PERGAMON

Expert Systems with Applications 23 (2002) 173–187

Expert Systems with Applications

www.elsevier.com/locate/eswa

Knowledge management strategy and its link to knowledge creation process

Byounggu Choi, Heeseok Lee*

Corporate Information System Laboratory, Graduate School of Management, Korea Advanced Institute Science and Technology (KAIST), 207-43 Cheongyangri-dong, Dongdaemoon-gu, Seoul 130-012, South Korea

Abstract

Knowledge has become to be considered as valuable strategic assets that can provide proprietary competitive advantages. It is more important for companies to distinguish themselves through knowledge management strategies. Without a constant creation of knowledge, a business is condemned to poor performance. However, it is still unclear how these strategies affect knowledge creation. Knowledge management strategies can be categorized as being either human or system oriented. This paper proposes a model to illustrate the link between the strategies and its creating process. The model is derived on the basis of samples from 58 Korean firms. The model depicts how companies should align the strategies with four knowledge creation modes such as socialization, externalization, combination, and internalization. It is found that human strategy is more likely to be effective for socialization while system strategy is more likely to be effective for combination. Furthermore, the survey result suggests that managers should adjust knowledge management strategies in view of the characteristics of their departments.

Keywords: Knowledge management strategy; Knowledge creating process; Corporate performance

1. Introduction

Managing knowledge is important because knowledge is one of the most strategic weapons that can lead to sustained increase in profits. It is no surprise that many researchers have investigated enablers for fostering knowledge (Nonaka, Toyama, & Konno, 2000; O'Dell & Grayson, 1998; Teece, 2000). Typically, these knowledge enablers are categorized from people, organization, process, and system perspectives. Although these enablers are essential for a firm's capability to manage knowledge effectively, it is still unclear how to employ them in a strategic fashion. Knowledge management strategies are necessary for facilitating these enablers; they determine how to utilize knowledge resources and capabilities (Beckman, 1999; Hansen, Nohria, & Tierney, 1999; Zack, 1999a).

Three research areas for knowledge management strategies have been identified (Zack, 1999b). First, which knowledge is unique and valuable? Studies on intellectual capital (Edvinsson & Malone, 1997; Kitts, Edvinsson, & Beding, 2001; Sveiby, 1997) or intangible resources (Hall, 1992) attempt to solve this issue. Second, how can these resources and capabilities support a firm's product and market positions? This research question deals with resource-based theory (Collins & Montgomery, 1995; Prahalad & Hamel, 1990) and organizational capability (Grant, 1996; Teece, Pisano, & Shuen, 1997). Lastly, the real challenge lies in finding the link between knowledge management strategies and its processes. This paper attempts to explore this issue.

The fit between knowledge management processes and knowledge management strategies is a lynchpin in improving corporate performance. It is essential to identify which knowledge processes represent unique and valuable capabilities for effective knowledge management (Holsapple & Singh, 2001; Zack, 1999b). However, implementing knowledge processes within a firm can be very costly and fragile (Soliman & Spooner, 2000). Therefore, knowledge processes should be guided by appropriate knowledge strategies. Knowledge management strategies that firms take have a significant influence on knowledge management processes (Zack, 1999a). Previous approaches have some difficulties in clarifying this relationship. Most studies fail to incorporate the dynamic characteristic of knowledge management strategies (Hansen et al., 1999; Jordan & Jones, 1997). Because the nature of knowledge varies depending upon knowledge processes, locations, or time (Wiig, Hoog, & Spek, 1997), knowledge management strategies need to correspond to this contingency.

* Corresponding author. Tel.: +82-2-958-3655; fax: +82-2-958-3604.
E-mail addresses: hsl@kgsm.kaist.ac.kr (H. Lee), bgchoi@kgsm.kaist.ac.kr (B. Choi).

0957-4174/02/$ - see front matter
PII: S0957-4174(02)00038-6

Table 1
Features of system and human strategies

Strategy	Features
System	Emphasize codified knowledge in knowledge management processes Focus on codifying and storing knowledge via information technology Attempts made to share knowledge formally
Human	Emphasize dialogue through social networks and person-to-person contacts Focus on acquiring knowledge via experienced and skilled people Attempts made to share knowledge informally

Furthermore, despite a great deal of discussion about knowledge management strategies, relatively little empirical evidence is available.

The primary objective of this paper is to explore how knowledge management strategies improve corporate performance. For this exploration, this paper attempts to investigate how managers can align knowledge management strategies with its creation process to improve corporate performance. A variety of studies divide knowledge process into several sub-processes (for example, creation, manifestation, use, and transfer by Wiig (1995)). Our investigation focuses on knowledge creation in isolation because it is a critical competitive weapon in today's global marketplace; without a constant creation of knowledge, a business is condemned to obsolescence. Today, business leaders have to be innovative to capture the collective wisdom of their employees, customers, and shareholders (Parent, Gallupe, Salisbury, & Handelman, 2000).

This paper is organized as follows. Section 2 surveys and summarizes the related studies. Section 3 explores knowledge creation process. Section 4 illustrates the sample and measures. Section 5 summarizes analysis results. Section 6 discusses the effective knowledge management strategy. Section 7 concludes the paper.

2. Knowledge management strategies

2.1. Three perspectives of knowledge management strategies

Knowledge management focus is one of the most common considerations for establishing knowledge management strategies; they can be described along two dimensions reflecting their focus (Hansen et al., 1999; Zack, 1999a). One dimension emphasizes the capability to help create, store, share, and use an organization's explicitly documented knowledge. The strategy as per this dimension emphasizes codifying and storing knowledge. Typically, knowledge can be codified via information technology (Davenport, Long, & Beers, 1998; Lee & Kim, 2001; Liebowitz & Wilcox, 1997; Swan, Newell, & Robertson, 2000). Codified knowledge is more likely to be reused. The emphasis is on completely specified sets of rules about what to do under every possible sets of circumstances (Bohn, 1994). In this paper, this strategy is referred to as system strategy.

Another dimension emphasizes knowledge sharing via interpersonal interaction. The strategy as per this dimension utilizes dialogue through social networks including occupational groups and teams (Swan et al., 2000). It helps share knowledge through person-to-person contacts (Hansen et al., 1999). This strategy attempts to acquire internal and opportunistic knowledge and share it informally (Jordan & Jones, 1997). Knowledge can be obtained from experienced and skilled people. This strategy can be referred to as human strategy. Table 1 summarizes the key features of system and human strategies.

Many studies have shed lights on guidelines for employing system or human strategy. These studies can be categorized into three views: focused, balanced, and dynamic. Fig. 1 compares these three views. The system-oriented degree corresponds to the degree of codifying and storing organizational knowledge to access and use it. The human-oriented degree corresponds to the degree of acquiring and sharing tacit knowledge through interpersonal interaction.

