Electronic Commerce Research and Applications 10 (2011) 75–84

Contents lists available at ScienceDirect

Electronic Commerce Research and Applications

journal homepage: www.elsevier.com/locate/ecra

Knowledge evolution strategies and organizational performance: A strategic fit analysis

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ARTICLE INFO

Article history:
Received 29 July 2008
Received in revised form 20 October 2010
Accepted 23 October 2010
Available online 17 December 2010

Keywords:
Knowledge management
Knowledge evolution
Knowledge acquisition strategy
Organizational performance
Strategic fit theory

ABSTRACT

The rapid growth of electronic commerce on the Internet provides a platform for organizational knowledge to be changed faster than ever. The process by which knowledge assets of an organization change over time to cope with the pressure of environmental variation is called knowledge evolution. In this paper, we adopt the strategic fit theory to examine whether different knowledge evolution strategies would affect organizational performance in different circumstances. We adopt the concept from natural evolution to define two knowledge evolution strategies: knowledge mutation that relies on internal knowledge sources and knowledge crossover that takes advantage of external sources such as online communities and professional consultants. A survey was conducted to explore the effects of different strategies on organizational performance, as measured by the balanced scorecard (BSC).

The results show that knowledge mutation and crossover have impacts on different aspects of organizational performance. In addition, many industrial factors, such as environment variation, knowledge density, and organizational factors, including IT capability and sharing culture, are found to have moderating effects. The findings of this research will help organizations choose the right strategy for knowledge enhancement and light up new directions for further research.

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1. Introduction

With the rapid development of e-commerce and the trend of globalization, the environment surrounding organizations is dramatically changing. Under these circumstances, knowledge assets have become an importance source of competitive advantages to most organizations. Peter Drucker (1999) stated that knowledge would replace tangible assets, such as equipment, capital, material, or labor as the key production factor; knowledge workers are replacing traditional labor to become an important enabler of organizational value. As such, how to manage knowledge assets effectively has become a critical issue to organizations in the Internet age. Knowledge management also plays a key role for e-businesses to cumulate their valuable intangible assets for higher competitive advantages. More and more organizations are taking advantage of external knowledge sources such as online communities (e.g., blogs and social networking websites) to enhance their competitiveness. Knowledge could become an intangible product to be traded in electronic commerce. However, not much research has investigated whether different knowledge acquisition strategies may affect organizational performance and under which circumstances a particular strategy has a better effect.

Many models have been proposed to manage valuable organizational knowledge. Early research on knowledge management (KM) proposes the perspective that focuses on the process of knowledge creation and sharing in organizations (Nonaka 1994, Davenport and Prusak 1998, Alavi and Leidner 1999). A well-known model is the knowledge creation cycle proposed by Nonaka (1994), which suggests that knowledge creation activities include socialization, externalization, combination, and internalization. An organization should properly manage the process of knowledge creation, storage, retrieval, transfer, and applications. Alavi and Leidner (1999) provided a nice review of the process view of knowledge management. Another research line adopts the resource-based view that treats knowledge as organizational resources to investigate its effect on organizational capabilities and firm performance (Hamel and Prahalad 1990, Grant 1991, Bharadwaj 2000, Billinfer and Smith 2001, Gold et al. 2001, Lee and Choi 2003, Liu and Wang 2009, Schroeder et al. 2009). These studies have found significant impacts of KM activities on organizational creativity and firm performance.

As KM is a continuous and dynamic process, understanding the patterns of knowledge development, their driving forces and organizational context is also an important issue. A better

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doi:10.1016/j.elerap.2010.10.004

understanding of the interaction between knowledge development and organizational context allows us to know more about how different evolutionary strategies affect organizational performance.

Zollo and Winter (2002) proposed a knowledge evolution cycle to explain how knowledge assets adapt to environmental pressure. They added an additional stage to Darwin's evolution process to include *variation*, *selection*, *replication*, and *retention*. Organizational knowledge evolves through these four stages recursively. This model defines the stages of knowledge evolution but fails to identify potential evolutionary strategies, nor provides empirical evidence to show the relationship between knowledge evolution, organizational context and firm performance.

In this research, we extend the knowledge evolution model by conceptually defining and empirically testing two knowledge evolution strategies that organizations use to enhance its knowledge and whether there exists a fit between evolution and organizational factors. The remainder of the paper is organized as follows: Section 2 reviews major literature concerning knowledge evolution and the strategic fit theory. Research model and hypotheses are developed in Section 3. Section 4 shows the results of our survey research. Finally, implications and conclusions are described in Section 5.

