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Knowledge Intensive Service Activities (KISAs) in Korea's Innovation System

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SUMMARY

This study aimed to provide an understanding of the innovation activities of the knowledge intensive service sectors in the context of Korea. Knowledge-intensive service activities (KISAs) are defined as service activities provided either internally or externally to a firm, in the manufacturing or service sectors. This study adopted a multi-facet approach with the review of pertinent literature, both manufacturing & service sectors, external & internal services, and public & private services inputs to user firms. Various statistics on knowledge intensive services (KISs) and computer software system (CSS) services were collected and analyzed.

After reviewing the literature, we found that the difference between innovation of the service sector and that of the manufacturing industry is narrower than expected. The key factor of convergence of innovation patterns appears to be IT technologies, which are vastly applied to the development of various other services. Integration of ICT into many knowledge intensive services has led to a new paradigm of service innovation. We also found the participation of specialized small service suppliers in service innovation was increased.

As manufacturing becomes information intensive, the interaction between KIS and manufacturing turn out to be natural. Hence, the roles of KIS in national innovation systems can be found in services association with manufacturing activities. KIS suppliers are core actors of the innovation system of KISAs. The national innovation system includes public, private, and hybrid KIS suppliers that provide communications management services, R&D services, management consulting services, IT consulting services, employment agency services, engineering consultancy, training services, and contract management services. Service users are diverse and come from all sectors. We concluded that interaction between service suppliers and their users is critical for the innovation of the KIS sector.

Our statistical analyses revealed that the number of firms and sales in the KISA and CSS Services sectors is increasing rapidly in Korea. The KIS sector accounted for 42.1 percent of the total sales of the service industry in 2000. CSS services accounted for 9.3 percent of the entire service industry in the same year. Although the number is small, the KIS sector employed 2.313 million persons in 2000. This accounts for 24.3 percent of the entire service sector's employment (69.8 percent in employment). Software consultancy and supply occupied the lion's share (69%) in service employment. In addition, the employment share of CSS services to the KIS sector jumped from 2.4 percent in 1996 to 5.8 percent in 2000. CSS services sales are almost even among the six categories (19-28%).

Growing fast, the trade deficit in the Korean KIS sector is at a serious level in Korea. The deficit of service trade (US $2.889 billion) is mostly generated from that of KIS trade (US $6.267 billion). Even worse, the imports volume of KIS and CSS grew faster than that of service imports as a whole. The trade deficit of CSS services amounted to US $385 million, accounting for 6.1 percent of the deficit of knowledge intensive services. Therefore, Korea needs to strengthen the international competitiveness of its KIS and CSS service sectors.

Specific case studies on the Korean CSS service sector and their user firms, led to the discovery that dominant software covers large markets without additional production cost. This causes a concentration of software in a few large firms. If the government does not provide support at a early stage, the dominance of foreign software firms becomes consolidated. Based on the "Software Industry Promotion Act" law

enacted in 1987, the Ministry of Information and Communication has put into effect many measures, including setting up institutes (*e.g.* an agency and associations) and promoting the development of the software industry through developing human resources, developing core software technologies, incubating software start-up firms, and expanding the demand for software. At the same time, the government strongly regulates illegal copying of software, which contributes to the sale increase of software.

In Korea, computer software-related services constituted 73.4% of the software industry, and packaged software occupied 23.5% in 2000. Local software firms work as service producers rather than product producers. When reviewing the software sector, we argued that the contribution of public services to the innovation of KIS suppliers was indirect and done mainly through education and public R&D activities. Direct input, such as public software service, is not utilised as much. However, provision of environment, such as a plan to support open source software development is likely to be promising.

We reviewed the general level of CSS services usage by user firms in the manufacturing sector, and found that CSS services could function as a launch pad for diversification of manufacturing firms into other knowledge intensive service sectors. CSS services become integrated to or loosely coupled with manufacturing firms. It was also found that the HMC implemented both tighter integration of familiar CSS service and loosely coupled collaboration of unfamiliar CSS services. Diverse responses are due to various factors, such as services specific to the automobile, existence of a strong service firm, and familiarity. Telematics services are rather mixed or partially integrated with many external services. Service suppliers appeared to play an intermediate role that connects automobile firms with telecommunication service firms.

The results of our field survey showed that large manufacturing firms that have an internal capability to build a service division are also active in external usage of CSS services and KIS services. Usage patterns of CSS services indicate no homogeneous solution to internalizing CSS services. Our analysis on the contribution of CSS services to innovation capability building of user firms revealed that the firms that intensively utilized CSS services proved to be more innovative than those that did not. Heavy users of CSS services also entertain benefit of capability enhancement as they improve monitoring and achieve efficient application of knowledge assets into product and process innovation.

Based upon the above findings, we developed some policy implications. Firstly, governments should play a role in developing innovation networks that are focused on knowledge intensive services. Establishment of service innovation centres may be one of the tools that function as an information hub and combine KISs with other production activities. Secondly, governments should provide training programs that enable service workers to work better with innovations. Along with human resource development programs, it is recommended that training courses involving service management and innovation management in services should be provided so that service suppliers and their users can improve their absorption capacity, which may lead to building innovation capability in the long run.

CHAPTER ONE

Introduction

1. Background of the Study

Knowledge intensive service activities have recently dominated economies in many of the advanced countries. This change has been described as post-industrialisation or as the transformation to a service economy. It also appears to be associated with productivity growth. The belief that growth of productivity is strongly associated with innovation, which has led to studies on both the nature of knowledge intensive service activities (KISAs) and on the nature of innovation. It has also led to many studies related to information technology (IT), computer software, and IT and communications services, where high growth has seemed to combine both an increasing reliance on services and a high level of innovation.

Many studies on service innovation have pointed out that the distinction between services and manufacturing are becoming blurred. For instance, AEGIS, an Australian research centre, discovered that competitive firms tend to adopt strategies that bundle both services and products together to add value and create competitive edge. This finding implies that the growth of knowledge-intensive services must be understood as a function of their links with manufacturing. Computer software system (CSS) services are regarded as being major contributors to this hybrid phenomenon. It also gives an insight that innovation of KISAs should be investigated as innovation systems of services.