The studies from a focused view propose that companies should pursue one strategy predominantly. Hansen et al. (1999) suggest that companies pursue one strategy while using another to support it. Swan et al. (2000) argue that a human-oriented strategy is superior to system-oriented strategy.

The balanced view suggests that companies should strike a right balance between the two strategies. Bierly and Chakrabarti (1996) found that firms, which acquire and share knowledge by combining system- and human-oriented strategies, tend to be more profitable. Jordan and Jones (1997) emphasize the balance between explicit and tacit knowledge based strategy for encouraging the development of more innovative knowledge. Zack (1999a) states that firms with an aggressive strategy, which integrates system-oriented strategy with human-oriented strategy, tend to outperform those of less aggressive strategy.

The dynamic view suggests that firms align their strategies with the characteristics of knowledge. For

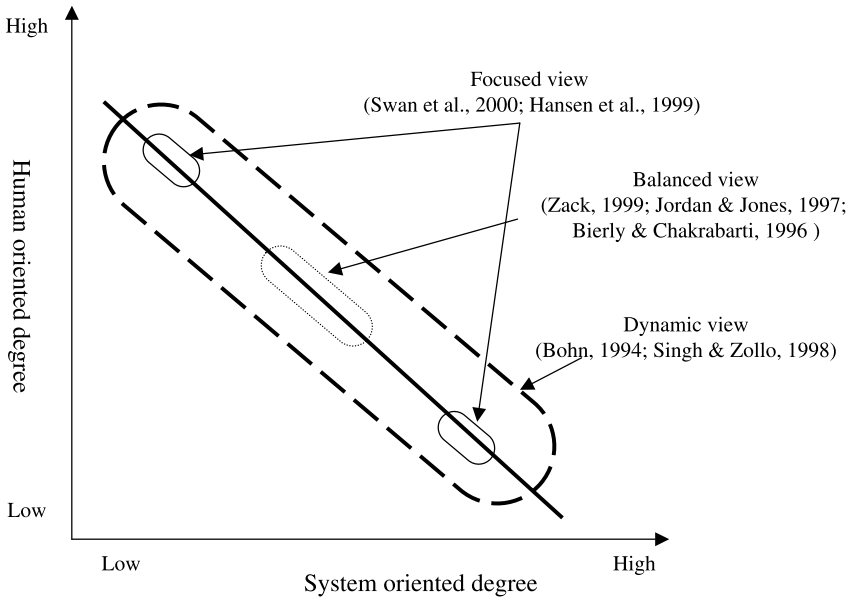

Fig. 1. Three perspectives of knowledge management strategies.

example, Bohn (1994) states that managers should align knowledge management strategies along with the spectrum from pure expertise to pure procedure. Singh and Zollo (1998) argue that firms should align knowledge strategies along with task characteristics.

Focused view proposes that a company should focus one strategy. In contrast, balanced and dynamic views insist that a company should utilize both strategies. Focused and balanced views fail to consider the dynamic nature of knowledge. Although knowledge should be analyzed as an active process that is inherently indeterminate and continually changing (Blackler, 1995; Nonaka & Takeuchi, 1995), these two views are static. Dynamic view proposes that the choice can vary depending upon knowledge characteristics (Bloodgood & Salisbury, 2001; Bohn, 1994; Singh & Zollo, 1998). The aforementioned previous studies can be compared in terms of knowledge management (KM) view, KM strategy categories, research method, and industry applications as shown in Table 2.

2.2. Knowledge strategies and knowledge types

Polanyi (1997) originally categorizes knowledge into two types: tacit and explicit. Tacit knowledge is difficult to formalize and communicate (Nonaka & Takeuchi, 1995). It is transferred through personal interaction, mental models, technical skills, and experience. It would appear that human strategy is utilized for fostering tacit knowledge only. However, human strategy can be employed to sharpen explicit knowledge (Kidd, 1998). For example, although breaking down a corporate vision into operationalized business or product goals results in explicit knowledge, human strategy such as face-to-face meeting is usually adopted for this session in Japanese firms (Nonaka & Takeuchi, 1995).

Explicit knowledge is easily formalized and expressed (Hippel, 1994; Nonaka & Takeuchi, 1995). It can be facilitated by traditional information processing technologies (Liebowitz & Wilcox, 1997). Typically, system strategy is quite effective for sharing explicit knowledge.

Table 2
Studies on knowledge management strategies

View	Researcher	KM strategy categories	Research method	Industry application
Focused	Hansen et al. (1999)	Codification, personalization	Case	Consulting
	Swan et al. (2000)	Cognitive, community	Case	Manufacturing financial
Balanced	Bierly and Chakrabarti (1996)	Explorer, exploiter, loner, innovator	Empirical	Pharmaceutical
	Jordan and Jones (1997)	Tacit-oriented, explicit-oriented	Conceptual	All
	Zack (1999a,b)	Conservative, aggressive	Case	All
Dynamic	Bohn (1994)	Pure expertise, pure procedure	Conceptual	All
	Singh and Zollo (1998)	Codification, experience accumulation	Conceptual	Banking
	This paper	System, human	Empirical	All

Table 3
Knowledge types and strategies

Strategy	Knowledge	
	Tacit	Explicit
System	Create networks through IT (video conferencing, groupware, and virtual reality)	Codify knowledge using traditional information processing technologies
	Facilitate face-to-face meeting	Emphasize person-to-documentation
Human	Community of practice, discussion group, and help task	Help transmit newly created concepts
	Emphasize person-to-person	Breakdown of concepts using face-to-face meeting (usually in Japanese firms)

Knowledge based systems have been introduced for system strategy (Liao, 2002). However, it can be employed for facilitating tacit knowledge. For example, in case of consulting firms, system strategy can help keep track of individuals with particular expertise and enable a rapid communication (Bloodgood & Salisbury, 2001; Sarvary, 1999). Examples include video conferencing, groupware, chatting features of the Intranet, and virtual reality technology (Cross & Baird, 2000; Malhotra, 2000; Scott, 1998). InfoTEST's Enhanced Product Realization (EPR) project uses electronic whiteboarding and videoconferencing to enhance exchanges of tacit knowledge (Riggins & Rhee, 1999). Online communities are also ways of sharing and distributing tacit knowledge. Members of these communities may share their tacit knowledge like experience and thoughts over the web (Liebowitz, 2001).

Table 3 highlights the relationship between knowledge types and knowledge strategies.

3. Knowledge creation process

Knowledge creation is a continuous process whereby individuals and groups within a firm and between firms share tacit and explicit knowledge (Bloodgood & Salisbury, 2001; Bohn, 1994). Organizational capability to create knowledge is the most important source of firms' sustainable competitive advantage (Junnarkar, 1997; Nonaka et al., 2000; Parent et al., 2000).

