Utilization of Knowledge Intensive Services for the Innovation of Manufacturers in Korea

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Summary

Abstract: This study aims to explore and understand the role of knowledge intensive service activities in the industrial innovation of Korea. It analyzes public and private service inputs to the innovation of manufacturers. The contribution of KISs to the innovation of both service suppliers and manufacturers was analyzed by using survey questionnaire.

The results of the analysis revealed that the contribution of KISs to the innovation capability of manufacturers is significant. Large manufacturers that hold internal capability to supply KISs are also active in using external KISs. The manufacturing firms that utilized KISs intensively proved to be more innovative than those did not. Heavy KISs users also entertained benefits of capability enhancement as they improved monitoring and achieved efficient application of knowledge asset into product and process innovation.

The role of public KISs in the innovation of manufacturers appeared to be indirect and done mainly through education and public R&D activities. Direct input, such as public software service, was not utilized as much in service suppliers themselves. The major reason is that public KISs may not be relevant to their actual needs. Manufacturers have implemented both tighter integration of familiar KISs and loosely coupled unfamiliar KISs.

Key words : knowledge intensive services, innovation, computer software services, service industry, Korea

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1. Introduction

Knowledge intensive services (KISs) have recently dominated economies in many of the advanced countries as well as in Korea. The number of firms and sales in the KIS sector appeared to be increasing rapidly in Korea. The portion of the Korean KIS sector in total sales of the service industry increased from 39.2 percent in 1996 to 42.1 percent in 2000. The sector also increased its portion in the employment of service industry as a whole from 22.2 percent in 1996 to 24.3 percent in 2000 as it employed 2,313 thousand persons.

These changes may be described as a symptom of the transformation from a simple manufacturing economy to a service economy. It may have, to a great extent, been caused by the adaptation of information and communication technology (ICT). ICT itself is important part of knowledge intensive services and vastly applied to the development of the manufacturing sector and various other services. Integration of ICT into KISs has led to a new paradigm of innovation that has influenced productivity growth and innovations of their user firms, mostly hardware manufacturers (Miles and Boden, 2000b).

As information technology has embodied into services, many KISs became technologically intensive. IT technologies allows for the electronic and optical storage and transmission of the information content of product and service relationships. For instance, telematic systems are often used for ordering, reservation as in software and information services. Automated teller machines and equivalent information services allow for service delivery outside normal office hours.

Many accounts of the specificities of KISs stress the importance of close interaction with their user firms. Like manufacturers, KIS suppliers that undertook innovations are adapting more of their outputs to suit specific users than the firms did not. Knowledge intensive services offered by service suppliers also play an important role in transferring and creating technological knowledge, and knowledge related to users' innovation and assimilation of new technologies (Miles and Boden, 2000).

These features of KISs indicate that they play an important role in the innovative performance of service suppliers as well as their user firms so as to increase the innovativeness of the industry. Specifically, the contribution of KISs to the innovative performance of manufacturers depends upon where they come from and what are purposes in using them. Public KISs and private KISs may have different influences on the innovation of manufacturers. Their contributions are also likely to vary by types of innovations that user firms generate by using KISs: processes, products and organization. This paper theoretically discusses the roles of KISs in the innovation of manufacturers and investigates into the Korean case.

2. Position of KISs in National Innovation System

2.1 Definition and Types of KISs

Typology of knowledge intensive services (KISs) is important element for identifying actors and their interactions that are bases of the innovation system of KISs. There are many different sorts of knowledge intensive services and activities. Different researchers have made diverse typology of KISs depending upon their purpose of research.

KISs can be grouped into the two sources of production: private KISs and public KISs. Private KISs are produced and supplied by private firms, while public KISs are produced and supplied by public or government organizations. Recently, hybrid type of KISs often puts into a different category as there is a hybrid sector where both the public sector has been transformed into the private sector so that the distinction between the private sector and the public sector is blurred.

Knowledge intensive services are classified by what they are doing with knowledge, e.g. R&D services, management consulting services, IT consulting services, employment agency services, etc. Classification of KISs based on the industry classification has been also diverse depending upon institutes or researchers. For instance, O, Sang-Bong, et al. (1999) included IT services, finance and insurance, software system, engineering, database services, management consulting, R&D, advertising, industrial design, education, health care, broadcast and culture related services. OECD (2001) excluded financial and insurance services, and education services from the O's classification. The gap in the scope of KISs between O's study and OECD may come from adapting different definition of KISs. OECD may have adapted a narrow level of definition.