Accordingly, we chose “KISAs in the Innovation System of Korea” as the title of this study, and decided to examine it in a system context. The basic idea behind this study is that a key role in improving productivity, and hence, economic growth, is performed by systemic elements that enable increased linkage, and complementarity of manufacturing and services within value chains, which may be depicted by examining the terminology, ‘user-producer interaction.”

2. Purposes of the Study

Many governments are focusing recently on ways to improve the efficiency of their national innovation systems. They have developed several new aspects of technology and innovation policy for encouraging national innovation performance. The OECD’s KISA project was designed to contribute to this line of thinking regarding approaches by exploring and understanding knowledge intensive service activities (KISAs). A primary focus of this study is also, in conjunction with OECD project, designed to explore KISAs in Korea’s context. The purposes of this study are summarized as follows.

Firstly, this study aims to understand the innovation characteristics of KISAs. Service innovation is understood as the renewal of an organisation and its products and services as defined in the innovation of the manufacturing industry. Knowledge-intensive service activities (KISAs) are defined as service activities provided either internally or externally to a firm, in manufacturing or service sectors. The basic supposition is that KISAs furnish user firms with capabilities in the operation and management of technological systems and information activities.

Second, this study describes the major lines of the provision and use of these KISAs in Korea's economy. It analyses positional changes of KISAs in the national economy by collecting data and analysing capability indicators, outcome indicators and trade indicators. Based upon these discovered trends of KISAs, this study draws policy implications. Results of the analyses are presented in Chapter three.

Third, this study also focuses on the contributions of publicly funded KISs to innovation-capability building of service suppliers. These include R&D services, ICT professional expertise, ICT related training, IT technical consulting, software package, research & development, IPR related professional services, management consultancy, engineering consultancy, professional and other explicit employment agencies, inter-organizational services provided within the public and within the public-private partnership spheres.

Fourth, in line with publicly funded KISs, this study examines the contributions of privately provided KISAs to innovation-capability building of KIS suppliers; for example, computer software system (CSS) services suppliers. It will also indicate the variety of business services used by private firms and their contributions to the innovation-capability building of user firms.

Fifth, it also explores the behaviour of user firms in using KISs and their contributions to innovation-capability building. Knowledge intensive services are likely to be used by firms as a major basis of competitiveness. User firms of KISs are, therefore, becoming an important part of innovation systems of KISAs. Some important knowledge-intensive services are produced and used internally, while some are supplied by outside specialized suppliers. This study analyses both external and internal service inputs to user firms. These are seen as practical mechanisms through which a system of innovation operates, and can be influenced so that gaps and weaknesses can be reduced and strengths better exploited.

Lastly, this study obtains policy implications through the sufficient understanding of public KISAs that improve productivity and economic growth. Policy implications should be concerned with enhancing the effectiveness of policy directions and program delivery in governments' support for innovation. The contributions that governments make to the national systems of KISAs, as providers, sponsors or founders of organisations or programs or in other roles, such as regulators or powerful users, make KISAs available to firms for innovation purposes.

3. Approaches and Methodologies

A distinctive aspect of the KISA study is that it focuses on linkages between actors in the innovation systems, linkages that can be analysed as knowledge- intensive services. An innovation system is analysed as a mix that involves flows of innovation-related services delivered in diverse modes. The flows of KISAs occur both within and between diverse ranges of organizations and serve as key connections in national innovation systems.

The research questions of this study focus on government as a service-providing actor, making substantive contributions to the development and function of KISAs. In this view, government can be seen participating as an actor in numerous KISAs. A range of strategies for providing and using KISs from public services accessed by firms on a self-service basis to services bundled with manufactured goods and self-funded services are investigated.

This study investigates KISAs in both the manufacturing and service industries, and in innovation systems analysed at both the national and sectoral levels. KISAs are analysed as mixes of services provided by public and private suppliers. Public KISAs include public research and development activities while private KISAs may include firms as suppliers in their own right. Some suppliers are hybrid public-private firms. The framework this study has adapted includes users, suppliers, public and private KISAs and governments in their capacity as regulators. The processes of this study are composed of the three following steps.

Step 1: Review of Literature

Existing papers on how firms use externally provided services and create new mixes to match their specific needs are likely to provide information on the roles performed by governments concerning KISAs. References and documents that the OECD KISA Focus Group provided are useful sources for the review of literature. Based upon past studies on KISAs, this study supplements them with special investigations using interviews or surveys to collect new primary data. A selection of different methodologies is desirable within a comparative framework.

Step 2: Analysis of National Statistics.

National statistical sources are reviewed so as to provide indications of the structure and scale of the industry studied and to provide the context for the study of KISAs. It may be useful to obtain information on what firms do themselves in relation to innovation. Indicators for innovation activities could include manpower in various categories, R&D expenditures, output of patents and acquisition of IP rights and licences. Sources of information for this step include the annual reports of associated agencies and programs, annual budget statements of expenditure, etc.

This study does not carry out a large-scale survey that creates new datasets of this kind. Any new statistics are normally produced by re-analysis of existing ones, or by combining existing statistics related to innovation and services, R&D, employment, business, etc. The purpose of this would be to find ways to use existing statistics to analyse the innovation trends in KISAs and services in innovation, and make recommendations on how statistics could be developed.

Step 3: Analysis of Survey Results and Description

This step focuses on describing the scale, scope and structure of contributions made by public KISAs as well as private KISAs. The survey questionnaire includes service categories respondents used and their contributions to product innovations, process innovations and organizational innovations. It also includes locations of service supplies, innovation potentiality of service suppliers and users, sources of service innovations, etc.

Sixty user firms in total were the respondents, of which forty were service suppliers and twenty user firms. Survey results were analysed and and new primary data on Korean KISAs were generated. Numerous individual interviews, or workshop feedback sessions were also conducted based on an interim analysis. The results of our analyses are presented in Chapters four to six.

