

Do External Knowledge Sourcing Modes Matter for Service Innovation? Empirical Evidence from South Korean Service Firms

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To source external knowledge, firms in the service area use various sourcing modes simultaneously suitable for their internal needs or external environments. Each external knowledge sourcing mode has distinctive characteristics, and as such, they can offer different advantages and/or disadvantages to the firms. Thus, the effects of external knowledge sourcing on service innovation may vary depending on the sourcing modes. The current study aims to empirically examine the different effects of various external knowledge sourcing modes on service innovation. The study identifies three external knowledge sourcing modes: joint development, technology purchasing, and external information acquisition. Three hypotheses are established to examine the relationships between the extent of utilizing each mode and service innovation performance in terms of new service introduction. The data for analysis are selected from the “Korean Innovation Survey 2006: Service Sector” (KIS 2006). It is regarded as South Korea’s version of the Community Innovation Survey (CIS). The KIS 2006 data set covers joint development, technology purchasing, and external information acquisition activities of corporations in the service sector in South Korea. The study empirically analyzes the data set using a negative binomial regression model. The results first demonstrate that the extent of the joint development has an inverted U-shaped relationship with the service innovation performance. Second, the results indicate that, on the other hand, service innovation performance decreases with the increase to the extent of the technology purchasing when the extent is below the threshold. On the other hand, it increases with the increase to the extent of the technology purchasing; this occurs when the extent exceeds the threshold. Third, the results show that external information acquisition has a positive effect on service innovation performance. These findings support that the extent of utilizing each mode has different relationships with service innovation performance. The findings suggest that service firms need to utilize joint development at a moderate level, active technology purchasing, and as much external information acquisition as possible to maximize service innovation performance. In practice, this finding can help managers of service firms select appropriate external knowledge sourcing modes and determine the optimum level of use for each mode. This study also can help firms build up strategies for external knowledge sourcing.

Introduction

Service firms are currently facing the challenges of rapidly developing technologies, dynamic customer needs, fierce competition, and short service life cycles. Consequently, the importance of service innovation has increased in relation to their competitiveness and profitability (Cainelli, Evangelista, and Savona, 2004; Elche and González, 2008; van Riel, Lemmink, and Ouwersloot, 2004). However, in today’s dynamic business environment, service firms cannot create sufficient innovations only with their internal knowledge

and experience. Outside-in knowledge (i.e., externally acquired knowledge) allows them to provide additional inputs to their services (Chesbrough, 2011). Therefore, external knowledge sourcing plays a crucial role in the service innovation (Leiponen, 2005; Love and Mansury, 2007; Tether, 2005).

To source external knowledge, the service firms use various sourcing modes simultaneously suitable for their internal needs or external environments (Hagedoorn and Hesen, 2007). Each external knowledge sourcing mode has distinctive characteristics, and as such, they offer different advantages and/or disadvantages to the firms (Kang and Kang, 2009; Lin and Wu, 2010). In other words, different sourcing modes may affect the innovation performance differently. Therefore, exploring the relationship between various external knowledge

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sourcing modes and the innovation performances is important in developing and executing an efficient external knowledge sourcing strategy. However, previous studies on external knowledge sourcing modes have focused mainly on the product or technological innovation in the manufacturing sector (Kang and Kang, 2009; Lin and Wu, 2010), and their effects on service innovation are rarely highlighted. This study, therefore, aims to analyze the different effects of various external knowledge sourcing modes on the service innovation.

This study considers three distinctive external knowledge sourcing modes, namely the joint development, the technology purchasing, and the external information acquisition. It examines the effects of these three modes on service innovation by incorporating three variables that represent the extent of simultaneous utilization of each mode within a single empirical model. It employs the Korea Innovation Survey 2006 (KIS 2006) data set covering the joint development, the technology purchasing, and the external information acquisition activities of the corporations in the service sector in South Korea, and analyzes the data set using the negative binomial regression model.

Different effects of the three external knowledge sourcing modes on service innovation performance are examined as follows. First, the three external knowledge sourcing modes are distinguished based on their characteristics. Then, based on the literature on these sourcing modes, three hypotheses which describe the relationships between each mode and service innovation performance are established. Next, the data and methods of the empirical analysis are described, and the results are presented.

In the final section, the implications of the results, some limitations of the present study, and directions for future research are discussed.

The study finds that the three external knowledge sourcing modes have different effects on the service innovation performance. The findings suggest that the effects of using external knowledge on the service innovation performance vary depending on the adopted external knowledge sourcing modes. In today's dynamic environment, the external knowledge sourcing is not an option for the service innovation and the competitive advantage in the service firms. They need to efficiently acquire external knowledge and leverage their innovation performance by utilizing each external knowledge sourcing mode in an appropriate manner. The findings will provide useful guidelines for the firms as they build and execute external knowledge sourcing strategies.

Conceptualization and Hypotheses

External Knowledge Sourcing Modes

Recent studies have highlighted the effects of external knowledge sourcing modes on innovation (Kang and Kang, 2009; Lin and Wu, 2010). There are various external knowledge sourcing modes ranging from technology purchasing, joint development, and joint venture to technological acquisition. Firms can choose any particular sourcing mode and use it according to the purpose of knowledge acquisition, properties of target knowledge elements, or internal and external conditions. They usually run several external knowledge sourcing projects concurrently using different sourcing modes. Each sourcing mode has distinctive characteristics, which affect the relationships between the external knowledge sourcing and the innovation performance. (Hagedoorn and Hesen, 2007; Kang and Kang, 2009).

The external knowledge sourcing modes that have been considered in previous studies can be categorized into *cooperation* and *buy* (Lin and Wu, 2010; Steensma and Fairbank, 1999). *Cooperation* for external knowledge sourcing refers to the activities to acquire the knowledge of partners, cocreate new knowledge, and perform a common objective through cooperative processes and interactions; this includes joint development, joint venture, and technological alliances among others. *Buy* in the context of external knowledge sourcing refers to the activities meant to acquire external knowledge by paying the costs of the knowledge; these include technology purchasing and acquisitions of other firms for knowledge sourcing.

