'Hara, 05, page 16-7]. However New Zealand is underrepresented in academic literature as a nearshore provider destination and little is known about the project experiences of software development firms located there [McLeod, 09].

3 Offshore Software Development

In the last two decades, development of software has moved away from the traditional co-located model, often called onsite development, to the offshore model. The offshore software development model offers an opportunity to contract out knowledge tasks thereby significantly reducing development costs and expands software development capacity. The process gives timely access to highly qualified technical talent and increases overall flexibility and quality [Ramasubbu, 08]. Offshore contracts are typically of two types – fixed price (FP) and time and material (T&M) – with differing risk implications for offshore clients and vendors. FP contracts include

a fixed fee for the software negotiated before the start of the project, where the vendor bears the major part of the risk. While in a T&M contract, the vendor contracts out services at a certain rate and the client is responsible for monitoring the progress on the project, and so the client bears the cost of over-runs [Gopal, 08].

To capitalise on the growing outsourcing scene, clients and vendors adopt business models, such as external/buy, joint ventures and subsidiaries/build at both onshore (national) and offshore (international) locations [Prikladnicki, 07]. Outsourcing specifically for software development work is not without its challenges and requires significant changes to the organisation, processes and culture [Eppinger, 06]. Ramasabbu suggest adoption of structured process models such as capability maturity model (CMM) "have both a direct and a learning-mediated effect in mitigating the negative effect of work dispersion" [Ramasabbu, 08, page 451]. Critics of CMM warn organisations that too many structured processes restrict developer autonomy for knowledge-based jobs such as software development [Adler, 05]. The formal structured processes used in quality-level certifications (CMM, ISO) "serve as instruments of power and control" as they impose responsibilities on individuals [Sahay, 03, page 41]. Keane has noted that the best vendors rank quite high on the CMM scale of maturity. Organisations at the lower end of the CMM scale need years of effort and massive cultural change to achieve the level of process maturity present in a best-in-class outsourcer [Keane, 03].

Various technical, social and cultural processes are inherent in knowledge transfer, including the manner in which offshore partners draw upon and apply different forms of tacit-explicit, formal-informal and internal-external knowledge into the end deliverable [Sahay, 03]. Hornett states that explicit information may form the basis of knowledge sharing, unless and until the members know each other. Tacit knowledge is hard to share if members do not have a common "mental schema" of ideas and so cannot understand how "ideas compete for value and use". Additional challenges occur for knowledge sharing when team memberships cross internal boundaries into other businesses. For example, clients, partners and vendors, have different "organisational allegiance" in different work environments [Hornett, 04, page 197-9].

Knowledge builds with the progression of software module development as they go through an iterative process of design, creation, distribution, integration, utilisation and revision. Each project deliverable is evaluated for new value addition by team members situated at different boundaries. The problem is magnified due to both technical and non technical challenges. Technical challenges are related to knowledge-intensive practices associated software platforms requiring multiple products, standards, tools and methodologies [Sahay, 03]; while non-technical challenges involve cross-cultural management, communication and collaboration over distance and time and overall team dynamics [Mishra, 11]. Thus offshore software development combines existing issues associated with onshore projects with new issues related to geographical spread.

The offshore environment has resulted in hybrid work patterns as practitioners make changes to their organisational models which are spread across multiple sites and nations to establish a collaborative team culture. For instance, deployment of vendor employees at offshore client locations aids in gathering end user requirements, retaining contextual information, reducing task uncertainty and providing quicker

feedback on prototypes in the software development process [Ramasubbu, 08]. Typically for outsourced software development work, 70 to 80 percent of the work is done offshore at the vendor's site and the other 20 to 30 percent is done onshore at the customer's site [Gopal, 02]. However, this onshore-offshore mix is not static and shifts over time depending upon peaks and troughs of workload in the software development life cycle [Sahay, 03]. The onshore and offshore teams engage in knowledge sharing and, because of large time and space differences, communicate via collaborative technologies to resolve social, tactical and architectural issues. Groupware tools such as chat rooms, discussion forums and mailing lists are used to share the interrelated project knowledge (e.g., test results, upgrade issues) which is embedded into project workspaces in organisational repositories.

4 Knowledge Management in Offshore Software Development

Knowledge management (KM) theories have amalgamated from diverse research fields such as strategic management, organisational culture, artificial intelligence, quality management and organisational performance management amongst many others. However since knowledge is innately human, organisational culture theories have dominated the knowledge-based concepts [Baskerville, 06] where individual (personal) and collective (shared) work processes are transformed into knowledge-based strategies at the organisational level.

Software development is a "knowledge-intensive activity that involves a large body of knowledge (*know what*) with a strong emphasis on practice (*know how*)" [Sahay, 03, page 134]. In distributed environments, these knowledge-intensive activities involve continuous interaction between members situated at distributed sites to identify new process initiatives for coding standards, peer design reviews, quality indicators and other organisational routines, to develop common understanding through shared efforts [Slaughter, 06]. These efforts have an informational component consisting of two parts: the explicit knowledge that can be laid out formally and the tacit knowledge regarding customer, design and programming choices and working practices that cannot [Heeks, 01]. Knowledge interfacing mechanisms enabled by communication technologies (e.g., phones, emails, chat rooms) and storage technologies (e.g., document management systems, version control systems) helps distributed teams to interact and apply different forms of tacit and explicit knowledge [Leonardi, 08]. New knowledge is created through managing the relationship between tacit and explicit knowledge, and designing processes to convert tacit knowledge into explicit knowledge and vice versa [Nonaka, 95]. Different technical, social and cultural experiences are integrated into a common model through technology to bring "KM-centric behaviour into workflows directly into the development activities" [Rao, 08, page 267]. However, it is the relationship at the operational level, rather than at the executive level, that determines how technology will support knowledge integration to develop effective knowledge representations of interrelated efforts [Gold, 05].