This study adapts more or less broad definition of KISs so that the scope of KISs will be broad. It includes ten kinds of services by the Korea Standard Industry Classification Code (KSIC). They are computer software system (CSS) services (721-729), electric and telecommunication services (642), advertisement services (743), movie services (871), broadcast services (872), financial services (65), insurance services (67), R&D services (73), business services (741-742), technical services (743-744), education services (80), health care and welfare services (85-86) and art services (873). This study will include all of these service types in the analysis, and conduct specific case analysis thereafter.

2.2 Functions of KISs in National Innovation System

Knowledge intensive services are widely regarded as sources of information and knowledge.

They continuously create new type of services by combining different knowledge and stimulate knowledge acquisition through integrating various networks. The KIS sector employs highly educated professionals not like general service industries that are low status, poorly paid, and often employing less educated workers. The staff of KISs suppliers includes many people with higher education and professional qualifications.

The employees of the KIS sector have increasingly high levels of social and institutional knowledge involved in many of the traditional professional services, or of science and technology related knowledge. But, there are many blurred boundaries between KISs and general services. For instance, logistics services, often grouped as one of general services, may both provide transport and undertake extremely knowledge-intensive activities in the organization of transport arrangements for clients.

All economic activities involve deployment of some human knowledge associated with knowledge intensive services. A pragmatic approach to knowledge-intensive services is to identify these with activities founded upon knowledge that is both learned and created through an innovation process involving the understanding of abstract principles. Usually, this process involves formal learning, though it may be experience-based, especially in the case of new professions - though these enlist people who have already displayed capacity for such learning in formal higher education.

Many types of new KISs emerged from science and technology activities or professional services. Nowadays, it is common to find KISs firms to supply software and other services to users in their sector. The KIS sector deals with a specialized knowledge rather than a service concerned with routine solutions to problems such as transport and logistics, entertainment and postal services. Much of what such services do is not routine - but a large share of the effort of their workforce is being expended in routine ways.

The KIS sector is among the fastest innovating and dynamic sectors. It contains many innovative users of new technologies in the manufacturing industry and provides considerable potential for future employment growth. It plays a role in improving the competitiveness of enterprises and the quality of public services. Furthermore, it constitutes important intermediaries and nodes of networks in national innovation systems. Through support and outsourcing of services, it can improve quality and help adjust an industrial structure to the challenges of the knowledge-based economy (Boden and Miles, 2000).

