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## **Closing the circle: the knowledge management spiral of project management**

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**Abstract:** Using Nonaka's conceptual framework, we present empirical findings from a study on project management knowledge-sharing practices. Following a review of key concepts on competitive advantage and project management, we present our theoretical framework and methodology. The paper places our knowledge-sharing spiral findings in the context of an earlier multivariate study. Our findings support the Socialisation-Externalisation-Combination-Internalisation knowledge transfer model, as the majority of the correlations were highest as one moved between the four quadrants; the lowest correlation was between Externalisation and Combination. Although the correlations between the four modes of knowledge sharing did not consistently show strong enough relationships to support the view that project management as a whole was a source of temporary or sustained competitive advantage, the findings support the importance of emphasising knowledge development and sharing among all four quadrants.

**Key words:** competitive advantage; empirical study; knowledge-sharing spiral; project management.

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## **1 Introduction**

'Strategy is a quest for profit', as Grant observes (Grant, 2005). Companies worldwide strive to maintain their positions in the marketplace by constantly assessing internal assets as strengths and weaknesses and by examining environmental opportunities and threats (Porter, 1998). A company's competitive advantages can vanish in the blink of an eye as rivals innovate and create new, better, or different services and products. As a result, it is a constant struggle for companies to develop a competitive advantage, let alone maintain that advantage. Innovations are fundamental to entrepreneurship and shape business success because innovations can improve an organisation's profit margin (Johannessen, Olsen and Lumpkin, 2001). Furthermore, organisational learning helps companies remain competitive and is thus synonymous with the capacity to innovate (Hurley and Hult, 1998).

In this paper, we use Nonaka's knowledge-sharing spiral (Nonaka, Toyama and Konno, 2000) to present a segment of the empirical findings from a study we did on project management as a source of competitive advantage. We focus on explicit and tacit knowledge-sharing practices. Since sources of competitive advantage tend to be intangible and are knowledge-based, we wanted to conduct an exploratory study using the knowledge spiral to assess the knowledge conversion processes used in project management. Following a brief literature review on competitive advantage in relation to the concepts of innovation and project management, we present our theoretical framework and methodology. We follow this with our results and discussion, and conclude with implications for research and practice. This paper places our findings in the context of the exploratory factor analysis and multivariate analysis findings of our previous study.

## **2 A brief overview on competitive advantage and the knowledge management literature in relation to project management**

### *2.1 Competitive advantage*

Faced with market challenges, many companies cut costs, make process improvements, restructure, sell under-performing assets and outsource non-core practices. These strategies enable companies to improve operational efficiencies and effectiveness; that is, they help companies achieve a temporary competitive advantage (Porter, 1996). However, these strategies are not effective over the long term because they can be copied by competitors. Companies that focus on developing their core competences (Hamel, 1994) and dynamic capabilities (Teece, Pisano and Shuen, 1997) to remain competitive can achieve sustained competitive advantage.

Since business success depends on competitive advantage, there is a heightened interest in the role innovation plays in helping companies remain competitive (Johannessen, Olsen and Lumpkin, 2001). A central concept of entrepreneurship involves entering markets with new or existing goods. Innovation, however, is a broader concept: it encompasses implementing new ideas, products, or processes and may not always involve new markets (Hurley and Hult, 1998). Singular innovations can readily be copied by competitors, particularly when competitors use one-off innovation to pursue other innovations (Bates and Flynn, 1995). Thus, a company must be on constant alert,

adapting to its environment and capitalising on its assets to create new innovations. These days, many companies are turning to project management to complete projects more efficiently and effectively. Project management can be viewed as the implementation of new processes, and thus it fits the definition of an organisational innovation.

As a discipline, project management has developed from engineering, decision sciences and operations management. Project management is a set of processes that encompasses the tools, techniques and knowledge-based practices applied to projects to achieve organisational goals and deliver products or services (Project Management Institute, 2004). The *guide to the Project Management Body of Knowledge (PMBOK® Guide)* describes a project as 'a temporary endeavour undertaken to create a unique product or service' (Project Management Institute, 2004). Project management involves practices based on tangible and intangible assets (DeFillippi and Arthur, 1998; Fernie et al., 2003). Tangible assets are concrete and codified whereas intangible ones are tacit. To date, most of the project management literature has focussed on the explicit and codified knowledge as shared through project management offices, methodologies and tools and techniques (Ulri and Ulri, 2000; Kloppenborg and Opfer, 2002); the implicit and tacit knowledge sharing practices warrants further study. There are also few empirical studies on knowledge management in the project management context. The 2003 issue of the *International Journal of Project Management* focused on knowledge management. These publications discussed the concepts of knowledge management but there were few empirical studies in the issue (Bresnen et al., 2003; Currie, 2003; Fernie et al., 2003; Koskinen, Pihlanto and Vanharanta, 2003; Liebowitz and Megbolugbe, 2003; Ramaprasad and Prakash, 2003; Schindler and Eppler, 2003).