According to Nonaka and Takeuchi, organisational knowledge is created through the interaction and conversion between tacit and explicit knowledge through processes of socialisation, externalisation, internalisation and conversion (SECI) [Nonaka, 95]. They posit that the creation and transfer of organisational knowledge

occurs through processes of conversion and assimilation through spirals moving from socialisation (tacit to tacit), via externalisation (tacit to explicit) and combination (explicit to explicit), to internalisation (explicit to tacit). The knowledge spiral emerges with the continuous and dynamic interaction of tacit and explicit knowledge as individual experiences are first articulated, then moved into concepts that are later combined with existing information. Finally the result is new knowledge as team members start 'learning by doing' [Nonaka, 95, page 71]. Figure 1 describes Nonaka and Takeuchi's SECI model for knowledge creation through dialogue, linking, learning and building processes, as tacit and explicit knowledge interact dynamically.

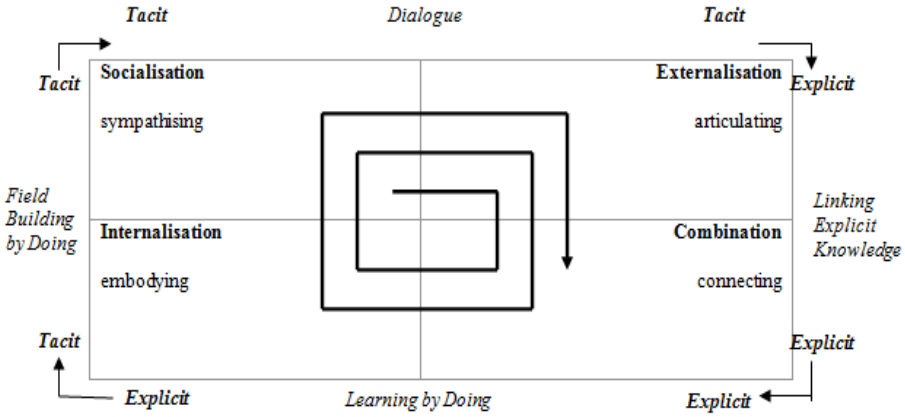

Figure 1: SECI Model [Nonaka, 95]

The SECI model is widely accepted in academic literature for knowledge creation, application and extension ([Baskerville, 06], [Choo, 06]) and has been used in diverse management studies for assessing knowledge strategies ([Joia, 02], [Rice, 05], [Sumita, 09]). Becerra-Fernandez and Sabherwal state that task contextualisation plays an important role for application of the four SECI modes in KM theories [Becerra-Fernandez, 01]. Critics of SECI argue that the model has been initially derived from purposeful managerial surveys as opposed to surveys being conducted on a broader population across other levels of management and hence some of the knowledge conversion modes are not supported by wider empirical data ([Gourlay, 03] , [Gourlay, 06]). The field of OSD is based on expertise of knowledge workers belonging to middle and higher management groupings. Moreover, the task characteristics of software development activities are confined by the organisational preferences on software development methodologies, tools, metrics and associated work practices. Thus, the adoption of SECI model for obtaining a knowledge-based view of the OSD is not limited by the critics' observations for this study.

5 Research Design

The practice of outsourcing IT functions such as software application development is "a practitioner-driven phenomenon" [Dibbern, 04, page 14]. Case studies report on

real-life IT experiences and inform us about the rapid changes occurring in the IT world as well as in organizations ([Benbasat, 87], [Dube, 03], [Yin, 03]). In case study research, field data are gathered in organisational settings to learn about the phenomenon under investigation, and are highly contextualised and based on observational evidence. A case study is "both a process of inquiry about the case and the product of that inquiry" [Stake, 03, page 88], to answer "how and why questions being asked about a contemporary set of events" [Yin, 03, page 9]. The research question posed in this study examines *how* vendor organisations in New Zealand and India manage knowledge-based activities in offshore software development projects to be successful.

Further, a multiple case study design provides the opportunity for cross-case comparisons to demonstrate the variability in context and therefore can yield generalisations and, this strengthens the experimental research findings ([Eisenhardt, 89], [Benbasat, 87], [Yin, 03]). The selection of cases needs to be specific and deliberate ([Eisenhardt, 89]; [Yin, 03]) so as to maximise what can be learned in the period of time available for the study [Dube, 03]. Two criteria were defined for selection of the vendor case studies: (1) the vendor should be involved in the business of software development and (2) the vendor should have been involved in some form of outsourcing arrangement – external/buy, joint venture or subsidiaries/build – with an offshore partner or client during the time of the interviews.

Sahay et al. suggest the use of research designs which emphasise the epistemology of empirical practice in OSD environments due to the subjective nature of the social, organisational and individual nature of processes adopted, requiring a "shared understanding of each other's products, processes and work practices" across geographical boundaries [Sahay, 03, page 36]. Using a systematic literature review focus in globally distributed software development area, recent research has identified the need for empirical evaluation of engineering practice by practitioners (specifically vendors) in different country contexts ([Khan, 11], [Smite, 10]).