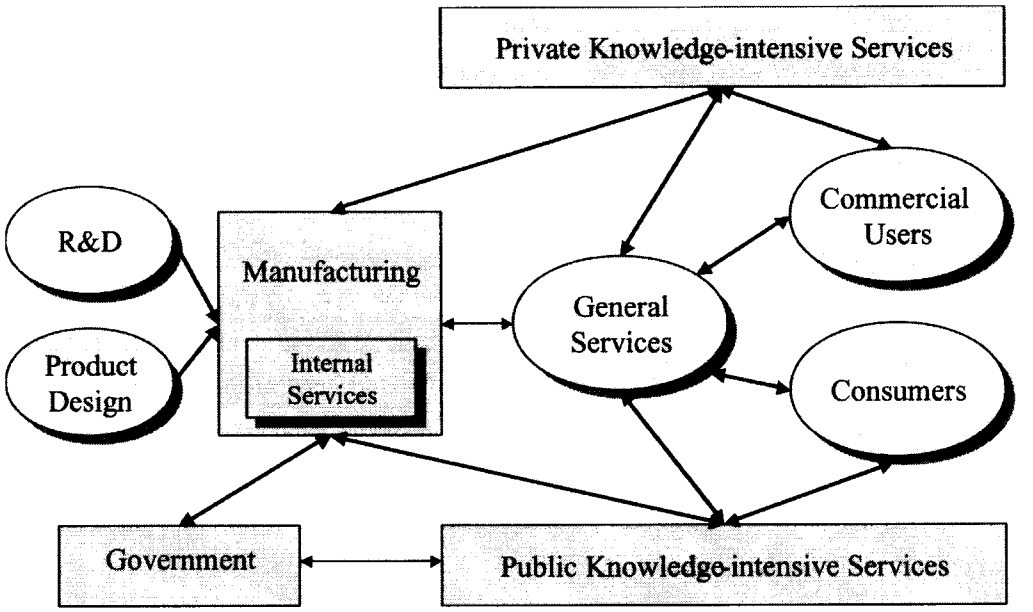

Fig. 1 : Interactions between Knowledge-intensive Services and Manufacturing

These accounts capture important features of the integration between service and manufacturing functions in national innovation system. Many aspects of interactions between service suppliers and manufacturers in national innovation systems are still weakly understood. Taking that 75 per cent of manufacturing costs and some similar share of employment is accounted for by the service sector into account, a simple dichotomy between manufacturing and services may be false. There must be specific complementarities between these two parts (Hauknes, 2000).

It is worth grasping the roles of KISs in national innovation systems. General services are usually conceptualized as parts of a value chain and assistant to manufacturing activities. Such R&D and product design activities can be included in KISs, but they play roles differently. Governments often intervene in both manufacturing activities and public knowledge-intensive services. Figure 1 is an expression of the interactions between services and manufacturing in national innovation system. KISs provide strategic value-added to manufacturing, general services and directly end users.

Such a depiction on the role of service does not make much qualitative distinction between services and manufacturing in national innovation systems. In outlining the roles of KISs, the functional integration of these services into manufacturing should be emphasized rather than focus on a dichotomous distinction of services and manufacturing. This consideration led to

consider 'innovative clusters' that span divisions between the two (Boden and Miles, 2000). The salient feature of a cluster approach is the emphasis on functional complementarities between different sectors and actors. Main context of innovation systems is, in fact, the cluster itself with interactions being contingent on the complementary divisions of labor.

Broadly, the linkages between the KIS sector and the manufacturing sector in an innovative cluster can be classified as forward linkages, backward linkages and horizontal linkages. Forward linkages correspond to the objectives and requirements that services are to satisfy, primarily related to the role of the service functions downstream. Backward linkages correspond to user-producer linkages as considered by Lundvall (1992). Horizontal linkages correspond to the acquisition of the means of service products, relating to service suppliers' usage of capital and intermediate goods and various services.

Some KISs may have an immediate forward impact that directly affects innovation activities of manufacturers (Lee, Kong-rae et al., 2002). Typically, they involve learning and capability building in user organizations. Depending upon the circumstances of demand for such services, they may be characterized as awareness enhancing, problem solving or solution providing. In general, these processes require often complex, transformation capabilities on the side of both the user and the supplier of KISs (Hauknes, 2000).

2.3 Major Actors in Innovation System of KISs

Innovation system of KISs is composed of actors and their interactions at its core. The actors of the innovation system are suppliers, users, regulatory actors and providers of other inputs associated with a core population of firms. When emerging technologies are involved, activities conducted by public and semi-public R&D performers such as government laboratories, universities or technology-transfer agencies are important to the development of the innovation system.

The boundary of the innovation system of KISs may be determined by the scope of KISs and their linkages that the specialized suppliers have with other agents that influence their capabilities for competition and innovation. Figure 2 shows main actors and elements constituting the innovation system of KISs. KIS suppliers include private service suppliers, public service suppliers and hybrid suppliers. Service users include manufacturing firms, private service suppliers, public organizations such as governments, universities, research and technology organizations (RTOs) and end users. The roles of main actors can be explained as follows.

KIS suppliers are core actors of the innovation system. Suppliers that provide specialised services are more likely to undertake innovations than are standardised service providers. Specialized

service suppliers claim that their innovations had an important impact on their users' innovative performance (OECD, 2002). This fact implies that they tend more to suit specific users than standardized suppliers. They may have better interactions with users and understanding of users' features and requirements; and they therefore build this understanding into their services to benefit the customers.