To be innovative, the practices within the project management discipline would have to be different from those used by competitors. One way of achieving this edge is through the knowledge-sharing practices that are culturally embedded and unique to a firm, as opposed to explicit knowledge and tangible practices, which can be copied. Most companies have many resources (tangible and intangible assets), but few are sources of competitive advantage. Within the Resource Based View framework (Barney, 2002), a company's assets can be assessed to see how *Valuable*, *Rare* and *Inimitable* they are, as well as the degree of *Organisational Support* (VRIO) they receive within the company. Since innovations can be viewed as tangible and intangible assets stemming from within the organisation, the resource-based view of the firm is useful in assessing project management. The resource-based view is also relevant because project management is a knowledge-based practice that emphasises human and organisational assets based on explicit and tacit knowledge. Many empirical studies have been completed using the resource-based view (Cool and Schendel, 1987, Barney, 1991, 1998, 2002; Collis, 1991; Henderson and Cockburn, 1994; Huselid, Levinthal and Myatt, 1994; Jackson and Schuler, 1997; Farjoun, 1998; Castanias and Helfat, 2001; Lopez, 2001; Montealegre, 2002; Ray, Wiggins and Ruefli, 2002; Zahra and Nielsen, 2002; Barney and Muhanna, 2004).

Based on the VRIO model, a company has a *competitive disadvantage* when its resources are not valuable, rare and inimitable, and there is little organisational support. A company achieves *competitive parity* when specific resources are valuable. For a company to achieve a *temporary competitive advantage*, it needs to have resources that are both valuable and rare. Beyond this, a company needs to have certain resources that are Valuable, Rare, and Inimitable in order to have a *sustained competitive advantage*. In

the VRIO model, as a company moves from competitive parity to a sustained competitive advantage, there is increasing evidence of organisational support for these resources.

When organisational assets meet the VRIO criteria, they can be labelled strategic assets. Strategic assets involve a mix of explicit and tacit knowledge embedded in a company's unique internal skills, knowledge and resources (Rumelt, Schendel and Teece, 1994; Foss, 1997). Examples of strategic assets include quality, reputation, managerial skills, brand recognition, patents, culture, technological capability, customer focus and superior managerial skills (Castanias and Helfat, 1991; Kogut and Zander, 1993; Barney and Zajac, 1994; Chakraborty, 1997; Hawawini, Subramanian and Verdin, 2002). Interestingly, the majority of organisational assets that are sources of competitive advantage are knowledge-based. This relates to the premise that *how* companies conduct project management practices and share knowledge can contribute to their being more successful relative to competitors.

## 2.2 Tacit knowledge, explicit knowledge and absorptive capacity

Knowledge is an intangible asset that is difficult to capture using traditional accounting or financial metrics (Bontis et al., 1999). Knowledge is a unique commodity that increases in value with use (Bontis et al., 1999). The common thread between knowledge, data and information is that they involve a personal dimension (Ferne et al., 2003). A useful way of looking at knowledge is with the iceberg analogy (Nonaka and Takeuchi, 1995; Ferne et al., 2003). The tip of this iceberg represents the explicit or visible body of knowledge, such as the knowledge developed and shared through tangible project management practices. Explicit knowledge is more formal, codified and transmitted systematically (Polanyi, 1966): it is the *know-what* that can be documented. What is ignored, however, is the larger part of the iceberg, the part that is submerged and tacit. From an organisational learning perspective, it could be argued that the use of project management involves companies being innovative because of *how* they share project management knowledge as the key to creating innovative products and services is through tacit knowledge (Nonaka and Takeuchi, 1995).

The concept of absorptive capacity is rooted in the Resource Based View (Cohen and Levinthal, 1990). Absorptive capacity shows an organisation's capability to innovatively exploit the value of new, external information, assimilate it, and apply it for commercial purposes. Absorptive capacity enables organisations to adopt or implement a new idea, process, or product successfully (Hurley and Hult, 1998). Absorptive capacity connotes the concept of sharing knowledge in its various forms, explicit and tacit.

Organisations have a certain capacity to absorb new knowledge the way sponges absorb liquids (Fiol, 1996). Fiol indicates that the research that focusses on *filling the sponge* is analogous to knowledge diffusion. This literature draws from organisational change, learning theories and institutional theories. Literature on *squeezing the sponge* may be called the new product/process development literature; its focus is efficiency and effectiveness. This stream of literature looks at relationships between innovation and specialisation, functional differentiation, professionalism, participatory work environments, administrative intensity and slack resources (Damanpour, 1991). The fields of innovation diffusion and absorption have been relatively separated from the field of organisational determinants of effective new product development (Fiol, 1996). The project management literature predominantly emphasises squeezing the sponge, in terms of project management efficiency and effectiveness (Ulri and Ulri, 2000; Kloppenborg

and Opfer, 2002), but not on filling the sponge (knowledge accumulation), in terms of organisational change and learning (Koskinen, Pihlanto, and Vanharanta, 2003; Liebowitz and Megbolugbe, 2003).