CHAPTER TWO

Innovation System of Knowledge Intensive Services

1. Characteristics of Innovation in Knowledge Intensive Services

Are there any differences between innovation of service sector and that of the manufacturing industry? What are the differences if they exist? These important questions arise when inquiring about characteristics and patterns of innovation in the knowledge-intensive service sector. One may think that the innovation patterns of the service sector differ from those of the manufacturing industry simply because services are not same as manufactured products, as most of the past innovation studies conjecture.

A recent study done by Tidd and Hull (2002) concluded after analyzing 108 service firms in a combined US and UK dataset, that the development strategy, processes, organization and tools derived from manufacturing are applicable to services. This statement implies that the innovation process of services is not much different from that of the manufacturing industry in a similar context. Miles and Boden (2000) compared various features of production, product, consumption and markets between services and manufacturing, and stated that there is something of a convergence of the manufacturing and service sectors taking place. They pointed out that each sector is acquiring some of the characteristics peculiar to the other.

A simple comparison of innovation between services and manufacturing may be misleading because there is a great deal of variety in both services and manufacturing. Diversity of manufacturing innovation has been well perceived, while that of service innovation has been only relatively recently explored. Knowledge intensive services (KIS) among various services and their activities are newly perceived as being an important element of the knowledge based economy and national innovation system (Miles, 1999b; OECD, 1996; Lamberton, 1997; Alic, 1997; Rooney and Mandeville, 1998). It has been argued that knowledge intensive service activities (KISAs) are different from general services in many aspects, particularly in terms of R&D and innovation.

The service industry too has been known not for being highly labor intensive, but for its low R&D intensity, low innovative performance and low productivity growth. These characteristics still may be right if confined to the general service sector. However, many studies on KISAs have found that their innovation features are similar and converge with those of the high-tech manufacturing industry (Sundbo and Gallouj, 2000). The knowledge intensive service sector is now characterized as a sector of high R&D intensity, good innovative performance, rapid sales growth and high growth rate of employment.

1.1 . Integration of IT Technologies

Innovations of knowledge intensive services were to a great extent generated by the adaptation of information and communication technology (ICT). ICT itself is an important part of knowledge intensive services and vastly applied to the development of various other services, *e.g.* financial services, R&D

services, health care services, etc. Integration of ICT into many knowledge intensive services has led to a new paradigm of technological innovation in the service industry. KIS suppliers are lead users of ICT, and their innovations have influenced productivity growth and innovation of their user firms, mostly hardware manufacturers (Miles and Boden, 2000b).

As IT technology becomes increasingly more embodied into services as in software delivered on floppy discs, many KISs are becoming technologically intensive. IT technologies enables 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 (ATM) and equivalent information services allow for service delivery outside normal office hours.

Such integration of ICT has reshaped the characteristic features of services in many ways. The immaterial, information intensive nature of many services has made it difficult to learn, modify, improve and diffuse related technologies. A large amount of capital investment is required in order to enter into the increasingly ICT intensive KIS sector. ICT based innovations require that users or other suppliers have their own terminals or PCs, and learn to use the systems involved. This can be a barrier to continuous innovations of the sector in the future.

1.2. Combining Multiple Innovations

Process and product innovation have been regarded to be distinctive types in the manufacturing sector. Organizational innovation was often separated from these two types. It has been well understood that in the manufacturing industry, process innovations tend to follow product innovations by several years, but the lag between major product change and major process change tends to be shorter as a product becomes standardized (Utterback, 1979). Utterback interestingly argued that a larger and larger initial investment is required to enter a line of business as more major innovations in the production process occur.

The process of innovation is, however, not simple as Utterback postulated. Innovations of knowledge intensive services should be taken into account in an integrated fashion. Product-type innovations concurrently occur with process-type innovations. Once a kind of service innovation takes place, it may soon cause organizational change so technological innovation and organizational innovation should be undertaken together. For example, application of ICT technologies reduced the layers of organizational hierarchies by de-layering and created flatter organizations (Miles and Boden, 2000b). The adaptation of advanced telecommunication technologies relocated key operations of service suppliers in areas of low labor costs, *e.g.* relocation of training centers in India by American software companies.

It may also be suggestive of differences in firms' strategic orientation. For example, more competitive suppliers may introduce and combine multiple types of innovations in order to achieve multiple effects. Small service suppliers may specialize in some particular part of service functions so as to introduce limited innovations. Competent large suppliers may play a certain role in linking various types of suppliers and clients, combining their innovations together and generating major innovations. Each supplier may pursue different innovation strategies based on its position in the market and production networks.

1.3. R&D Activities

According to the findings of a Dutch innovation survey (Brouwer, 1995) on the Dutch service industry, service suppliers are commonly innovating. However, technologically innovating firms are about two times more frequent in the manufacturing industry than in services. Contrary to the trends of innovations, the survey reported that a large majority of service suppliers do not perform R&D in the traditional sense. An even larger majority of these suppliers do not have an R&D department. More interestingly, a large portion of R&D activities that take place in service suppliers are performed by departments other than R&D departments.

Contrary to the finding that the service industry tends to lag behind the manufacturing industry in R&D activities, the R&D intensity of the KIS sector appeared quite high. The computer related service sector particularly shows a higher R&D expenditure than manufacturing industries. The KIS sector obviously is similar to high-technology manufacturing sectors in terms of R&D effort and technological intensity (Tether and Hipp, 2000). Adapting Pavitt's taxonomy, KIS suppliers are similar to specialized technology suppliers, and their activities are equivalent to science-based activities that generate and develop their own innovations and new technologies (OECD, 2001).

The high R&D intensity of the KIS sector is linked with rapid innovations. Due to fast technological change, KIS suppliers are compelled to conduct R&D activities vigorously in order to absorb new knowledge so as to catch up with front runners. It is, nonetheless, not easy to justify expenditures on R&D activities for the KIS sector as well, compared with the manufacturing industry, since the achievements of innovation are hard to quantify in KIS services as in general services.