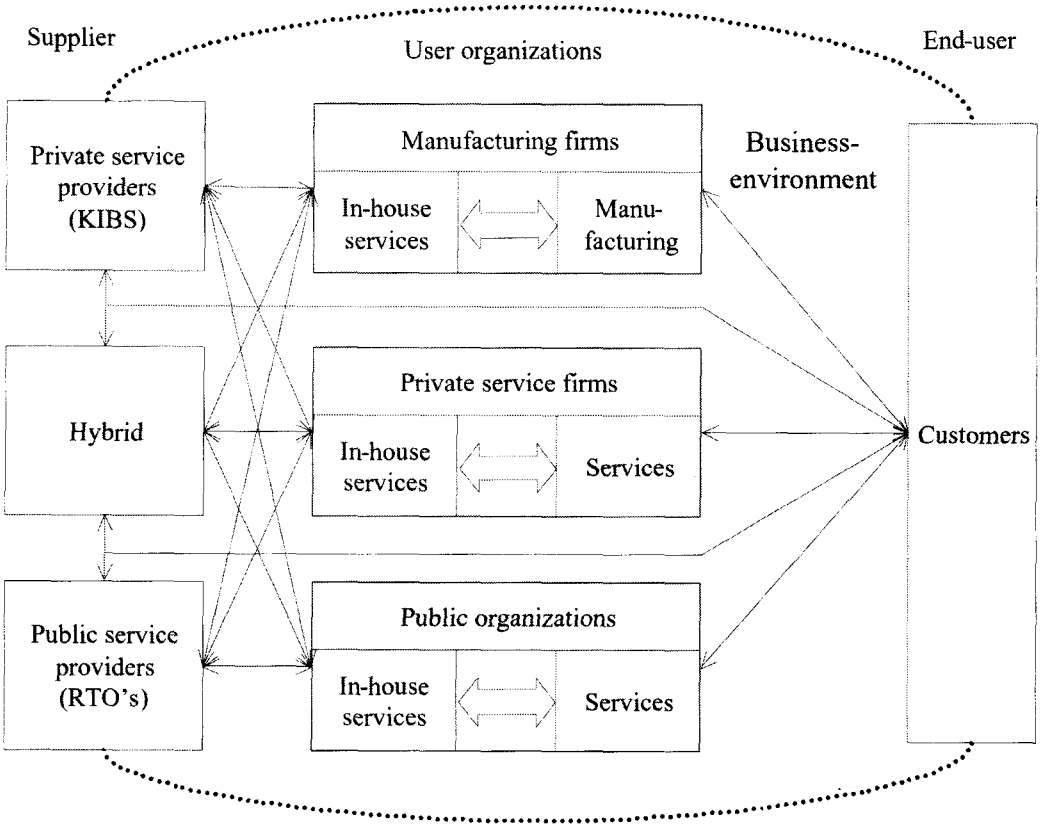

Fig. 2 : Major Actors in Innovation System of KISs

KIS users have also been often regarded as an important actor of the innovation systems. They perceive problems and obtain innovative ideas in the process of using KISs to solve various problems, and conduct in-house production of KISs for their own use. They often convey the ideas to KISs suppliers to solve problems and to improve service quality. Due to this role of user firms, many accounts of the specificities of KISs stress the importance of close interaction with users. It indicates that service suppliers who adapt more of their outputs to suit users'

needs are able to act effectively on the basis of superior understanding of these needs. This was the case not only for those introducing service innovations, but also for non-service innovations.

Public research and technology organizations (RTOs) are often lead users of KISs. They adopt new services innovated by specialized service suppliers so as to provide a market for new services. Spin-offs companies emerged from public RTOs have created a hybrid area where the public sector and the private sector are mixed, therefore their distinction is vague. Many government-sponsored R&D institutes and universities are the cases. Some public R&D institutes are financed by governments, but behave like private KISs suppliers. Some private universities should be regarded as public KIS suppliers in aspect of their function. Nowadays, private consulting companies provide KISs to public organizations that usually obtain consulting services only from public institutes in the past.

Governments play regulatory roles in the innovation system of KISs. Their roles appear under two categories. The one is such research and technology service supply such as technical education, collaborative R&D, basic research, operation of collaborative programs and cluster initiatives. The other is regulation. Because innovation system is especially concerned with the roles of government, government activities are also included.

In some OECD countries, public provision of KISs often crosses national boundaries through trade, collaboration or ownership. In this case, countries may decide that data from other countries involved should be included in the analysis of the national innovation system. Cross-boundary provision of KISs may be complementary in some ways to national innovation systems of globalizing countries.