To describe the knowledge creation process systematically, this paper adopts the work by Nonaka and Takeuchi (1995) for the following reasons. First, their work has become widely accepted in a variety of management fields such as organizational learning, joint ventures, new product development, and information technology (Kidd, 1998; Nonaka et al., 2000; Scott, 1998). Second, it includes not only knowledge creation but also knowledge transfer (Venzin, Krogh, & Roos, 1998). Because transfer of existing knowledge and creation of new knowledge have become two major management tasks, both should be considered together (Krogh & Grand, 2000).

Nonaka and Takeuchi proposed the SECI modes which explores knowledge creation through conversion between tacit and explicit knowledge. The SECI modes consist of socialization (S), externalization (E), combination (C), and internalization (I). Socialization converts new tacit knowledge such as shared mental models, technical skills, and shared experience. Typically, it occurs from an apprenticeship rather than documents or manuals. Externalization transfers tacit knowledge into explicit concepts. Externalization can be seen in the process of concept creation and triggered by dialogue or collective reflection. Combination converts explicit knowledge into more systematic sets. Internalization embodies explicit knowledge into tacit knowledge. Explicit knowledge can be internalized into individuals' tacit knowledge. Fig. 2 shows these four modes of knowledge conversion (Nonaka et al., 2000).

4. Samples and measures

This paper investigates Korean firms empirically to find the link between knowledge management strategies and knowledge creation. Hundred firms (in *Annual Corporation Reports* by Maeil Business Newspaper (2000)) were selected randomly. We surveyed from 5 to 15 middle managers in each firm. Middle managers were selected for the following reasons. First, middle managers tend to play key roles in knowledge management (Nonaka & Takeuchi, 1995). Second, top managers may be eager to highlight their roles in organizational success (Easterby-Smith, 1997). Finally, line managers are incapable of understanding the characteristics of the overall organization. Both interviews and mails were used for sampling.

Research constructs were operationalized through related studies and a pilot test. For the questionnaires, a multiple-items method was used and each item was based on a six point Likert scale from 'very low' to 'very high'. A six point Likert scale avoids a midpoint, which prevents respondents from a neutral default option (Amabile, Conti, Coon, Lazenby, & Herron, 1996).

All operational definitions of instruments and their

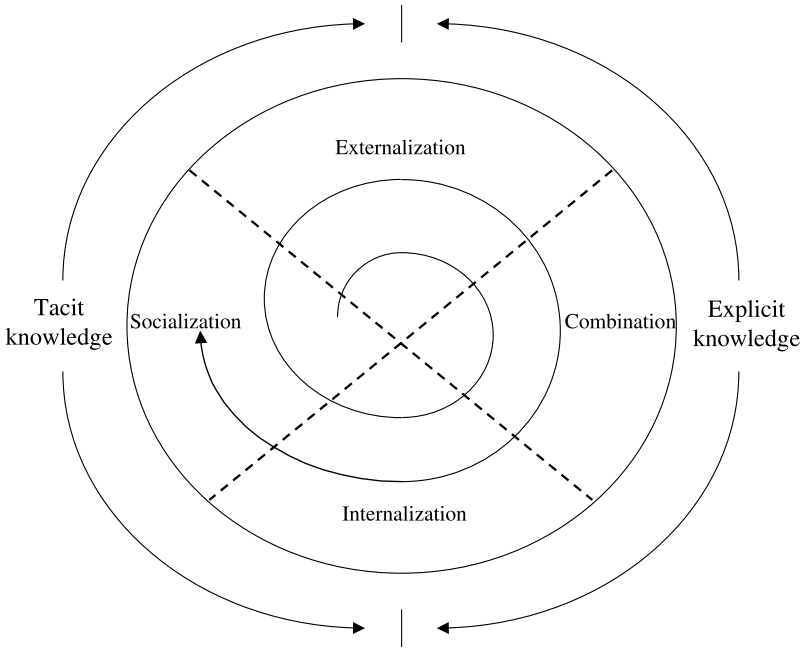

Fig. 2. Knowledge creation process.

related literature are summarized in Appendix A. We adopt the constructs that have already been used and validated by Nonaka et al. (2000) for assessing the level of knowledge creation. To measure corporate performance, the constructs by Deshpande, Jarley, and Webster (1993) and Drew (1997) were adopted. Although corporate performance items do not present a fully balanced scorecard, these items are effective for comparing business units and industries (Drew, 1997).

5. Sample analysis

5.1. Sample characteristics

In total, 441 questionnaires from 61 out of 100 firms were returned. Seventeen responses from three firms were eliminated from analysis due to incomplete data, and thus 424 responses from 58 firms were analyzed. Table 4 summarizes the respondent characteristics in terms of industry type, total sales revenue, and total number of employees.

5.2. Reliability and validity

Table 5 outlines the results of reliability and validity tests for survey items. The content validity of the instruments is established by adopting the constructs that have already been validated by other researchers. The reliability is assessed by Cronbach's alpha (Kerlinger, 1964). Internal scale reliabilities (Cronbach's alpha) vary from 0.7902 to 0.8845. For convergent validity, items whose item-to-total correlation score was lower than 0.4 were eliminated from further analysis. Discriminant validity was checked by a factor analysis. Because multi-item constructs measures each variable, factor analysis with varimax is conducted to check the unidimensionality among the 34 items. Among them, one item related to corporate performance had an item-to-total correlation below 0.4 and thus was eliminated from further analysis. Items with factor loading values lower than 0.5 were also eliminated. All the measures used in this study are reported in Appendix B.

5.3. Interrater reliability and agreement analysis

Interrater reliability and agreement analysis are necessary because of multiple respondents (Venkatraman & Grant, 1986). Interrater reliability, an index of consistency, presents prepositional consistency of variance among raters (Kozlowski & Hattrup, 1992). In contrast, interrater agreement represents interchangeability among raters, i.e. the extent to which raters make the same ratings (James, Demaree, & Wolf, 1993).

The interrater reliability is assessed by the use of the interclass correlation coefficient (ICC). Because each organization is rated by different raters and their ratings are averaged, ICC $(1,k)$ is appropriate. ICC $(1,k)$ can be calculated via one-way analysis of variance (ANOVA) (Shrout & Fliess, 1979).