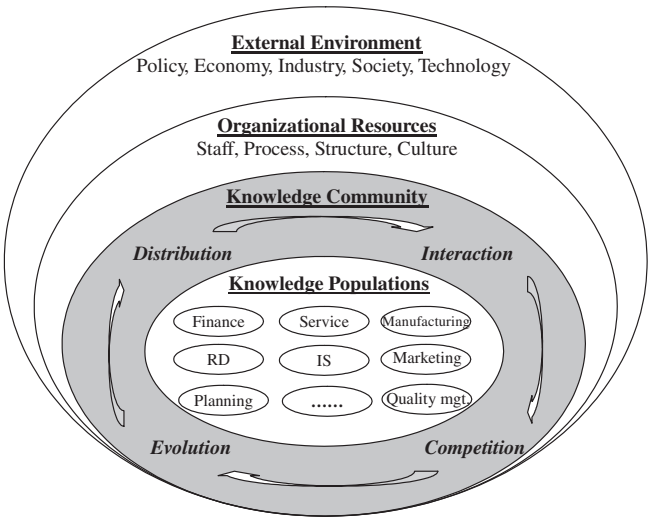

Fig. 1. A conceptual model of knowledge ecology.

2. Theoretical background

2.1. Ecological view of knowledge management

Research in knowledge management can be traced to early work in the sociology of knowledge around the 1970s and technical work in knowledge-based expert systems in the 1980s. In a review on knowledge management and knowledge management systems, Alavi and Leidner (2001) examine how KM has attracted significant attention in organizations, and consider previous KM research from a process view, including activities such as creation, storage, retrieval, transfer, and application of knowledge.

A quite different view was proposed recently to examine organizational knowledge from the ecological view. Ecology is a science used to analyze the relationship among members (species) of a community and their interaction with its environment. Traditionally, ecology is defined as "the scientific study on the interactions that determine the distribution and abundance of organisms" (Krebs 1978, Carroll 1988, McGlade 1999).

In their recent work, Chen and Liang (2005) and Chen et al. (2010) define the knowledge ecology of an organization as a combination of knowledge communities, organizational resources, and external environment. Different types of knowledge owned by different divisions or employees are viewed as different knowledge communities (or populations) in an eco-system. These knowledge communities build on top of organizational resources (including staff, process, structure, and culture) and maintain a balance with the external environment to maximize its interests through four ecological mechanisms: *distribution*, *interaction*, *competition*, and *evolution*. Fig. 1 illustrates their relationships.

2.2. Knowledge evolution

Knowledge evolution represents the fact that organizations change their knowledge contents to cope with the changing pressure from the environment. Evolution is a strategy that a population uses to cope with the pressures of environmental variation (Burgelman 1991, Usher and Evans 1996). It is a dynamic capability which allows every firm to integrate, build, and reconfigure their competences under a rapidly changing environment (Teece et al. 1997). Those with higher adaptability are more likely to survive in a dynamic business environment. A similar concept developed in strategic management is the strategic fit theory, that suggests the importance of matching strategic selection with environmental features (Thompson 1967). The theory will be explained in Section 3.1.

A typical knowledge evolution cycle may include four stages: variation, selection, replication, and retention (Zollo and Winter 2002). In the variation stage, individuals or groups in an organization generate new ideas to meet the challenges of external stimuli and feedback. Internal selection is a mechanism to ensure that only the most valuable approaches will be selected for further implementation. In the replication stage, the retained and implemented ideas will be shared throughout the organization to further enhance organizational competence. Finally, the new knowledge is routinized in the organization in the retention stage.

Van den Bosch et al. (1999) proposed a framework for the co-evolution of a firm's absorptive capacity with its knowledge environment. The framework offered an explanation of how knowledge environments co-evolve with the emergence of organization forms and combinative capabilities that are suitable for absorbing knowledge. In another relevant work, Bieber et al. (2002) proposed an architecture for developing a community of knowledge evolution that could be used to improve members' tasks in a virtual community.

Menon and Pfeffer (2003) suggest two knowledge sources that may be the driving forces of knowledge evolution: internal and external. The pressure of competition coming from internal colleagues or external rivals drives these two types of knowledge sources respectively. Therefore, these two major forces may cause the variation of the knowledge assets and affect the knowledge evolution strategies in organizations. Chen and his colleagues (2005, 2010) named these two major knowledge evolution strategies driven by internal and external forces *knowledge mutation* and *knowledge crossover*, respectively.

2.2.1. Knowledge mutation strategy: internal-driven evolution

The concept of knowledge mutation is derived from the concept of mutation in genetics, which stands for random changes that occur in a particular gene of a species. Genetic mutation can be recognized as an internal force to change the population through self-adaptation. In knowledge ecology, knowledge mutation allows new knowledge to be created from existing knowledge. The changes or enhancements of knowledge are provoked by internal forces, such as the outcomes from internal Research and Development (R&D) projects or combination of existing knowledge. New

knowledge derived from internal mutation should be innovative and significantly different from the existing knowledge.

The importance of internal knowledge evolution has been supported by previous studies. For instance, Shih et al. (2006) emphasize the importance of internal environmental auditors in a firm, which serve as a trigger for internal mutation. They found that in environmental management, the better a firm improves its internal mechanisms, the better its financial performance will be. This environmental awareness helps a firm continuously update its operating knowledge and hence results in performance enhancement.