The aim of this study is to investigate the real life practices involved in management of knowledge transfer within the contemporary phenomenon of offshore software development under different global settings (New Zealand and India). Methodologists have affirmed the importance of subjectivity in the phenomological society, and accordingly coined mixed approaches as logical positivism, logical empiricism or realism [Patton, 02].The multiple case study method utilising mixed research methods is the preferred research design for this study to measure empirical practice against Nonaka's SECI model theory. Semi structured interviews were conducted with senior management teams (chief executive officers, chief operations officers, chief technology officers, vice presidents, general managers) and middle management teams (project managers, developers, quality assurance personnel). Interviews helped to gather rich insights from practitioners when they described their knowledge-intensive work processes. Observations complemented the interview data and took the form of sitting with team members during project meetings, examining related project documents and software tools to understand the practitioners' processes. Each interview was transcribed verbatim by the researchers, to be as close to the conversation as possible. The textual data have been analysed to identify categories which have been contextualized with the SECI model to report on empirical findings on KM initiatives adopted by practitioners across diverse

sociological, technical and cultural boundaries. The data analysis is described later and is supported by direct quotations from notes and interviews, as raw field notes and verbatim transcripts reflect "the undigested complexity of reality", to give the reader a real world perspective [Patton, 02, page 463].

6 Research Context

The research study included five case organisations each from New Zealand and India. The five New Zealand and five Indian cases have been referred with use of pseudonyms (i.e., NZ1, NZ2, NZ3, NZ4, NZ5, IN1, IN2, IN3, IN4 and IN5) for confidentiality and brevity. A brief overview of the ten case studies has been briefly described in Table 1. The table also describes their head office locations, development centres and offshore partners (if any) and total number of employees at the development site where interviews were conducted.

Vendor Case	**Head Office (HO), Development Centres (DC) and Partners (P)**	**Total Employees (approximate)**
NZ1 (estd. 1992)	HO: Wellington, NZ DC: NZ and P: India	180
NZ2 (estd. 1980)	HO: Auckland, NZ DC: NZ, India & Australia	100
NZ3 (estd. 1993)	HO: Auckland, NZ DC: NZ and Vietnam	20
NZ4 (estd. 2000)	HO: Auckland, NZ DC: NZ & India	40
NZ5 (estd. 2004)	HO: Auckland, NZ DC: NZ and P: Australia, India & US	30
IN1 (estd. 1988)	HO: Pune, India DC: India, China & Poland	1500
IN2 (estd. 1945)	HO: Pune, India DC: India	1800
IN3 (estd. 1997)	HO: Pacifica, California DC: India	200
IN4 (estd. 1999)	HO: Toronto, Canada DC: India & Canada	100
IN5 (estd. 2001)	HO: Minneapolis, Minnesota DC: India & US	90

Table 1: Overview of Vendor Cases

Offshore outsourcing may include various combinations of degree (total, selective) and ownership by offshore partner/ purchaser (totally, partially, externally) to yield different types of outsourcing arrangements ([Carmel, 05], [Dibbern, 04], [Prikladnicki, 07]):

a. Spin-offs are situations when the ownership is internal, but the function is either totally or selectively outsourced.
b. Joint ventures are when spin-offs are jointly owned between the clients and the vendors.

c. Traditional outsourcing is when the function is completely outsourced and there is no joint ownership of resources.
d. Selective outsourcing is when the function is selectively outsourced and there is no joint ownership of resources.

Drawing directly upon above descriptions of outsourcing arrangements, the Table 2 describes the specifics of outsourcing arrangements for each of the participating vendor cases.

<table>
<tr><th rowspan="2">Degree</th><th colspan="3">Ownership</th></tr>
<tr><th>Internal</th><th>Partial</th><th>External</th></tr>
<tr><td>Total</td><td rowspan="2">Spin-offs / Wholly owned subsidiary
- IN3, IN4 and IN5 are owned by US companies
(Note: NZ3 owns a subsidiary in Vietnam)</td><td rowspan="2">Joint venture
None
(Note: NZ2 and NZ4 each have joint ventures in India)</td><td>Traditional
- IN1, IN2, NZ2, NZ3 and NZ4</td></tr>
<tr><td>Selective</td><td>Selective
- NZ1 and NZ5</td></tr>
</table>

Table 2: Outsourcing Arrangements for the Vendor Cases

Next, based upon organisational level field data collected, we have identified three dimensions, namely organisation size, cultural mix of employees at local vendor offices and the types of software development contracts (i.e., time and material and fixed) mostly entered into by vendors. The three dimensions are explained next:

1. Organisation Size: The variation in the number of employees for each of the case organisation has a wide range in the two country contexts. In view of the diverse structures of economies between New Zealand and India, the comparisons between vendor groups belonging to these nations cannot be made against one absolute number of employment measure ([Confederation of Indian Industry, 07], [Ministry of Economic Development, 08]). After discussions with government officials from New Zealand and India, this study has categorised large and SME organisations as follows: (1) In New Zealand context, organisations having number of employees over 90 are large and organisations having employees less than 90 but more than 20 are SME, (2) In Indian context, organisations having employees more than 1000 are categorised as large and organisations having less than 1000 but more than 90 are categorised as SME.
2. Multi-cultural teams: Each vendor was queried to understand the ethnicity of the employees in the main software development centre where the interviews were being conducted. The study realises that this dimension is influenced by the economic condition of the country and government policies on immigration. New Zealand with its OECD status and open immigration policy encourages knowledge professionals from other cultures to migrate, much more, as compared to India.
3. Types of Contracts: The development teams interviewed were involved in the operational aspect of the project implementation and stated they acted according to the commercial agreements of their contracts with the company. Further due to the confidential nature of offshore contractual agreements, the vendors' senior

management did not divulge much information on their contract details, other than the type of standard contracts they mostly enter into.

Table 3 summarises the field data for these three dimensions based upon organisations which share a common country culture (i.e., New Zealand and India).