James, Demaree, and Wolf (1984) developed indexes for measuring within-group agreement for a set of raters for a single target with a single item ($r_{wg(1)}$) or multiple-item scale ($r_{wg(J)}$). Because the multiple-item scale is adopted, $r_{wg(J)}$ is assessed for each target and these $r_{wg(J)}$ values are averaged for all targets. Table 6 summarizes the results of

Table 4
Respondent characteristics

Industry type (main)	Industry type (sub)	Frequency	Percent
(a) Industry type			
Manufacturing	Machinery	5	8.6
	Electronics	3	5.2
	Chemistry	5	8.6
	Pharmaceutical	3	5.2
	Food/beverage	2	3.4
	Others	1	1.7
Financing	Insurance	5	8.6
	Banking	4	6.9
	Security	5	8.6
Service	Construction	6	10.3
	Retailing	4	6.9
	Transportation	5	8.6
	Communication	9	15.5
	Others	1	1.7
Total		58	100.0
(b) Total sales revenue			
Range			
Less than $ 50 million		7	12.1
$ 50 million to below $ 100 million		3	5.2
$ 100 million to below $ 500 million		12	20.7
$ 500 million to below $ 1 billion		4	6.9
$ 1 billion to below $ 5 billion		25	43.1
$ 5 billion to below $ 10 billion		3	5.2
$ 10 billion and above		4	6.9
Total		58	100.0
(c) Number of total employees			
Range			
Less than 100		2	3.4
100 to below 200		4	6.9
200 to below 500		8	13.8
500 to below 1000		8	13.8
1000 to below 3000		10	17.2
3000 to below 10, 000		9	15.5
10,000 to below 30,000		7	12.1
30,000 and above		5	8.6
Total		58	100.0

Table 5
Reliability and validity test results for measures

Measure single factors	Acronym	Item	Reliability (cronbach alpha)	Convergent validity (correlation of item with total score-item)	Discriminant validity (factor loading on single factors)
Knowledge creation process					
Socialization	KC_S	5	0.8589	0.5977; 0.7330; 0.6937; 0.6859; 0.6565	0.737; 0.843;0.815; 0.815; 0.785
Externalization	KC_E	5	0.8845	0.7298; 0.7675; 0.6527; 0.7061; 0.7539	0.862; 0.851; 0.835; 0.815; 0.702
Combination	KC_C	5	0.8524	0.5915; 0.6573; 0.7439; 0.7118; 0.6306	0.859; 0.834; 0.793; 0.760; 0.728
Internalization	KC_I	5	0.8763	0.7083; 0.7443; 0.7517; 0.7483; 0.5944	0.854; 0.849; 0.847; 0.827; 0.725
Knowledge management strategy					
System	S	4	0.8268	0.7134; 0.7263; 0.5713; 0.6067	0.859; 0.867; 0.745; 0.776
Human	H	4	0.7902	0.6047; 0.6652; 0.6233; 0.5125	0.796; 0.837; 0.800; 0.705
Corporate performance	CP	5	0.8651	0.7569; 0.5507; 0.7670; 0.7345; 0.6368	0.856; 0.700; 0.865; 0.842; 0.772

Table 6
Results of interrater reliability and agreement

Index	Variables				KM strategy		Performance
	Knowledge creation processes				System	Human	
	S (Socialization)	E (Externalization)	C (Combination)	I (Internalization)			
ICC (1,k)	0.8606	0.7668	0.5985	0.6852	0.6673	0.6618	0.8667
$r_{wg(J)}$	0.8563	0.8827	0.8499	0.8664	0.8194	0.7754	0.8572

Table 7
Analysis of agglomeration coefficients

Number of clusters	Agglomeration coefficient	Differences in coefficient	Percentage change in coefficient in next level
10	0.16	0.04	0.20
9	0.20	0.07	0.25
8	0.26	0.16	0.38
7	0.43	0.19	0.30
6	0.61	0.36	0.37
5	0.97	0.45	0.32
4	1.41	0.94	0.40
3	2.36	1.41	0.37
2	3.77	11.59	0.75
1	15.36		

interrater reliability and agreement. In the fields of management, a number of studies suggest that ICC ranges from 0.512 to 0.991, and $r_{wg(J)}$ ranges from 0.69 to 0.96 (Amabile et al., 1996; Hater & Bass, 1988). Our results are consistent with these ICC and $r_{wg(J)}$ ranges, and thus interrater reliability and agreement may be guaranteed.

5.4. Classification of system and human strategy

A cluster analysis is performed to derive high or low system strategy according to system-oriented degrees. The decision on the number of clusters is guided by an agglomeration schedule, which displays the squared Euclidean distances between each case or between group of cases (Bierly & Chakrabarti, 1996; Hair, Anderson, Tatham, & Black, 1995). The agglomeration coefficient shows rather large increases from four to three clusters ($2.36 - 1.41 = 0.95$), three to two clusters ($3.77 - 2.36 = 1.41$), and two to one cluster ($15.36 - 3.77 = 11.59$). To help identify large relative increases in the cluster homogeneity, the percentage change in the clustering coefficient is calculated (Table 7). Based on the percentage change in agglomeration coefficients, the appropriate number of clusters is determined to be two.

Table 8 summarizes the result of cluster analysis according to system strategy by using Ward's hierarchical technique. Firms are categorized in view of high or low level of system strategy. Similarly, firms are categorized in view of high or low level of human strategy by the use of Ward's hierarchical technique.

Table 8
Result of cluster analysis

KM strategy	Group			
	High	Low	Mean	p-value
System	4.45	3.61	3.95	0.00
Number of cases	23	35		
Human	4.65	3.96	4.22	0.00
Number of cases	22	36		

6. Effective knowledge management strategy

6.1. Knowledge creation process and KM strategy

In order to explore their link with knowledge management strategies, knowledge creation modes are measured from high or low system strategy perspective. Firms in the highly system strategy-oriented group attempt to increase codifiability and thus decrease complexity in acquiring and using knowledge; knowledge is managed in a formal and public fashion. Conversely, firms in the low system strategy-oriented group show little interest in codifying, storing, and acquiring knowledge.

As shown in Fig. 3, a significant difference is noted among knowledge creation modes in the highly system

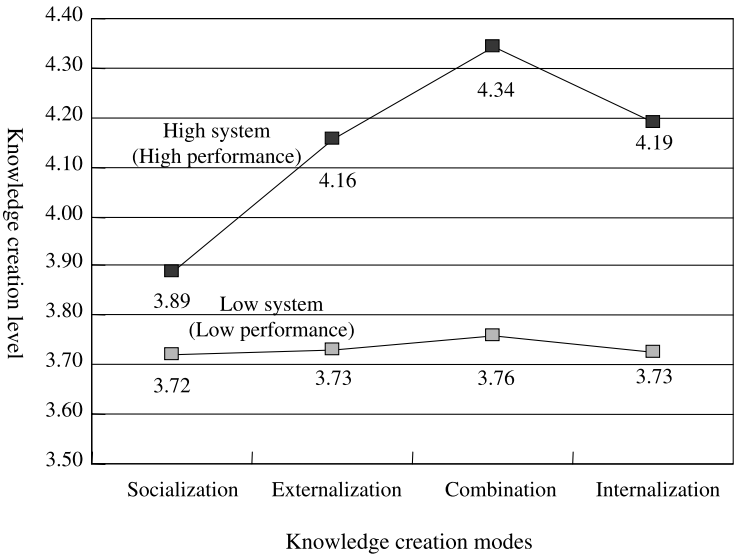

Fig. 3. Knowledge creation modes and system strategy.

strategy-oriented group ($p = 0.019$). The figure takes a 'skewed arc' form. Combination shows the highest level while socialization shows the lowest. In contrast, the figure for the low system strategy-oriented group has a nearly horizontal form; no significant difference is noted among low groups in terms of knowledge creation level ($p = 0.985$).