1.4. Protection of Innovations

Innovations in the service industry have not been well protected by the intellectual property system due to the lack of adequate intellectual property right (IPR) protection and the problem of the ease of imitation of service innovations (Miles et al., 2000b; Andersen et al., 2000). There are significant differences in how service suppliers view the issue of IPR (Licht, 1999). Licht reported that 40% of software firms in Germany regard ease of imitation as a barrier to innovation. Imitation of KIS innovation is easy not only because of the lack of IPR protection but also because information is often cheap to copy and share (OECD, 2001).

Innovations associated with KIS have an increasing tendency to obtain patent rights. There has been much effort to extend the scope of copyright regimes, so that now knowledge intensive services are governed by such systems in much of the world (Miles and Boden, 2000b). Computer software system services and mobile telecommunication services are typical examples. New media companies are examining the scope for intellectual property protection via copyright and related systems. Efforts are under way to establish new systems for trading of pictures, videos, recordings, texts, etc., which are used in multimedia systems.

In Korea, computer related services and telecommunication services have become the largest patenting sectors, as introduced in Chapter Two. It is worth mentioning that ICT related industries of Korea are more advanced than other developed countries, which may be a cause of active patenting in spite of peculiarities of services.

1.5 Interaction with Users

Many accounts of the specificities of knowledge intensive services stress the importance of close interaction with users. A German survey of service innovation allows one facet of this to be studied: it asked firms how far their activities were standardized, as opposed to being specialized to the requirements of specific users. Hipp et al's (2000) data analysis suggested that KIS suppliers are likely to produce specialized service for specific clients. They found that 27% of technical services, and 18% of software firms, reported more than a third of their output being specialized for specific clients. Comparable figures were 4% for banking and insurance, 18% for other financial services and 10% for other business services.

Like manufacturers, KIS suppliers that undertook innovations are adapting more of their outputs to suit specific users than firms that did not. The former has a better understanding of users' features and requirements; and they build this understanding into their services to benefit the users. Knowledge intensive services offered by suppliers also play an important role in transferring and creating technological knowledge, and knowledge related to the user's assimilation of new technologies (Miles and Boden, 2000).

Recently, the adaptation of IT technologies tends to bring about a reduction in direct interaction between users and suppliers of knowledge intensive services. It has been understood that user-suppler interaction is more active in the service industry than in the manufacturing industry (Foxall, 1986; Lundvall, 1992; Kong-Rae Lee, 1996, Parkinson, 1982; Rothewell, 1986; von Hippel, 1976, 1979, 1988). Since interaction, whether person-to-person or firm-to-firm, is perceived as an important element that leads to innovation, reduction of interaction may have an impact on the characteristics of innovation in the KIS sector of the future, perhaps limiting trust between users and suppliers.

1.6 . Impact on User Performance

It looks like KIS suppliers that adapt more of their outputs to suit a user's specific needs are able to act effectively on the basis of superior understanding of these needs. They are likely to claim important effects for their innovations on their user's performance. KIS suppliers that introduced more than one type of innovation are likely to report important effects on their own and their user's performance.

Larsen (2000) distinguished three types of knowledge that user firms gain from KIS suppliers: core, operational, and peripheral knowledge. He argued that the impact on user performance of knowledge intensive services varies by the kinds of knowledge user firms obtain from the use of KISs. In the case of acquisition of core knowledge, users try to relate it to their internal knowledge and is a strategic asset. Requirements regarding standards of expertise and transfer in this case are usually high so that the impact of related KISs must be strong. In the case of operational knowledge and peripheral knowledge, users may utilize it to make the factory run with respect to day-to-day operations. Since they are not essential for actual production of user firms, the impacts of related KISs may be weaker than that associated with core knowledge.

The contribution of knowledge intensive services to the innovative performance of user firms depends upon where they come from and the purposes for using them. Public KISs and private KISs may have different influences on user performance. There must be a certain degree of preferences and differences in effectiveness by public sources, such as research institutes, universities, government agents, etc. Contributions are also likely to vary by types of innovations that user firms generate by using KISs: processes, products or organization. These issues are to be dealt with in Chapters four, five and six.

2. KISAs in the National Innovation System

2.1.Innovation in Economic Systems

Innovation is an act undertaken to solve technological problems so as to accomplish commercial objectives. Firms are central agents in the process of innovation for exploiting opportunities and meeting challenges in the business environment. There are innovations in all facets of economic systems. Hauknes (2000) argued that orientation, intensity and structure of innovation vary according to characteristics of the activity in which it happens, and the competitive environment of that activity.

Schumpeter systematically argued for the role of innovation in the development of economic systems. According to his argument, the capitalist economic system includes two complementary actors: the firm and the entrepreneur. The entrepreneur generates new ideas and introduces innovations, any way of doing things differently in the realm of economic life (Schumpeter, 1961). Schumpeter perceived innovation as the process of creative destruction, and regarded it as the central facet of the capitalist economy. He argued that creative destruction begins as technological competition takes place.

Innovation often involves significant trade-offs between technological and economic considerations. Radical innovations that form new technological paradigms often emerged as a result of basic research, far from economic motives. Adaptation to user needs, leading to innovations with commercial objectives, narrows down the options that are opened by technological paradigms and trajectories. Dosi (1982) argued that economic criteria act “as selectors defining more and more precisely the actual paths followed inside a much bigger set of possible one.”

Innovation requires a time-consuming, costly and prolonged process. It also requires building up innovative capabilities to observe, learn, adapt and implement for doing things differently. Innovative capabilities vary in character and in intra-organizational distribution. While innovation literature mainly focuses on functional capabilities, management literature is more strongly oriented toward organizational and strategic capabilities. It is their integration that forms the basis for economic action and innovations. What all these capabilities have in common is the centrality of the interaction between internal and external repositories of competencies (Hauknes, 2000).