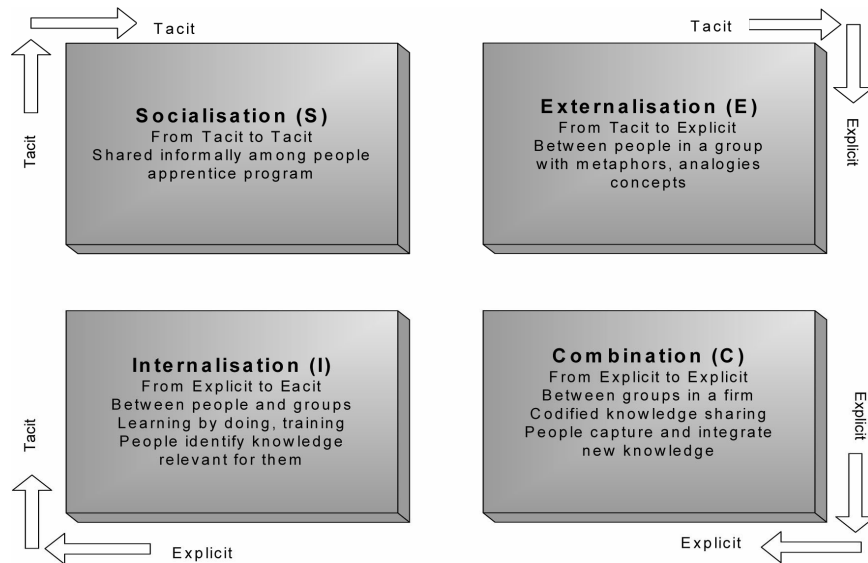
Filling the sponge, or absorbing new tacit and explicit knowledge into an organisation, however, is necessary for innovation. Tacit knowledge involves the ability to innovate. This knowledge assumes significance when considering innovation as a source of competitive advantage (Leonard and Sensiper, 1998). Tacit knowledge is personal, experiential, context-specific and rooted in action (Polanyi, 1966). Nonaka divides tacit knowledge into a technical and cognitive dimension (Nonaka and Takeuchi, 1995). The technical dimension covers informal personal skills and crafts and could be called *know-how*; the cognitive dimension involves beliefs, ideals, values and mental models. Tacit knowledge involves experiential knowledge and since it involves knowledge, which is difficult to document, people can often share their experiential knowledge through stories that involve metaphors and examples. Stories allow people to relate new concepts with those already known (Tsoukas, 1991). Such tacit knowledge is shared through socialisation (Granovetter, 1985). More specifically, project teams share what they know through communities of practice. Some in project management claim that when companies improve codified and documented project management practices along the lines of project management maturity models that assess the breadth and depth of codified knowledge (or *know-what*), project management can be a source of competitive advantage (Cabanis, 1998; Dinsmore, 1998; Ibbs and Kwak, 2000).

### 2.3 *Knowledge-sharing spiral*

Nonaka discusses four modes of knowledge conversion in the dynamic knowledge spiral (Nonaka, Byosiere, and Borucki, 1994; Nonaka, Toyama and Konno, 2000). Knowledge can be converted from tacit to tacit (through shared experiences), explicit to explicit (through information processing), explicit to tacit (often called internalising learning), and tacit to explicit (through meaningful dialogue to draw out tacit knowledge).

The above framework is also known as the S-E-C-I model whereby knowledge can be changed in four ways: Socialisation, Externalisation, Internalisation and Combination. These four processes involve knowledge capture, sharing, application and discovery. The S-E-C-I model is a dynamic spiral because knowledge is created and shared at the individual, group and organisational level.

Socialisation involves knowledge sharing through shared experiences in the same physical space. In socialisation, people work towards the same goal and strive to understand what others are doing. Socialisation converts tacit knowledge through shared experiences to new tacit knowledge. Tacit knowledge is shared by spending time together. Sharing tacit knowledge requires mutual trust and an environment where people can create and share world-views and mental models. Examples of socialisation include apprenticeships, hands-on experience and informal exchanges. Socialisation facilitates knowledge management effectiveness at the *group level* (Sabherwal and Becerra-Fernandez, 2003).

**Figure 1** Knowledge sharing spiral

Externalisation is a form of knowledge conversion that involves meaningful dialogue to draw out tacit knowledge into explicit knowledge. In externalisation, people essentially express ideas and images as words, concepts and visuals, or through figurative language (metaphors, analogies, narratives). Through externalisation, people crystallise knowledge so it can be shared with others, and they create new knowledge. Concept creation and quality control circles are two examples of externalisation. The knowledge conversion process of externalisation facilitates knowledge management effectiveness at the *individual level* (Sabherwal and Becerra-Fernandez, 2003).