3. KISs in the Innovation of Service Suppliers

3.1 Method of Investigation

Field survey was conducted for empirical investigation into the role of KISs in the innovation of the industry in Korea. Survey questionnaire includes service categories respondents used and their contributions to product, process and organizational innovations of their user firms. It also includes locations of service supplies, innovation potentials of service suppliers and users, sources of service innovations, etc.

Among 250 questionnaires sent, 60 questionnaires were finally collected. The number of KISs suppliers was 40 and the number of user firms was 20 as shown in Table 1. To deepen the findings by the questionnaire, we had semi-structured interview with 17 firms. We analyzed

the survey results and generated primary data on Korean knowledge intensive services. We had also many individual interviews, or workshops to have feedback from respondents based on interim analyses.

Table 1 : Respondents of Questionnaire Survey

Classification	No. of firms	Venture firms		Organization		
		Yes	No	Independent	Subordinate	Others
Large firms	10	2	2	5	5	
SMEs	50	35	11	45	4	1
Total	60	37	13	50	9	1

3.2 Utilization of Public KISs

Among various public KISs, R&D service and ICT training services appeared to be the most frequently used one (see Table 2). It implies the kinds of efforts that should be exerted by the government. In 2001, over 30% of total government R&D budget, which was the largest, was allocated to the development of information and communication technology. The Ministry of Information and Communication (MIC) in Korea has especially designed and implemented policy programs to train graduates who are not employed yet. This measure led those graduates to maintaining and developing their skills. It was reported that in 1999, the MIC educated 3,500 graduates in the topics of ICT switching, multimedia contents, start-up related with internet, etc.

When comparing large manufacturers and SMEs in the utilization of public KISs, while large manufacturers used more ICT expert services, SMEs used more KISs associated with employing professionals for developing products and processes than large firms did. KISs suppliers also used KISs, but less frequently than manufacturers. Table 2 shows that the score of R&D service and ICT training marked by KISs suppliers is 2.0, meaning KISs suppliers used public KISs a few times.

According to the semi-structured interview, the major reason why KISs suppliers did not use much public KISs is that they are not relevant to their actual needs so as not to satisfy with them. It indicates that public organizations supplying KISs should closely interact with private firms in order to provide firms with relevant public KISs.

Table 2 : Utilization of Public KISs

(No. of respondents = 40)

Public KISs	Average Score			X^2 Value
	Large Firms	SMEs	Average	
Research & development	2.3	2.0	2.0	0.449
ICT related training	2.5	1.9	2.0	1.805
IPR related professional service	1.8	1.6	1.6	1.110
Software package	1.5	1.6	1.6	0.102
ICT professional expertise	2.3	1.3	1.4	5.974**
IT technical consulting	1.5	1.4	1.4	0.588
Management consultancy	1.8	1.3	1.4	1.468
Employment agency of professionals	1.5	1.3	1.3	2.228*
Engineering consultancy	1.5	1.2	1.2	2.613*
Average	1.9	1.5	1.5	1.822

Notes : scale (never: 1, seldom: 2, a few: 3, many: 4, often: 5), *: significant at the 15 percent level, **: significant at the 5 percent level.

Source : STEPI Survey (October, 2002).

3.3 KISs in the Innovation of KISs Suppliers

In order to look into the role of KISs in the innovation of KISs suppliers, we asked, "how much did KISs contribute to product, process and organizational innovations of your company?" in the questionnaire. We found that the score of consulting service on product development and process engineering was the highest, 4.7 indicating very highly contributed to the innovation of KIS suppliers. In the cases of process innovation, R&D service was the most important contributor in the innovation of KISs suppliers. Other KISs appeared to be not much helpful for the innovation of KISs suppliers.

Like the case of process innovation, KISs seems not well associated with organizational innovation of KIS suppliers. They do not regard KISs contributed much to changes in their organizational forms. Such KISs as ICT related training services, research and development services, and expert services for intellectual property rights obtained relatively high scores in contributing the organizational innovation of KISs suppliers as shown Table 3. The average score was 2.2, which means "not much".