With capability formation at the core of such innovative activities, networks or links between agents may be an important element of innovation environment. Innovation in a firm’s behavior at one point in the network has an impact on the behavior of other firms in the network. Such impact patterns outline the role of innovation in an economic system. This is closely related to the idea of “innovative cluster” that is defined as strongly inter-linked functions of different economic agents in a value added chain, providing a “structure of diffusion, transmission and amplification of microeconomic impulses and dynamic feedbacks” (Dosi and Orsenigo, 1988).

Innovation studies have identified three central determinants of innovation: the existence of and ability to utilize technological opportunities, market conditions and opportunities, and appropriability conditions. Perceptions on these conditions and opportunities may determine the development of economic systems as firms utilize and adapt to them. In terms of a resource-based perspective on the firm (Penrose, 1959; Fransman, 1984), these conditions affect innovation through shaping learning processes and subsequent capability building of firms. Using such wider notions of economic competencies, involving user-producer linkages further enriches the idea of innovation system, and helps in understanding the growth of knowledge intensive service sectors.

2.2. Services in National Innovation Systems

Knowledge intensive services are sources of information and knowledge. They continuously create new types of services by combining knowledge and stimulating knowledge acquisition through integrating various networks. The KIS sector employs highly educated professionals unlike the general service industries whose workers are of low status, poorly paid, and often less educated. The workforce of KIS suppliers includes many people with higher education and professional qualifications.

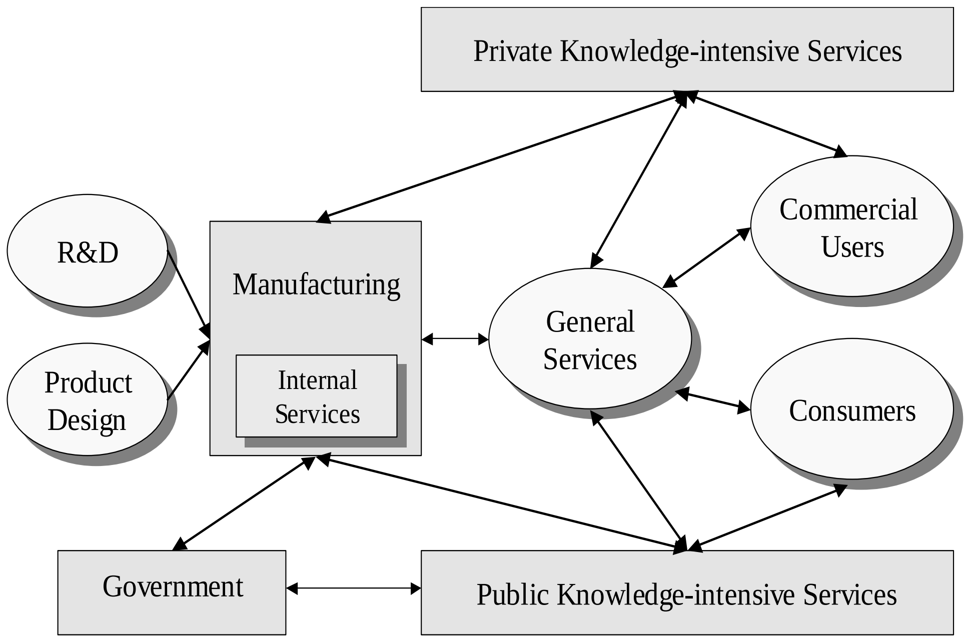
KIS employees have increasingly high levels of social and institutional knowledge, are involved in many of the traditional professional services, and have science and technology related knowledge. But, there are many blurred boundaries between KIS and general services. For instance, logistics services, often grouped as one of the 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 service activities (KISAs)” 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 professions enlist people who have already displayed capacity for such learning through formal higher education.

Many types of new KIS have emerged from science and technology activities or professional services. Nowadays, it is common to find KIS suppliers to supply software and other services to users in their sector. The KIS sector deals with specialized knowledge rather than a service concerned with routine solutions to common 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 of the economy as shown in the previous chapter. It contains many innovative users of new technologies in the manufacturing industry, and they provide considerable potential for future employment growth. The KIS sector 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 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).

These accounts capture important features of the integration between service and manufacturing functions in national innovation systems. Service function has been treated as an add-on to material wealth creation. Many aspects of interactions between service function and manufacturing functions in national innovation systems are still inadequately understood. Considering that 75 per cent of manufacturing costs and some similar share of employment are accounted for by the service sector, a simple dichotomy between manufacturing and services may be false. There must be specific complementarities between these functions (Hauknes, 2000).



[Figure 2-2-1] Interactions between Knowledge-intensive Services and Manufacturing

Appreciating the roles of knowledge intensive services in national innovation systems is important. General services are usually conceptualized as parts of a value chain and assistant to manufacturing activities. They closely interact not only with commercial users and consumers, but also with private and public knowledge-intensive services. KISAs also play a supportive role in manufacturing activities. Such

R&D and product design can be included in knowledge-intensive services, but they play roles in different ways. Governments intervene in both manufacturing activities and public knowledge-intensive services. Figure 2-2-1 is an expression of the interaction between services and manufacturing in a national innovation system. KISAs provide strategic value-added to manufacturing, general services and direct end users. They are strategically important, even to the extent of appealing to manufacturing firms that they should conceptualize their business as a service provision.

Such a depiction of the role of service does not make much qualitative distinction between service functions and manufacturing functions in national innovation systems. Complementarities between the two have direct implications for how we should think of KISAs in national innovation systems. In outlining the roles of KISAs on national innovation activities, the functional integration of these services in 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. The main context of innovation systems is, in fact, the cluster itself with interactions being contingent on the complementary divisions of labor.

Broadly, 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’ use of capital and intermediate goods and various services.

Some KISAs may have an immediate forward functional impact that directly affects innovation activities (Lee, Kong-rae et al., 2002). Typically, they involve learning and capability building in the client organization involving transformation of the service-product. 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 often require complex transformation capabilities on the side of both the user and the supplier of knowledge intensive services (Hauknes, 2000).

