

Seeking Innovation: A Typology of Knowledge Search Strategy by SMEs

Taewan Kim
University of Scranton

Sang M. Lee
University of Nebraska-Lincoln

Byungku Lee
University of La Verne

Byungheon Lee
Kwangwoon University

While firms' search for new knowledge has been investigated mostly for large enterprises, there is a lack of empirical research to examine knowledge search strategy by small and medium enterprises (SMEs). This study seeks to fill this gap in the innovation literature by examining differences in knowledge search strategy by SMEs. Drawing on a survey data obtained from 3,175 SMEs, we used cluster analysis to identify groups of SMEs that pursue homogenous knowledge search strategy. The study results shed insights about how SMEs should develop knowledge search strategy and technological dynamism to proactively harness the benefits of knowledge search.

Keywords: innovation, search strategy, cluster analysis, SMEs

INTRODUCTION

As corporations face fierce competition in the global market, they are under increasing pressure for innovation as a key competitive strategy (Lee & Tsai, 2005; Lee & Olson, 2010). In such an environment, firms search for new knowledge as a critical innovation source for survival and success (Hill & Rothaermel, 2003). Today most firms pursue innovation strategies, where they not only rely on internal research and development (R&D) but search for new knowledge beyond their boundaries through external channels (Chesbrough, 2003; Rigby & Zook, 2002). Some researchers found how different search strategies for new knowledge influence innovative performance of firms (Katila & Ahuja, 2002; Laursen & Salter, 2006; Rothaermel & Alexandre, 2009).

Despite the increasing interest in firms' search for new knowledge, few empirical studies have examined knowledge search strategy by small and medium enterprises (SMEs). Unlike large firms with an ample internal endowment, few SMEs have sufficient capabilities and resources to do in-house R&D and simultaneously source knowledge from external channels. Thus, SMEs face constant challenges for

making strategic decisions to allocate limited resources to the search for new knowledge. Given these resource and capability limitations, it is equally important for research and practice of SMEs to devise proper knowledge search strategy (Casson & Wadson, 2007). This study seeks to fill this gap in the innovation literature by examining differences in knowledge search strategy by SMEs. Drawing on survey of 3,175 SMEs, we use cluster analysis to identify groups of SMEs that pursue homogenous knowledge search strategy. This research also analyzes the impact of SMEs' search strategy on innovation performance. Furthermore, we investigate how technology dynamism affects the relationship between search strategy and innovation performance.

The rest of the paper is organized as follows. Section 2 presents a review of the relevant literature on knowledge search and innovation in SMEs. Section 3 discusses research methods used in this study. The results of the study are articulated in Section 4 with a focus on clustering SMEs based on their approaches to knowledge search. Section 5 concludes the study with the discussion of contributions and limitations of this study, and future research needs

LITERATURE REVIEW

Search is defined as one part of the learning process through which firms make efforts to find solutions to a problem (Huber, 1991). While firms are involved in various search activities such as superior organizational structures (Bruderer & Singh, 1996) and the best manufacturing practices (Jaikumar & Bohn, 1992), this study focuses on the search for new knowledge. As the heterogeneous knowledge base is a key source of sustained competitive advantage (Ghoshal & Moran, 1996; Grant, 1996; Kogut & Zander, 1992), a firm's search strategy for new and unique knowledge becomes critical to its superior performance.

Prior studies have argued that a firm's search for new knowledge vary on two distinct dimensions. First, a firm not only searches new knowledge internally but sources it from beyond its boundary when developing innovation (Rigby & Zook, 2002). That is, the search efforts for knowledge can vary in the boundary of a firm (Rosenkopf & Nerkar, 2001). Second, a firm's search activity for knowledge differs in terms of whether it searches broadly and deeply (Katila & Ahuja, 2002). In this study, we use these two dimensions of search to have a better understanding about a firm's strategic approaches to knowledge search.

Internal and External Dimension of Search

A firm's organizational boundary is one of important delineation standard when searching for new knowledge. The knowledge-based view of the firm suggests that organizational boundaries correspond to a combinative capability to integrate current and acquired knowledge (Kogut & Zander, 1992). Built into this definition is the idea that organizational boundaries matter: 'current' knowledge is already possessed and the source of internal search of the firm, while 'acquired' knowledge is one that exists beyond a firm's boundary and sourced through external search. Thus, managers need to decide whether to obtain knowledge internally, externally, or both.

First, a firm can do internal R&D within the boundary of a firm. Internal search for knowledge has proven to be deeply related to "exploitation of old certainties" (March, 1991). This internal search enables a firm to identify valuable knowledge which is easily managed by the firm's existing routines (Nelson & Winter, 1982). By relying on closely related current knowledge inside a firm, it can focus on similar technologies and develop incremental innovations which are intended to meet current customers' needs by marginally modifying existing products (Tushman & Smith, 2002). It also helps the firm restrict the scope of search areas, resulting in the reduction of the search process cost.

Second, a firm can rely on external search to access knowledge located beyond a firm's boundary. Several scholars argued that external knowledge search leads a firm to innovation. For instance, Stuart and Podolny (1996) argued that external search through alliances allows a firm to access different technologies, resulting in its technological repositioning. Rosenkopf and Nerkar (2001) also found empirical evidence that external search has a greater impact on explorative technology evolution than

internal search. Thus, these studies suggest that external search naturally leads to spanning more technological boundaries and explorative innovation which can allow firms to change from existing products to completely new ones (Chesbrough, 2003).