New Zealand					
Dimension	**NZ1**	**NZ2**	**NZ3**	**NZ4**	**NZ5**
Organisation size*	Large	Large	SME	SME	SME
Multi –cultural teams	Yes	Yes	Yes	Yes	No
Types of contracts	T&M and FP	T&M and FP	T&M and FP	FP	FP
India					
Dimension	**IN1**	**IN2**	**IN3**	**IN4**	**IN5**
Organisation size*	Large	Large	SME	SME	SME
Multi –cultural teams	No	No	No	No	No
Types of contracts	T&M and FP	T&M and FP	FP	FP	FP

Table 3: Organisational Level Field Data

The field data reveals four large (i.e., NZ1, NZ2, IN1 and IN2) and six SME (i.e., NZ3, NZ4, NZ5, IN3, IN4 and IN5) organisations. None of the Indian vendors have a multi-cultural group of employees at their local development centres in contrast to NZ organisations where with the exception of one vendor (NZ5), the other four vendors had employed diverse cultural groups at their development centres. Finally, in both countries the SME organisations bear more risk than their clients with FP contracts between them, while the larger vendor organisations are involved in risk sharing with clients, as they enter into both FP and T&M contracts with clients. However, the exception is NZ3 who is the only SME vendor involved in risk sharing with offshore clients and enters into T&M contracts.

7 Data Collection and Analysis

Previous literature has identified both tacit and explicit knowledge as vital to extending the organisational knowledge base ([Choo, 06], [King, 08]). Organisations create their knowledge capital by organising explicit knowledge (code, test scripts and related metrics), capturing tacit knowledge (people skills, insights, relevant experiences and motivation) and integrating them into explicit knowledge domains (files, templates, coding standards and libraries). Team members interpret each other's knowledge-based activities to create new knowledge assets which are externalised into organisational repositories for future projects. The knowledge domains evolve as organisations learn and apply insights gathered from new offshore experiences.

The vendor responses affirmed the need to foster knowledge creation by capturing tacit knowledge and then disseminating the expertise and experience into

explicitly defined knowledge repositories. Takeuchi and Nonaka state that although much has been written about the importance of knowledge in management, "little attention has been paid to how knowledge is created and how the knowledge creation process is managed" [Takeuchi, 02, page 142]. KM is implemented through initiatives defined at three management levels namely operational, design and strategic. At strategic management level, core competencies and organisational risks are evaluated to design knowledge-oriented infrastructure (e.g., tools, networks, roles and responsibilities). This provides a supportive operational environment which intertwines people, processes, services and locations to foster knowledge growth [Maier, 08]. Maier has described KM initiatives at three levels for shared office spaces (e.g., floor plans, meeting room layouts, informal lounges). However, in the context of distributed software development, shared office space is virtual rather than physical, and is enabled by collaborative tools such as email, Web conferencing, telephones and chat, shared file repositories, virtual private networks and organisational portals. Analyses of the ten vendor cases have revealed KM initiatives for managing knowledge in offshore software development. The following subsections synthesises these initiatives at operational and design level for the ten cases, which are subsequently analysed and discussed at the strategic level in the subsequent section.

7.1 KM Initiatives at Operational Level

The field data revealed the operational factors influencing KM initiatives as communication, employee domain skills and change management strategies. In OSD environments, team members share knowledge through face-to-face (F2F) communication or over electronic social networks. Tacit knowledge realised through dialogue is made explicit via technology tools, such as through informal postings made on mailing lists and discussion forums, or formally through technology tools and documents in defined project workspaces. To correctly utilise the evolving knowledge assets, operational skills and expertise is needed to interpret the embedded knowledge in the project workspaces and then implement suggested updates to the project deliverables.

Communication strategies have been identified as F2F interactions between the vendor software development teams and also with the client teams using synchronous communication methods (e.g., telephone conversations, videoconferences and real time presentations), asynchronous methods (e.g., emails, blogs, discussion forums) and use of common meeting places (e.g., centralised vendor offices at offshore locations, deployment of employees at offshore client or partner sites, organisational portals) ([Powell, 04], [Sakthivel, 05]). This study has revealed that operational aspects associated with implementation of communication strategies are influenced by management hierarchy and perceptions on cultural compatibility between vendors, partners and clients in five out of the ten case organisations. However, five organisations (IN1, IN2, IN3, NZ1 and NZ3) do not consider F2F meetings between culturally diverse teams to be an issue for knowledge transfer. Of these, the three large organisations (NZ1, IN1 and IN2) have offshore offices and development centres at client countries to enable development teams to travel and work offshore as and when required. But the remaining organisations expressed some concern on cultural compatibility and do not prefer direct F2F communication, though each cited

different reasons. NZ2 expressed that similarity in cultures helped in direct communications. *"Kiwis speak Kiwi and Australians speak Australian. So it helps to use a local team because our customers are either Australians or Kiwis"*. NZ4 stated that their teams handle *"small projects"* and *"work is quite straight forward*" already having an explicit nature, hence information could easily be communicated over organisational portals. NZ5 added that they have an experienced and technical senior manager who interacts directly with offshore clients and partners to understand their local knowledge needs which is then often transferred in explicit detail into a central repository, hence offshore development teams do not need to interact directly. Two Indian vendors (IN4 and IN5) have experienced teams with similar country background as clients located at offshore centres who interact directly with clients to gather project requirements. Later these requirements are explained to the development teams in India through the organisational portal. A senior manager at IN4 voiced *"Indians sometimes find it difficult to break the ice, as the clients do not share their domain knowledge easily. So, our Canadian counterparts manage it for us through regular face-to-face meetings with clients and create some comfort level in them"*. A developer at IN5 explained their communication strategy *"the American team provides us with the clients so they are our internal clients. They talk to the client – but they are not technical people so they come back to the team here for a technical solution. So sometimes our team also gets involved with the relationship management dealings with the client but not as a regular practice"*. These actions at the operational level influence creation and build up of knowledge repositories of these firms.