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Cooperation and *buy* are the representative external knowledge sourcing modes and are efficient channels to access and acquire external knowledge. However, because both are formal external knowledge sourcing activities based on a formal agreement between focal firms and external knowledge sources, previous studies have a significant limitation in that they have neglected such sourcing activities which do not require formal agreements. Obviously, firms can access external knowledge sources and acquire information without any formal agreement. The results of the Scientific Activity Predictor from Patterns with Heuristic Origins (SAPPHO) project indicated that informal channels are more important success factors for innovation than formal channels (Rothwell et al., 1974). Moreover, the importance of informal networks as channels for knowledge transfer has been emphasized (Hakansson and Johanson, 1992; Pyka, 1997). Therefore, an additional study to consider the external knowledge sourcing modes that do not involve a formal agreement is strongly required. The present study examines the following external knowledge sourcing modes: (1) *joint development*, which is a representative mode of cooperation; (2) *technology purchasing*, a representative mode of buy; and (3) *external information acquisition*, a representative activity that does not involve any formal agreement.

Joint development refers to any activity wherein two partners contribute different types of knowledge to accomplish the agreed-upon complementary aims (Dodgson, 1993). It is a formal external knowledge sourcing mode as it is constructed by a formal agreement. A joint development agreement allows the firms to establish a governance structure for collaborative learning with a partner, thereby providing them easy access to the knowledge base of that partner. Joint development offers the firms opportunities to learn from partners by bringing together different knowledge bases (Inkpen and Dinur, 1998). It typically involves the interlocking of complementary knowledge, know-how, and skills through close interactions (Steensma and Fairbank, 1999). It also supplies the service firms with channels through which they can access knowledge embedded in a partner that would not otherwise have been available in the absence of close and collaborative interactions (Inkpen, 1998).

Technology purchasing involves buying technological knowledge from external knowledge sources. It includes licensing, acquiring ownership of technologies, and contracting research and development (R&D) (Cho and Yu, 2000; Steensma and Fairbank, 1999). It assists the firms in quickly solving technological problems and commercializing innovations. From a hierarchy-market perspec-

tive, technology purchasing agreements can be regarded as unilateral contracts and market arrangements, wherein access to specific technology is purchased from an external source (Mowery, Oxley, and Silverman, 1996). In contrast to the joint development, the technology purchasing does not involve close interactions between the focal firm and technology providers.

External information acquisition refers to the activity of acquiring information by scanning and monitoring the external environment of organizations to provide managers with the perception on external events and trends (Frishammar and Horte, 2005; Hambrick, 1982). As externally acquired information can be transformed into useful knowledge by information processing processes of the firms, it can be regarded as a kind of external knowledge sourcing mode. Service firms access external knowledge sources and acquire information that have been spilled over from external sources or have been opened to the public by external sources. Therefore, external information acquisition neither requires a formal agreement nor a close interaction between a focal firm and its external knowledge sources.

Technology purchasing, joint development, and external information acquisition have different characteristics in terms of, for example, the formality of relationships or the degree of organizational interactions between focal firms and external knowledge sources. Each has its own pros and cons, and these differences may affect the relationships between the extent of utilizing each mode and the service innovation performance. Table 1 briefly shows the distinctive characteristics of the three external knowledge sourcing modes. The following sections explore the detailed characteristics of these modes and develop three corresponding hypotheses to examine the influence of each mode on service innovation.

Joint Development and Service Innovation

The most distinctive characteristic of joint development compared with the two other external knowledge sourcing modes is the close interactions between partners. This is because it typically involves the combination of complementary knowledge through close organizational interactions (Steensma and Fairbank, 1999). Close interactions among partner organizations have a critical advantage in transferring knowledge. Knowledge has tacitness, stickiness, and organization-specific factors, making it difficult to translate external knowledge when applied to different domains; thus, it may not be readily utilized successfully for innovation (Kogut and Zander, 1992; Teece, Pisano, and Shuen, 1997). Through a close

Table 1. Characteristics of Three External Knowledge Sourcing Modes

Modes	Formal Agreements	Close Organizational Interactions	Other Properties
Joint development	Yes	Yes	Efficient tacit knowledge transfer Sharing resources and capabilities Opportunistic behavior of partners Coordination problems
Technology purchasing	Yes	No	Rapid acquisition of technological knowledge Allowing firms to focus on core service competence Acquiring best available technology
External information acquisition	No	No	Monitoring and scanning external knowledge sources Useful in identifying external opportunities Very low managerial costs

interaction, the joint development fosters the sharing of tacit knowledge, which is internalized in the mental processes of an individual. Moreover, it enables the service firms to observe operations of their partners and receive any feedback from them directly (Osborn and Baughn, 1990), thereby allowing the firms to successfully acquire organization-specific knowledge of their partners. It also facilitates them to source external knowledge efficiently and contributes to the enhancement of their innovation performance.

The relationships between a focal firm and its joint development partners exhibit properties of a strong tie, because a close organizational interaction occurs through them (Hansen, 1999). The strong tie has the advantage of sharing not only knowledge but also critical resources and capabilities; thus, joint development allows the firms to overcome the limitations of internal resources and capabilities for innovation (Narula, 2004), reduce the time to market of innovation projects by focusing their resources and their partners (Pisano, 1990), enjoy the advantages of scale and scope of economies (Kogut, 1988), and last but not least, share the costs and risks of development with their partners (Tyler and Steensma, 1995).

A service firm utilizing joint development to a large extent may have a large and diversified alliance portfolio. It allows the firm to acquire various information, knowledge, and resources as well as offers more opportunities for innovation (Koka and Prescott, 2002). An increase in the extent of the joint development (*JOINTDEV*) increases the diversity of the alliance portfolio. Thus, a high utilization of joint development would enable the firm to access various partners and enhance the possibility of acquiring complementary knowledge, thereby allowing it to maximize the benefits it can obtain from an individual partner.