Previous studies point out that the extreme position along the internal and external search continuum may not be viable. In particular, a firm that searches for all of its innovation needs within a firm's boundary is unlikely to improve its performance because of increased risks, including obsolescence (Powell, et al., 1996; Teece, et al., 1997). In contrast, a firm that exclusively searches for innovation beyond its boundary cannot achieve competitive advantage, because lack of competences necessary to exploit opportunities does not allow a firm to obtain the returns of innovation (Teece, 1986).

Breadth and Depth Dimension of Search

A firm's search for new knowledge can vary not only based on the boundary of a firm, but also by its breadth and depth. Search breadth is defined as the number of search channels that firms depend on in their search activities (Laursen & Salter, 2006). Search depth refers to the extent to which firms draw deeply from various search channels (Laursen & Salter, 2006). Together these two concepts represent firms' search behaviors for new knowledge. Levinthal and March (1993) stated that one of challenging tasks for managers is to determine the optimal search strategy in terms of being broader or deeper.

A high breadth search can develop innovation through two mechanisms. First, it increases the number of knowledge elements that a firm can access (Fleming, 2001). The larger the set of knowledge elements searched, the greater the chance a firm learns from search activities, *ceteris paribus*. Second, it enhances the variety of knowledge elements investigated and the variance in search activity (Fleming, 2001; March, 1991). An increase in the variance of search opportunities develops a firm's current knowledge base (Levinthal & March, 1981). The "value of variance" (Mezias & Glynn, 1993) in search also increases the number of highly radical solutions to be realized (Levinthal & March, 1981; March, 1991).

Search for new knowledge is not just about scanning a wide number of sources. It also includes drawing knowledge deeply from these sources. The depth of search can positively influence innovation through three mechanisms. First, employing a same knowledge source deeply and repeatedly lowers the chance of mistakes and promotes the establishment of routines, making search activities more stable (Levinthal & March, 1981). Second, the increased experience is likely to make search activities more predictable as a firm is familiar with the knowledge to be searched (Katila & Ahuja, 2002). Third, repeated contacts with a given knowledge source can lead to a better understanding of knowledge elements and enhance the transfer of in-depth knowledge, resulting in well-defined solutions (Leana & Van Buren, 1999; Dyer & Nobeoka, 2000).

Some studies point to the tension that firms encounter when pursuing knowledge search broadly and deeply simultaneously. Obstfeld (2005) describes this as the tension between 'the idea problem' versus 'the action problem.' While search with a high level of breadth can allow firms to access a variety of new ideas and knowledge (Stuart, 1998), they must be integrated to capture the potential of new ideas. Exploitation and implementation of new ideas also require search with a high degree of depth. Thus, a trade-off is that the potential for new ideas could be lost by deep search, and the potential for integrating new knowledge might be lost by broad search. The efforts that balance the breadth and depth of knowledge search might then provide what Burt (1992) would define as the ideal configuration.

Innovation in SMEs

Due to the increasing global competition, ever shortening product life cycles, and the constant stream of new technologies, a firm's success is often dependent on the success in embracing innovation (Lee & Olson, 2010). In particular, SMEs that do not embrace innovation as a core business strategy may become laggards because of obsolete products and processes. Thus, SMEs invest in in-house R&D to develop their innovative capability for sustaining competitive advantage (Migdadi, 2009). In doing so, SMEs have taken an increasingly prominent role in the contemporary innovation landscape. For instance, Chesbrough (2003) cited statistics of how SMEs contribute to total industrial R&D expenses in the US; accounting for around 24 percent of all R&D spending in 2005, compared to only 4 percent in 1981.

Despite SMEs' investment in internal R&D, SMEs are less likely to achieve the success rate of innovative work beyond expectation due to the high level of risk, complexity, and uncertainty innate in the innovation process (Cooper, et al., 2003; Koufteros, et al., 2005). Furthermore, SMEs face difficulty in developing innovation, due to resource constraint (Verhees & Meulenberg, 2004), lack of a multidisciplinary competence base (Bianchi, et al., 2010), and usage of less systematic approaches to innovation (De Toni & Nassimbeni, 2003). Because of these factors, SMEs may fail to innovate successfully and gain competitive advantage.

In order for SMEs to overcome their inherent limitations, they search new knowledge externally to achieve innovation through collaboration with broadly distributed external actors (Chesbrough, 2003; De Clercq, et al., 2014; Geneste & Galvin, 2015). Indeed, many studies have shown that SMEs are in favor of exploratory search, such as proactive acquisition of new knowledge (Zara, et al., 2000), higher level learning (Busenitz & Barney, 1997), product leadership (Eisenhardt & Schoonhoven, 1990), and the aggressive utilization of resources in new fields (Romanelli, 1987). Many researchers even argued that the success of SMEs, in comparison to their larger counterparts, is based on the capability of utilizing external sources of innovation more efficiently (Rothwell & Dogson, 1994).

Given the nature and limitations of SMEs regarding innovation, they confront challenges of allocating limited resources to internal and external search. Thus, it is difficult for SMEs to pursue search activity broadly and deeply simultaneously. It is important to understand the current state of SMEs' strategic approaches to knowledge search and examine how knowledge search strategy affects their innovation performance.