Domain skills of knowledge workers have been objectified by the ten vendors as essential to understand the tacit knowledge before it can be transferred into the knowledge repository. They asserted that software development is a knowledge building exercise and requires a mix of technical and administrative skills. Rottman and Lacity state that inexperienced employees can increase both client and vendor risks, as they take a longer time to learn, and some clients "try to mitigate risk by demanding to see resumes of supplier employees or by setting minimum years of experience" [Rottman, 04, page 124]. Though, none of the vendors mentioned this aspect of the client's demands, the vendors generally agreed that employee skills and expertise play a role for proper utilisation of knowledge assets. "Software development, being primarily a learning activity," involves new assembly of knowledge when the client requirements are translated into executable form, leading to discovery of new knowledge and fine-tuning of performance of deliverables [Armour, 06, page 20]. Armour advises software development organisations to provide an environment for learning, where employees are motivated with new technologies rather than are "shutting down". Motivated employees with the required skill sets further cultivate a collaborative and sharing culture, encouraging discussions across distributed groups to share their expertise and add to the organisational repositories. This sharing of expertise is critical to support cross-training, as skills are transformed into rules, instructions, specifications, standards, methodologies, classification systems and so on [Choo, 06].

Managers were queried on two issues, namely the type of skills preferred for their employees and practices used for motivating employees to improve their skill sets and gather relevant experience. The field data reveals that generally New Zealand

organisations have preference for project management skills compared to technical skills. Most of the New Zealand vendors had transferred technical jobs which were loosely referred as *"coding"* to offshore partners in low cost countries (India and Vietnam). The Indian vendors on the other hand lay emphasis on technical skills or *"hands-on approach"* with new technologies and software platforms. The software teams in Indian organisations are involved in technical design and development of software deliverables, while their counterparts at client sites are involved in project management.

Change management (also referred to as scope management by the practitioners) is an ongoing issue for software development, as requirements change with progress of the project requiring flexible software processes. Agerfalk and Fitzgerald warn of maintaining a balance between the two extremes for managing change or project scope in global software development. One extreme is too much explicit formalisation of processes leading to meetings and "huge wordy documentation" which are "vague, poorly organised and difficult to use". The other extreme is "relying on pure tacit, undocumented knowledge" which considers changes in projects with the view that: "Code is a document and all the document we need' [Agerfalk, 06, page 29-30].

The field data reveals that with the exception of two NZ based SME vendor organisations (NZ3 and NZ4) all other organisations used formal or semi-formal processes for managing volatility in customer requirements. The two organisations NZ3 and NZ4 manage the changes in project modules informally. NZ3 believes in minimal documentation, and the director said: *"We only document the essential, and prefer using spreadsheets"*. The project manager said that direct discussions with clients are done if any major changes are requested, which are resolved amicably across the table, rather than sending the client a *"huge document listing out the seriousness of the change"*. The project manager of NZ4 compared their project histories to *"fire fighting stories"* as they do not maintain any documents to record changes that they may have made earlier. He added that with a large number of projects spanning a life cycle anywhere between five days to two weeks, the time to document changes formally *"is simply not feasible"*. The remaining eight organisations use some sort of configuration management and version control tool, to document history of changes (i.e., reason for change, date of change and seriousness level of change). Moreover the two large Indian organizations (IN1 and IN2) have been certified by international agencies (CMM, ISO) for their work processes; hence all changes – major or minor – have to compulsorily go through explicitly defined standard documentation before they can be implemented. If any discrepancy in documentations is found, they are issued a *"non compliance report during the internal audits which happen quite frequently"*. These findings are in agreement with recent studies conducted in New Zealand organisations showing a change in operational practices for bringing in more standardisation to development practice [McLeod, 09] and also with research emphasising strict discipline on development standards by Indian organisations [Ramasubbu, 08].

7.2 KM Initiatives at Design Level

Once tacit knowledge is made explicit in organisational repositories, it can be accessed across distributed sites by software teams. But the interdependent nature of software development means that team members must find a collective way of

organising and designing interfaces to access knowledge, since different groups of people share the project workspace in the common repository. Further explicit knowledge continually evolves from interaction with tacit knowledge created by individuals and teams who drive this interaction with new project experiences [Nonaka, 95]. If management does not implement appropriate designs to capture the knowledge, there is a risk of that experience being lost. This is because the owner of the experience may have been relocated to another project or may have left the organisation, taking away the valuable knowledge and experience acquired [Matturro, 10]. The field data reveals the KM initiatives at the design level account for procedures designed to guide process improvements and manage the shared knowledge repository. These include procedures to establish quality controls, manage project activities and identify measures to manage the negative impact of staff attrition, discussed next.

Quality processes encompass many aspects of the software development life cycle phases at various levels of granularity. Organisations define product and project specifications which need to be adhered to by all the stakeholders as expectations are associated with each stakeholder. Organisations may describe their intent of expectations formally or informally, depending upon their development environment. Formal processes include international accreditations by recognised agencies and include audits by outside experts on a regular basis, while less formal processes may include internal audit checks on the current processes and work progress. The study finds that both large Indian organisations (IN1 and IN2) have many quality certifications (e.g., ISO 9001, BS 7799, CMMi – level 5, PCMM – level 5), and use many formal process documents (e.g., pre-defined templates, documents referred as *"solution blueprint"* and *"design roadmap"*) for managing software development tasks. These documents outline how each task complies with relevant certifications in different functional areas, and are regularly reviewed by management and operational teams for further improvements. The CTO of IN2 added *"International certifications are considered necessary by all large Indian groups who operate globally"*. However, such formal processes with international certifications were found only in the large Indian organisations. The two large New Zealand organisations (NZ1 and NZ2) considered such certifications expensive and unnecessary as is evident by these responses made during the interview process: *"you've also got to be making enough money to support the certifications; else you pass the expense to your client"* and, *"There is no need to tell any external auditor that we are doing this. The responsibility of our quality processes lies with us"*.