3. Innovation System of KISA

3.1 Typology of KISAs

Typology of knowledge intensive services (KISs) is an important element for identifying actors and their interactions that compose the base of the innovation system of knowledge intensive services. There are many different sorts of knowledge intensive services and activities. Different researchers have mapped a diverse typology of KISs depending upon their purpose of research. KISs are generally grouped by sources of production, what they are doing with knowledge, and types of output, like industry classification. We begin with classification of KISs at a macro level and narrow down to industry classification at a micro level typology.

KISs can be grouped into two sources of production: private KISs and public KISs. Private knowledge intensive services are produced and supplied by private firms, while public knowledge intensive services are produced and supplied by public or government organizations. Recently, a hybrid type of KISs often is put into a different category, as there is a hybrid sector where both the private sector and the public sector have been increasingly transformed into the private sector to an extent that distinguishing between the private sector and the public sector is blurred.

Knowledge intensive services are classified by what they are doing with knowledge: communications management services, R&D services, management consulting services, IT consulting services, employment agency services, engineering consultancy related to user innovations, training services, etc. Each of them can be understood as follows.

Communications management services may serve user firms by seeking to mediate information flows from the user to its environment. In some cases, this may be largely a matter of processing data handed directly from the user firms. For instance, financial and environmental auditing service suppliers may involve substantial efforts to locate or produce information. These services often are used to organise the media as interfaces between the users and their internal and external environments, and to establish the routines whereby the user firms will continue to shape the flows of information into and out of the firms through these media (Miles, *et al.*, 1995).

R&D services produce or locate information generated from research, development, etc. and use it to produce solutions to problems of user firms in the form of reports or presentations. R&D services may be about the organization itself, about innovation, about its environment, or about its position relative to its environment. For example, strategic R&D services may be related to how do its practices compared to those of competitors and what its levels of emission of pollutants are. R&D services may also include prioritizing R&D projects, recommending technological choices, and other similar innovation related activities.

Management consulting services typically involve dialogue with top management of user firms. They may require a mediating role where views and objectives held by different members of the firms are different. Sometimes this is precisely why knowledge intensive services are employed to recommend and promote courses of action already favored by the firm. In-depth understanding of the sorts of problems the firm faces is important. In the supply of the services, the personal relationships and networks established with specific clients and other professionals are critical.

IT consulting services are solving internal problems associated with information and communication technologies. IT consultants locate, test, and negotiate with the internal IT managers of user firms. The service supplier may need to try and compare different systems and packages. It is a role of systems integration. Another role may be related to network management.

Employment agency services are associated with personnel recruitment, headhunting and selling opportunities to viable candidates. Some services offer knowledge-intensive temporary work services, *e.g.* contract management services and locating and sometimes supporting a new staff. Such services effectively implant human-embodied knowledge into user firms rather than trying to cultivate it among the existing staff.

Engineering consulting services include hardware and software management, i.e. telecommunication networks supply and management in relation to managing the resource. Services provide user firms with a service that the firm is reluctant to devote its own staff and management time to. It may be highly strategic, but require expertise and effort that the user is not willing to make a long-term investment in because of focusing on core competences.

Lastly, training services are to inform or educate practices and skills. This may involve preparation of documentation and other material for the employees of user firms to undertake specific tasks. Services increasingly involve such cyber tools as web based learning programs and learning aids. However, face-to-face training is often more important than any other education tool. It needs to be developed for more generalized knowledge to help staff members develop skills and capabilities, and sometimes, the motivation required for their jobs (Miles, et al., 1995).

Typology of KISAs based on the industry classification also has been 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 as KISAs. The OECD (2001) excluded financial and insurance services, and education services from those O classified as KISAs. The gap in the scope of KISAs between O's study and the OECD's study may come from adapting a different definition of KISAs. The OECD may have adapted a narrow definition.

<Table 2-3-1> Classification of Knowledge Intensive Service Sectors

Classification	KSIC (2000)	Major Activities
General services	40-93	
Knowledge intensive services		
(1) Computer software system (CSS) services	721	Hardware consultancy
	722	Software consultancy and supply
	723	Data processing
	724	Database activities
	725	Maintenance and repair of office, accounting and computing machinery
	729	Other computer related activities
(2) Electric and telecommuni-cation service	642	Electric and telecommunication Activities
(3) Broadcast and movie services	743	Advertisement
	871	Movie production and distribution
	872	Broadcasting
(4) Financial & insurance services	65	Financial activities
	67	Insurance activities
(5) R&D services	73	Research and development
(6) Business services	741	Law, accountant and project consulting
	742	Market survey and management consulting
(7) Technical services	743	Architecture, engineering and others
	744	Scientific and technical support activities
(8) Education services	80	Education activities
(9) Health and welfare service	85	Healthcare activities
	86	Social welfare activities
(10) Art services	873	Art performance and maintenances of record facilities

Source: Lee, Kong-Rae et al. (2002), Innovation and Strategy of the Knowledge-intensive Service Sector in Korea (in Korean), Seoul: STEPI.