METHOD

Sample

Data for this study were drawn from a survey of innovation practices of SMEs in South Korea from 2003 to 2004 and their innovative performance in 2004. This survey was conducted with the support of two government agencies, the Korea Federation of Small and Medium Business (KFSM) and Small and Medium Business Administration of Korea (SMBA) in 2005. The sample was derived from the database provided by these government agencies, because they maintained the most complete coverage of SMEs in South Korea. This survey targeted SMEs, defined as "enterprises with the number of employees between 10 and 300." A survey approach was used because there was a lack of archival data describing the detailed information to measure knowledge search strategy and performance of SMEs in South Korea.

We utilized the widely accepted double translation protocol (Brislin, et al., 1973) to develop the survey questionnaire. The questionnaire was first prepared in English by researchers. Then, the questionnaire was translated into Korean by a bilingual university faculty. The Korean version was then translated back onto English by another bilingual professional. The researchers examined the two English versions of the questionnaire and found no significant difference. The survey questionnaire was sent to 13,207 SMEs. A total of 3,700 valid responses were received. Firms with more than 300 employees, new start-ups and other entrepreneurial ventures with less than 10 employees were excluded. Firms with less than 10 employees were not included because they generally have no or limited identifiable search activities for new knowledge. The final sample size was 3,175, a response rate of 28.02 percent.

We examined the sample across firm size. The sample was classified into two groups: small sized enterprises (10-99 employees) and medium-sized enterprises (100-300 employees) as shown in Table 1. Most of SMEs (72.9 percent) in the sample were small-sized. We also examined the sample across technology classes. Because industry sectors may not describe the technological dynamism of different industries (He and Wong, 2004), we adopted OECD's (1996) definition of technology classes; high, medium-high, medium-low, and low. Most of SMEs (80.12 percent) in this study belonged to either high or medium-high technology classes as shown in Table 1. A relatively small number of SMEs (19.88 percent) in this research was in the medium-low and low technology classes.

TABLE 1
DISTRUBUTION OF SAMPLE ACROSS TECHNOLOGY AND SIZE CLASSES

Technology classes	Small-sized Enterprises (n = 10 – 99)	Medium-sized Enterprises (n = 100 – 300)	Total
High Technology	964	228	1192
Medium-high Technology	921	431	1352
Medium-low Technology	210	110	320
Low Technology	219	92	311
Total	2314	861	3175

Cluster Analysis

To classify SMEs' knowledge search strategy, this study adopted organizational configurations which represent sets of firms that share a common profile along conceptually distinct variables (Meyer, et al., 1993; Miller & Mintzberg, 1983). The use of configuration in management research allows researchers to distinguish organizations based on relationships between multiple domains (Hambrick, 1984). Given our interest in identifying groups of similar organizations in terms of knowledge search strategy, we carried out cluster analysis which provides very rich descriptions of configuration and is known to be more useful than other multivariate techniques in taxonomies (Hambrick, 1984).

In order to identify groups of SMEs pursuing homogeneous search strategy, we chose two dimensions of search: organizational boundary of search, and breadth and depth of search. To characterize a firm's search in terms of organizational boundary, first we made the distinction between internal and external search. For internal search for knowledge, we used a binary variable: 0 when a firm does not search knowledge within a firm's boundary and 1 for searching internally. We also used a binary variable to measure external search: 0 when a firm does not search knowledge beyond its boundary through external search channels and 1 for searching externally.

The second dimension used was the breadth and depth of search. We adopted Laursen and Salter's (2006) approach to measure breadth and depth of search. For external search, first, we used 14 external sources to measure the breadth of search. As a starting point, each of the sources was coded as a binary variable: 0 being not used and 1 being used of the given knowledge source. Subsequently, the number of sources used was summed to represent the breadth of external search, ranging from 0 when no knowledge source was used to 14 when all external knowledge sources were searched. The depth of external search was measured by the extent to which a firm draws deeply from each search channel. Accordingly, the depth was measured using the same 14 external sources of knowledge as for the breadth. Each of the 14 sources was measured with a Likert scale from 1 to 5 in terms of use (1 for the minimum to 5 for the maximum). Thus, the depth of external search ranged from 0 to 60. Since a firm searches new knowledge within a firm's boundary mainly through in-house R&D (Cassiman & Veugelers, 2006), the breadth of internal search is measured with a binary variable: 0 doing none in-house R&D and 1 doing in-house R&D. The depth of internal search was measured by the extent to which a firm draws knowledge deeply from in-house R&D. A five-point Likert scale was used where a value of 1 indicates the minimum use of the given source and a value of 5 for the maximum. Thus, the depth of internal search ranged from 0 to 5. For our analysis, we listed 15 types of search channels as shown in Table 2.

Among the various statistical clustering methods, we carried out a two-step cluster analysis for the following reasons. First, the two-step cluster analysis is specifically designed to handle the issue of mixed variables measured on different scale levels (Chiu, et al., 2001). Since this study had both continuous and categorical variables, we chose two-step cluster analysis, rather than the k-means clustering and hierarchical technique that is difficult to handle mixed variables. Second, this analysis is known to be effective in dealing with a very large sample of 500 or more subjects (Erik & Marko, 2011). Finally, research has shown that two-step cluster analysis, in general, helps obtain more stable and robust taxonomies (Milligan & Sokol, 1980; Punj & Stewart, 1983).