2.2.2. Knowledge crossover strategy: external-driven evolution

Similarly, the concept of knowledge crossover is adapted from gene crossover, one of the most important mechanisms for genetic variation. Gene crossover is the interchange of sections between pairing homologous chromosomes during the prophase of meiosis. It is a method used to vary the chromosomes from one generation to the next. In the knowledge ecology, knowledge crossover is the strategy that acquires new knowledge from outside the firm and assimilates this knowledge with existing knowledge. The changes or enhancements of knowledge are provoked by forces outside a knowledge community, such as acquiring a patent license or hiring a consultant from another organization. The importance of absorbing outside knowledge is also supported by literature (Mason et al. 2004). For example, Menon and Pfeffer (2003) highlight the importance of outsider knowledge and argue that managers value external knowledge more than internal knowledge because firms like to take advantage of learning from others.

Therefore, Zollo and Winter's knowledge evolution cycle can be extended to include the above two evolution strategies, as shown in Fig. 2.

2.3. Strategic fit theory

The *strategic fit theory* was originally proposed in Thompson (1967) that regards organizational strategy as an organizational process to fit the environment. That means, a good strategy should fit the external environment in order to gain competitive advantages (Hedley 1977) and to cope with the environmental uncertainty (Bergeron et al. 2001). The external environment, including market opportunities, competition position, and environmental uncertainty, has a great influence on organizational performance. Hence, organizations have to adjust their strategies to cope with the environmental variation (Thompson 1967). Those having a better strategic fit are more likely to generate higher organizational performance.

The strategic fit theory has been supported by many empirical studies. For example, Chan et al. (1997) investigated the business and IS (information systems) strategic orientation from the strategic fit perspective and found significant positive impact of the fit between business strategy and IS strategy on business performance. Doty et al. (1993) also reported that a better organizational fit to the environment would lead to better organization effectiveness.

Applying the strategic fit theory to knowledge evolution, we argue that different evolution strategy may lead to different organizational performance in different industries. In other words, there will be no single knowledge evolution strategy that fits all contingencies.

2.4. Organizational performance

There are many different ways to measure firm performance. A typical one is to use financial measures such as return on investment (ROI) or return on assets (ROA). However, this is often criticized to be too narrow and short-term-oriented. This constraint is particularly significant, as knowledge management is a long-term endeavor. In additional to financial figures, some other methods are available. For instance, Lee and Choi (2003) reported four different approaches: financial, intellectual capital, tangible and intangible benefits. A more comprehensive method used in management research is the balanced scorecard (BSC) proposed by Kaplan and Norton (1996).

The balanced scorecard includes four major dimensions: finance, customer, internal process, and learning and growth. The major advantage of BSC is that it retains financial performance and supplements it with measures on the drivers of future potential. In addition, it is more useful than intellectual capital or a tangible and intangible approach in that it shows cause and effect links between knowledge components and organization strategies (Lee and Choi 2003). As knowledge management is an activity that penetrates the whole organization, we considered BSC to be more proper to measure KM performance.

3. Research model and methodology

Based on the strategic fit theory, we developed a research model to investigate the effect of knowledge evolution strategies on organizational performance and conducted an empirical study to test the hypotheses.

3.1. Research model and hypothesis development

The strategic-fit concept includes internal alignment between strategy and organizational features and fit between organizational strategy and its external environment (Miller 1992). Therefore, our research framework consists of the main effects of two knowledge evolutionary strategies (fit between strategies and external environment) and the moderating effect of four contingency variables (fit between strategy and organizational features). The dependent variable is organizational performance as measured by BSC. Fig. 3 shows the research framework.

3.1.1. Evolutionary hypotheses

The basic evolution rule argues that species with stronger adaptability is more likely to perform better. In other words,

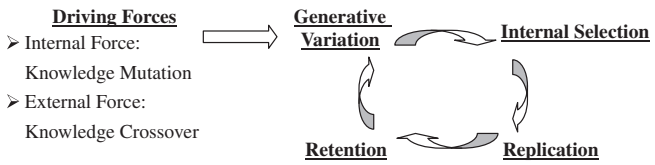

Fig. 2. An extended knowledge evolution model.

