Exploring the Antecedents of New Knowledge Creation in Organizational Settings: An Empirical Study

15/6/2006

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Abstract
This study aims to understand the antecedents of new knowledge creation in knowledge-intensive organizations. A model of knowledge management and new knowledge creation inspired by the works of Nonaka, Nahapiet and Ghoshal and others was used to develop a questionnaire. 213 individuals responded from a knowledge-based organization in Singapore. The results of the study indicated that knowledge tools and technologies interact with the modus of knowledge combination to influence knowledge outcomes in terms of worker skills, competencies, market knowledge and client relationships. The key ingredients for creating new knowledge as well as synergistic collaborations between various knowledge players are also discussed.
Introduction

Despite the increasing literature on knowledge management and governance (Stehr 1994; Davenport et al. 1998; Menkhoff, Chay and Evers 2005) in fields such as organizational studies, information systems, sociology, psychology, and economics, there are few empirical studies concerning the mechanisms of new knowledge creation. New knowledge creation through cross-fertilization of ideas and so forth is still little understood; there is no coherent theory which could explain what it takes to leverage upon organizational human capital assets within organizations in order to create something new. In a recent study carried out to address this gap in the theoretical literature, we explored the causal efficacy between the drivers of knowledge creation and its respective outcomes. The findings from our study underline the importance of new knowledge creation in organizations and also identify and describe how the various antecedents of this process facilitate knowledge creation in knowledge-intensive organizations. A discussion of future research directions using the proposed theoretical model concludes the essay.

Theoretical Background

In his analysis of knowledge creation, Nonaka (1994; see also Nonaka & Takeuchi 1995; Nonaka, Konno & Toyama 2001) examined the concept in terms of a knowledge spiral encompassing four basic patterns of interaction between tacit and explicit knowledge – socialization, externalization, combination, and internalization. Nonaka uses the term socialization to emphasize the importance of social interaction and joint activities in converting tacit knowledge to explicit knowledge. He argues that since tacit knowledge is context specific and difficult to formalize, transferring tacit knowledge requires sharing the same experience through joint activities such as being together, spending time, or
working in the same environment (Szulanski and Cappetta 2003). The next process in his theory of the knowledge spiral is externalization which is the process of articulating tacit knowledge into explicit forms by sharing it through social interaction. Through externalization, tacit knowledge that is unstructured in the individual’s mind becomes crystallized through a process of reflection between sharing individuals. Through combination, explicit knowledge becomes more complex and systematic as this level of knowledge is exchanged and combined through documented media such as documents and notations. And finally in internalization, explicit knowledge is internalized or reflected by the individual and turned back into tacit knowledge. This is closely related to the ‘learning by doing’ philosophy where what is read and understood is translated into action.

Of great interest in the context of this study is Nonaka’s knowledge creation modus combination. One can easily think of examples where innovations were created by simply combining various pockets of expertise and/or knowledge resources in areas such as medicine (e.g. the story of the DNA), marketing (the story of the Swatch watch), politics (e.g. the collaboration between Singapore and the People’s Republic of China with regard to the China-Singapore-Suzhou Industrial Park), in biomedical research (e.g. bioinformatics) or in higher education (e.g. formation of interdisciplinary study groups). While the process itself appears to be relatively simple from the outside, the various antecedents such as organizational culture, incentives, sustainability and so forth represent challenges for both theoreticians and practitioners in terms of conceptualization and obtaining buy-in amongst organizational members (Gefen 2000; Gupta and Govindarajan 2000). The story of the GlowCard might help to illustrate the significance of knowledge creation and its outcomes.
Innovation through Combination: The GlowCard

The GlowCard is a credit-card sized device that reads a person's temperature when placed on the forehead. It is the brainchild of InfoWave (www.InfowaveMobile.com), a subsidiary of Singapore Technologies. In 2003 Info Wave Pte Ltd launched the GlowCard, a new temperature-sensing device that retains and displays the temperature reading. The debut of the GlowCard had been planned for Singapore’s 38th National Day on 9 August 2003, i.e. the year Singapore and the region was hit by the SARS crisis. The invention helped the National Day organizers to screen (out) people with high temperature waiting to enter the National Stadium to participate in the National Day celebrations*. The device is convenient as users can carry the Glowcard as part of their personal items. Temperature is taken by using the forehead temperature as an indicator of the temperature of the person. The accuracy of this traditional practice was improved by adapting it into the GlowCard through the use of technology. The patent for the GlowCard was filed in 2003. As Mr Seah Moon Ming, Chairman of InfoWave noted, “the DSTA’s (Defence Science Technology Agency) Defence Medical Research Institute has assisted us in an intensive study and tests on forehead temperature, relating forehead temperatures to fever indication. The functioning of the GlowCard is based on this research to sense feverish indications in individuals” (Press Release 30 June 2003: GLOWCARD to make its debut on National Day). As he pointed out further, the