Combination involves information processing, databases and codified knowledge to turn explicit knowledge into complex explicit knowledge. Through combination, people communicate complex sets of explicit knowledge by creating manuals, documents and databases so that knowledge can be used to transmit newly created concepts and create new knowledge (Nonaka, Konno, and Ryoko, 2001). The knowledge conversion process of combination facilitates knowledge management effectiveness at the *organisational level* (Sabherwal and Becerra-Fernandez, 2003).

Internalisation is a form of knowledge conversion that involves the use of common guidelines and goals related to the project so that explicit knowledge can be turned into tacit knowledge, which can be used on subsequent projects. In internalisation, people learn by doing. Examples of internalisation include training programmes, as well as reading and reflecting to enrich tacit knowledge. Other examples of internalisation include developing simulations, experimenting, benchmarking, prototyping, observing, or simply reading and listening to stories about the experiences others have had. The knowledge conversion process of internalisation facilitates knowledge management effectiveness at the *individual level* (Sabherwal and Becerra-Fernandez, 2003).

### 3 Study propositions

There is growing interest in understanding how project management can be a source of competitive advantage. In this paper, we present the exploratory findings of a study on the knowledge-sharing spiral as applied to project management. As the project management literature predominantly emphasises squeezing the sponge, there is a gap in the literature on how we can fill the sponge (knowledge accumulation) (Fiol, 1996). By examining the dimensions of knowledge-sharing practices within project management, we can incrementally work towards an improved understanding of the intangible assets in project management. This study contributes to the body of empirical work on project management as a source of competitive advantage in terms of intangible asset development. This study also contributes to the field of knowledge management.

Since the S-E-C-I model is presented as a dynamic model involving progression between the knowledge-conversion processes, we propose that the correlations between S-E-C-I in a linear manner are higher than those between S-C and E-I on the diagonals. We base this proposition on the understanding that the literature depicts the knowledge transfer process as occurring progressively between the quadrants:

**Proposition 1.** *A higher positive correlation exists as one progresses in a linear manner between S-E-C-I than going diagonally between the knowledge processes, that is, between S-C and E-I.*

Because project management is rooted in engineering and involves systematic tools, techniques and templates, we suggest that the discipline is dominated by a linear thinking mode that may not be as receptive or open to creative or free-form thinking, such as that which is implied by the externalisation knowledge process whereby tacit knowledge is made explicit. We view the externalisation process as primarily focusing on ‘filling the sponge’. As stated earlier, from a knowledge management perspective, companies focus more on ‘squeezing the sponge’ than they do on ‘filling the sponge’. The literature on externalisation indicates, “Managers perform facilitation of creative and essential dialogue, the use of ‘abductive thinking,’ the use of metaphors in dialogue for concept creation”. (Nonaka, Konno, and Ryoko, 2001). As we reflected on management practices and reviewed the literature on the externalisation process, explanations on the process did not seem to reflect the sorts of practices most project teams use, e.g., metaphors, analogies and abductive thinking. On this basis, we present our second proposition:

**Proposition 2.** *A lower positive correlation exists between the Externalisation knowledge process and the Combination knowledge process (E-C) than between the other knowledge processes.*

### 4 Methodology

In this paper, we report on the knowledge-sharing correlations from a multivariate study we completed in 2005 on project management as a source of competitive advantage as assessed using the VRIO framework (Jugdev and Mathur, 2006). In that study (where we gathered the knowledge-sharing data), we invited 2,000 randomly selected North American Project Management Institute® members to participate. Copies of the study instrument and/or a white paper on the study are available upon request. We mailed these

members an invitation to the study and included a consent form, as well as a stamped, self-addressed return letter so that they could provide us with their email address to participate. We sent interested individuals an email with the link to the survey hosted at Zoomerang<sup>®</sup>. From the initial 2,000 letters mailed, only 44 were returned by the post office due to old mailing addresses, which indicated that the Project Management Institute's<sup>®</sup> mailing list was very up to date. We received responses from 241 people indicating an interest in completing the survey, and 202 people completed the survey for a true response rate of 10.1% ( $202/2000 \times 100$ ). This is a very acceptable response rate for an internet survey (Dillman, Sinclair and Clark, 1993; Schaefer and Dillman, 1998; Boyer et al., 2001; Couper, Traugott, and Lamias, 2001; Simsek and Veiga, 2001).