Table 3 : Contribution of KISs to the Innovation of KISs Suppliers

KISs	Product Innovation	Process Innovation	Organizational Innovation
ICT professional expertise	2.5	2.0	1.7
ICT related training	2.8	2.5	2.5
IT technical consulting	2.2	1.9	1.9
Software package	2.5	2.6	2.3
Research and development	3.1	2.9	2.6
Expert service concerning IPR	2.7	2.5	2.5
Management consultancy	2.2	2.4	2.4
Engineering consultancy	4.7	2.0	2.2
Eemployment agency of professionals	2.3	1.8	2.0
Others	3.0	2.0	1.7
Average	2.8	2.3	2.2

Notes : Score (never: 1, seldom: 2, a little: 3, much: 4, very much: 5).
Source : STEPI Survey (October, 2002).

4. KISs in the Innovation of Manufacturers

It was found that small and medium sized manufacturers tend to purchase standard KISs, e.g. standard software and modifiable modules and that large manufacturers have internal capability to produce KISs. This implies possible difference between firms in terms of using external services. The level of KISs utilization and size of manufacturers is analyzed by using the results of the survey. The usage level of KISs in large firms is slightly higher than that of small firms. The usage of private KISs is higher than that of public KISs in both small & medium sized and large manufacturers.

Manufacturing firms appeared not to prefer public KISs to private KISs. Public KISs manufacturers relatively frequently used are R&D services, and education & training services. They utilized government programs associated with ICT when they need education of employees. At the same time, they willingly participate in government R&D programs in order to access to advanced knowledge.

Manufacturers purchased software packages and related services from private KISs suppliers. They frequently used intellectual property related professional services along with external data processing services. It was found that manufacturers have tried to internalize firm-specific operation procedure and relevant data processing as much as possible. This is because they are too specific for manufacturers to outsource necessary KISs from outside suppliers.

Software-based consultancy with customized package that manufacturing firms have used is

highly complementary and less internalized. It may not be so efficient if supplied in-house because users standardized administration procedures. Software service suppliers usually know solutions better than manufacturers. This indicates strong position of software consulting service that provides customized software in markets.

KISs users in the manufacturing industry show a lukewarm attitude toward consulting services as the level of internalization increasers. The reason can ascribe to small firms that purchase hardware and server without consulting the hardware providers to complete networking services. Recent servers become user-friendly and even with easy installation guide for home networking available. They provide basic hardware installation services and basic database setup by themselves. Users tend to learn the basic maintenance to minimize the interruption of operation, which causes relatively high level of internalization.

Table 4 : Intensity of KISs Utilization in Korean Manufacturers

(Responses = 20)

Contents of KISs	Private	Public	Average
ICT Related KISs	2.6	1.4	2.0
Software package	3.3	1.3	2.3
ICT related training	2.5	1.5	2.0
ICT professional expertise	2.3	1.4	1.8
IT technical consulting	2.2	1.3	1.7
Non ICT KISs	2.2	1.4	1.8
Research & Development	2.2	1.9	2.1
IP*-related professional services	2.8	1.3	2.1
Management consultancy	2.2	1.3	1.8
Engineering consultancy	2.1	1.3	1.7
Employment agency of professionals	1.7	1.4	1.6
Average total	2.4	1.4	1.9

Notes : Intensity of usage was measured with Likert scale (None: 1, Occasionally: 2, Average: 3, Frequently: 4, Very Frequently: 5). ICT: Information and Communication Technology, IP: Intellectual Property.
Source : STEPI Survey (October, 2002).

The level of internalizing KISs differs amongst manufacturers. The results of analysis show that user firms internalizing data processing do not much internalize software-based consultancy. In addition, relatively close relationship between hardware based consultancy and data processing was found, indicating that manufacturers internalizing hardware-based consultancy tend to internalize data processing as well. Are those firms using KISs innovating more than those firms without utilization of KISs? It has been argued that efficient interface with KISs suppliers

increases absorptive capacity of user firms and consequently increases the success rate of innovation (Cohen and Levinthal, 1989). Our survey results revealed that by and large, the users with a high level of KISs utilization show higher innovation rate that is statistically significant at 10% level.

Table 5: Internalization of Computer Software System (CSS) Services

CSS Services	Level of Internalization and Complement		
	In-house	Complement	Relation*
Average	2.7	2.8	.
721: Hardware based consultancy	3.2	2.8	ALL
722: Software consultancy and supply	2.4	3.2	OUT
723: Data processing	3.1	2.7	IN
724: Database activities	2.5	3.2	OUT
725: Maintenance and repair of office, accounting and computing machinery	3.3	3.0	ALL
729: Other computer related activities	1.4	1.7	OUT

Notes : IN: In-house is higher and complement is lower than average; OUT: In-house is lower and complement is higher than average; ALL: In-house is higher and complement is higher than average.
Source : STEPI Survey (October, 2002).