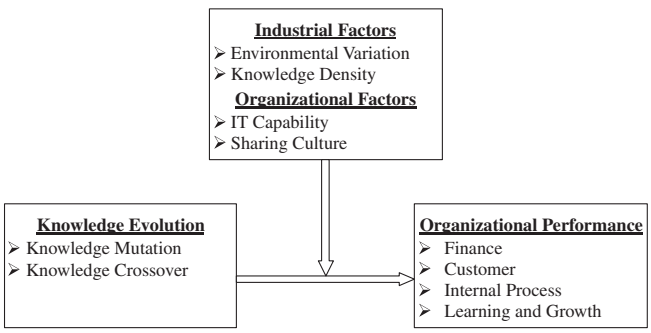

Fig. 3. The research model.

organizations with better knowledge evolution capabilities (either mutation or crossover) are more likely to perform better. Accordingly, two sets of main hypotheses with respect to the relationships between knowledge evolution strategies and organizational performance can be postulated in H1 and H2:

H1: Knowledge mutation can increase organizational performance.
H1.1: Knowledge mutation can increase financial performance.
H1.2: Knowledge mutation can increase customer performance.
H1.3: Knowledge mutation can increase internal process performance.
H1.4: Knowledge mutation can increase learning and growth performance.
H2: Knowledge crossover can increase organizational performance.
H2.1: Knowledge crossover can increase finance performance.
H2.2: Knowledge crossover can increase customer performance.
H2.3: Knowledge crossover can increase internal process performance.
H2.4: Knowledge crossover can increase learning and growth performance.

3.1.2. Strategic fit hypotheses

The strategic fit includes fit between strategy and environment and fit between strategy and organizational features. We chose environmental variation to represent the nature of the environment and the density of knowledge and organizational factors (information technology and sharing culture) to represent organizational features related to knowledge evolution. They are treated as moderators, because moderation is a proper approach for handling the fit between organizational features and strategies (Venkatraman 1989, Hoffman et al. 1992).

(1) Industrial factors

To cope with environment uncertainty, organizations must change to keep pace with certain industry-specific and firm-specific factors. Different industries often face different environmental variations (Miller 1992, Doty et al. 1993, Chan et al. 1997). Therefore, environmental factors are expected to vary the effects of knowledge evolution on firm performance. Another factor is the knowledge density of products or services. Intuitively, knowledge-intensive products and services tend to be more sensitive to knowledge evolution strategy. Here, knowledge intensity is measured by the importance of intangible assets such as patents and brand, as well as the portion of tangible costs in the total cost of the product/service (Miles et al. 1995, Hertog 2000).

Therefore, we propose H3 to examine whether environmental variation and knowledge density moderate the relationship between knowledge evolution and organizational performance.

H3.1: The effect of different knowledge evolution strategy on organizational performance is moderated by the environmental variation facing the organization.
H3.2: The effect of different knowledge evolution strategy on organizational performance is moderated by the knowledge density of the product/services.

(2) Organizational factors

A second group of potential moderating variables for assessing the strategic fit theory is related to the nature of the organization. Previous research has found that information technology (IT) is an important enabler to facilitate knowledge management success (Gold et al. 2001, Lee and Choi 2003). Alavi and Leidner (2001) claimed that information technology is the foundation for establishing knowledge management in organizations. Therefore, the first factor to be examined is the information technology capability of the organization.

Sharing culture is another organizational specific factor that may affect the success of knowledge management (Alavi and Leidner 2001, Alavi et al. 2005, Gold et al. 2001, Lee and Choi 2003). Davenport and Prusak (1998) argue that a knowledge sharing friendly culture is a good catalyst for a knowledge management initiative in organizations. Therefore, H4 is proposed to examine whether the IT capability and sharing culture moderate the relationship between knowledge evolution and organizational performance.

H4.1: The effect of different knowledge evolution strategy on organizational performance is moderated by the IT capabilities.
H4.2: The effect of different knowledge evolution strategy on organizational performance is moderated by the sharing culture of the organization.

3.2. Data collection

In the research model, ten research constructs should be measured. The items in the survey questionnaire and their respective references are shown in Appendix A. To ensure the face validity of our instruments, the questionnaire was reviewed by three knowledge management experts. A pilot test was conducted before the actual survey. We randomly selected ten graduate students to review our questionnaire and clarify any possible confusion in the measurements. The revised questionnaire was then distributed to 226 senior organizational representatives who participated in a forum discussion as part of an extended education program in Taiwan and returned before the end of the forum.

A total of 129 responses were received, which resulted in 97 unique cases with no missing or invalid data. The effective response rate is 42.9%. The respondents came from six different industries, including IT services (23), semi-conductor manufacturers (15), IC design (10), communication service (8), finance (18), and traditional manufacturers (23). The number in the parenthesis is the sample size in a particular industry.

Among the informant, 72 of them held a master degree and 25 had a college degree. The average working years in their organizations was 7.97. Most of them held a manager or senior manager position. These indicate that they were knowledgeable about their organizations and their reported data could reasonably represent the actual situation of their organizations.

4. Data analysis

4.1. Reliability and validity analysis

The reliability of the collected data was assessed using Cronbach's alpha to check for their internal consistency (Hair

Table 1
Reliability analysis.