Considering its various advantages, the *JOINTDEV* may be associated positively with the innovative performance of the service firms. However, the extent of utilizing the joint development may negatively affect their innovation performances. The joint development represents a kind of alliance between organizations. Alliance partners may show opportunistic behaviors, such as asymmetric knowledge sharing and knowledge leakages during their close interaction (Bruce, Fiona, Dale, and Dominic, 1995; Dodgson, 1993; Pisano, 1990). Such opportunistic behaviors of the partners may lead to a delay and failure of innovation activity, causing negative effects on the innovation of the focal firms (Lhuillery and Pfister, 2009; Pisano, 1990). When firms increase the *JOINTDEV*, they actively use more diverse partners for the joint development, which in turn increases the difficulty of monitoring. However, their available capability for monitoring the joint development partners is limited. Although they can build monitoring systems to prevent risks of the opportunistic behavior of the cooperation partners, building such systems can generate a dispersion of their managerial resources and capabilities, thereby hindering their focus on service innovation activities. The monitoring systems also increase the rigidity of cooperative process of the joint development, obstructing an efficient innovation activity.

When the firms increase the *JOINTDEV*, at least two kinds of coordination problems may occur. The first problem may arise when they undertake joint developments with too many different partners. These partners have different interests or motivations, and utilizing various partners can lead to conflicts among them. Hence, the joint development with a partner may negatively affect the performance of concurrent joint development activities with other partners (Hoffmann, 2005; Narula, 2004), and the firms may not enjoy synergies

from utilizing a variety of partners. The second problem may arise when they run several joint development projects with a particular partner. In such a case, problems in one project can cause a negative impact on the other projects (Hoffmann, 2005). Thus, the coordination among the projects with a partner is important, and a failure to do so may hinder the firms from enjoying the advantages of the joint development. The internal capabilities of the service firms including their coordination ability are also limited. Therefore, the utilization of the joint development exceeding their alliance capabilities will rapidly increase the coordination costs, decrease the efficiency of innovative activities with partners, and, as a result, will negatively affect their innovation performance.

Considering the monitoring costs for opportunistic behaviors of the partners and the coordination costs brought about by the complexity of partnership, it may become disadvantageous for firms to utilize joint development beyond their internal capabilities. Thus, the service firms should maintain *JOINTDEV* within a controllable scope. It is expected that there is a point at which *JOINTDEV* becomes disadvantageous, and that if the service firms rely on joint development excessively for utilizing external knowledge sources, they would exhibit lower service innovation performance. In sum, a hypothesis can be stated as:

H1: The extent of utilizing the joint development mode has an inverted U-shaped relationship with service innovation performance.

Technology Purchasing and Service Innovation

Technology purchasing agreements can be regarded as unilateral contracts and market arrangements, wherein access to a specific technology is purchased from an external source (Mowery et al., 1996). The most important advantage of technology purchasing for the service firms is that it allows them to focus their resources and capabilities on developing the core service competences. At present, many service innovations have been realized based on technological progresses. However, because the core competencies of the service firms lie in their service activities, it is difficult for them to quickly develop new technological elements internally, or even cooperatively, with other firms. This limitation may make it difficult for them to cope with the fast-changing business environment. Under the conditions of very high technological uncertainty, the firms who have low technological capabilities are compelled to choose a technology purchasing

strategy rather than pursue internal or cooperative development (Harrigan, 1986; Walker and Weber, 1984). The technology purchasing strategy renders great advantages when the service firms have technological problems that cannot be solved internally, or require the creation of new knowledge for service innovation on a short notice. Technology purchasing allows them to concentrate their internal resources and capabilities on service activity and to specialize deeper in their core service competence while relying on outside firms that specialize in complementary technological expertise and skills (Grant and Baden-Fuller, 2004). Therefore, through the technology purchasing from external knowledge sources, the service firms can achieve faster and more efficient service innovations.

When service firms purchase technologies, it is advantageous for them to use various technology providers actively. The purpose of the technology purchasing is to acquire the most appropriate technology with respect to the new service developments and service delivery. In these days, the superior technological knowledge has been distributed among various organizations (Chesbrough, 2003). *Ex ante*, managers do not know which external technology provider would be the most fruitful. Under this condition of uncertainty, the likelihood of obtaining a relevant and valuable technology through technology purchasing increases with an increase in the number of external technology providers. Therefore, by actively accessing a broader spectrum of external technology providers, the firms enhance the possibility of gaining relevant technological knowledge, which then positively affects their subsequent technology innovation. Those who have access to various technology providers and choose to utilize them actively are more likely to acquire the most appropriate technology and generate new service ideas through their encounter with a wide range of technologies.

In contrast to joint development, technology purchasing does not involve a close interaction between buyer firms and technology providers; thus, the relationship between the focal firms and the technology providers has a property of a weak tie (Hansen, 1999). This allows the firms to enjoy various advantages in knowledge sourcing and innovation activities. First, the relationship for technology purchasing does not inflict high managerial or maintenance costs. Thus, the firms are less likely to suffer monitoring or coordination problems when they utilize various technology providers than when they utilize joint development. Second, because technology purchasing is less likely to generate rigid relationships between the firms and their external knowledge sources,

service firms can easily move from one technology provider to another, allowing them to fully enjoy the advantages of utilizing various technology providers. In sum, the second hypothesis is established as follows:

H2: The extent of utilizing the technology purchasing mode has a positive effect on service innovation performance.

External Information Acquisition and Service Innovation

Firms monitor and scan external knowledge sources and acquire information from them. In contrast to joint development and technology purchasing, external information acquisition does not require a formal agreement between firms and external knowledge sources. Therefore, channels between them for external information acquisition can be regarded as informal networks (Hakansson and Johanson, 1992; Pyka, 1997). Moreover, because external information acquisition does not involve a close interaction between firms and external knowledge sources, the relationship required for external information acquisition can be regarded as a weak tie (Hansen, 1999). Informal and weak networks do not incur high maintenance and managerial costs for the relationships, thus allowing firms to build a wide path for external information acquisition with abundant external knowledge sources as well as acquire abundant and diversified information at low costs under the conditions of limited resources and capabilities. In addition, external information acquisition allows firms to easily detect changes in the external environment, rapidly react to such changes, and grab opportunities to identify useful external knowledge or technologies. It also enhances the openness of the focal firms (Birkinshaw and Fey, 2000) and assists them in developing and executing better innovation strategies in the era of open innovation. Therefore, external information acquisition helps service firms improve their innovation performance.