None of the SME organisations in India and New Zealand had certifications, though NZ5 earlier had formal international certification for their quality processes (i.e., ISO 9001), but they had let the certifications lapse. The management of NZ5 said that having learnt the rigorous practices that went with these certifications, they now "*had templates and checklists as a baseline for improvement*" to better manage their quality processes themselves through internal audits. Overall, SME organisations used less formal processes to document quality processes and the sentiment *"Certifications aren't necessary, they're just overheads"* was shared by many of them.

Project management for distributed software development is another area identified as critical to management of evolving knowledge assets. People with

different skill sets ranging from users, domain experts, architects, developers and testers situated at different locations coordinate and align their activities in accordance with the proposed project plan. The project plans elaborate project schedules, align interrelated tasks to control project updates and keeps distributed teams on a common knowledge platform. Vendors affirmed the use of groupware technologies help to ascertain the project progress of confirmed and pending activities through status reports, allow use of standard documentation templates, and bring about version control of knowledge assets being generated at different sites. Some groupware tools mentioned by vendors are, Event Track, Project Web Server, Microsoft SharePoint, Go to Meeting, Bugzilla, PVCS, Seapine CM and TestTrack. These tools have been configured with defined process roles and individual responsibilities to enable groups to share their local knowledge. Further VoIP tools (e.g., MSN messenger, Skype) are often used to clarify issues across distributed sites. Some documents mentioned by development teams for managing project deliverables are FMEA (Failure Mode Effect Analysis) templates, SRA (Service Release Agreement), MRD (Market Requirement Document), TRD (Technical Requirement Document), ISD (Implementation Specification Document) and LD (Learning Document), amongst others.

One project manager commented: *"getting the technical development done properly is not that bad particularly the logical ride which is actually quite straight forward and most good intelligent IT people can learn the technology mental path really well but it is about getting the whole process right."*. Another interviewee described project management as *"understanding people's expectations and managing those expectations.* He explained *"For a project plan we are very transparent. Each one of us knows the project plan for each one of us. We also have a weekly update. There is a daily update in terms of issues and we have a development tracking tool called Event Track which we have bought and have synchronised between each country for our medical applications. EvTrack is a great tool and both teams work out their plans smoothly. The project deadlines are set by us. The progress reports are all sent to us and we have a team in house, both in Australia and New Zealand. We do keep a local presence here and do not send all work to be done offshore. The local presence fixes and sees to the release process. They look very seriously at acceptance testing, bug fixing and load balancing, and they communicate with partners"*. Another manager explained why project management is important, *"If a decision is made on a system, we need to clarify the rules – the whats and the whys – because we have so many things to worry about before we can bring the system into the maintenance mode. The whats and whys provide us with an opportunity for improvement. You can only do what you know, so validation of the new process is important"*.

Findings suggest that more formal project practices are followed by Indian vendor organisations opposed to New Zealand vendor organisations. Also, the large organisations (NZ2, IN1 and IN2) have designed more formal project controls than the SME organisations. The reasons for such formalisation vary with international certifications and by the nature of project tasks. Critics of such certifications have also identified too much formalisation and standardisation associated with these certifications (e.g., CMM, ISO) [Adler, 05]. One vendor (NZ2) deals with medical data of clients, and hence due to the confidential nature of related project tasks, they

have established very formal processes to maintain privacy of client data so that client data cannot be accessed inappropriately by their offshore partner.

Staff attrition has a huge impact on the software development process. Developers' skills are becoming increasingly specialised in their particular area of discipline. These skills and expertise are based on past project experiences as they create, translate, update and apply knowledge assets in software projects. Knowledge-based organisations are at a great risk of losing their professional advantage, in the event of skilled employees leaving their organisations [Mehta, 09]. However, staff turnover is an unavoidable part of any organisation, hence organisations aim to extract knowledge from individuals and convert into some form of knowledge asset in their repository for future reuse in other projects. Further, to motivate individuals to share their expertise, management encourages them through financial rewards for knowledge sharing and conforming to product quality and project schedules [Mathrani, 11].

The reasons for staff attrition have been revealed as downsizing, re-structuring, offshoring and also as a natural phenomenon commonly occurring in most knowledge-based industries. The New Zealand organisations attribute attrition mostly to downsizing, re-structuring and offshoring, while Indian organisations said staff turnover was commonly prevalent in software organisations due to the young and ambitious workforce. Overall, the staff attrition percentages have been found to be higher for the Indian vendors as compared to the New Zealand vendors. One vendor (NZ2) had recently gone through a massive restructuring as they had partnered with an Indian offshore software vendor, and this had resulted in 50% staff turnover. Other vendors (NZ2 and NZ4) have offshore centres in India, and were appreciative of additional employees working in their development centres in India. However, the other two NZ vendors (NZ3 and NZ5) said they had no issues with staff attrition in their organisations. The high attrition rate of Indian software development organisations has been reported as a major issue in literature [Dibbern, 08]. The three Indian SMEs agreed with this view voiced by one manager *"Attrition is an industry wide problem because there is a lot of demand for trained man power. After two three years when the experienced people become useful, then we have to always work on retaining these people. That retention is always such that competition has to be in line with the market. So we do a market study, find out what salaries are going on. You have to provide people with meaningful and interesting work and you have to sometimes rotate the work, so that they see new things and are not bored"*. One large Indian vendor (IN2) has a *"blanket rule"* policy of not recruiting people again, who have previously left employment from IN2 or any of its sister group of companies. This policy acts as a deterrent for employees to not leave employment at IN2, as IN2 is a subsidiary of a hugely respected conglomerate group of industries in India. However, these firms also suggested extraction and retention of as much tacit knowledge as possible from staff leaving the organisation. The staff are encouraged and mostly required to create as much documentation as possible or even share their knowledge about their work processes with the new replacement staff before leaving. A proper handover of duties including passing on relevant information also forms part of leaving process before the organisational relieving letter or experience certificate could be issued.