ANOVA is performed between system strategies and corporate performance. Table 9 depicts that the highly system strategy-oriented group shows corporate performance significantly higher than the low group at the 0.01 confidence level.

Similarly, the relationship between knowledge creation modes and human strategy is investigated. Compared with the system strategy-oriented group, it shows different features.

As shown in Fig. 4, in the case of the highly human strategy-oriented group, socialization shows the highest level while combination shows the lowest. The figure takes a 'skewed U' form. A significant difference is noted among knowledge creation modes ($p = 0.023$). The shape of the figure is opposite to that of the highly system strategy-oriented group.

However, the figure of the low human strategy-oriented group has a 'skewed arc' form. Contrary to low system strategy-oriented group, a significant difference is noted among knowledge creation modes ($p = 0.000$). Combination shows higher level than other modes. This difference may be due to two reasons: (i) an early stage of knowledge management in Korea and (ii) a sample characteristic of the low human strategy-oriented group. First, because of still being at the introductory stage, many Korean firms may emphasize explicit knowledge, which is more likely to be easier to manage than tacit knowledge. Second, 10 out of 36 firms in the low human strategy-oriented group belong to banking or financing industries. These industry sectors have invested in information technology more than others (Marcoccio, 1999); information technology is important to enhance combination (Nonaka, Reinmoeller, & Senoo, 1998).

ANOVA is performed between human strategies and corporate performance. Table 10 shows that the highly human strategy-oriented group has corporate performance significantly higher than the low group at the 0.01 confidence level.

6.2. Knowledge management strategy and corporate performance

Based on the above two figures, a distinctive guideline is pointed out. Firms, which are to employ knowledge

Table 9
ANOVA test results for system strategy and corporate performance

System strategy	Sum of square	Degree of freedom	Sum of mean square	*F*-value	*p*-value
Between group	5.49	1.00	5.49	17.17	0.00
Within group	17.92	56.00	0.32		
Total	23.42	57.00			

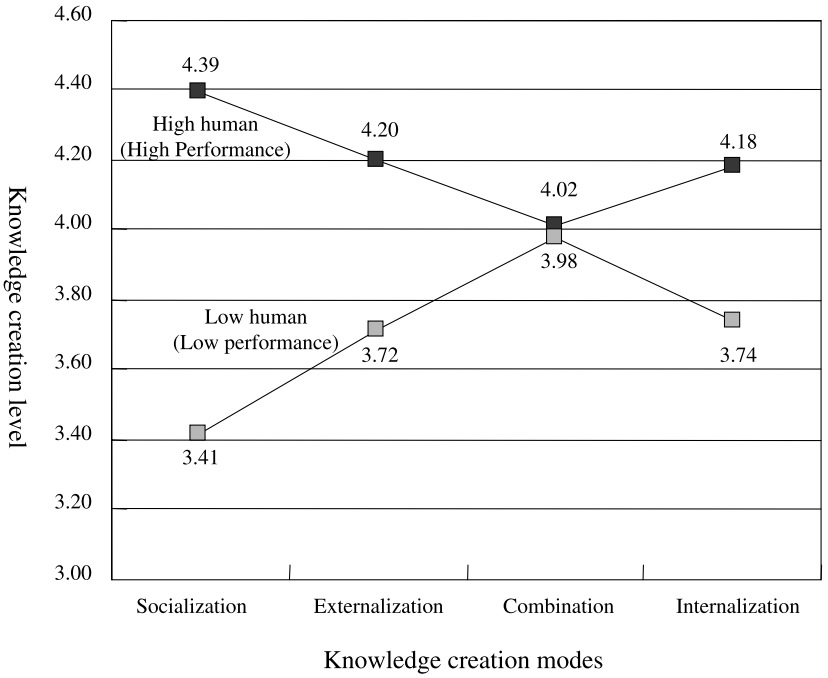

Fig. 4. Knowledge creation modes and human strategy.

management strategies effectively, need to adjust them as their knowledge creation process varies. They tend to focus on human strategy in case of socialization, or system strategy in case of combination. For the sake of presentation, analysis results may be summarized in the form of an effective knowledge management zone (Fig. 5). The effective zone confirms that human strategy is appropriate for socialization while system strategy is appropriate for combination. In addition, the zone shows that balancing human and system strategies is appropriate in case of externalization and internalization.

Our finding sharpens the previous research results. Bloodgood and Salisbury (2001) proposed that human strategy should be appropriate for socialization while system strategy should be appropriate for externalization. However, they did not investigate combination and internalization. Riggins and Rhee (1999) indicated that system strategy should be appropriate for externalization while human strategy should be appropriate for internalization. However, they did not consider socialization and combination. In comparison, our model covers all four knowledge creation modes.

To demonstrate the feasibility of our effective strategy zone empirically, we compare the firms in the effective knowledge management zone with those out of it. Five out of 58 firms fall into the effective zone. Table 11 shows that these five firms within the zone significantly improve corporate performance.

6.3. Knowledge creation and department type

The proposed model with the effective knowledge management zone can be used to adjust strategies along with management factors such as department types. Department types are closely related to knowledge types (Hansen et al., 1999). For example, tacit knowledge are highly required for R&D activities, while explicit knowledge is related to repetitive manufacturing functions (Bohn, 1994). Similarly, the sales department is more likely to deal with customer knowledge, while the knowledge in information systems department is usually technology oriented (Davenport & Prusak, 1998).

Departments may be grouped into six categories such as planning, sales, production, accounting, IS, and R&D (see

Table 10
ANOVA test results for human strategy and corporate performance

Human strategy	Sum of square	Degree of freedom	Sum of mean square	*F*-value	*p*-value
Between group	5.42	1.00	5.42	16.86	0.00
Within group	18.00	56.00	0.32		
Total	23.42	57.00			