Although external information is useful for a firm, previous studies have asserted that too much external information beyond its internal capabilities may generate negative consequences on its innovative performance. Information is viewed as a kind of preliminary stage to knowledge (Lueg, 2001). Leonard and Sensiper (1998), for example, knowledge is defined as “information that is relevant, actionable, and based at least partially on experience.” Knowledge, in this context, is often seen as well-processed information with specific properties. Therefore, firms need information processing capabilities to utilize external information acquisition as a useful

external knowledge sourcing mode. Koput (1997) asserts that acquiring too much external information can generate a waste of resources, because the external information acquisition activities incur costs, and the amount of information that a firm can absorb is limited. In this context, several studies have suggested that there is a point at which the extent of external information acquisition (*EXTINFOR*) becomes disadvantageous (Katila and Ahuja, 2002; Laursen and Salter, 2006). According to these studies, excessive exploration and acquisition of highly diversified external information may negatively affect innovation performance because of the lack of absorptive capacity and oversearch problem found in the firms.

However, the rapid development of information technology allows service firms to rapidly increase their information absorption capabilities and decrease the costs for acquiring external information and processing useful knowledge (Clemons, Reddi, and Row, 1993). At this point, it may be ideal to apply some of the computer-based information management techniques, such as information retrieval and information filtering. Information management refers to the collection and dissemination of information for the benefit of an organization and its individuals (Lueg, 2001). Through it, the disadvantages of external information acquisition have been relaxed, and the firms can utilize external information for innovation more efficiently (Kang and Kang, 2009). In the era of open innovation, the importance of external information is increasing, whereas the risk of external information acquisition is being reduced with the fast development of information technology. Therefore, this study proposes the following hypothesis:

H3: The extent of utilizing the external information acquisition mode has a positive effect on service innovation performance.

Methods

Data and Sample

The data for analysis are selected from the “Korean Innovation Survey 2006: Service Sector” (KIS 2006) gathered by the Science and Technology Policy Institute (STePI) of South Korea. The KIS is regarded as the South Korean version of the Community Innovation Survey (CIS). The survey method and questionnaire used in the KIS 2006 are based on the CIS and the third edition of the Oslo Manual of the Organization for Economic Cooperation and Development. The KIS 2006 includes abundant

questions related to innovation activities of service firms, and its questionnaire draws from a long tradition of innovation research. The KIS started in 1996, the year after the CIS was started. Since then, it has been implemented more than 10 times.

Similar to the CIS data, the KIS data offer a direct measure of success in commercializing innovations for a broad range of industries that more traditional measures may not capture (Leiponen and Helfat, 2010). The questionnaire asks the subject firms to indicate whether or not they have been able to achieve a service innovation. They are then asked to state how many new services they have introduced. The KIS refers to the service innovation as an introduction of new services that are created based on new knowledge or technology; these are different or more greatly improved than the existing services in terms of technological aspects, customer relations, or other features. Alongside such innovation performance questions are a number of questions on the information sources for innovation, joint development and technology purchasing activities for innovation, intellectual property strategies, and other innovative activities.

The KIS 2006 survey is 16 pages long and includes several pages of informative definitions for the respondents. The population for the KIS 2006 was created by the “Basic Statistical Survey 2004” of the Korea National Statistical Office. The STEPI chose 6545 samples from this population according to the Neyman method. The samples were selected by second order stratification. First, the STEPI stratified the population on 20 categories according to the Korea Standard Industrial Classification; most of the categories of the Korean service sectors were included within the 20 categories. Second, the STEPI stratified each category on four subcategories according to the number of employees. The population was stratified on 80 subcategories, and the STEPI selected 6545 sample firms from 80 subcategories using the difference of variance between subcategories. The survey was sent to 4898 firms in the service sector of South Korea in May 2006, with the exception of 1647 firms who had closed their business or refused to answer the survey. The STEPI received 2498 replies (response rate of 51%), after which it called the sample firms to confirm the survey. The responses were voluntary; in addition, the respondents were promised confidentiality and that the survey would be used to design government policies. The survey was completed by the managing director or the R&D manager of the firm who is responsible for new service development and other innovation activities. The subsample of the KIS 2006 for empirical analysis included 454 firms that replied to all the variables indicating that this

analysis examines and draws from the entire South Korean service sector.

Descriptive Statistics

Using the KIS 2006, the study explores the knowledge sources for the service innovation in the South Korean service sector. Four hundred fifteen firms (91.4%) in the subsample utilized the external information acquisition, whereas 154 firms (33.9%) utilized the joint development, and 99 firms (21.8%) utilized the technology purchase. The results indicate that the firms utilize external information acquisition more actively than joint development or technology purchasing. Considering the costs of external knowledge sourcing modes, external information acquisition is the cheapest mode, and thus, the firms utilize it more easily than other modes.

Table 2 lists nine external knowledge sources for joint development, nine for technology purchasing, and thirteen for external information acquisition listed in the KIS 2006. Table 2 presents the results for the entire range of external knowledge sources for the South Korean service firms. The results indicate that the most important source for external information acquisition is media and information network, followed by customers and competitors. Suppliers make up the most important source for joint development, followed closely by competitors and customers. Customers make up the most important source for technology purchasing, followed closely by competitors. The results indicate that customers and competitors are important external knowledge sources in all sourcing modes. The results indicate that the innovation activities of the South Korean service firms are strongly determined by the relations among themselves and their customers and competitors. These results are consistent with the assertion of Chesbrough (2011), which states that innovations in service are closely linked with customers.

Dependent Variable

This study analyzes the effects of the different external knowledge sourcing methods on the service innovation performance. The ultimate purpose of innovation is to maximize profitability by providing customers with an enhanced value, which is generated mostly by developments and introductions of new and improved services or products. From this perspective on innovation, previous studies have tried to capture product or service innovation using the introduction of new products or services (Kang and Kang, 2009; Love and Mansury, 2007; Rothaermel, 2001). The service firms continuously develop new