TABLE 2
SOURCES OF KNOWLEDGE FOR SEARCH IN SMES

Organizational boundary	Types of search channel	Usage (Yes=1/No=0)
External	Fairs, exhibitions	.57
	Professional conferences, meetings	.38
	On-line	.46
	Technical standards	.38
	Technical/trade press	.26
	Competitors	.43
	Suppliers of raw materials and components	.23
	Suppliers of equipment	.16
	Commercial laboratories/R&D enterprise	.13
	Consultants	.12
	Customers	.31
	Universities	.25
	Government research organizations	.21
	Private research institutes	.09
Internal	In-house R&D	.57

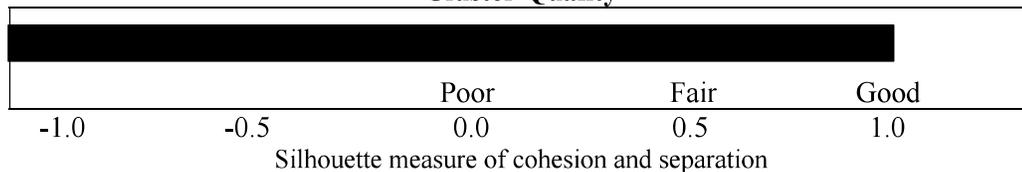
Two-step cluster analysis is based on a two-stage approach. In the first stage, hierarchical technique is used to define the number of clusters and cluster centroids based on the squared Euclidian distance. In the second stage, these results serve as the starting point for using a non-hierarchical technique to determine the final solution. In this study, the cluster analysis resulted in a solution with four groups of SMEs as shown in Figure 1. The overall goodness-of-fit of clustering solution was calculated based on the average distances between the objects and varied between -1 and +1. Specifically, a silhouette measure of less than 0.20 indicates a poor solution quality, a measure between 0.20 and 0.50 a fair solution, whereas values of more than 0.50 indicate a good solution (Erik and Marko, 2011). In our case, the measure indicated a satisfactory cluster quality (0.8). In addition, two-step analysis showed the relative importance of each variable for the clustering solution (Erik and Marko, 2011). All of clustering variables used in this study were found to be important for the clustering solution (Feature importance = 1).

FIGURE 1
TWO-STEP CLUSTERING

Model Summary

Algorithm	Two Step
Input Features	4
Clusters	4

Cluster Quality



RESULT

Cluster analysis revealed four groups of SMEs, firms with similar knowledge search strategies, as shown in Table 3. Cluster 1 represents SMEs with internal oriented search strategy. While firms in this cluster searched knowledge through external search, they heavily focused on internal search. In particular, SMEs in this cluster drew knowledge most deeply from internal R&D. In addition, they were involved in the least number of external channels for search and were also less likely to draw knowledge from external sources. Cluster 2 consists of SMEs pursuing most balanced search strategy. Along the organizational boundary, these firms searched knowledge through both internal and external search. Compared to firms in other three clusters, firms in this cluster used a relatively broad set of external channels to search knowledge and drew knowledge deeply from each external channel. Thus, they achieved an appropriate balance in knowledge search along two dimensions.

**TABLE 3
CLUSTERS**

Variables	Mean (n=3175)	Cluster1 (n=911)	Cluster2 (n=592)	Cluster 3 (n=303)	Cluster 4 (n=1369)
Breath of internal search	0.57	1.00	1.00	1.00	0.00
Depth of internal search	2.13	3.76	3.73	3.55	0.00
Breadth of external search	4.01	1.61	5.45	12.55	3.05
Depth of external search	13.32	5.47	18.34	38.86	10.53

Cluster 3 includes SMEs with external search oriented balanced strategy. Regarding the boundary of search, these SMEs accessed new knowledge through both internal and external search. However, firms in this cluster used the broadest external channels to search for knowledge. Thus, they pursued some extent of balanced search strategy that was leaning toward external search. SMEs in cluster 4 were pursuing external oriented search strategy. They did not make any effort to search knowledge through in-house R&D. Firms in this cluster did also not actively search knowledge through a large number of external channels. However, they tended to be more actively involved in drawing knowledge from each search channel. The largest number of firms in the sample belonged to this cluster.

To further explore the differences between clusters, we investigated internal characteristics of SMEs across clusters. Table 4 provides additional information on clusters, including firm age, firm size, R&D intensity, exploitative sales, and explorative sales. Firstly, firm size, measured by the number of employee was found to be significantly different across clusters. The firms in clusters 2 and 3 were larger than those in clusters 1 and 4. Specifically, firms in cluster 2 and 3 were largest in size and were employing balanced knowledge search strategy. However, smaller firms in cluster 1 and 4 were pursuing unbalanced knowledge search strategy. In turn, firm size was significantly associated with the degree of balance in knowledge search strategy.

Secondly, we found significant differences in firm age across clusters. The results indicated that firms in clusters 2 and 3 were older than ones in clusters 1 and 4. In particular, firms pursuing most balanced knowledge search strategy (cluster 2) were oldest among those in other clusters. The second oldest SMEs (cluster 3) were pursuing external search oriented balanced strategy. In contrast, relatively younger firms tended to adopt one sided knowledge search strategy. Thus, firm age was positively related to the firm's ability to develop balanced search strategy for knowledge. Concerning the R&D intensity, measured with the ratio of R&D expenditure to total sales, we found significant differences across clusters. The firms in clusters 2 and 3 had a higher level of R&D intensity than those in clusters 1 and 4. Accordingly, firms with a relatively high level of R&D intensity (clusters 2 and 3) were pursuing some extent of balanced search strategy. However, firms with a relatively lower level of R&D intensity (clusters 1 and 4) were

employing search strategy in one direction. Thus, the level of R&D intensity was significantly associated with the firm's approach to balance in knowledge search strategy.