* As reported in a press release (see also Straits Times 24/7/2003), all 120,000 spectators for the shows were required to have their temperatures taken before they were allowed into the National Stadium. Air-conditioned thermal scanning stations were set up at all four entrances to the stadium, to ensure proper temperature checks. Guests who failed the scanner's test had their temperatures taken orally. Anyone with a reading higher than 37.5 degrees C was not allowed in. Those who failed both the thermal and oral screenings were allowed to cool off and were re-tested. Once inside the stadium, spectators could choose to sport either a sticker or the GlowCard, to show that they had been screened. 70,000 cards were given out to spectators and participants at the August 9 event.
GlowCard can be adapted to include more functions to be incorporated for use in people’s daily lives such as a smart card, access card, badges or physical exercise machines.

The GlowCard is a fine example of Nonaka’s knowledge creation modus ‘combination’ as both explicit and tacit knowledge assets of various knowledge-based organizations were combined to develop this product in a very short time span. As Mr Seah stressed, “from conceptualisation to design, prototyping, manufacture, assembly, packaging and distribution, the efforts that went into each and every process were strongly supported by Singapore companies… the arrival of the GlowCard … closely follows upon the heels of the success of the Infrared Fever Screening System and underscores the power and the depth of electronics knowledge in Singapore while reinforcing the country's ability to respond creatively and rapidly in times of crises and emergencies”. Companies who participated in the production of the first batch of GlowCards include local enterprises like Chartered Semiconductor Manufacturing, ST Assembly Test Services Ltd, Hi-P International Pte Ltd, GP Batteries International Ltd and Intelligent Micro Devices Pte. Ltd. DSTA’s Defence Medical Research Institute assisted InfoWave to conduct a comprehensive medical study to relate forehead temperatures to fever indication.

The Singapore Government played an active knowledge management leadership role in this case, effectively influencing participating organizations to join forces and to create a relatively simple innovation in a very short time span. National pride, patriotism and ‘survival issues’ (SARS) provided a strong ‘business case’ and motivational force for the GlowCard project participants to collaborate and innovate.
Hypothesis Development

Knowledge Tools as Drivers of Knowledge Combination

Knowledge leadership is essential to initiate knowledge combination processes (Menkhoff et al. 2006). This includes the ability to use knowledge management tools and technologies as key drivers of knowledge sharing processes in organizations (Hosmer 1995; Hansen 1999; Helmstaedter 2003; Ipe 2003). Knowledge leadership tools can be relatively simple ones such as story telling or hi-tech tools such as electronic sharing platforms. The formation of communities of interest (COI) or temporary network alliances represent other suitable tools. The point we want to make here is that the use of knowledge tools has to be initiated by knowledge leaders so as to get the process started. In view of the importance of knowledge tools as drivers of new knowledge creation, we hypothesized the following:

*Hypothesis 1: Knowledge tools are positively related to knowledge combination.*

Knowledge Combination as Driver of Knowledge Creation

As Nonaka has pointed out, knowledge combination is a key knowledge creation modus. Explicit (or tacit) knowledge can be shared during meetings, via document exchange, e-mails or through training and development measures (Polanyi 1967; Rulke and Zaheer 2000; Stenmark 2001). Knowledge combination enables the cross-fertilization of ideas which often lead to product and/or service innovations. A well-documented case are the various communities of practice (COP) set-up by the World Bank, e.g. the Knowledge for Development group whose experts develop innovative development interventions by combining their respective competencies. According to Burt (2004:9), “organizations
with management and collaboration networks that bridge structural holes in their markets seem to learn faster and be more productively creative”. Thus, we hypothesized the following:

Hypothesis 2: Knowledge combination is positively related to knowledge creation.

Knowledge Creation as Driver of Knowledge Outcomes

The studies by Nonaka & Takeuchi (1995) or Voelpel & Han (2005) suggest that knowledge creation has positive effects in terms of organizational effectiveness. Organizations can reap many benefits from proactively initiating knowledge creation processes such as increased knowledge sharing (both horizontally across departments, functions or business units and vertically up the organizational hierarchy), improved productivity and skills, enhanced customer relations, new product and/or service development, flexibility in production and innovation or improved organizational memory. In view of this, we argue:

Hypothesis 3: Knowledge creation is positively related to knowledge outcomes.