Table 2. Available External Knowledge Sources Categorized by Sourcing Modes

External Knowledge Sourcing Modes	Types of Available External Knowledge Sources	Used (Percentage)	
Joint development (nine types of sources)	Subsidiaries of same headquarters	5.51	
	Competitors in same industry	15.86	
	Customers or clients	14.10	
	Business service firms (e.g., consulting)	14.31	
	Suppliers of raw materials or equipment	16.30	
	Private research institutes	11.23	
	IT firms	10.79	
	Universities	13.88	
	Government research organizations	9.69	
	Technology purchasing (nine types of sources)	Subsidiaries of same headquarters	3.96
		Competitors in same industry	11.67
		Customers or clients	12.78
		Business service firms (e.g., consulting)	11.45
Suppliers of raw materials or equipment		11.23	
Private research institutes		8.59	
IT firms		7.49	
Universities		8.37	
Government research organizations		6.83	
External information acquisition (thirteen types of sources)		Subsidiaries of same headquarters	13.66
		Competitors in same industry	57.71
		Customers or clients	60.35
		Business service firms (e.g., consulting)	47.58
	Suppliers of raw materials or equipment	51.32	
	Private research institutes	34.80	
	IT firms	35.90	
	Universities	32.60	
	Government research organizations	26.43	
	Informal networks of CEO or CTO	47.14	
	Patents review	41.85	
	Fairs, exhibitions	53.52	
	Media and information network (e.g., newspaper, TV)	63.22	

CTO, chief technology officer.

services through innovative activities and provide them to their customers to acquire and maintain their competitive advantage. An introduction of a new service can represent the performance of the innovation activities of service firms. The study defines *service innovation* as the introduction of new services that are created based on new knowledge or technology; are definitely different; or greatly improve the existing services in terms of the technological aspects, customer relations, or other features. The study counts the number of new service introductions during the period of 2003–2005 to measure service innovation performance.

Independent Variables

The extent of utilizing external knowledge sources is determined by the various types of the sources used by focal firms and their importance (Katila and Ahuja, 2002; Laursen and Salter, 2006; Leiponen and Helfat, 2010; Levinthal and March, 1993). The present study measures

the extent of utilizing each sourcing mode while considering the variety of such sources as well as their importance. The extent is measured by the sum total of the importance of each type of the external knowledge source. This work identifies three modes of utilizing external sources and suggests three independent variables accordingly: *EXTINFOR*, *JOINTDEV*, and the *extent of technology purchasing (PURCHASING)*. The types of the external knowledge sources that can be utilized by the each mode are introduced in Table 2.

JOINTDEV

The KIS introduces nine types of external sources for joint development and measures the importance of each partner to the service innovation of a firm using a 6-point scale: 0 = not used, 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high. In order to measure the extent of joint development, the sum total of the importance of nine types of the external knowledge sources that

are available for joint development was calculated. This has an integer value ranging from 0 to 45. Next, the value was standardized so that *JOINTDEV* has a value ranging from 0 to 1. Each firm gets a 0 when no knowledge source is used for joint development, whereas it gets the value of 1 when all knowledge sources are used.

PURCHASING

The KIS introduces nine types of external sources for technology purchasing and measures the contribution of each source to the service innovation of a firm using a 6-point scale: 0 = not used, 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high. In order to measure *PURCHASING*, the sum total of the importance of the nine types of the external knowledge sources that are available for technology purchasing was calculated. This has an integer value ranging from 0 to 45. Next, the value was standardized so that *PURCHASING* has value in the range of 0 to 1. Each firm gets a 0 when no knowledge source is used for the technology purchasing, whereas it gets the value of 1 when all knowledge sources are used.

EXTINFOR

The KIS introduces 13 types of external sources for information utilization and measures the importance of each source to a focal firm's service innovation using a 6-point scale: 0 = not used, 1 = very low, 2 = low, 3 = moderate, 4 = high, and 5 = very high. In order to measure *EXTINFOR*, the sum total of the importance of the thirteen types of the external knowledge sources that are available for the external information acquisition was calculated. This has an integer value ranging from 0 to 65. Next, the value was standardized so that the *EXTINFOR* has a value ranging from 0 to 1. Each firm gets a 0 when no knowledge source is used for external information acquisition, whereas it gets the value of 1 when all knowledge sources are used.

Control Variables

The study employs five control variables, which are firm size, R&D intensity, start-up, market size, and participation of users. The firm size has an important effect on the innovativeness of a firm and is therefore frequently used as a control variable in many studies related to innovation. It is measured by the logarithm of the number of total employees who work in focal firms (*LOGSIZE*).

Start-up firms tend to innovate more vigorously than incumbents; therefore, the study considers whether the

firm is a start-up (*STARTUP*). If a firm started within the period of 2001–2005, then it is considered a *STARTUP*. Hence, the variable takes the value of 1 when the focal firm started up within the period 2001–2005, and 0 otherwise.

In addition, it controls for the size of the market of the focal firm (*GEOMARKET*). A firm that operates in large areas has to upgrade its service suitable to the various needs of different regions (Altinay and Wang, 2006). Services competing in broad markets are more likely to be obsolete than those competing in small ones. Hence, firms competing in broad markets may exert more efforts to innovate more intensively than those competing in small markets. In this research, the *GEOMARKET* variable takes the value 1 when corresponding to the area within a radius of 50 km, 2 when corresponding to the area within 100 km, 3 when corresponding to the area within 200 km, 4 when corresponding to whole country area, and 5 when corresponding to the international market.

Previous studies on the innovation insist that the relatedness of customers to the innovation has a significant effect on the innovation (Kang and Kang, 2009; Laursen and Salter, 2006; Rothwell et al., 1974; von Hippel, 1988) and that the cooperation with them has a positive effect on knowledge creation (Weck, 2006). The customers freely give firms feedback on services that they have used. Love and Mansury (2007) also suggest that they significantly enhance service innovation. This work includes the variable *CUSTOMER* to control the effect of their relatedness to innovation. This variable is created based on the “clients or customers” source of informal transfer for the innovation and takes the value of 1 when the firm indicates that it uses clients or customers to a degree of 4–5 as sources of knowledge for innovation activities, and 0 otherwise.