A large sample helps reduce the margin of error and increases the possibility that the sample represents our population of interest, we achieved a fair response. The survey took most participants about 15–20 minutes to complete. We sent out three reminders approximately a week apart, and this dramatically improved the response rate. As an added incentive, we included all survey participants in a draw for several US\$ 50 gift certificates to Staples<sup>®</sup>. Our approach was faster and more cost effective than a mail-out survey with repeat mail reminders.

As a first step in examining project management using the knowledge-sharing spiral, we focussed on Nonaka's works (Nonaka, 1994; Nonaka, Byosiere, and Borucki, 1994; Nonaka and Takeuchi, 1995; Nonaka, Toyama, and Konno, 2000) on the knowledge conversion processes. Correlations measure the relationship between variables, but they do not indicate causation. In this paper, we focus specifically on the research question '*What are the correlations between the knowledge-sharing processes used in project management?*' We used a 7-point Likert scale with the anchors being 'Strongly Agree' and 'Strongly Disagree'. Where relevant, we included a 'Not Applicable' category. A Likert scale is appropriate when asking questions on perceptions (Tabachnick and Fidell, 2000). See Table 1 for the study instrument.

Study limitations allow readers to assess the extent to which they accept the findings of the study and believe that the findings can be generalised to a broader audience. The limitations of our study are those of a survey: we know that surveys are a snapshot in time and that whenever people are asked to provide their opinions, the views can be biased and people can forget things. This is one reason we asked participants to think about the questions in the context of the past year of their work experiences. We also know that the Project Management Institute's<sup>®</sup> mailing list is not representative of all practitioners, but it is an up-to-date list. Since we adapted our knowledge-sharing questions from publications by Nonaka and his colleagues, our items are being used for the first time. We analyzed non-response bias by conducting Chi squared tests on the participants and original mailing list of 2,000. There was no gender bias related to the response group (males: 116, 8.9%; females: 67, 9.9%) vs the non-response group (males: 1190, 91.1%; females: 608, 90.1%),  $\chi^2(1) = 0.578$ ,  $P = 0.462$ , which is not statistically significant. The reason that the response group total does not add up to 202 and the non response group does not add up to 2,000 is that some participants did not provide their gender in the study. Finally, correlations focus on pairs of variables instead of an entire set, so the results should be interpreted cautiously.



**Table 1** Excerpt from full study instrument

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**Q4 Project Management ‘Know-What’ (Combination):** ‘Know-what’ is the formal (explicit) knowledge that can be shared with others. ‘Know-what’ is easy to write down.

- 1 We share project management knowledge (know-what) through our intranet.
- 2 We share project management knowledge (know-what) through databases.
- 3 We have adequate organisational systems to share project management knowledge (know-what).
- 4 We have adequate organisational processes to share project management knowledge (know-what).
- 5 We regularly use our organisational systems and processes to share project management knowledge (know-what).

**Q5 Project Management ‘Know-How’ (Socialisation):** ‘Know-how’ (or tacit knowledge) is the personal, informal knowledge we develop through experience. ‘Know-how’ is the knowledge that resides in our hearts and minds. ‘Know-how’ is difficult to share in writing.

- 1 Our project management mentoring programme helps us be more effective on projects.
- 2 At my organisation, we share project management knowledge (know-how) by showing each other how we do things in project management.
- 3 At my organisation, we shadow each other to share project management knowledge (know-how).
- 4 We explore project management topics among ourselves through informal get togethers (e.g., over coffee, lunch, hall way chats, casual get togethers).
- 5 Constructive brainstorming is often used to improve project management practices at my organisation.

**Q6 Project Management ‘Know-How’ To ‘Know What’ (Externalisation):** Knowledge can also be shared by starting with ‘know-how’ and turning it into ‘know-what.’

- 1 At my organisation we use collective reflection to share project management knowledge. Collective reflection involves people pooling their concepts, ideas and ‘aha moments!’
- 2 Descriptive and vivid language (with metaphors and analogies) helps provide insights and may lead to ‘Aha moments!’ At my organisation, we use such practices to share ideas in project management. A metaphor is a figure of speech that makes comparisons between two things that are not likely obvious e.g. the brain is a computer. An analogy is a figure of speech that shows a relationship between two concepts to help understand a concept that is less clear, e.g. project management is like building a house.

**Q7 Project Management ‘Know-What’ To ‘Know How’ (Internalisation):** Knowledge can also be shared by starting with ‘know-what’ and turning it into ‘know-how.’