Construct	Composite reliability	AVE	Cronbach's α
Knowledge mutation	0.820	0.534	0.710
Knowledge crossover	0.837	0.634	0.714
Finance	0.878	0.647	0.811
customer	0.914	0.780	0.855
Internal process	0.827	0.546	0.710
Learning and growth	0.924	0.754	0.891
Environment variation	0.875	0.778	0.715
Knowledge density	0.871	0.772	0.703
IT capability	0.932	0.774	0.900
Sharing culture	0.897	0.744	0.827

et al. 1998). A Partial Least Squares (PLS) analysis of the measurement model (Table 1) shows that all items loaded on their intended constructs with loadings of at least 0.7. Thus, our measurement instrument exhibits acceptable reliability (Nunnally 1978). Average variance extracted (AVE), on the other hand, represents an alternative assessment of internal consistency (Chin 1998, Chin and Marcolin 1995) that allows items to be weighted differentially with respect to the intended latent construct. The AVE values shown in Table 1 range between 0.534 and 0.780, which are above the acceptable level of 0.5, as recommended by Chin (1998). The square roots of these AVE scores are greater than the corresponding inter-correlations, which indicate satisfactory discriminant validity (Table 2). A further analysis of the multi-collinearity between knowledge mutation and crossover results in a VIF value of 1.471, far smaller than the hurdle value of 10, which shows low multi-collinearity. In summary, the results presented here indicate that the data are reliable and valid for hypothesis testing.

4.2. Main effect analysis

The main effects were analyzed by PLS with 500 times of resampling. The resulting model is shown in Table 3 and Fig. 4. Knowledge mutation that focuses on internal exchange of knowledge has shown significant effects on the internal aspects of organizational performance, including improvements in internal process and learning and growth. Knowledge crossover that brings in new knowledge from outside sources shows significant effects on both internal and external aspects of organizational performance, including finance, customer, and internal process. In other words, we find that *the knowledge evolution strategy driven by internal forces improves internal performance, while strategy originating driven by external forces improves external performance, except that it also affects internal process improvement.* No single KM strategy can improve all four performance dimensions. These results suggest that both research hypotheses H1 and H2 are partially supported. When the knowledge evolution strategy fits its driving forces, significant improvement in performance can be anticipated.

A possible explanation of the above observed phenomena is the coordination theory, which deals with the issue of coordination among multiple interdependent actors (Malone and Crowston 1990). As external performance dimensions involve external actors such as customers, the evolution strategy that takes advantage of external knowledge is more likely to have an advantage in better coordinating the activities and needs of external actors. Similarly, internal knowledge is more useful for coordinating internal actors to drive higher internal dimension of performance.

4.3. Analysis of moderation effects

Since four moderating variables were included in the research model, four subgroup analyses were conducted to examine the effect of individual moderators. In each analysis, the whole dataset was divided into two sub-groups, denoted as high (49 observations) and low (48 observations), by the medium of the selected variable. Each subgroup was then analyzed by PLS. The moderating effect is observed by comparing the significant dimensions between the two groups and between sub-groups and the entire sample.

Table 3
The result of main effect analysis.

I.V.	D.V.	β	t value
Knowledge mutation	Finance	0.218	1.629
	Customer	0.158	1.502
	Internal process	0.282*	2.114
	Learning and growth	0.503***	4.390
Knowledge crossover	Finance	0.236*	1.960
	Customer	0.353***	3.132
	Internal process	0.260*	2.231
	Learning and growth	0.087	1.016

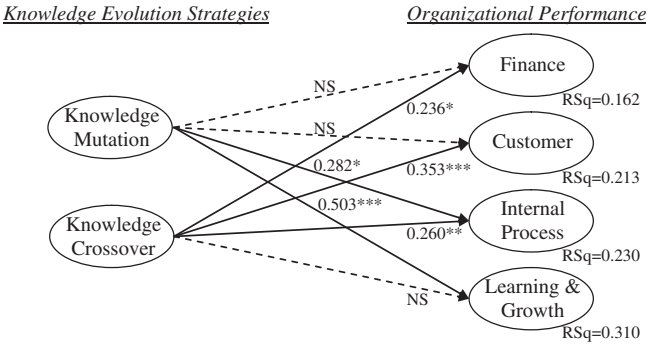

Fig. 4. Effect of knowledge evolution on organizational performance. (*: p-value < 0.05, **: p-value < 0.01, ***: p-value < 0.001; NS: Non-Significant).

(1) Effect of environmental variation

Table 4 shows the result of the subgroup analysis. For knowledge mutation, the significance effect of internal process improvement disappears in the high variation group. This means, *knowledge mutation may not be effective in improving the internal process when a firm faces high environmental variations.* The effect of knowledge mutation on learning and growth remains significant in both sub-groups, but the effect is higher in the low variation group (.546) as compared with the high variation group (.407). This makes sense because a firm may need new knowledge to cope with high environmental variation it faces.

Knowledge crossover has significant effects on finance and the customer in the whole sample, but these relations change in the subgroup analysis. *The effect on finance holds only in the low*

Table 2
Correlation of latent variables.