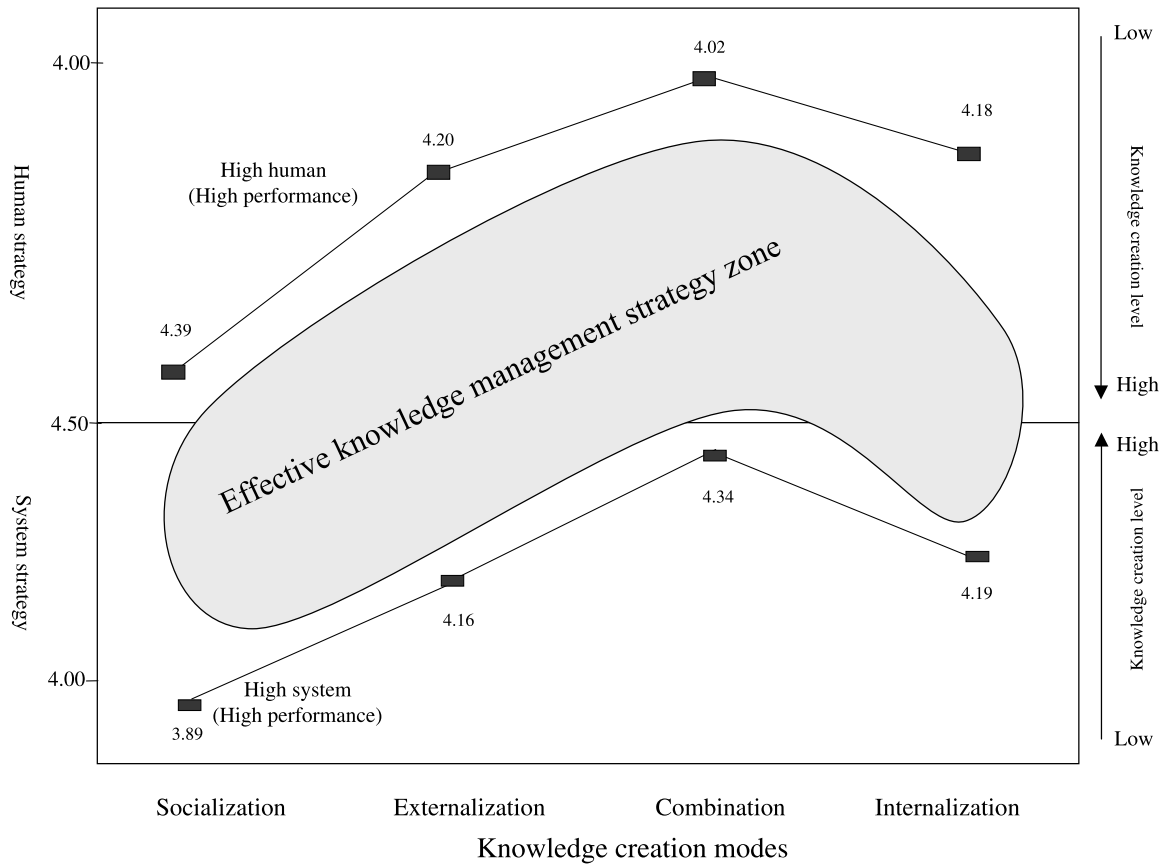

Fig. 5. Knowledge creation modes and KM strategies.

Table 11
Dynamic strategy and corporate performance

Performance	Sum of square	Degree of freedom	Sum of mean square	*F*-value	*p*-value
Between group	3.29	1	3.29	9.14	0.00
Within Group	20.13	56	0.36		
Total	23.42	57			

Table 12
Relationship between knowledge creation modes and department types

Modes	Source of variance	Sum of square	Degree of freedom	Sum of mean square	*F*-value	*p*-value
Socialization	Between group	18.04	5.00	3.61	6.22	0.00
	Within group	230.36	397.00	0.58		
	Total	248.40	402.00			
Externalization	Between group	10.65	5.00	2.13	3.40	0.01
	Within group	248.91	397.00	0.63		
	Total	259.55	402.00			
Combination	Between group	4.82	5.00	0.96	1.59	0.16
	Within group	240.74	397.00	0.61		
	Total	245.56	402.00			
Internalization	Between group	6.01	5.00	1.20	2.01	0.08
	Within group	236.92	397.00	0.60		
	Total	242.93	402.00			

Appendix C). Twenty-one out of 424 respondents are excluded because they do not belong to any of the six departments.

Table 12 shows the relationship between knowledge creation modes and department types. Socialization, externalization, and internalization differ in department types while combination does not. This may imply that organizational factor like department type is not likely to influence combination.

A multiple comparison test (Duncan method) results between knowledge creation modes and department types are summarized in Appendix C. It is found that planning and sales departments have relatively high socialization and externalization while information systems, production, and R&D departments have relatively high combination and internalization. This finding suggests that human strategy is more appropriate for planning and sales departments while system strategy is more appropriate for information systems, production, and R&D departments.

R&D shows relatively low knowledge creation in case of socialization. This rather unexpected result may reflect the career orientation of R&D professionals in Korea. Kim and Cha (2000) reported that 45% of R&D professionals in Korea favor a technical orientation while 15% of them favor a transfer orientation. Technically orientated professionals are more interested in their reputation and research publication; they are reluctant to share their knowledge before turning it into explicit knowledge through presentation or publication. Combination is more likely to be appropriate for this technical orientation. Combination can be fostered relatively easily by information technologies and thus currently many Korean firms tend to begin their knowledge management with R&D divisions.

It is noted that knowledge creation in accounting department is low except for combination. The current primary role of accountants is to provide reliable financial or nonfinancial data (Hall, 2001). They record the financial effects of the firms' transactions and distributes this information to managers. Therefore, it is no surprise that accounting functions are not knowledge-intensive. Companies need to sharpen knowledge-aware accounting functions such as portfolio management or risk management.

7. Conclusions

The primary objective of this paper is to investigate how knowledge management strategies differ in knowledge creating. Our empirical test results in a 'skewed arc' model to relate strategies with creation process. The model implies that companies should align their knowledge strategies along with knowledge creation modes.

Our study has the following contributions. First, it is the first to highlight that dynamic alignment of knowledge strategies can lead to better corporate performance. Second, it proposes a guideline for this alignment with four knowledge creation modes. Our empirical results provide a theoretical foundation for why firms should adjust their knowledge strategies along with its creation modes. Third, it finds that knowledge strategies should differ according to department types. Finally, our study takes a process-oriented perspective. Although managing knowledge relies on process more than objects, very few empirical studies have been explored from process-oriented perspective (Raven & Prasser, 1996).

On the basis of our research, the following future studies are of interest. First, which knowledge management enablers trigger which knowledge creating modes? Strategies still need enablers such as organizational structure, culture, or information technology for actually implementing their strategies. Second, our results may differ in particular industries or companies. A comparative study is of interest (e.g. consulting vs. manufacturing). Third, further exploration of the relationship between knowledge creation and department types may be necessary. Some departments such as planning and R&D may need different strategies in case of externalization and combination. Furthermore, an analysis from an individual department's, not overall firm's perspective, may lead to different implication.

Acknowledgments

This work was supported in part by a grant from KOSEF (98-0102-08-01-3).

Appendix A. Operational definition and related literatures

See Table A1.

Appendix B. Questionnaire items

See Table B1.

Appendix C. Multiple comparison test results between knowledge creation processes and department types

See Table C1.