- 1 Our community of practice helps us be more effective in project management. Communities of practice are typically used to share project management ideas, problems and best practices in a collaborative manner.
  - 2 We share project management knowledge (know-what) through documented practices at my organisation, e.g. written reports, manuals, policies and procedures.
  - 3 We often share know-how through ‘war stories’ about our project experiences.
  - 4 We regularly share project lessons learned in a face-to-face manner.
  - 5 There are people at my organisation we can turn to for practical advice on projects.
  - 6 We have project management best practice databases to help us with our projects.
  - 7 Learning by doing is supported at my organisation.
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#### 4.1 *Placing the knowledge-sharing findings into the context of our multivariate study*

Before discussing the knowledge-sharing spiral findings, we would like to briefly summarise the findings from the multivariate study. In that study, we focussed on the research question ‘*What is the relationship between the tangible and intangible assets in project management, and how do they influence project management’s VRIO profile?*’ Our dependent variable was the performance of the project management process according to the VRIO criteria; and the two independent variables were tangible and intangible assets. We proposed that an investment in tangible project management assets led to competitive parity, and that an investment in intangible project management assets led to a sustained competitive advantage.

Using SPSS® v. 13, we conducted descriptive analyses including data screening, distributions and correlations. Then we used exploratory factor analysis and extracted six factors from the two independent variables (tangible and intangible assets). These six factors represented 64.05% of the total variance of the original variables. Four of the six factors represented tangible project management practices: *Project Management Maturity*, *Training and Development*, *Sharing Know-What* and *Resistance to Sharing Knowledge*. Two of the six factors represented intangible project management practices: *Sharing Know-How* and *Resistance to Sharing Know-How*. Our original conceptual model used four concepts (*Valuable*, *Rare*, *Inimitable* and *Organisational Support*) to describe the *Project Management Process Performance* (as the dependent variable). The *Valuable*, *Rare* and *Organisational Support* variables explained 55.07% of the total variance. Whereas we had proposed four concepts in our preliminary model, we did not include the fourth factor (*Inimitable*) in our study (primarily because of our smaller sample size and because it consisted of two items).

In terms of the project management process being a source of competitive advantage (the degree of VRIO), our structural equation modelling findings supported the position that tangible project management assets (Project Management Maturity and Sharing Know-What) provided a firm with a competitive disadvantage. A company has a competitive disadvantage when its resources are not Valuable, Rare and Inimitable, and there is little Organisational Support. We did, however, find that intangible project management assets (Sharing Know-How) provided firms with competitive parity through the project management process practices (assets) being valuable with organisational support. We also found that Sharing Know-How provided firms with a temporary competitive advantage as assessed by the practices (assets) being Valuable and Rare with Organisational Support.

We now turn to the results on the questions in our study that focussed on the knowledge spiral.

## 5 Results

In terms of the demographics:

- About 60% of the participants were from the US and the rest from Canada.
- The male to female participant ratio was nearly 2:1.

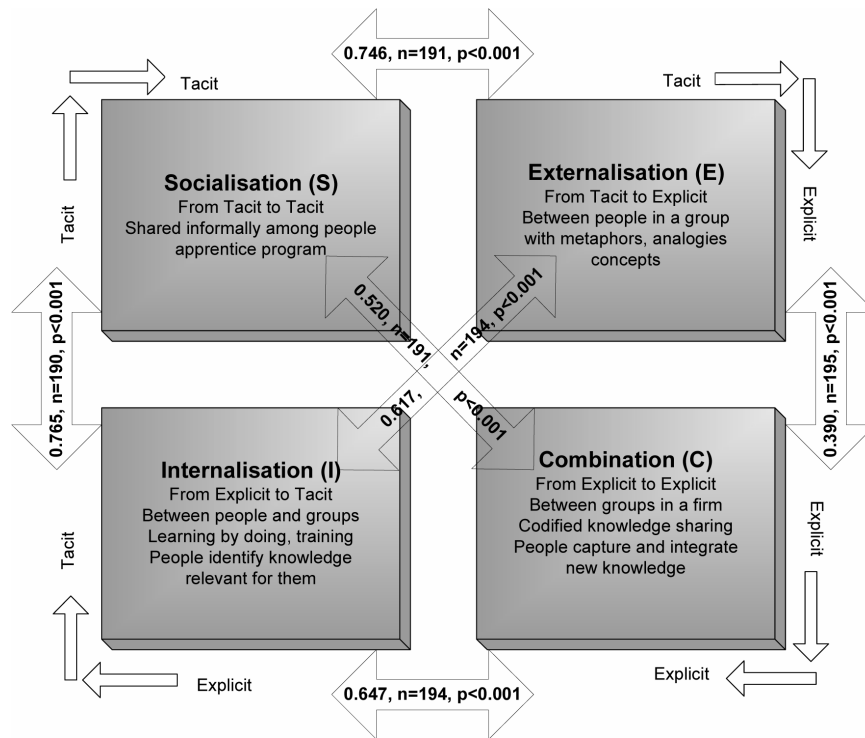
- Two thirds of the participants were between 30–49 years of age.
- Nearly three quarters of the participants had their Project Management Professional® designation.
- Well educated, over 90% have at least an undergraduate degree.
- Most participants were in middle-management positions or technical roles.
- About one third of the participants had 6-9 years of experience and about another third had 10-19 years of experience. About two thirds of the participants had been with their current company for less than 9 years.
- 61% of the participants were in the top four industries: information industry (23.0%); scientific and technical services industry (16.4%); finance and insurance industry (12.0%); manufacturing industry (9.8%).