Finally, there were significant differences in innovative performance across clusters. Previous research used one-dimensional indicators of firm performance to measure the effect of search strategy on the firm's overall success. For instance, sales growth rate was employed as a sole indicator of firm performance. However, these indicators may run the risk of producing biased estimations of the organization's search strategy contribution to its innovative performance. To measure the effect of knowledge search strategy more accurately, this study used multiple performance dimensions including exploitative and explorative sales. First, exploitative sales were measured by the ratio of sales of the existing products to total sales as the proxy measure. The results showed that firms pursuing some extent of balanced search strategy (clusters 2 and 3) generated significantly higher exploitative sales than ones adopting unbalanced strategy. Second, we measured explorative sales by the ratio of sales occurring from new products over total sales. Table 4 shows that firms with some extent of balanced search strategy (clusters 2 and 3) also had significantly higher explorative sales than those with one-sided search activity (clusters 1 and 4). In particular, firms pursuing external oriented balanced strategy (cluster 3) had the highest explorative sales among all clusters. However, firms with external oriented search strategy (cluster 4) generated the lowest level of explorative sales.

TABLE 4
INFORMATION ON THE CLUSTERS

Variables	Mean	Cluster1	Cluster2	Cluster 3	Cluster 4	Significance
Firm age	13.31	12.45	14.53	13.96	13.21	.00**
Firm size	76.03	75.93	83.69	79.28	72.06	.00**
R&D intensity	0.23	0.22	0.24	0.23	0.21	.02*
Exploitative sales	36.72	40.29	43.62	44.98	29.54	.01*
Explorative sale	33.03	30.15	42.75	44.94	28.10	.00***

*P <.05; **P <.01; ***P <.001

To further analyze the effect of firms' environment on the relationship between knowledge search strategy and innovative performance, we adopted OECD's (1996) definition of technology classes that represents technology dynamism. As shown in Table 5, we compared innovative performance of firm clusters at various technology classes from high to low technology. The results revealed the effect of technology dynamism on the relationship between knowledge search strategy and innovative performance in different technology classes. At high technology, we found significant differences in explorative sales across clusters. The results showed that firms in clusters 2 and 3 outperformed firms in clusters 1 and 4 in terms of explorative sales. In particular, firms pursuing external oriented balanced search strategy (cluster 3) achieved the highest explorative sales. Although no significant difference in exploitative sales was found, the firms in cluster 3 had high exploitative sales. At high technology, thus, we found that external oriented balanced search strategy was most effective. At medium-high technology, we found that there were significant differences in explorative sales across clusters. The firms that pursue some extent of balanced search strategy (clusters 2 and 3) generated higher explorative sales than those only adopting one sided search strategy. More specifically, we found that firms with most balanced search strategy for knowledge (cluster 2) generated the highest explorative sales among all clusters. At medium-low technology, we found that exploitative sales varied significantly across clusters. Firms pursuing most balanced search strategy (cluster 2) performed much better than ones in other clusters in terms of exploitative sales. Thus, the results confirmed that balanced search strategy allowed SMEs to achieve superior innovative performance. At low technology, however, there was no significant difference in both explorative and exploitative sales across clusters. It was evident that the effect of search strategy on innovative performance becomes less influential at low technology.

TABLE 5
INNOVATIVE PERFORMANCE OF CLUSTERS ACROSS DIFFERENT
TECHNOLOGY CLASSES

Technology classes	Performance	Cluster 1	Cluster 2	Cluster 3	Cluster 4	ANOVA <i>F</i>
High technology	Explorative sales	36.16	43.15	50.01	29.40	0.01**
	Exploitative sales	35.28	36.88	42.77	25.87	0.12
Medium-high technology	Explorative sales	27.01	37.54	34.97	26.45	0.03*
	Exploitative sales	51.50	45.46	53.83	32.26	0.12
Medium-low technology	Explorative sales	22.68	48.62	25.49	22.58	0.10
	Exploitative sales	26.53	43.76	17.92	29.71	0.01*
Low technology	Explorative sales	27.37	49.57	48.89	37.10	0.27
	Exploitative sales	30.30	43.93	33.64	30.17	0.38

*P <.05; **P <.01

DISCUSSION AND CONCLUSION

Based on two dimensions of search, we identified groups of SMEs that pursue homogenous knowledge search strategy. This study also examined the impact of SMEs' search strategy on innovative performance and the effect of technology dynamism on the relationship between search strategy and innovative performance. To our knowledge, this is the first large-scale empirical study that investigates knowledge search strategy of SMEs.

The results of the cluster analysis clearly showed that most SMEs (71.81 percent) employ unbalanced knowledge search strategy. Among these SMEs, firms in cluster 4 (43.12 percent) used external oriented search strategy for knowledge, accounting for the largest portion in the sample. We also found that firms in cluster 2 (18.64 percent) pursued most balanced knowledge search strategy. These findings are consistent with previous research on SMEs' innovation. For instance, some researchers found SMEs on average tend to be biased toward exploratory activities (Zara et al., 2000; Busenitz & Barney, 1997; Eisenhardt & Schoonhove, 1990). Lubatkin et al. (2006) also argued while SMEs confront competitive pressures to pursue exploitative and explorative activities simultaneously, it is very challenging for SMEs to reconcile contradictory knowledge demands.