Empirical Estimation Method

The study counts the number of new service introductions from 2003 to 2005 to measure service innovation performance of the focal firms. The number of a new service introduction is a “count” variable and takes a nonnegative integer value. When analyzing a countable and nonnegative dependent variable, researchers can employ the Poisson regression or negative binomial regression models. With Poisson regression models, it should be assumed that the conditional mean and variance of the dependent variable are equal. However, the Poisson regression rarely fits in practice because in most applications, the conditional variance is greater than the

Table 3. Descriptive Statistics and Correlations

Variables	Mean	Standard Deviation	1	2	3	4	5	6
<i>Service innovation</i>	10.06	56.75						
1. <i>JOINTDEV</i>	18.34	13.52						
2. <i>PURCHASING</i>	4.18	7.66	0.468					
3. <i>EXTINFOR</i>	3.01	7.21	0.467	0.372				
4. <i>LOGSIZE</i>	4.15	1.43	0.197	0.180	0.256			
5. <i>STARTUP</i>	0.05	0.22	0.051	0.122	0.006	−0.126		
6. <i>CUSTOMER</i>	0.09	0.29	−0.014	−0.017	0.007	0.049	0.070	
7. <i>GEOMARKET</i>	3.52	1.05	0.024	0.077	0.097	0.138	−0.042	0.032

conditional mean (i.e., overdispersion problem). The presence of the overdispersion problem causes standard errors of parameters to be underestimated, resulting in spuriously large *z*-values and overstated significance of coefficients (Cameron and Trivedi, 1986). The mean of the number of a new service introduction is 10.06, and its standard deviation is 56.75 (Table 3). As the conditional variance of the dependent variable is much larger than its conditional mean, the dependent variable may have an overdispersion problem and infringe on the basic conditions of Poisson distribution. To compare the fit of the Poisson and the negative binomial regression models, both the likelihood ratio (LR) and chi-square goodness-of-fit tests were performed. In these supplementary analyses, overdispersions in all the models presented in this paper can be found. The results of goodness-of-fit tests show that the negative binomial regression model is more proper than the Poisson ($p < .05$) in all models. The results of the LR test also show that the null hypothesis that the data are from a population with the Poisson distribution is rejected ($p < .05$). Consequently, the negative binomial regression model which allows overdispersion is chosen for the analysis.

Results

We explore the relationships among the three external knowledge sourcing modes and the service innovation employing data set from the KIS 2006. Table 3 shows the summary of descriptive statistics and correlations among the variables. There are relatively high correlations between the independent variables. Thus, a variance inflation factor (VIF) analysis was conducted to examine whether a multicollinearity problem exists among the independent variables. Table 4 shows the result of the VIF analysis, and the *EXTINFOR* variable exhibits the largest value of VIF (1.94). It is generally accepted that there is no multicollinearity problem when the VIF value is less than 10 (Hair, Anderson, Tatham, and

Black, 1995). Therefore, relatively high correlations among the three independent variables merely illustrate that a firm possessing an attitude towards external knowledge is likely to use a combination of various external knowledge sourcing modes.

Table 5 presents the results of the three negative binomial regression models used to analyze the effects on service innovation of the extent of utilizing each of the external knowledge sourcing modes. Each model commonly contains the control variables, such as *LOGSIZE*, *STARTUP*, *GEOMARKET*, *USER*, and the industry dummies. Model 1 contains only the control variables. Model 2 additionally includes three more variables, namely, *EXTINFOR*, *JOINTDEV* and *PURCHASING*, to analyze the effects on service innovation of the extent of utilizing each strategy for external knowledge sourcing. Model 3 contains the additional square terms of *EXTINFOR*, *JOINTDEV*, and *PURCHASING* to analyze the curvilinear relationship between the three independent variables and the service innovation. The chi-square values of all three models are significant ($p < .01$); hence, these models are considered valid.

When including square terms of the independent variables to test the quadratic effect, a multicollinearity problem between the independent variables and their square terms may occur; thus, they cannot enhance the explanation power of the negative binomial regression

Table 4. VIF Test Results

Variables	VIF
<i>JOINTDEV</i>	1.38
<i>PURCHASING</i>	1.36
<i>EXTINFOR</i>	1.48
<i>LOGSIZE</i>	1.13
<i>STARTUP</i>	1.05
<i>CUSTOMER</i>	1.01
<i>GEOMARKET</i>	1.03
Average	1.20

VIF, variance inflation factor.

Table 5. Negative Binomial Regression Explaining Relationships between External Knowledge Sourcing Modes and Service Innovation

Model Dependent Variable	1		2		3	
	Service Innovation		Service Innovation		Service Innovation	
Independent variables	Coefficient	SE	Coefficient	SE	Coefficient	SE
<i>JOINTDEV</i>			1.079	0.730	8.093***	1.651
<i>JOINTDEV</i> ²					−14.460***	2.761
<i>PURCHASING</i>			0.523	0.648	−6.172***	1.733
<i>PURCHASING</i> ²					11.960***	3.088
<i>EXTINFOR</i>			1.239**	0.534	−1.354	1.557
<i>EXTINFOR</i> ²					4.207*	2.267
<i>LOGSIZE</i>	0.465***	0.068	0.357***	0.070	0.275***	0.070
<i>STARTUP</i>	−0.211	0.430	−0.260	0.415	−0.056	0.402
<i>CUSTOMER</i>	−0.458	0.334	−0.569*	0.328	−0.384	0.315
<i>GEOMARKET</i>	0.018	0.095	−0.046	0.097	−0.001	0.090
Industry dummies	Yes		Yes		Yes	
Number of observations	454		454		454	
Log likelihood	−1231.39		−1222.27		−1207.72	
Chi-square	108.16***		126.41***		155.49***	

* $p < .10$; ** $p < .05$; *** $p < .01$.
SE, standard error.

model. Models 2 and 3 were compared by performing a log-LR test (G-test) to inspect whether a multicollinearity problem exists. The log likelihood of Model 2 is −1222.27 and that of Model 3 is −1207.72, making the LR value 29.1. Model 3 contains three more variables than Model 2; hence, the number of degrees of freedom is 3. The critical value of LR ($p = .05$) is 7.82 when the number of degrees of freedom is 3. The LR between Models 2 and 3 is greater than the critical value of LR; furthermore, there is a significant difference between Model 2 and 3. Therefore, there is no significant multicollinearity problem between the independent variables and their square terms, and Model 3 has significantly higher explanation power than Model 2.

Model 2 shows that the parameter for the *JOINTDEV* is not significant. However, Model 3 shows that the parameter for *JOINTDEV* is positive and significant, whereas that for *JOINTDEV* squared is negative and significant. Therefore, H2, which asserts that the extent of cooperation with external sources exhibits an inverted U-shaped relationship with service innovation performance, is supported. Moreover, the inflection point of the inverted U shape (i.e., the peak of the inverted U, $\partial \text{Service innovation performance} / \partial \text{JOINTDEV} = 0$) appears when *JOINTDEV* takes the value of 0.28.