Regarding employee retention strategies, the study finds that all Indian vendors lay more emphasis on training and certification programmes than NZ vendors. One large vendor (IN1) has formed an academic alliance with a recognised tertiary sector from Pune and other overseas institutes, and offers a Post Graduate Diploma in Business Transformation. The other large vendor (IN2) has People CMM level 5 certification amongst other certifications. PCMM deals with the best current practices in fields such as human resources, knowledge management, and organisational development. It provides guidance to organisations to improve their processes for managing their workforces and integrate workforce professional development with process improvements to establish technical and managerial excellence.

A senior manager of an Indian SME explained: *"Software industry does not have a paradigm for comparison. The technology I started with 20 years back was very different. Every two years technology changes so all yardsticks in terms of estimates and work done are never the same. In an automobile industry if a job earlier took one hour, then at most it will come down to 40-50 minutes because of technology improvements. Here, the paradigm changes completely. Then, the people who are working with you are young and each person is different and then again their measurement yardstick is different. You generally don't have people with too much of work experience working with you all the time. So, we track projects very carefully, and measure everything'.*

Other methods to motivate employees are through financial rewards, such as having a fixed and variable component in pay, and other spot awards for low defect rates, meeting deadlines, and other value addition exercises in Indian organisations. One NZ vendor (NZ3) rewarded employees with *"bank points"* for extra skills which they may have achieved. Bank points are like *"financial rewards or quarter rewards given to employees"*. However, the bank points rewarding scheme is not considered suitable by NZ3 for their Vietnamese development teams, who are offered annual bonuses based upon their technical skills and achievements. NZ3 explained the reason that the Vietnamese teams believed in sharing the reward money by hosting lavish dinner parties for their colleagues, which often resulted in monetary loss than a monetary gain for the concerned employee.

8 Discussion

Recent studies have highlighted challenges based upon organisational size, country context and infrastructural capabilities to define a working OSD framework to "create, share and integrate information" across organisational, team and individual level processes ([Hernandez-Lopez, 10, page 32], [Khan, 11]). Organisations apply various mitigation strategies to reduce barriers in knowledge integration. The case study data reveals that to improve shared understanding, organisations use a mix of KM initiatives for socialisation, externalisation, combination and internalisation at operational and design level. Organisations provide an environment conducive for encouraging knowledge workers to contribute to the knowledge base enabled by technology and processes to capture experience and evolving knowledge assets.

The vendors are *sympathetic* to distributed team members interrelated tasks and are using socialising strategies to involve teams and share their tacit knowledge. This leads to more meaningful interactions where knowledge is *articulated* and expressed

explicitly to remove ambiguity. Proper standardisation practices (e.g., templates, libraries, blueprints) are designed which are eventually externalised in knowledge repositories. Vendors in turn reflect, *connect* and combine their externalised knowledge to advance their capabilities for future offshore projects. These vendors extend the knowledge assets gained by *embodying* the practices learnt into current and future projects and train employees on preferred work practices. In this manner individual tacit knowledge is internalised into organisational units at distributed sites.

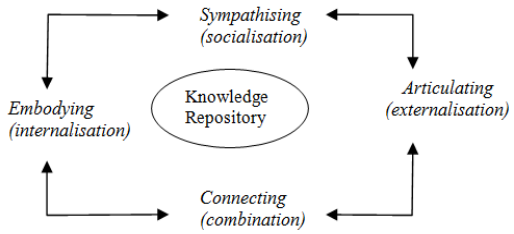

Figure 2: Application of SECI Model

The main research question asked in the study is: *"How do vendor organisations in different global environments (New Zealand and India) manage knowledge-based activities in offshore software development projects to be successful?"*. The field data have revealed the KM activities that assist in integrating *tacit* and *explicit* knowledge assets. Vendors consider many activities to build relationships, motivate personnel, manage projects, reduce uncertainty and extract project related knowledge to build organisational repositories. These activities integrate technical, social and cultural boundaries at operational level to provide insights on managerial designs for implementing knowledge-based tasks. Mol raises questions on the emerging management agenda specifically for outsourcing firms, and recommends empirical investigation of the link between outsourcing and management to explain "the notion of outsourcing as a management innovation" [Mol, 07, page 178].

Next, the knowledge-based activities identified from the field data have been broken down into the four quadrants of the SECI model (i.e., socialisation, externalisation, combination and internalisation) in Figure 3 to understand the vendors' knowledge management processes. The vendors' knowledge spiral emerges when distributed team members engage in dialogue, linking, learning and building processes to integrate their tacit and explicit knowledge assets. Figure 3 has thus been derived from existing theories (SECI, and offshore outsourcing literature) and empirical data (ten case studies) to explain vendors' knowledge sharing practices at operational and design level.