Table A1

Variables	Operational definition	Related literatures
Socialization	Degree of Tacit knowledge accumulation Extra-firm social information collection Intra-firm social information gathering Transfer of tacit knowledge	Nonaka and Takeuchi (1995) and Nonaka et al. (2000)
Externalization	Degree of Creative dialogue Deductive and inductive thinking Use of metaphors Exchanging ideas	
Combination	Degree of Acquisition and integration Synthesis and processing Dissemination	
Internalization	Degree of Personal experiences Simulation and experimentation	
System	Degree of Knowledge codification Documentation Knowledge acquisition in codified forms Knowledge sharing through codified forms	Bierly and Chakrabarti (1996), Bohn (1994), Hansen et al. (1999), Jordan and Jones (1997), Swan et al. (1999) and Zack (1999a)
Human	Degree of Knowledge acquisition from experts and co-workers Face-to-face help by experts Informal dialogues for knowledge sharing Knowledge acquisition by one-to-one mentoring	Bierly and Chakrabarti (1996), Hansen et al. (1999), Jordan and Jones (1997), Nonaka and Takeuchi (1995), Venzin et al. (1998) and Zack (1999a)
Corporate performance	Degree of Overall success Market share Growth rate Profitability Innovativeness in comparison with major competitors	Deshpande et al. (1993) and Drew (1997)

Table B1

Construct	Items	Remarks
(1) *Knowledge creation processes*		
Socialization (KC_S; 5 items)	My company stresses KC_S1:…gathering information from sales and production sites KC_S2:…sharing experience with suppliers and customers KC_S3: …engaging in dialogue with competitors KC_S4: …finding new strategies and market opportunities by wandering inside firm KC_S5: …creating a work environment that allows peers to understand the craftsmanship and expertise	Adopted from Nonaka et al. (2000)

(*continued on next page*)

Table B1 (*continued*)

Construct	Items	Remarks
Externalization (KC_E; 5 items)	My company stresses KC_E1: …creative and essential dialogues KC_E2: …the use of deductive and inductive thinking KC_E3: …the use of metaphors in dialogue for concept creation KC_E4: …exchanging various ideas and dialogues KC_E5: …the subjective opinion	
Combination (KC_C; 5 items)	My company stresses KC_C1: …planning strategies by using published literature, computer simulation and forecasting KC_C2: …creating manuals and documents on products and services KC_C3: …building databases on products and service KC_C4: …building up materials by gathering management figures and technical information KC_C5: … transmitting newly created concepts	
Internalization (KC_I; 5 items)	My company stresses KC_I1: …enactive liaisoning activities with functional department by cross-functional development teams KC_I2: …forming teams as a model and conducting experiments, and sharing results with entire departments KC_I3: …searching and sharing new values and thoughts KC_I4: …sharing and trying to understand management visions and values through communications with fellows KC_I5: …benchmarking and test marketing	
(2) *Knowledge management strategy*		
System (S; 4 items)	S 1: Knowledge (know-how, technical skill, or problem solving methods) is well codified S 2: Knowledge can be acquired easily through formal documents and manuals S 3: Results of projects and meetings should be documented S 4: Knowledge is shared in codified forms like manuals or documents	Adopted from Choi and Lee (2000)
Human (H, 4 items)	H 1: My knowledge can be easily acquired from experts and co-workers H 2: It is easy to get face-to-face advice from experts H 3: Informal dialogues and meetings are used for knowledge sharing H 4: Knowledge is acquired by one-to-one mentoring	
(3) *Corporate performance*		
Corporate performance (CP, 5 items)	Compared with key competitors, my company CP 1: …is more successful CP 2: …has greater market share CP 3: …is growing faster CP 4: …is more profitable CP 5: …is more innovative	Adopted from Deshpande et al. (1993) and Drew (1997)

Table C1

Department	Number of cases	1	2
(1) *Socialization*			
Accounting	43	3.44	
R&D	44	3.47	
Production	22	3.71	
IS	82	3.75	
Sales	73		3.96
Planning	139		4.01
P-value		0.07	0.11
(2) *Externalization*			
Accounting	43	3.46	
Production	22		3.78
R&D	44		3.84
IS	82		3.95
Sales	73		3.92
Planning	139		4.00
P-value		1.00	0.24
(3) *Combination*			
Accounting	43	3.78	
Sales	73	3.80	
Planning	139	3.87	
Production	22	3.93	
R&D	44	4.01	
IS	82	4.09	
P-value		0.21	
(4) *Internalization*			
Accounting	43	3.60	
Sales	73	3.84	
Planning	139	3.89	
R&D	44		3.91
Production	22		3.92
IS	82		4.05
P-value		0.08	0.24

References

Amabile, T., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal*, *39*(5), 1154–1184.

Beckman, T. (1999). The current state of knowledge management. In J. Liebowitz (Ed.), *Knowledge management handbook* (pp. 1-1–1-22). Boca Raton: CRC Press.

Bierly, P., & Chakrabarti, A. (1996). Generic knowledge strategies in the U.S. pharmaceutical industry. *Strategic Management Journal*, *17*, 123–135.

Blackler, F. (1995). Knowledge, knowledge work, and organizations: an overview and interpretation. *Organization Studies*, *16*(6), 1021–1046.

Bloodgood, J. M., & Salisbury, Wm. D. (2001). Understanding the influence of organizational change strategies on information technology and knowledge management strategies. *Decision Support Systems*, *31*, 55–69.

Bohn, R. (1994). Measuring and managing technological knowledge. *Sloan Management Review, Fall*, 61–73.

Choi, B., & Lee, H. (2000). *Knowledge management enablers, processes, and organizational performance: An integration and empirical examination.*, *APDSI*, 2000.

Collins, D. J., & Montgomery, C. A. (1995). Competing on resources: Strategy in the 1990s. *Harvard Business Review*, *July–August*, 118–128.

Cross, R., & Baird, L. (2000). Technology is not enough: improving performance by building organizational memory. *Sloan Management Review*, *Spring*, 69–78.

Davenport, T. H., Long, D., & Beers, M. C. (1998). Successful knowledge management projects. *Sloan Management Review*, *Winter*, 43–57.

Davenport, T. H., & Prusak, L. (1998). *Working knowledge*. Boston: Harvard Business School Press.

Deshpande, R., Jarley, U., & Webster, F. (1993). Corporate culture, customer orientation, and innovativeness in Japanese firms: A quadrad analysis. *Journal of Marketing*, *57*, 23–37.

Drew, S. (1997). From knowledge to action: the impact of benchmarking on organizational performance. *Long Range Planning*, *30*(3), 427–441.

Easterby-Smith, M. (1997). Disciplines of organizational learning: contributions and critics. *Human Relations*, *September*, 1085–1113.

Edvinsson, L., & Malone, M. S. (1997). *Intellectual capital*. New York: HarperCollins.

Grant, R. M. (1996). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science*, *7*(4), 375–387.

Hair, J. F., Anderson, R., Tatham, R., & Black, W. (1995). *Multivariate data analysis with readings*. Englewood Cliffs, NJ: Prentice Hall.

Hall, R. (1992). The strategic analysis of intangible resources. *Strategic Management Journal*, *13*, 135–144.

Hall, J. A. (2001). *Accounting information systems* (3rd ed.). Thomson Learning.