Model 2 shows that the parameter for *PURCHASING* is not significant. Thus, H3, which suggests a positive relationship between *PURCHASING* and service innovation performance, is not supported. However, Model 3 shows that the parameter for *PURCHASING* is negative

and significant. It also shows that the parameter for *PURCHASING* squared is positive and significant. The results for Model 3 present a U-shaped relationship between *PURCHASING* from external sources and service innovation performance. The results indicate that, on the one hand, service innovation performance decreases with the increase in *PURCHASING* when the extent is below the threshold. On the other hand, it increases with the increase in *PURCHASING* when the extent exceeds the threshold. Furthermore, the results indicate that the inflection point of the U shape (i.e., the threshold, where $\partial \text{Service innovation performance} / \partial \text{PURCHASING} = 0$) appears where *PURCHASING* takes the value of 0.26, and the service innovation performance is maximized when it takes the value of 1.

Model 2 shows that the parameter for the *EXTINFOR* variable is significant and positive. Thus, H1, which asserts a positive relationship between the extent of utilizing external information acquisition and service innovation performance is supported. When a firm acquires information that is spilled over from external sources or is opened to the public, the larger the extent to which the firm acquires external information, the higher it gains the service innovation performance.

Discussion

We empirically demonstrate that each of the external knowledge sourcing modes has a different relationship with service innovation performance. The results show

that *JOINTDEV* has an inverted U-shaped relationship with service innovation performance. This finding implies that there are diminishing returns when it comes to the benefits originating from joint development, and firms have to utilize this kind of activity only within their capabilities. Capabilities are path dependent and are constrained by the past investments, prior experiences, and current resource endowments of a firm (Dierickx and Cool, 1989). Given that history matters, there are limitations on any firm-level capability, including the *JOINTDEV* that a firm can manage productively. Therefore, declining performance is likely the observable outcome when the activities of a firm exceed its finite capabilities. Rothaermel and Deeds (2006) suggest that the point of diminishing total returns in the relationship between the alliances of a firm and its new product development is reflective of the firm's maximum ability to manage alliances effectively. According to the results and the findings of previous studies, the service firms must be able to maintain *JOINTDEV* within a controllable scope, pay attention to the opportunistic behaviors of its partners (Kaufman, Wood, and Theyel, 2000; Williamson, 1985), and effectively coordinate the different interests of its partners.

Joint development has a unique and critical advantage over the two other modes—it allows firms to share resources and capabilities with their partners. As complexities, risks, and costs of new service and product development are increasing, the unique advantages of joint development are quickly becoming significant in maintaining the competitiveness of a firm. Thus, the advice that firms need to maintain *JOINTDEV* within a controllable scope is quite inappropriate. Because many firms tend to actively use it beyond their internal capabilities, they must improve their alliance capabilities including the alliance management capability (Doz, 1996; Dyer and Chu, 2003) and the alliance portfolio capability (Hoffmann, 2005, 2007). The alliance management capability refers to the capability to handle or manage any individual alliance (Doz, 1996; Dyer and Chu, 2003), whereas the alliance portfolio capability refers to the capability to manage a portfolio of alliances (Hoffmann, 2005, 2007). When a firm's alliance management capability is enhanced, it can manage each alliance more efficiently. Moreover, if it develops its alliance portfolio capability, it can also successfully coordinate its complex alliance networks. By developing these two capabilities, the firms can resolve potential problems of joint development and successfully profit from it. The alliance capabilities are path dependent capabilities that are built over time through repeated engagements in alli-

ances (Levitt and March, 1988). If a firm settles for a controllable scope of alliance, it may lose competitive advantage because of the lost opportunities to build alliance capabilities further on. Therefore, firms should not only try to extend their scope of alliances, but also exert efforts to develop alliance capabilities.

We hypothesize that *PURCHASING* from external sources positively affects the service innovation performance. However, the results indicate that, on the one hand, service innovation performance decreases with the increase in *PURCHASING* when the extent is below the threshold. On the other hand, it increases with the increase in *PURCHASING*; this occurs when the extent exceeds the threshold. The results indicate that service innovation performance exhibits a maximized value when *PURCHASING* variable takes 1. Thus, the highest level of technology purchasing is most advantageous for service innovation performance. This finding corresponds with the open innovation perspective. It is important for firms to outsource noncore knowledge, resources, or capabilities that they cannot have internally. Their core competence is not technological competence; thus, they need to actively outsource solutions for technological problems and channel their resources and capabilities on their core service activities.

Previous studies of technology purchasing that focused on the manufacturing sector have raised the problems of technology purchasing. First, heavy reliance on technology purchasing may decrease the internal development capabilities of the firms, ultimately weakening their core technological competencies (Quinn, 1992; Sen and Rubenstein, 1989). This increases the risks of them becoming hollow and losing their competitive advantage (Dodgson, 1993; Miles and Snow, 1992). Second, technology purchasing, including the licensing-in and buying technology, is usually associated with outdated or at least not very state-of-the-art technologies (Auster, 1990; Kogut, 1988). In the manufacturing sector, transactions involving state-of-the-art technologies are difficult because such technology is the core competence of firms, and the relationship between technology providers and buyer firms is potentially competitive. These limitations may hinder them from enjoying the advantage obtained from technology purchasing for innovation. However, the role of technology purchasing in service innovation is quite different from that in product innovation. The core competence of service firms does not lie in their technological capabilities but in their service capabilities; in addition, most of them do not have technological competences internally. Therefore, technology purchasing does not cause a weakening of the core competence of

service firms. Moreover, innovative service firms utilize technology purchasing for the purpose of acquiring the best available technology so as to realize new or enhanced services. These firms, therefore, actively purchase state-of-the-art technologies to be able to provide new and enhanced services through a combination of externally acquired new technologies and their internal service capabilities (Ang and Straub, 1998; Grover, Cheon, and Teng, 1994).