Construct	Sqrt. of AVE	I1	I2	D1	D2	D3	D4	M1	M2	M3	M4
Knowledge mutation (I1)	0.73	1.00									
Knowledge crossover (I2)	0.80	0.56	1.00								
Finance (D1)	0.80	0.32	0.32	1.00							
Customer (D2)	0.88	0.32	0.44	0.68	1.00						
Internal process (D3)	0.74	0.38	0.39	0.71	0.67	1.00					
Learning and growth (D4)	0.87	0.53	0.37	0.68	0.59	0.74	1.00				
Environment variation (M1)	0.88	0.35	0.40	0.28	0.35	0.35	0.39	1.00			
Knowledge density (M2)	0.88	−0.04	−0.02	−0.24	−0.12	−0.06	0.09	0.03	1.00		
IT capability (M3)	0.88	0.43	0.40	0.49	0.56	0.63	0.53	−0.41	0.04	1.00	
Sharing culture (M4)	0.86	0.51	0.35	0.49	0.46	0.54	0.59	−0.32	−0.10	0.55	1.00

Table 4
Moderating effects of industrial factors.

Control variable	I.V.	D.V.	β (High)	β (Low)
Environmental variation	Knowledge mutation	Finance	0.173	0.229
		Customer	0.253	0.126
		Internal process	0.237	0.405*
		Learning and growth	0.407*	0.546***
	Knowledge crossover	Finance	0.147	0.344*
		Customer	0.398**	0.271
		Internal process	0.313	0.155
		Learning and growth	0.058	0.094
Knowledge density	Knowledge mutation	Finance	0.218	0.168
		Customer	0.125	0.233
		Internal process	0.299	0.282
		Learning and growth	0.525***	0.374*
	Knowledge crossover	Finance	0.224	0.282
		Customer	0.375**	0.306*
		Internal process	0.220	0.322
		Learning and growth	0.049	0.260

NS: Non-Significant.
(The high/low in the parenthesis after β denotes the level of control variables.)
* p-value < 0.05.
** p-value < 0.01.
*** p-value < 0.001.

variation group and *that on the customer holds only in the high variation group*. A possible explanation is that the effect of knowledge enhancement on financial performance may be overshadowed by other key factors such as short product life cycle or new competitors entering the market in a highly dynamic environment. However, knowledge crossover that brings in new knowledge from outside can still help better understand the customer in a highly dynamic environment. For the low variation group, better knowledge crossover can still improve the financial performance of the company. This implies that a firm in the low variation environment can take advantage of outside expertise to improve its financial performance, but this strategy may not work well in the high variation environment.

(2) Effect of knowledge density

Table 4 also shows the result of the subgroup analysis on knowledge density. Compared with the overall effect as shown in Table 3, the effect of knowledge mutation on internal process disappeared, but the effect on learning and growth remains significant. The effect size is higher for the high density group (.525) than for the low density group (.374). This indicates that *knowledge mutation can better enhance employee learning and growth in a firm with high knowledge density*. Knowledge crossover has significant effects on the customer in both density groups, but the effect on finance and internal process disappeared in the subgroup analysis. Overall, hypothesis H3 is supported.

(3) Effect of IT capabilities

Table 5 shows the result of the subgroup analysis on organizational IT capability and sharing culture. For knowledge mutation, the effect on learning and growth holds for both sub-groups. However, the effect of mutation on internal process disappears. The major moderation effect exists on knowledge crossover. The effect of knowledge crossover on the customer remains significant in the low IT capability group but is not significant in the high IT capability group. The effect on learning and growth is stronger for the high IT subgroup (.511) than the low IT one (.461). This indicates that IT does have some effect on facilitating learning.

(4) Effect of sharing culture

The effect of the sharing culture is shown in Table 5. Under a high level of sharing culture, internal knowledge mutation has significant effects on three dimensions: finance, internal process, and learning and growth. This is the only case in which knowledge mutation affects financial performance. This may be because *the high knowledge sharing culture motivates people to get the most out of everyone and this effort pays off financially*. In the lower sharing culture subgroup, knowledge mutation only affects learning and growth. As the effects differ in two performance dimensions between the high and low sharing culture sub-groups, the moderating effect exists. External knowledge crossover has no effect on any performance dimensions in the high sharing subgroup, but has significant effects on finance in the low sharing subgroup. This also shows the existence of the moderating effect of the sharing culture. Consequently, hypothesis H4 is supported.

5. Discussion and conclusions

5.1. Summary of findings

In this paper, we have proposed two knowledge evolution strategies and empirically evaluated how they affect organizational performance as assessed by the balanced scorecard. The results show that different knowledge evolution strategies have affected different dimensions of organizational performance. Knowledge mutation that relies on internal creation of new knowledge has significant impacts on the improvement of internal process, while knowledge crossover that takes advantage of external knowledge sources can benefit financial and customer dimensions. It implies that when the goal of knowledge management is for improving business processes, internal innovation may be better than seeking advice from outside sources, but when the goal is to improve customer satisfaction and retention, bringing in outside expertise will be better than relying on internal knowledge.