We found that the correlations between the four knowledge conversion processes were all significant (see Table 2).

Recall that the knowledge-sharing spiral involves knowledge conversion processes that go from Socialisation to Externalisation to Combination to Internalisation (S-E-C-I) (see Figure 2). The highest correlation was between Socialisation and Internalisation (S-I) (0.765, a strong correlation), followed by the correlation between Socialisation and Externalisation (S-E) (0.746, a strong correlation). The next highest correlation was between Combination and Internalisation (C-I) (0.647, a moderate correlation) followed by the correlation between Externalisation and Internalisation (E-I) (0.617, a moderate correlation). Then, the two lowest correlations were evident between Combination and Socialisation (C-S) (0.520, a moderate correlation), with the lowest correlation being between Combination and Externalisation (C-E) (0.390, a weak correlation). Correlations between 0 and 0.20 are considered weak to negligible; correlations between 0.20 and 0.40 show weak to low relationships; correlations between 0.40 and 0.70 are considered moderate; correlations between 0.70 and 0.90 show strong and high relationships; and correlations between 0.90 and 1.0 reflect very strong and very high relationships (Rowntree, 2004).

**Table 2** Knowledge-sharing process correlations

		<i>Q4</i>	<i>Q5</i>	<i>Q6</i>	<i>Q7</i>
		<i>Combination</i>	<i>Socialisation</i>	<i>Externalisation</i>	<i>Internalisation</i>
Q4	Pearson correlation	1.000	0.520	0.390	0.647
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	197	191	195	194
Q5	Pearson correlation	0.520	1.000	0.746	0.765
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	191	191	191	190
Q6	Pearson correlation	0.390	0.746	1.000	0.617
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	195	191	195	194
Q7	Pearson correlation	0.647	0.765	0.617	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	194	190	194	194

**Figure 2** Knowledge-sharing spiral correlations

## 6 Discussion

Our findings support the S-E-C-I model in that the majority of the correlations were higher as one moved between the S-E-C-I quadrants. The highest correlation was between Internalisation and Socialisation (0.765) and the lowest correlation was between Externalisation and Combination (0.390). The lower correlations were evident on the diagonals (between S-C and E-I). The diagonals reflect lower correlations as knowledge conversion is an incremental process between S-E-C-I. For example, it may not be possible to go from Combination to Socialisation without first going from Combination to Internalisation, and only then to Socialisation, as the incremental approach allows individuals and groups to validate knowledge. For example, let us assume that a project management template on status reports exemplified Combination knowledge. As project team members use the template and identify what has relevance to them and what does not, they internalise the knowledge (Internalisation). As project team members then discuss (Socialisation) the pros and cons of some of the project templates they are using (such as the status report form), they may also vent about the status reports more freely or laud their value, thereby validating or negating the value of the form. However, it would not be possible for project team members to go from having a status report template (Combination) to discussing it informally with others (Socialisation) without going

through the Internalisation quadrant where they assimilate the form as a tool relevant to their practice.

Our findings thus partially support the first proposition. The correlations were higher as one progressed between three of the quadrants of the S-E-C-I framework except for the E-C knowledge process, which has the lowest correlation of the six assessed in the study. Recall that in the VRIO framework, all four elements of VRIO are necessary for project management to be a source of sustained competitive advantage. If there is insufficient organisational support for project management to be Valuable, Rare and Inimitable, there may well be insufficient support for such knowledge-sharing practice to be balanced and aligned between the quadrants, especially tacit practices. Our multivariate analysis study showed that tangible project management assets provided a firm with a competitive disadvantage and that intangible project management assets provided a firm with a temporary competitive advantage. It made sense that the correlations between the S-E-C-I quadrants were high as they reflect participant use of knowledge sharing in different formats.

Our findings support the second proposition. We found that the correlation between the Externalisation knowledge process and the Combination knowledge process (E-C) was the lowest. Externalisation involves metaphors, analogies and concepts. These terms are quite abstract and may not be ways in which most people think about project management, let alone how they process such concepts at all levels from the individual to the organisation level (Sabherwal and Becerra-Fernandez, 2003). The lower correlation may also reflect less organisational support for the development and use of such knowledge-sharing practices. The lower E-C results also partially support our VRIO study findings on project management, which show that the intangible project management assets provided a firm with a temporary competitive advantage at most. In order for companies to achieve a sustained competitive advantage through project management, they should place increased emphasis on the Externalisation quadrant. By doing so, companies may be able to balance their efforts and strengths among the four quadrants.