There are several aspects of technology purchasing that require managerial attention. First, it is possible that newly purchased technological elements do not fit into already existing systems or services. In such a case, the service firms suffer a delay in the development of a new service, which utilizes the newly acquired technology, and the service innovation performance may decrease. Second, there is a possibility that the service firms will fail to develop new service innovations based on newly purchased technologies for which they paid large amounts. In this scenario, their failure to utilize externally acquired technology for new service innovation can be a significant problem. Third, because technology purchasing does not involve close interactions, it may show low efficiency of learning and a weak point in transferring tacit knowledge. As such, the firms should utilize technology purchasing carefully considering these problems.

The results show that external information acquisition has a positive effect on service innovation performance. Changes in the external environment of firms are accelerating, suggesting the importance of external information acquisition through monitoring and scanning of external knowledge sources. The finding implies that service firms that actively scan external organizations and acquire external information can gain a higher service innovation performance and thus enjoy a competitive advantage. Some previous studies have insisted that firms may suffer from an oversearch problem when they acquire too much information from external sources (Koput, 1997; Laursen and Salter, 2006). However, the finding indicates that they do possess sufficient information processing capabilities to treat abundant, externally acquired information. Moreover, the results also demonstrate that the benefit of increasing the *EXTINFOR* is greater than its cost. The finding corresponds with those found in previous studies asserting that the oversearch problem is diminished due to the improvement of the information absorption process as well as the reduced searching costs brought about by the rapid developments in the field of information technology (Clemons et al., 1993; Kang and Kang, 2009). Service firms need to acquire external information actively through monitoring

and scanning of external knowledge sources and then transform the information into useful knowledge.

Contributions, Limitations, and Future Research

The findings of the present study provide further understanding of external knowledge sourcing in the service sector. This study focuses on the external knowledge sourcing modes, such as joint development, technology purchasing, and external information acquisition, whereas previous studies on the relationship between external knowledge sources and service innovation have concentrated on the role of each source type, such as competitors, customers, suppliers, and research organizations (Leiponen, 2005; Love and Mansury, 2007; Tether, 2005). Similar to manufacturing firms, most service firms tend to use various external knowledge sourcing modes simultaneously. The present paper considers three different modes of utilizing external sources and analyzes the effect of each method on the service innovation performance. It demonstrates that the effect varies with the particular methods employed. The findings highlight the fact that firms have to consider various strategic alternatives for carefully utilizing external knowledge sources. They also can assist managers in selecting a particular external knowledge sourcing mode and determining optimum levels of the extent of utilizing each mode.

Moreover, the present study contributes to extending the scope of the external knowledge sourcing modes to informal mode of knowledge transfer. Previous studies have focused merely on the formal external knowledge sourcing modes, and the informal external knowledge sourcing activities (including external information acquisition) that do not involve any formal agreement have not been highlighted. However, the results indicate that external information acquisition is the most flourishing external knowledge sourcing mode. Moreover, it is the only mode with a positive linear relationship with service innovation performance, whereas the two other modes exhibit curvilinear relationships. Considering the importance of external information acquisition, studying its role is an important subject in this field.

This work is an explorative study, which examines the roles of the external knowledge sourcing modes in the service sector. Traditionally, innovation in services has been studied largely on the basis of theories of innovation in the manufacturing sector (Drejer, 2004; Gallouj, 2002), and the assimilation approach asserts that innovation in the service sector is basically similar to that in the manufacturing sector (Gadrey, Gallouj, and Weinstein,

1995; Gallouj, 2002; Sirilli and Evangelista, 1998). Therefore, it is reasonable to explore the characteristics of each of the external knowledge sourcing modes based on literature on the manufacturing sector. However, because the service innovation and product innovation processes differ in some aspects (Coombs and Miles, 2000; Drejer, 2004; Gadrey et al., 1995), the theoretical framework may not be fully appropriate for service innovation, and, as a logical result, the findings may not provide appropriate implications to service firms to the fullest extent. Thus, subsequent studies that analyze the external knowledge sourcing modes while considering service-specific contexts are required. Also, comparative studies that examine the different effects of the external knowledge sourcing modes between the service and the manufacturing sector can be an interesting research challenge.

Because resources and capabilities which allow a firm to invest in external knowledge sourcing are limited, it can be said that various external knowledge sourcing modes may have a substitutive relationship. At the same time, as each of the modes has a different advantage in acquiring different kinds of knowledge, it can also be said that they may demonstrate a complementary relationship. Therefore, it is imperative to find the right balance among the different types of external knowledge sourcing modes. In future studies, additional examinations of the interaction effects among the external knowledge sourcing modes are required to find the right balance among the modes in the portfolio.

Analyzing the KIS 2006 database has an advantage as it provides a large number of samples. However, it is difficult to find variables that fit precisely with the object of this study. Here, the study used the “number of service innovations in 2005” as a measure of service innovation. The measurement may still be limited because each service innovation has different effects on the innovation of the firms and different degrees of innovativeness. Moreover, the perception of innovation varies among the firms. Thus, in future research, more meaningful results can be obtained if data that fit more precisely with the research purpose are available.

This study summed up the importance of each type of external knowledge sources to measure the extent of utilizing the external knowledge sourcing mode. As the maximum value of the importance of each type is 5, a firm with an extremely high dependence on one type would have a relatively low score, even if it uses this type more heavily than other firms. This limitation comes from the structure of the KIS 2006 data. Future works that are able to objectively measure the importance of each

type of the external knowledge sources are, therefore, highly recommended.

Conclusion

Service innovation is a crucial determinant of the growth of the service sector. As such, service firms should execute efficient and effective strategies for service innovation. Because they cannot innovate successfully by merely exploiting their internal knowledge in today’s dynamic business environment, they have to explore and exploit external knowledge sources for innovation. When they try to acquire knowledge from external sources, various external knowledge sourcing modes can be used simultaneously. In addition, due to the fact that each mode has distinctive characteristics, different external knowledge sourcing modes may have different effects on the service innovation performance. This work has successfully demonstrated the different effects of the three external knowledge sourcing modes on the service innovation performance. The results suggest that service firms need to utilize joint development at a moderate level, technology purchasing actively, and external information acquisition as much as possible to maximize their service innovation performance. In practice, this finding can help managers of service firms in selecting appropriate external knowledge sourcing modes and determining the optimum level of use for each mode. This study also has significant implications for them as they build up strategies for external knowledge sourcing.

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