In addition to the overall relations, we have also investigated the contingency effect derived from *the strategic fit theory* that stresses the importance of matching organizational strategy with

its environmental and organizational features (Datta 1991, Miller 1992, Doty et al. 1993, Chan et al. 1997). We identified four contingency variables (two related to the industry and two related to the organization itself) and investigated how these variables may moderate the impact of knowledge evolution on firm performance. Table 6 summarizes the result of our hypothesis testing.

5.2. Managerial implications

The study has contributed toward our understanding of the relationship between knowledge evolution strategy and firm performance, which has valuable managerial and theoretical implications. Our research findings support the argument that different strategies affect different aspects of organizational performance in different environmental settings. This has plenty of managerial implications. For example, organizations in the high environmental variation sector (such as mobile phones or computer products) can enhance its performance by adopting the crossover strategy that brings in more new knowledge from the outside bodies to keep pace with the rapidly changing customer needs. Organizations in the low environmental variation sector can focus more on knowledge enhancement over time through internal knowledge sharing, which may not have significant effect on the financial performance but can enhance their learning and growth. Adopting the crossover strategy can help improve the financial performance.

For practitioners, the findings inform them of the effect of different knowledge evolution strategies, which will be very helpful in implementing knowledge management. Managers may use the reported relationships to choose a proper strategy for improving a specific performance dimension. General procedures for such as purpose include (1) determining the target dimension for improvement, (2) determining the characteristics of the industry and organization, and (3) using the identified relationships to choose a suitable strategy.

For example, if a firm intends to improve its learning and growth, and the firm is in a low variation, low knowledge density, high IT capability and high knowledge sharing setting, then using internal knowledge mutation will be more effective than bringing outside experts for knowledge crossover. On the other hand, if the target is to improve customer satisfaction, and the firm is in a high environment variation, high knowledge density industry, then bringing outside expertise for knowledge crossover will be better than internal mutation through brainstorming or other means.

The findings also can be applied to the management of e-commerce business. As the technology and applications of e-commerce are changing rapidly, the environmental uncertainty is higher than most other industries and the knowledge density is high. Knowledge management for e-commerce needs to use the crossover strategy that takes advantage of external knowledge sources.

5.3. Research implications

The findings have indicated several key concepts that will be useful for future research. First, no single knowledge evolution strategy is capable of improving all aspects of organizational performance. Knowledge development driven by internal forces tends to benefit internal performance, whereas that driven by external forces tends to benefit external performance. We interpret this observation from the coordination theory perspective. The interdependence of the involving parties determine the coordination needs and the knowledge evolution strategy that matches the coordination needs will prevail. This is an innovative view to knowledge management that may trigger future research in the area.

Table 5
Moderating effects of organizational factors.

Control variable	I.V.	D.V.	β (High)	β (Low)
IT capability	Knowledge mutation	Finance	0.050	0.291
		Customer	0.243	0.039
		Internal process	0.087	0.304
		Learning and growth	0.511**	0.461**
	Knowledge crossover	Finance	0.266	0.235
		Customer	0.199	0.438**
		Internal process	0.300	0.261
		Learning and growth	0.028	0.087
Sharing culture	Knowledge mutation	Finance	0.427**	0.048
		Customer	0.149	0.171
		Internal Process	0.331*	0.194
		Learning and growth	0.695***	0.342*
	Knowledge crossover	Finance	−0.081	0.399*
		Customer	0.144	0.288
		Internal process	0.272	0.282
		Learning and growth	−0.028	0.153

NS: Non-Significant.
(The high/low in the parenthesis after β denotes the level of control variables.)
* p-value < 0.05.
** p-value < 0.01.
*** p-value < 0.001.

Table 6
Summary of hypothesis testing.

Hypothesis	Result
H1.1: Knowledge mutation can increase the financial performance	Unsupported
H1.2: Knowledge mutation can increase customer performance	Unsupported
H1.3: Knowledge mutation can increase internal process performance	Supported
H1.4: Knowledge mutation can increase learning and growth performance	Supported
H2.1: Knowledge crossover can increase finance performance	Supported
H2.2: Knowledge crossover can increase customer performance	Supported
H2.3: Knowledge crossover can increase internal process performance	Supported
H2.4: Knowledge crossover can increase learning and growth performance	Unsupported
H3.1: Environmental variation will moderate the effect of different knowledge evolution strategy on organizational performance	Supported
H3.2: Knowledge density will moderate the effect of different knowledge evolution strategy on organizational performance	Supported
H4.1: Organizational IT capabilities will moderate the effect of different knowledge evolution strategy on organizational performance	Supported
H4.2: Sharing culture of the organization will moderate the effect of different knowledge evolution strategy on organizational performance	Supported

Second, we have reported strong evidence to support the strategic fit theory in knowledge management. The findings from our moderating analysis show that both industrial factors (environmental variation and knowledge density) and organizational factors (IT capability and sharing culture) may change the impact of knowledge evolution on firm performance. Therefore, the strategy for knowledge evolution should change, if the environment changes or the nature of the organization changes.