In understanding the various factors that influence knowledge combination and the achievement of knowledge outcomes, a model of knowledge creation was developed based on the work of Nonaka, Nahapiet and Ghoshal as well as other scholars. The model is presented in Figure 1.
Method

Sample

An online survey was developed and subsequently administered in a tertiary educational institution (academic staff, administrators and students) in Singapore. Email invitations were sent to all individuals in the organization. A total of 213 persons responded to the survey giving a response rate of 35.5%. 42.3% of respondents were male (N=90) with 75.1% (N=160) of Chinese ethnicity. Indians made up 11.3% (N=24), Malays 4.7% (N=10) with the remaining 8.9% belonging to other ethnic races. The academic community of respondents comprised 36.6% students, 50.7% administrative staff, and 12.7% faculty members (see Table 1). Because of missing data, the final usable sample size was 172.
Table 1 Sample Distribution – Higher Educational Institution

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students</td>
<td>78</td>
<td>36.6</td>
<td>36.6</td>
</tr>
<tr>
<td>Admin Staff</td>
<td>108</td>
<td>50.7</td>
<td>87.3</td>
</tr>
<tr>
<td>Faculty</td>
<td>27</td>
<td>12.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>213</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

To assess the various knowledge creation dimensions, a number of scale measures were used to assess the antecedents and outcomes of knowledge creation.

**Measures**

Knowledge outcomes, knowledge creation, knowledge tools and knowledge combination were assessed using scale measures adapted from Liebowitz (1999).

**Knowledge Creation**: A 5-item measure was used to measure the creation of knowledge. Response options ranged from (1) ‘strongly disagree’ to (5) ‘strongly agree’. Sample items are, ‘my organization’s management minimizes restrictions on developing strategic or collaborative alliances’, and ‘my organization’s management aggressively support new or innovative ideas to grow competitive advantage’. The scale’s alpha reliability in this study is .89.

**Knowledge Combination**: This variable was assessed using a 5-item measure. Response options followed the Likert-type format and ranged from (1) ‘strongly disagree’ to (5) ‘strongly agree’. Sample items are, ‘… I like to collect new information and old knowledge to create new concepts / ways of thinking’, and ‘I tend to help organize ideas and make conclusions to facilitate discussion’. The scale’s alpha reliability in this study is .80.
Knowledge Tools: A 3-item scale measure was used to assess this variable. The Likert-type response format ranged from (1) ‘strongly disagree’ to (5) ‘strongly agree’. Sample items are, ‘… has specific knowledge of technology tools, e.g. portals, intelligent agents, collaborative technologies, search engines, expert systems etc.’, and ‘has ability to assess the effectiveness of technology tools and uses these in the course of work’. The scale’s alpha reliability in this study is .93.

Knowledge Outcomes: The items used to assess knowledge outcome were concerned with improvements in worker efficiency, productivity, knowledge of markets, skills, among other aspects of their work related roles and functions. The 5-item scale measure was adapted from Liebowitz (1999). Response options ranged from (1) ‘strongly disagree’ to (5) ‘strongly agree’ for each of the items. Sample items are ‘Knowledge Management practices in this organization have improved client / customer relations’, and ‘Knowledge Management practices in this organization have increased our adaptation of products or services to client requirements…’. The alpha reliability in this study is .91.

Analysis

Controls. Three demographic variables, age, full-time work experience and gender were employed as control variables. Gender was coded (0) ‘male’ and (1) ‘female.’

Hierarchical regression analysis was used to examine the predictors of knowledge outcome. Explanatory (independent) variables were entered into the regression in a specified order as a means of determining their individual and joint contributions to explaining the outcome variable. The main terms were entered first and the interaction terms were subsequently entered into the regression analysis.
Results

The means, standard deviations and inter-correlations of measures of knowledge outcome and its antecedents are shown in Table 2.

Insert Table 2 about here
Table 2: Correlations of Major Variables in the Study

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Age</th>
<th>Gender</th>
<th>Work Experience</th>
<th>KM Tools</th>
<th>Knowledge Combination</th>
<th>Knowledge Creation</th>
<th>Knowledge Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age</td>
<td>29.11</td>
<td>( - )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Gender†</td>
<td>.58</td>
<td>- .12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3. Work Experience</td>
<td>6.88</td>
<td>.76**</td>
<td>- .09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. KM Tools &amp; Technologies</td>
<td>3.36</td>
<td>- .02</td>
<td>- .01</td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Knowledge Combination</td>
<td>3.56</td>
<td>.05</td>
<td>- .06</td>
<td>.11</td>
<td>.18*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Knowledge Creation</td>
<td>3.12</td>
<td>- .14</td>
<td>.02</td>
<td>- .17</td>
<td>.10</td>
<td>.19*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Knowledge Outcome</td>
<td>3.74</td>
<td>.16</td>
<td>.09</td>
<td>.16</td>
<td>.02</td>
<td>.01</td>
<td>.05</td>
<td></td>
</tr>
</tbody>
</table>