Hansen, M., Nohria, N., & Tierney, T. (1999). What's your strategy for managing knowledge? *Harvard Business Review*, *March–April*, 106–116.

Hater, J. J., & Bass, B. M. (1988). Superiors' evaluations and subordinates perceptions of transformational and transactional leadership. *Journal of Applied Psychology*, *73*(4), 695–702.

Hippel, E. (1994). Sticky information and the locus of problem solving: Implications for innovation. *Management Science*, *40*(4), 429–439.

Holsapple, C. W., & Singh, M. (2001). The knowledge chain model: Activities for competitiveness. *Expert Systems with Applications*, *20*, 77–98.

James, L. R., Demaree, R. G., & Wolf, G. (1984). Estimating within-group interrater reliability with and without response bias. *Journal of Applied Psychology*, *69*(1), 85–98.

James, L. R., Demaree, R. G., & Wolf, G. (1993). r_{wg}: An assessment of within-group interrater agreement. *Journal of Applied Psychology*, *78*(2), 306–309.

Jordan, J., & Jones, P. (1997). Assessing your company's knowledge management style. *Long Range Planning*, *30*(3), 392–398.

Junnarkar, B. (1997). Leveraging collective intellect by building organizational capabilities. *Expert Systems with Applications*, *13*(1), 29–40.

Kerlinger, F. (1964). *Foundation of Behavioral Research*. New York: Rinehart and Wiston.

Kidd, J. B. (1998). Knowledge creation in Japanese manufacturing companies in Italy: reflection upon organizational learning. *Management Learning*, *29*(2), 131–146.

Kitts, B., Edivinsson, L., & Beding, T. (2001). Intellectual capital: from intangible assets to fitness landscapes. *Expert Systems with Applications*, *20*, 35–50.

Kim, Y., & Cha, J. (2000). Career orientation of R&D professionals in Korea. *R&D Management*, *30*(2), 121–137.

Kozlowski, W., & Hattrup, K. (1992). A disagreement about within-group agreement: Disentangling issues of consistency versus consensus. *Journal of Applied Psychology*, *77*(2), 161–167.

Krogh, G., & Grand, S. (2000). Justification in knowledge creation: Dominant logic in management discourses. In G. Krogh, I. Nonaka, & T. Nishiguchi (Eds.), *Knowledge creation: A source of value* (pp. 13–35). New York: St Martin's Press.

Lee, J., & Kim, Y. (2001). A stage model of organizational knowledge management: A latent content analysis. *Expert Systems with Applications*, *20*, 299–311.

Liao, S. (2002). Problem solving and knowledge inertia. *Expert Systems with Applications*, *22*, 21–31.

Liebowitz, J. (2001). Knowledge management and its link to artificial intelligence. *Expert Systems with Applications*, *20*, 1–6.

Liebowitz, J., & Wilcox, L. C. (1997). *Knowledge management and its integrative elements*. Boca Raton: CRC Press.

Maeil Business Newspaper (2000). *Annual Corporation Reports*. Maeil Business Newspaper Co.

Malhotra, Y. (2000). Knowledge management and new organization forms: A framework for business model innovation. *Information Resources Management Journal*, *13*(1), 5–14.

Marcoccio, L. (1999). Lead: year 2000 world status: the last check-in. *Gartener Group Symposium ITXP*.

Nonaka, I., Reinmoeller, P., & Senoo, D. (1998). The ART of knowledge: systems to capitalize on market knowledge. *European Management Journal*, *16*(6), 673–684.

Nonaka, I., & Takeuchi, H. (1995). *The knowledge creating company*. New York: Oxford University Press.

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, *ba* and leadership: A unified model of dynamic knowledge creation. *Long Range Planning*, *33*, 5–34.

O'Dell, C., & Grayson, J. (1998). If only we knew what we know: Identification and transfer of internal best practices. *California Management Review*, *40*(3), 154–174.

Parent, M., Gallupe, R. B., Salisbury, Wm. D., & Handelman, J. M. (2000). Knowledge creation in focus group: can group technologies help? *Information and Management*, *38*, 47–58.

Polanyi, M. (1997). The tacit dimension. In L. Prusak (Ed.), *Knowledge in organizations* (pp. 135–146). Boston: Butterworth-Heinemann.

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review*, *May–June*, 79–91.

Raven, A., & Prasser, S. G. (1996). Information technology support for the creation and transfer of tacit knowledge in organizations. *AIS 1996 Conference* (http://hsb.baylor.edu/ramsower/ais.ac.96/papers/RAVEN.htm).

Riggins, F. J., & Rhee, H. (1999). Developing the learning network using extranets. *International Journal of Electronic Commerce*, *4*(1), 65–83.

Sarvary, M. (1999). Knowledge management and competition in the consulting industry. *California Management Review*, *41*(2), 95–107.

Scott, J. E. (1998). Organizational knowledge and the internet. *Decision Support Systems*, *23*, 3–17.

Shrout, P. E., & Fliess, J. L. (1979). Interclass correlation: uses in assessing rater reliability. *Psychological Bulletin*, *86*, 420–428.

Singh, H., & Zollo, M. (1998). The impact of knowledge codification, experience trajectories and integration strategies on the performance of corporate acquisitions. *The Wharton School Working Paper No. 98-24*.

Soliman, F., & Spooner, K. (2000). Strategies for implementing knowledge management: Role of human resources management. *Journal of Knowledge Management*, *4*(4), 337–345.

Sveiby, K. (1997). *The new organization wealth: Management and measuring knowledge-based assets*. Berrett-Koehler Publishers.

Swan, J., Newell, S., & Robertson, M. (2000). Limits of IT-driven knowledge management for interactive innovation processes: towards a community-based approach. *Proceedings of 33rd HICSS*.

Teece, D. (2000). Strategies for managing knowledge assets: The role of firm structure and industrial context. *Long Range Planning*, *33*, 35–54.

Teece, D., Pisano, G., & Shuen, A. (1997). Dynamic capability and strategic management. *Strategic Management Journal*, *18*(7), 509–533.

Venkatraman, N., & Grant, J. H. (1986). Construct measurement in organizational research: A critique and proposal. *Academy of Management Review*, *1*(11), 71–87.

Venzin, M., Krogh, G., & Roos, J. (1998). Future research into knowledge management. In G. Krogh, J. Roos, & D. Kleine (Eds.), *Knowing in firms* (pp. 223–252). London: SAGE Publications.

Wiig, K. (1995). *Knowledge management methods*. Texas: Schema Press.

Wiig, K. M., Hoog, R., & Spek, R. (1997). Supporting knowledge management: A selection of methods and techniques. *Expert Systems with Applications*, *13*(1), 15–27.

Zack, M. H. (1999a). Developing a knowledge strategy. *California Management Review*, *41*(3), 125–145.

Zack, M. H. (1999b). *Introduction. Knowledge and strategy*, Boston: Butterworth-Heinnemann, pp. vii–xii.