Table 6 shows close relationship between the level of KISs usage and innovation in the user firms of KISs. Chi-square value shows statistically significant difference between them at the 10% level. It also appeared that user firms with a high level usage of ICT related KISs tend to innovate more vigorously. Innovative manufacturers are, therefore, likely to utilize KISs more intensively than less innovative users.

Table 6: Level of KISs Utilization and Rate of Innovation

Innovation in Recent 2yr.	Level of KISs Usage		Total	%
	Low	High		
Yes	8	7	15	75.0
No	4	-	-	20.0
N.A.	-	1	1	5.0
Total	12	8	20	100.0

Notes : 1) the number of respondents = 20, 2) the difference is statistically significant at 10% level. ($x^2 = 2.96$).
Source : STEPI Survey (October, 2002).

Those manufacturers who appreciate hardware-based consulting services are likely to evaluate software-based consulting and other computer related services highly. Major contribution of KISs comes from two sources, data processing and database activities including internet services. Manufacturers tend to associate data processing with customized software. The contribution of KISs to organizational innovation of manufactures mainly comes from data processing, which is inherently linked with a manufacturing process like automation of production process.

Table 7 indicates that database activities among types of KISs contribute to product innovation of manufacturers most. Data processing is highly recognized in every aspect of the innovation of user firms. This is well reflected in their effort to internalize KISs supply. Manufacturing data is accumulated as data processing activity continues in producing set of datum. The results led manufacturers to produce in-house database specially designed to firm-specific manufacturing process. Database activities frequently request software-based consulting services to supervise production overall scheme.

Table 7: Contribution of Computer Related Services to the Innovation of Manufacturers

Computer Related Services	Contribution to Types of Innovation			
	Product	Process	Organization	Average
Average	2.3	1.8	1.7	1.90
721: Hardware based consultancy	1.7	1.4	1.5	1.53
722: Software based consultancy and supply	2.3	1.7	1.2	1.73
723: Data processing	3.0	2.5	2.8	2.77
724: Database activities	3.4	2.5	1.9	2.60
725: Maintenance and repair of office, accounting and computing machinery	1.4	1.2	1.3	1.30
729: Other computer related activities	1.9	1.2	1.3	1.47

Source : STEPI Survey (October, 2002).

It was also found that hardware-based consultancy did not make great impact on the innovation of manufacturers. It owes to the fact that small user firms rarely use expensive system integration services. As described above, software consultancy and supply provides contents and linkages between telecommunication and database activities. However, its influence on organizational innovation seems not to be higher than expected.

5. Conclusions

This study explored and understood the utilization of knowledge intensive services for the innovation of the manufacturing industry in Korea. This paper looked into external and internal KISs, and public and private service inputs to manufacturers for the specific cases of knowledge intensive services. It analyzed the contribution of KISs to the innovation of both KISs suppliers and manufacturers based on the responses of the survey questionnaire.

The contribution of public KISs to the innovation of KISs suppliers appeared indirect and done mainly through education and public R&D activities. The direct input, such as public software service, was not utilized much in KISs suppliers. The major reason is that public KISs are not relevant to their needs, suggesting that governments should closely interact with private firms in order to provide firms with suitable public KISs.

The results of analyses on manufacturers, user firms of KISs revealed that KISs could function as a platform for their diversification into other knowledge intensive service sectors. KISs become integrated to or coupled with manufacturing activities. Manufacturers have implemented both tighter integration of familiar KISs and loosely coupled unfamiliar KISs.

According to our survey, large manufacturers that have internal capability to produce KISs are also active in the utilizationof KISs. Utilization patterns of KISs indicate no homogeneous solution of internalizing the services. We confirmed that the contribution of KISs to the innovation of manufacturers is significant. The users that utilized KISs intensively proved to be more innovative than those did not. Heavy KISs users also entertained benefits of capability enhancement as they improved monitoring and achieved efficient application of KISs into product and process innovation.

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