To further investigate the differences across clusters, we examined internal characteristics of SMEs such as firm age, firm size and R&D intensity. We found that firm age was significantly and positively related to SMEs' approaches to some extent of balanced knowledge search strategy. These results are not consistent with the findings of Tushman and Romanelli (1985). They argued that firm age is related with inertia, difficulty in processing information regarding changing resources, and failure to adopt to changing resource conditions. An explanation for the effect is that SMEs may be pursuing balanced search strategy sequentially over time. In turn, balance in search behavior for knowledge could be achieved by sequentially allocating resources to exploitation and exploration (Simsek, 2009). Our results suggest that SMEs may start to focus on one-sided search strategy and then pursue more balanced search strategy as they mature. We also found SMEs tend to adopt balanced search strategy as they grow in size. The results of this study support previous studies that argued firm resource differences may moderate the effects of ambidexterity on firms' performance (Kyriakopoulos & Moorman, 2004; Venkatraman, et al., 2005). For instance, Lubatkin et al. (2006) claimed that firms with lack of resources could not be able to manage a trade-off between exploitation and exploration. It was also found that effective balancing between exploitation and exploration requires a firm to utilize slack resources (Jansen *et al.*, 2006). Our results suggest that SMEs' balance in knowledge search strategy may be contingent upon the size of firms. Lastly, we found that R&D intensity was significantly associated with SMEs' capability to develop

balanced knowledge search strategy. This result resonates with Cohen and Levinthal's (1990) argument that an adequate level of R&D intensity not only allows firms to explore new knowledge, but also be more proactive in exploiting acquired knowledge through integrating internal and external search activities. Our results suggest that R&D intensity allows a firm to develop balanced knowledge search strategy.

Concerning the innovative performance of firms, we found that while relying on one-sided search may weaken SMEs' competitive positions, pursuing balanced knowledge search strategy may lead to superior innovative performance. These results confirm the assumption that there is a positive relationship between organizational ambidexterity and performance (Tushman & O'Reilly, 1996). While this association has been hypothesized in the literature, there have been few studies offering direct empirical evidence (Raisch & Birkinshaw, 2008). The results of our study provide new empirical evidence to contribute to the existing literature suggesting that there is definite a positive association between ambidexterity and innovative performance in the context of knowledge search strategy. Furthermore, we found the effect of the technological environment on the relationship between SMEs' search strategy and financial performance. In particular, high tech SMEs pursuing external oriented balanced search strategy performed much better than ones in other clusters. At medium-high and low technology, the results showed that balanced search strategy led to superior innovative performance. At low technology, however, there was no significant difference across clusters. Our findings support previous research regarding the effect of the business environment on organizational ambidexterity (Lewin et al., 1999). Although exploration was positively related to performance in a dynamic environment, Raish and Hotz (2010) found that ambidexterity did not significantly affect performance in a less dynamic environment. The results of this study indicate that SMEs' balanced search strategy may be more effective and a critical factor that leads to superior innovative performance at the high and medium-high level of technology.

Our findings provide a number of important managerial implications regarding knowledge search strategy for innovation. First, an overly strong one-sided knowledge search strategy would result in less than satisfactory innovative performance for SMEs. Managers in SMEs should recognize that balanced knowledge search strategy enhances both exploitative and explorative sales. This implies that they should create and maintain a proper organizational structure and culture that allow the firm not only to reconcile conflicting activities, but also to integrate short-term alignment with long-term adaptability (Meijaard, et al., 2005; Raisch, 2008; Tushman & O'Reilly, 1996). Second, achieving balance in knowledge search strategy is a necessary, but not a sufficient factor for improving firm performance. SMEs should consider the relationships among search strategy, technological dynamism of markets, and financial performance for innovation related decision making. It is still necessary to make smart choice of different strategies to proactively harness the benefits that can be harvested from balancing two dimensions of search. Although balanced search strategy, in general, improves innovative performance, managers should adopt an external oriented approach to maximize the benefits at the high level of technology dynamism. While balanced search strategy is effective across various levels of technology dynamism, it becomes the most effective at medium-high and-low level of technology dynamism to draw maximum financial results.

This study has several limitations. First, dimensions of knowledge search behavior of firms are complex and the ones we used in this study may not include all essential ones. Previous studies proposed other dimensions that were not included in this research. For instance, technological boundary is often regarded as an important dimension when sourcing for external knowledge (Rosenkopf & Nerkar, 2001). While a firm sources new knowledge within a firm's boundary mainly through in-house R&D (Cassiman & Veugelers, 2006), in addition, future research should consider more items to measure breadth and depth of internal search. Second, this research included only SMEs in South Korea. This could be another limitation of this study in terms of generalizability of the results. Thus, the future study could focus on different cultural and economic settings that might influence the relationship between knowledge search strategy and firms' financial performance by collecting data across broader regions. Lastly, due to data limitations, this study could not examine the impact of knowledge search strategy on long-term performance. This study focuses on SMEs' knowledge search and their performance in one period from

2003 to 2004. To address this issue, a longitudinal study is required to examine the effect of knowledge search strategy on innovative performance over time.