†Gender coded Male=0, Female=1
Cronbach α reliability index shown in brackets
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)
The results of the correlational analysis are consistent with the proposed hypothesis, $H_1$, indicating support that the ability to understand and use knowledge (management) tools are indeed a critical factor in the creation of (new) knowledge. Hypothesis $H_2$ is also supported; a high degree of knowledge combination is associated with greater levels of knowledge creation. However, hypothesis $H_3$ is not supported.

Table 3 presents the results of the hierarchical regression analyses.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>3.74***</td>
<td>3.36***</td>
<td>3.32***</td>
</tr>
<tr>
<td>Age</td>
<td>.01</td>
<td>.01</td>
<td>.1</td>
</tr>
<tr>
<td>Work Experience</td>
<td>-.01</td>
<td>-.01</td>
<td>-.01</td>
</tr>
<tr>
<td>Gender</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>KM Tools</td>
<td>.02</td>
<td>.02</td>
<td>.02</td>
</tr>
<tr>
<td>Combining Knowledge</td>
<td>.08***</td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td>Knowledge Creation</td>
<td>.01</td>
<td>.02</td>
<td></td>
</tr>
<tr>
<td>KM Tools x Knowledge Combination</td>
<td></td>
<td></td>
<td>.04***</td>
</tr>
<tr>
<td>KM Tools x Knowledge Creation</td>
<td></td>
<td></td>
<td>-.02</td>
</tr>
</tbody>
</table>

The results (Table 3) show that knowledge combination significantly predicted knowledge outcome in the second step of the regression analysis (Model 2). Furthermore,

\[ F^{2} = .867 \quad 3.752*** \quad 5.086*** \]
\[ R^{2} = .010 \quad .081 \quad .139 \]
\[ \Delta R^{2} = .010 \quad .071 \quad .058 \]

* $p \leq .05$
** $p \leq .025$
*** $p \leq .01$

The $\beta$ values are the unstandardized coefficients from the final regression equation, each term being corrected for all other terms.
knowledge combination and knowledge tools also jointly influenced knowledge outcomes (Model 3). This significant interactive effect is graphically presented in Figure 2.

**Figure 2: Relation between Knowledge Outcome and Knowledge Tools for High and Low Levels of Knowledge Combination**
When the level of knowledge tools is low, the modus of knowledge combination does not significantly affect knowledge outcomes in terms of worker skills, competencies, market knowledge and client relationships, etc. However, at high levels of knowledge tools (+ 1sd), knowledge outcome is very much dependent on the degree of knowledge combination. That is, high knowledge combination results in significantly greater levels of knowledge outcomes.

**Discussion and Conclusions**

As our study shows, new knowledge creation in organizations is important and needs to be carefully nurtured through capable knowledge leadership and the application of adequate tools. Quite often, management does little to facilitate knowledge combination processes, forgoes opportunities to build upon different knowledge domains that could lead to new innovations, and/or over-manages the knowledge creation process thereby alienating knowledge workers. An interesting prospect for further research would be to extend the present study and to examine knowledge combination processes in multi-cultural contexts by using ‘cultural variation frameworks’, for instance, the model proposed by Bhagat, Kedia, Harveston and Triandis (2002:212). As Bhagat and his colleagues noted, “organizations in societies where vertical individualism is the dominant cultural pattern (e.g. United States, United Kingdom) have a clear preference for types of knowledge – whether human, social, or structured – that is linear (i.e. cause-effect relationships are clearly specified), credible, and explicitly logical … The strength of collectivist cultures lies in their propensity to absorb and transmit tacit information …”. National culture is obviously an important intervening variable in knowledge combination and creation processes whose impact in Southeast Asian societies has yet to be
ascertained. Potential research questions include: 1. How do cultural transaction models influence knowledge transfer and combination processes? 2. What are the key success factors for creating knowledge synergies between ethnic Chinese, Indians, Malays and/or members of non-Asian groups such as Australians or Germans? 3. What does it take in terms of multi-cultural knowledge leadership to effectively manage knowledge creation processes in mixed knowledge-based teams?
References:


Straits Times 24 July 2003: Stay cool for fever checks at NDP preview and parade.