For companies to transform knowledge from E-C, they need to be innovative and creative in codifying project management metaphors and analogies into explicit knowledge for organisation-wide use (Combination). Creating such new knowledge of the Combination type may be difficult, partly if companies are in a core rigidity mode in terms of both the value of codified and explicit knowledge in project management and the predominant emphasis on project execution over concept creation, initiation and extensive planning. A core rigidity refers to a company's having capabilities that, although useful in the past with previous projects, are no longer useful and instead, become practices that are difficult to overcome and change (Leonard-Barton, 1992). The emphasis on explicit knowledge and codified practices may make it difficult for companies to transform knowledge from tacit to explicit.

We recommend that companies focus on all four modes of knowledge exchange in project management to develop it as a source of competitive advantage. We suggest that companies first assess their practices in terms of the knowledge-sharing spiral. Companies could use the following reflective questions to determine their knowledge-sharing practices in terms of the four categories – socialisation, externalisation, combination and internalisation.

- What project management practices can be identified to fit each of the four categories?

Responses to this question will help participants identify project management examples for each category and enable participants to clarify their understanding of the framework.

- How extensively are the four knowledge-sharing processes used in the project management context?

Answers to this question will help organisations determine the breadth of use of the knowledge-sharing processes.

- Which of the four knowledge-sharing processes are weak at the company? Which of the four knowledge-sharing processes reflect strengths at the company?

Responses to these questions will help organisations determine how good the firm's knowledge-sharing processes are.

- Which knowledge-sharing practices do members of the organisation deem important to develop and why?

Answers to this question will help the organisation determine which category or categories they want to focus on as areas for improvement. Answers should also relate to the gaps that were identified in terms of knowledge-sharing processes.

Companies will be in a better position to assess their receptiveness to sharing various forms of knowledge after completing the knowledge-spiral assessment. As organisations reflect on their knowledge-sharing practices, they could also reflect on and assess their current investments in project management training and development. Companies can then examine organisation-specific (unique) ways in which they can develop knowledge-sharing practices and support their use, especially regarding tacit knowledge (know-how).

Specific to project management, key examples of the socialisation knowledge conversion process include informal discussions over coffee or lunch, or at the water cooler. Job shadowing and apprenticeships are also examples of socialisation. To find examples of the externalisation knowledge conversion process, we turned to the new product and innovation literature (Klein and Sorra, 1996), where there is a heavy emphasis on idea generation, concept designs, and new product development. These fields emphasise brainstorming as well, which may involve the use of metaphors and analogies. In project management, an increased emphasis could be placed on the idea generation and initiation phases of the project lifecycle, where concepts are identified and crystallised before the actual implementation occurs. Examples of the combination knowledge conversion process include creating documents, developing methodologies, tools and templates. This category also includes developing and/or integrating project management bodies of knowledge and assessment tools, such as maturity models into the organisation's processes. Examples of the internalisation knowledge conversion process include ways in which people reflect on what they are doing and learning, for example, through benchmarking, or through lessons learned, whereby specific lessons can be internalised for personal development or training programmes.

In terms of implications for research, there is value in using Nonaka's framework (Sabherwal and Becerra-Fernandez, 2003) to assess current project management knowledge practices and how various forms of knowledge are transformed. Knowledge

conversion concepts also relate to the concept of social capital (Nahapiet and Ghoshal, 1998). Granovetter (1985) has done extensive work on the 'strength of weak ties'. Interesting research on social capital within project management remains to be done as considerable work takes place informally on projects and is based on 'who you know' in your network of contacts. For example, research could involve assessing the breadth and depth of social capital within project management at companies and relating this to the knowledge conversion practices used.

## **7 Conclusion**

To summarise, in this exploratory study we used Nonaka's framework on knowledge conversion processes to study project management. The paper placed our knowledge-sharing spiral findings in the context of our earlier multivariate study. Our findings support the S-E-C-I knowledge transfer model in that the majority of the correlations were higher as one moved between the four quadrants. The lower correlations were evident on the diagonals. The lowest correlation was between Externalisation and Combination. Although the correlations between the four modes of knowledge sharing did not consistently show enough strong relationships to support the view that project management as a whole was a source of temporary or sustained competitive advantage, the findings do support the importance of emphasising knowledge development and sharing among all four quadrants.

Based on the findings supporting our propositions, we recommend that companies not be misled that an investment in tangible project management assets will provide them with competitive parity. It takes more than tangible project management assets to enable the project management process to improve performance. We recommend that companies constantly assess their investment in both tangible and intangible assets in project management.

Tacit knowledge in project management continues to be under-appreciated, yet it has the potential to be a source of competitive advantage as evident from its positive relationships with the VRIO elements. We recommend that companies make a concerted effort to develop their intangible assets in project management and invest in them because these may contribute to project management becoming a source of temporary competitive advantage: knowledge-based assets are more likely to be rare than tangible ones.

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