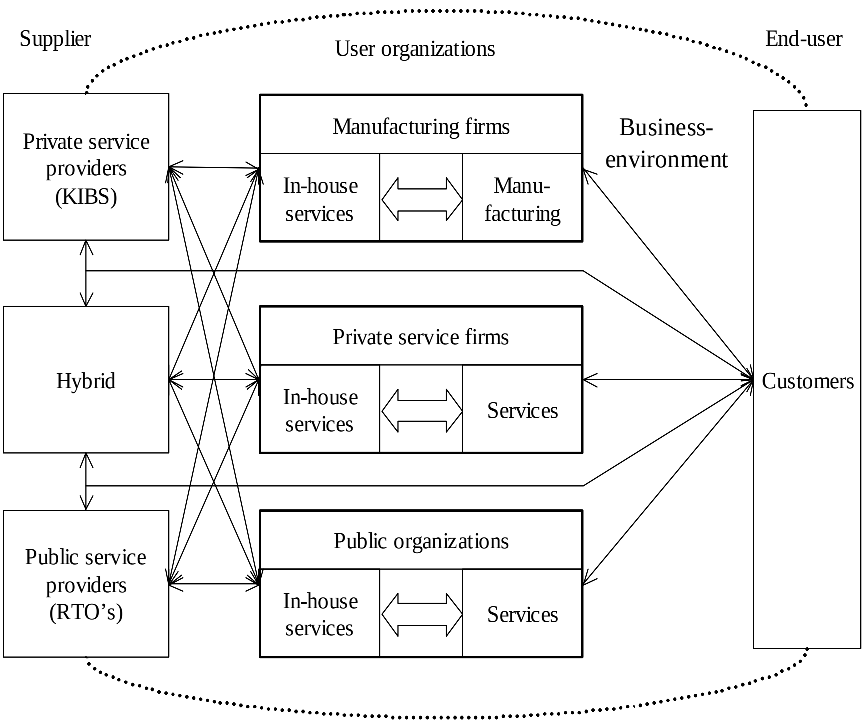
This study adapts more or less broad definition of knowledge intensive services so that the scope of KISAs will also be broad. It includes ten kinds of services in the knowledge intensive service (KIS) sector by the Korea Standard Industry Classification Code (KSIC) as shown in Table 2-3-1. They are 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 analyzes all of these service types in Chapter three to discover their general statistical trends. Specific case analysis will be undertaken for the CSS services thereafter.

3.2 Actors and Their Interactions

It is useful to explore KISAs in terms of innovation systems. The innovation system of KISAs is defined by the 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 involved in a particular area of KISAs. When emerging technologies are involved, activities conducted by public and semi-public R&D performers such as government laboratories, universities or technology-transfer agencies may be important to the development of the innovation system.

The boundary of the KISA innovation system may be determined by the scope of KISAs and their linkages that the specialized suppliers have to other agents that influence their capabilities for competition and innovation. Figure 2-3-1 shows the main actors and elements of the KISA innovation system.. KIS suppliers include private service providers, public service providers 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 KISA innovation system. Suppliers that provide specialised services are more likely to undertake innovations than are standardised service providers. One third of the specialized suppliers claim that their innovations had an important impact on their users' innovative performance (OECD, 2002). This fact implies that the specialized suppliers 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 may build this understanding into their services to benefit the customers.



[Figure 2-3-1] KISA Innovation System

KIS users have been often regarded as an important actor of the innovation systems of KISAs. They perceive problems and obtain innovative ideas to solve problems, and conduct in-house production of knowledge intensive services for their own use. They often convey the ideas to suppliers to solve problems and to improve service quality. Due to this role of user firms, many accounts of the specificities of KISAs stress the importance of close interaction with users. It indicates that suppliers who adapt more of their outputs to suit specific 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 newly innovated services by specialized suppliers so as to provide a market for new services. Spin-offs companies emerging 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 KIS suppliers. Some private universities should be regarded as public KIS suppliers with regard to their function. Nowadays, private consulting companies provide KISs to public organizations that formerly obtained consulting services only from public institutes.

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

In some OECD countries, public provision of KISAs often crosses national boundaries through trade, collaboration or ownership. In this case, countries may decide that data from other countries involved should therefore be included in the analysis of the national innovation system of KISAs. Cross-boundary provision of KISAs may be complementary in some ways to innovation systems of globalized countries. Conversely, where boundaries seem to be strongly defined at the sub-national level, *e.g.* a region or district, countries too should include it in the KISA innovation system.

4. Implication for This Study

The above discussions provide many implications for this study. It was found from the discussions that characteristics of the innovation in the KIS sector tend to converge with that of the manufacturing industry, although some different elements still exist. Also discovered was that the innovation system of KISAs is mingled with the national innovation system, implying that conventional sector study has a limitation for exploring the inside-black box of the KIS sector. Our temporary findings imply that empirical investigation will be essential in order to further understand knowledge intensive service activities.

Another implication is that KISAs need to be separated into public KISAs and private KISAs as their characteristics and impacts are different and the innovation system of KISAs is complex. We are, therefore, going to investigate the contribution of public KISAs and private KISAs separately to the innovation-capability building of KIS suppliers. To what extent private KISAs contribute may be determined by markets, while that of public KISAs is not clear. We will measure it based upon the results of a questionnaire survey.

One other implication is that a study on KISAs should look at the linkage between service suppliers and their users. As previously discussed, an interaction between service suppliers and their users is critical for the innovative contributions of knowledge intensive services. In this aspect, this study will investigate the contribution of some knowledge intensive services to the innovation-capability building of the user firms. It will also be measured by using the results of the field survey as well.

CHAPTER THREE

General KISA and Computer Software System (CSS) Services Innovation Trends

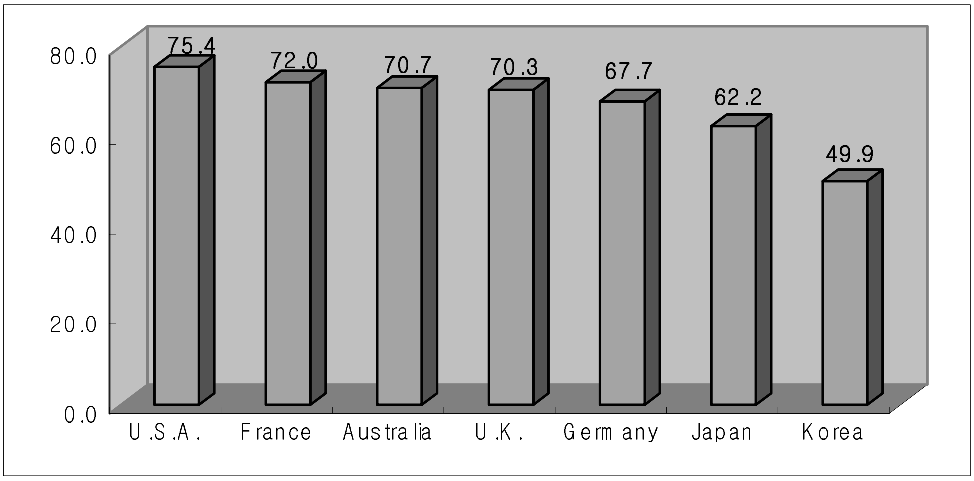
1. Position Changes in the National Economy

Korea's service industry seems to be lagging far behind other OECD member countries. According to an OECD (2001) survey, Korea's service industry was amounted to 49.9 percent of its GDP in 1999, which is far lower than Japan (62.2%), Germany (67.7%) and U.K. (70.3%). This indicates that the Korean economy has specialized in the creation of value added in the manufacturing sector. Taking into account the fact that the US service industry's portion of GDP was 75.4 percent, Korea has ample room to develop and utilize its service sector to increase employment in the future.