REFERENCES

- Bianchi, M., Orto, S.C., Frattini, F., & Vercesi, P. (2010). Enabling open innovation in small- and medium-sized enterprises: How to find alternative applications for your technologies. *R & D Management*, 40(4), 414–430.
- Brislin, R.W., Lonner, W.J., & Thorndike, R.M. (1973). *Cross-cultural research methods*. New York: John Wiley and Sons.
- Bruderer, E., & Singh, J.V. (1996). Organizational evolution, learning, and selection: A genetic-algorithm-based model. *Academy of Management Journal*, 9(5), 1322-1349.
- Burt, R.S. (1992). *Structural holes: The social structure of competition*. Boston: Harvard University Press.
- Busenitz, L.W., & Barney, J.B. (1997). Differences between entrepreneurs and managers in large organizations: Biases and heuristics in strategic decision-making. *Journal of Business Venturing*, 12(1), 9-30.
- Cassiman, B., & Veugelers, R. (2006). In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition. *Management Science*, 52(1), 68-82.
- Casson, M., & Wadeson, N. (2007). The discovery of opportunities: Extending the economic theory of the entrepreneur. *Small Business Economics*, 28(4), 285-300.
- Chesbrough, H.W. (2003). *Open innovation: The new imperative for creating and profiting from Technology*. Boston: Harvard Business School Press.
- Chiu, T., Fang, D., Chen, J., Wang, Y., & Jeris, C. (2001). *A robust and scalable clustering algorithm for mixed type attributes in large database environment*. Presented at the 7th ACM SIGKDD international conference in knowledge discovery and data mining, San Francisco.
- Cohen, W.M., & Levinthal, D.A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128–152.
- Cooper, R.G., Edgett, S.J., & Kleinschmidt, E.J. (2003). *Best practices in product innovation: What distinguishes top performers*. Ancaster: Product Development Institute.
- De Clercq, D., Thongpapanl, N., & Dimov, D. (2014). Contextual ambidexterity in SMEs: The roles of internal and external rivalry. *Small Business Economics*, 42(1), 191-205.
- De Toni, A., & Nassimbeni, G. (2003). Small and medium district enterprises and the new product development challenge. *International Journal of Operations and Production Management*, 23(6), 678–697.
- Dyer, J. H., & Nobeoka, K. (2000). Creating and managing a high performance knowledge sharing network: The Toyota case. *Strategic Management Journal*, 21(3), 345-367.
- Eisenhardt, K. M., & Schoonhoven, C. B. (1990). Organizational growth: Linking founding team, strategy, environment, and growth among U.S. semiconductor ventures, 1978-1988. *Administrative Science Quarterly*, 35(3), 504-529.
- Erick, M., & Marko, S. (2011). *A concise guide to market research: The process, data, and methods using IBM SPSS statistics*. Berlin: Springer.
- Fleming, L.O. (2001). Recombinant uncertainty in technological search. *Management Science*, 47(1), 117-132.
- Geneste, L., & Galvin, P. (2015). Trust and knowledge acquisition by small and medium-sized firms in weak client-firm exchange relations. *International Small Business Journal*, 33(3), 277-298.
- Ghoshal, S., & Moran, P. (1996). Bad for practice: A critique of the transaction cost theory. *Academy of Management Review*, 21(1), 13-47.
- Grant, R.M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(2), 109-122.

- Hambrick, D.C. (1984). Taxonomic approaches to studying strategy: Some conceptual and methodological issues. *Journal of Management*, 10(1), 27-41.
- He, Z.L., & Wong, P.K. (2004). Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. *Organization Science*, 15(4), 481-494.
- Hill, C.W.L., & Rothaermel, F.T. (2003). The performance of incumbent firms in the face of radical technological innovation. *Academy of Management Review*, 28(2), 257-274.
- Huber, G. (1991). Organizational learning: The contributing processes and a review of the literatures. *Organization Science*, 2(1), 88-115.
- Jaikumar, R., & Bohn, R.E. (1992). A dynamic approach to operations management: An alternative to static optimization. *International Journal of Production Economics*, 27(3), 265-282.
- Jansen, J.J.P., Van Den Bosch, F.A.J., & Volberda, H.W. (2006). Exploratory innovation, exploitative innovation, and performance: Effects of organizational antecedents and environmental moderators. *Management Science*, 52(11), 1661-1674.
- Katila, R., & Ahuja, G. (2002). Something old, something new: A longitudinal study of search behavior and product introductions. *Academy of Management Journal*, 45(6), 1183-1194.
- Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science*, 3(3), 383-397.
- Koufteros, X., Vonderembse, M., & Jayaram, J. (2005). Internal and external integration for product development: The contingency, effects of uncertainty, equivocality, and platform strategy. *Decision Science*, 36(1), 97-133.
- Kyriakopoulos, K., & Moorman, C. (2004). Tradeoffs in marketing exploitation and exploration strategies: The overlooked role of market orientation. *International Journal of Research in Marketing*, 21(3), 219-240.
- Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, 27(2), 131-150.
- Leana, C.R., & Van Buren, H.J. (1999). Organizational social capital and employment practices. *Academy of Management Review*, 24(3), 538-555.
- Lee, S.M., & Olson, D.L. (2010). *Convergenomics: Strategic innovation in the convergence era*. Surrey: Gower Publishing.
- Lee, T.S., & Tsai, H.J. (2005). The effects of business operation mode on market orientation, learning orientation and innovativeness. *Industrial Management & Data Systems*, 105(3), 325-348.
- Levinthal, D.A., & March, J.G. (1981). A model of adaptive organizational search. *Journal of Economic Behavior and Organization*, 2(4), 307-333.
- Levinthal, D.A., & March, J.G. (1993). The myopia of learning. *Strategic Management Journal*, 14(2), 95-112.
- Lewin, A.Y., Long, C.P., & Carroll, T.N. (1999). The coevolution of new organizational forms. *Organization Science*, 10(5), 535-550.
- Lubatkin, M.H., Simsek, Z., Ling, Y., & Veiga, J.F. (2006). Ambidexterity and performance in small-to medium sized firms: The pivotal role of top management team behavioral integration. *Journal of Management*, 32(5), 646-672.
- March, J.G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2(1), 71-87.
- Meijaard, J., Brand, M.J., & Mosselman, M. (2005). Organizational structure and performance in Dutch small firms. *Small Business Economics*, 25(1), 83-96.
- Meyer, A.D., Tsui, A.S., & Hinings, C.R. (1993). Configurational approaches to organizational analysis. *Academy of Management Journal*, 36(6), 1175-1195.
- Mezias, S.J., & Glynn, M.A. (1993). The three faces of corporate renewal: Institution, revolution, and evolution. *Strategic Management Journal*, 14(2), 77-101.
- Migdadi, M. (2009). Knowledge management enablers and outcomes in the small- and medium sized enterprises. *Industrial Management & Data Systems*, 109(6), 840-858.