This implies that the strategic fit theory and the evolutionary view of organizational knowledge are useful new angles in knowledge management. A possible extension from this foundation is to further examine the mechanism by which knowledge evolution affects different aspects of organizational performance. Theories of organizational learning may be a useful new direction for enriching the current findings.

Another possible theoretical extension is to examine whether the rapid increase of electronic commerce may change the effect of knowledge evolution strategy. This is particularly useful in the wave of online community and social networking, which are often considered to be useful external knowledge sources. So far, we do not know how (or whether) external knowledge from online communities affects organizational knowledge evolution.

5.4. Research limitations

Although our study has shown some interesting findings for organizational knowledge management, it is not without limitations. First, the analysis is based on a survey conducted on Taiwanese companies. The sampling was not totally random and the generalizability of the findings to other regions or cultures may be limited. Knowledge management is more art than science in some aspects; organizational cultural plays an important role, as we have found in our study. Therefore, it would be interesting to conduct a survey in another culturally different region. A comparative analysis of the findings from different countries may also be interesting.

The second issue is the relatively small sample size of the study. Although the total sample size of 97 is acceptable for PLS analysis, the sample size of sub-groups in conducting the moderator analysis becomes small, which might cause a lower statistical power. Hence, the result of the moderation analysis should be used more carefully.

A third limitation is that we did not investigate different types of knowledge in our study. Evolution of marketing knowledge may be different from that of product development knowledge in the same organization. This was not consider in our study but could be investigated in the future. The balanced scorecard was arbitrarily chosen as our performance measures, due to its multidimensional coverage. There might be other approaches that can better demonstrate the effect of KM. Developing a better method to measure the impact of KM on organizational performance is an issue for future research.

Another potential issue is the crowding effect. In some cases, hiring external consultants may reduce the motivation for developing new knowledge internally and eventually damage the long-term performance. Alternatively, it may be possible that "internal" drivers (e.g., drop in productivity) induce changes to existing knowledge stocks but new knowledge for supporting the changes is only available from "external" sources (e.g. consultants). This raises another potential research issue of choosing a particular strategy in different contexts. Some scholars may want to see a qualitative study when knowledge evolution is analyzed. Exploring the insight from the longitudinal perspective can definitely increase the value of this research line.

Appendix A. Research constructs and measurement items

Construct		Measurement items	References
Knowledge evolution	Knowledge mutation	1. We take a refresher course because of superiors' request 2. We take a refresher course spontaneously 3. In our company, there are lots of new strategies come from employee's ideas 4. In our company, there are lots of new technologies come from R&D staffs	Menon and Pfeffer (2003), Zollo and Winter (2002)
	Knowledge crossover	1. The external emerging new technologies have pushed us to learn 2. To cope with the competitive pressure, we have brought in new strategy 3. To fight with the environmental variation, we have brought in new technology	
Organizational performance	Finance	1. Your company is better than the competitor on the Return on Investment (ROI) 2. Your company is better than the competitor on the growth rate of return 3. Your company is better than the competitor on the percentage of revenue generated from new products 4. Your company is better than the competitor on the market share of major product	Kaplan and Norton (1996)
	Customer	1. Your company is better than the competitor on the customer retention rate 2. Your company is better than the competitor on the customer satisfaction rate 3. Your company is better than the competitor on the representation and goodwill	
	Internal process	1. Your company is better than the competitor on the creating new product and service 2. Your company is better than the competitor on the percentage of proprietary product	

Appendix A (*continued*)

Construct		Measurement items	References
		3. Your company is better than the competitor on the efficiency of inner operation and balance time	
		4. Your company is better than the competitor on the efficiency of after-sale service	
	Learning and growth	1. Your company is better than the competitor on the staffs' productivity	
		2. Your company is better than the competitor on the staffs' keeping rate	
		3. Your company is better than the competitor on the staffs' satisfaction	
		4. Your company is better than the competitor on the growth in staffs' capabilities	
Industrial factor	Environment variation	1. The product lifecycle is short in my industry 2. The technology revolution is fast in my industry 3. The customer's demand is changing rapidly	Duncan (1972), Powell (1996), and McGahan and Porter (1997)
	Knowledge density	1. It is important to get patents for competition in my industry 2. It is important to own a famous brand in my industry 3. What is the percentage of material cost in your company?	Miles et al. (1995), Hertog (2000), and Laihonen (2005)
Organizational factor	IT capability	1. Most documents have been digitized in my organization 2. We use information systems widely in my organization 3. We interchange information by network system in my organization	Gold et al. (2001), Lee and Choi (2003)
	Sharing culture	1. Benefits for the organization is the preemptive goal when we collaborate with others in our company 2. Everybody has an open mind to sharing knowledge/experience in my organization 3. It is helpful to collaborate with others in my organization	Gold et al. (2001) and Lee and Choi (2003)

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