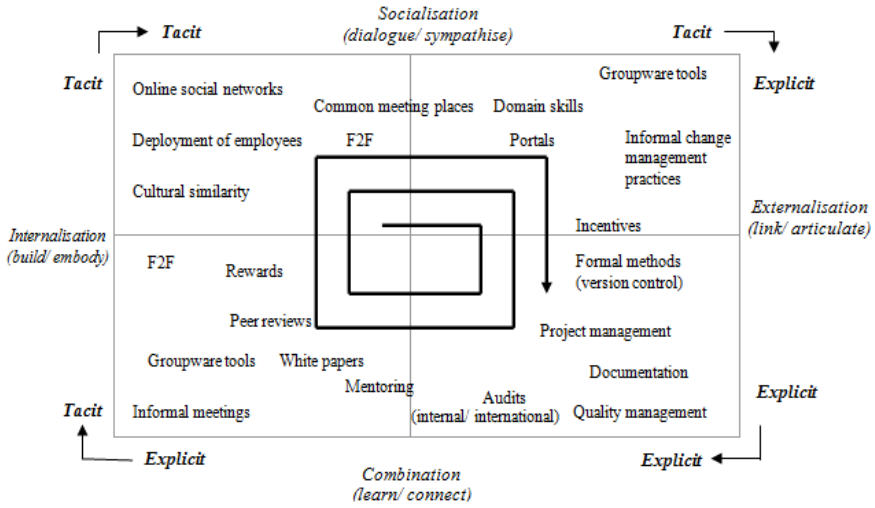

Figure 3: KM initiatives aligned with SECI Model

The above figure illustrates how the tacit and explicit knowledge interact with each other to extend the organisational knowledge repository which is shared across distributed sites. In a distributed environment knowledge developed somewhere else has to be applied at another place. Individual knowledge which is in tacit form is converted into new explicit collective knowledge held in organisational repositories. Upgrades to the knowledge repositories are made as the newly created knowledge is applied and new insights are gained from them. Such management interventions into handling knowledge (also called KM initiatives) ultimately lead to increased organisational effectiveness [Maier, 08].

Cross case searching further reveals how national and organisational contexts affect the initiatives at the strategic level for management of knowledge. The economic aspects of outsourcing favours India as a vendor destination and accordingly more software application development and services are produced there. This has influenced the labour market needs and management has identified strategic areas of competencies and gaps that need to be addressed. The environment of India favours technical and programming skills and the study confirms this. Many New Zealand organisations in conjunction with client companies have outsourced their technical activities to low cost countries such as India and Vietnam. On the other hand New Zealand vendors prefer their employees to have better project management, administrative and client-facing skills.

Organisational context such as size (large or SME) also has an influence on identifying KM initiatives at the strategic management level. The large-sized vendors in both countries operate at lower contractual risk than the SME sized vendors as large vendors enter into both time-bound or fixed price contracts (high risk) and flexible or time and material contracts (low risk). The SME vendors mostly enter into fixed-price contracts and the study finds that they are more careful in their approach with offshore clients and partners. The SME vendors have established direct client-

facing communication roles to senior management or to employees belonging to similar cultural groupings as offshore clients. These communication roles may be influenced by perceptions of risk, which makes vendors wary of what information is projected to offshore clients or partners. In this study the attrition figures are higher for the larger organisations, and these organisations have designed more formal and disciplined processes to capture project experiences and the evolving knowledge assets. Findings suggest that the Indian organisations are more susceptible to staff turnover than New Zealand organisations, and Indian firms have established more processes to motivate and retain their staff. The organisational size also influences the degree of ownership as none of the large organisations have external ownership by offshore parent groups. But while the Indian SME organisations are wholly owned subsidiaries of offshore parent groups, this was not the case for New Zealand vendors who have no external ownership. The New Zealand vendors have opened wholly owned subsidiaries and started joint venture partnerships with vendors in low cost countries.

By conducting systematic literature reviews, Khan et al. have identified a lack of outsourcing literature addressing knowledge barriers in vendor organizations when competing internationally. Through their systematic reviews, they have identified organization size to have an influence on knowledge practices, and have briefly summarized some knowledge barriers as language and cultural barriers, poor contract management, lack of control, poor infrastructure, communication gap and country instability [Khan, 11]. This study has done an in-depth investigation of both small and large vendor organisations across two countries to explain how vendors perceive these barriers, and offers new insights on design of KM initiatives adopted by vendors to overcome them. The reasons for initiatives used at operational, design and strategic level have been explained with a dynamic perspective involving social and technical processes used in knowledge transfer.

9 Conclusions

This study has brought together empirical data from ten cases across two country contexts to offer new insights on useful practices and techniques for managing knowledge. Further, this study has provided an empirical assessment of Nonaka and Takeuchi's SECI model in the offshore software development environment by examining vendors' strategies to assimilate free flowing organisational knowledge into explicit repositories. The complexity of knowledge transfer in international outsourcing is context-dependent, and accordingly KM initiatives are still evolving to overcome social, technological and institutional challenges. Several new insights for operational, design and strategic influences on KM initiatives have been offered. Investigation of diverse national and organisational settings has revealed managerial designs for day-to-day operational activities, as organisations strategically build their core competencies and bridge knowledge gaps. The study has revealed that diverse circumstances such as labour market conditions and organisational size impact KM influences. The New Zealand country context emphasise more on client relationship and project management skills since these vendors are mainly intermediaries who have further outsourced technical specialist skills to low cost countries. The Indian context, influenced by this approach, rely more on technical skills and delivery of

products to clients and intermediaries. Small organisation size involves more risk for vendors of both countries in the types of outsourcing contracts they mostly entered into, and for Indian firms, the size further influences the degree of ownership by offshore partner. Further research can study cases in other countries which are popular choices for offshoring software work to evaluate vendors approach in those countries towards KM initiatives and compare with this study.

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