- Miller, D., & Mintzberg, H. (1983). The case for configuration. In G. Morgan (Ed.), *Beyond method*. Beverly Hills: Sage.
- Milligan, G.W., & Sokol, L.M. (1980). A two-stage clustering algorithm with robust recovery characteristics. *Educational and Psychological Measurement*, 40(3), 755–759.
- Nelson, R.R., & Winter, S.G. (1982). *An evolutionary theory of economic change*. Boston: Harvard University Press.
- Obstfeld, D. (2005). Social networks, the tertius lungens orientation, and involvement in innovation. *Administrative Science Quarterly*, 50(1), 100–130.
- OECD. (1996). *Science, technology and industry outlook 1996*. Paris: OCED.
- Powell, W.W., Koput, K.W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. *Administrative Science Quarterly*, 41(1), 116–145.
- Punj, G., & Stewart, D.W. (1983). Cluster analysis in marketing research: Review and suggestions for application. *Journal of Marketing Research*, 20(2), 134–148.
- Raisch, S. (2008). Balanced structures: Designing organizations for profitable growth. *Long Range Planning*, 41(5), 483–508.
- Raisch, S., & Birkinshaw, J. (2008). Organizational ambidexterity: Antecedents, outcomes, and moderators. *Journal of Management*, 34(3), 375–409.
- Raisch, S., & Hotz, F. (2010). Shaping the context for learning: Corporate alignment initiatives, environmental munificence, and firm performance. In S. Wall, C. Zimmermann, R. Klingebiel, & D. Lange (Eds.), *Strategic reconfigurations: Building dynamic capabilities in rapid-innovation-based industries*. Cheltenham: Edward Elgar Publishing.
- Rigby, D., & Zook, C. (2002). Open-market innovation. *Harvard Business Review*, 80(10), 80–89.
- Romanelli, E. (1987). New venture strategies in the microcomputer industry. *California Management Review*, 30, 160–175.
- Rosenkopf, L., & Nerkar, A. (2001). Beyond local search: Boundary-spanning, exploration, and impact in the optical disc industry. *Strategic Management Journal*, 22(4), 287–306.
- Rothaermel, F.T., & Alexandre, M.T. (2009). Ambidexterity in technology sourcing: The moderating role of absorptive capacity. *Organization Science*, 20(4), 759–780.
- Rothwell, R., & Dodgson, E.M. (1994). Innovation and size of firm. In M. Dodgson (Ed.), *The handbook of industrial innovation*. Aldershot: Edward Elgar.
- Simsek, Z. (2009). Organizational ambidexterity: Towards a multilevel understanding. *Journal of Management Studies*, 46(4), 597–624.
- Stuart, T.E. (1998). Network positions and propensities to collaborate: An investigation of strategic alliance formation in a high-technology industry. *Administrative Science Quarterly*, 43(3), 668–698.
- Stuart, T.E., & Podolny, J.M. (1996). Local search and the evolution of technological capabilities. *Strategic Management Journal*, 17(1), 21–38.
- Teece, D.J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy*, 15(6), 285–305.
- Teece, D.J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509–533.
- Tushman, M., & Romanelli, E. (1985). Organizational evolution: A metamorphosis model of convergence and reorientation. In L.L. Cummings & B.M. Staw (Eds.), *Research in Organizational Behavior* (Volume 7). Greenwich: JAI Press.
- Tushman, M.L., & O'Reilly, C.A. (1996). Ambidextrous organizations: Managing evolutionary and revolutionary change. *California Management Review*, 38(4), 8–30.
- Tushman, M.L., & Smith, W.K. (2002). Organizational Technology. In J. Baum (Ed.), *Companion to Organization*. Malden: Blackwell.

- Venkatraman, N., Lee, C.H., & Iyer, B. (2005). *Strategic ambidexterity and sales growth: A longitudinal test in the software sector*. Presented at the 65th Annual Meeting of the Academy of Management, Honolulu.
- Verhees, F. J. H. M., & Meulenbergh, M. T. G. (2004). Market orientation, innovativeness, product innovation and performance in small firms. *Journal of Small Business Management*, 42(2), 134–154.
- Zara, S.A., Ireland, R.D., & Hitt, M.A. (2000). International expansion by new venture firms: International diversity, mode of market entry, technological learning, and performance. *Academy of Management Journal*, 43(5), 925-950.