The position of the knowledge intensive service industries in the national economy can be found by looking at the portion of gross domestic product (GDP) held by the sectors.[1] Unfortunately, knowledge intensive service industries have not been included in detail in the Report on Mining and Manufacturing Census published by National Statistical Office. The Ministry of Science and Technology (MOST) together with Korean Institute for Science and Technology Evaluation and Planning (KISTEP) has regularly surveyed some statistics associated with research and development services, technical services, and computer services. Their statistics are, however, not relevant for use in finding the position of the knowledge intensive service sectors due to limited number of samples. There are random surveys on some parts of knowledge intensive services by related government agencies.

To find the position of knowledge intensive service sectors, we used turnover statistics, instead of value added statistics. We were able to collect most turnover statistics for the years 1996 and 2000, except for some sectors from the Report on the Census on Basic Characteristics of Establishments made by National Statistical Office. The statistics that could not be obtained from the census were collected from other sources.

[1] Knowledge intensive service sectors here include ten sectors: computer related services, telecommunication services, broadcast and movie services, art related services, financial services, R&D services, business services, technical services, education services, and health and welfare services.



[Figure 3-1-1] Shares of Service Sectors in GDP in Major Countries

Source: OECD (2001), Services: Statistics on Value Added and Employment.

The turnover for Korean knowledge intensive service industries amounted to approximately US $209 billion in 2000. It grew at the annual rate of 2.6 percent from 1996, which is faster than that of industry total and the entire service industries as a whole. It accounted for 42.1 percent of the total turnover of the Korean service industry in 2000. The trend shows that the knowledge intensive service industries' position has increases from its 39.2 percent in 1996. As the OECD (1999) reported, outsourcing is an important driving force for this change. Korean firms have increasingly procured from specialized suppliers such knowledge intensive business services as law related consultancy, hardware consultancy, software, marketing and technology information, logistic and so on. Of the various KISA, the computer software system (CSS) service sector is regarded to be the leading player.

<Table 3-1-1> Positions of KISA and CSS Services in Turnover

(Unit: US$ million)

Classifications	1996	2000	AGR (1996 -2000)
INDUSTRY TOTAL (A)	982.586	996.674	0.4
Service industries (B)	480.874	495.587	0.8
Knowledge intensive services (C)	188.470	208.591	2.6
CSS services (D)	2.870	8.759	32.2
B/A (%)	48.9	49.7	-
C/B (%)	39.2	42.1	-
D/C (%)	1.5	4.2	-

Note: AGR indicates annual average growth rate.

Source: National Statistical Office, Republic of Korea (1996-2000), *Report on the Census on Basic Characteristics of Establishments*.

2. Changes in Capability Indicators

2.1 Number of Firms

The number of firms is one of the relevant and convenient indicators or proxies for the national capability of KISA and computer software system (CSS) services. The more firms exist in the sector, the stronger their capability can be expected to be from the aggregation aspect. It can be an indicator to look at the dynamism of the industries in terms of entries and exits of firms. The portion of the industries in the number of firms may also partially indicate their importance in the national economy. A rapid increase in the number of firms possibly implies active entries of new start-ups, exits of existing companies and fierce market competition. A slow increase in the number of firms implies vise versa.

It is evident that their competitiveness is far more important than is simple number of firms. Since the objective of this study is to capture the general trends of knowledge intensive service activities, we simply analyzed changes in the number of firms, employees and R&D expenditures.

The number of firms in the knowledge intensive service industries was 244 thousand in 2000, accounting for 9.3 percent of service industry's total, which was 8.4 percent in 1996. The portion of the industry in terms of the number of firms appeared to be relatively low compared with those shown in terms of turnover and employees. The speed of its growth, however, is faster than that in terms of turnover and employees. The annual average growth rate in the number of firms of the knowledge intensive service industries was 4.6 percent from 1996 to 2000 as shown in Table 3-1-3, while the rates were 2.6 percent in turnover, and 3.6 percent in the number of employees.

<Table 3-2-1> Portion of KISA and CSS Services in Number of Firms

(Unit: each)

Classifications	1996	1998	2000	AGR

				(96-00)
INDUSTRY TOTAL (A)	2,807,802	2,785,659	3,013,417	1.8
Service industries (B)	2,417,874	2,436,963	2,627,003	2.1
Knowledge intensive service (C)	204,217	210,670	244,068	4.6
CSS service (D)	3,059	4,428	10,793	37.1
B/A (%)	86.1	87.5	87.2	-
C/B (%)	8.4	8.6	9.3	-
D/C (%)	1.5	2.1	4.4	-

Note: AGR indicates annual average growth rate.

Source: National Statistical Office, Republic of Korea (1996-2000), *Report on the Census on Basic Characteristics of Establishments.*

In the computer software system (CSS) service sector, there were 10,793 firms in 2000, accounting for 4.4 percent of the knowledge intensive service industries. It was just 3,059 in 1996, which tripled over the last four years, growing at the annual average rate of 37.1 percent. This speed of growth in the number of firms is remarkable, and reflects how dynamic the Korean CSS service industry is. We found that more than 3,000 firms out of 10,793 firms were new start-ups, called venture business. The portion of venture companies out of existing companies in CSS services was highest among the service industries.

As shown in Table 3-1-3, the number of firms in the CSS service sector has rapidly increased faster than any other sector. CSS services can be divided into six categories according to such UN SIC codes as hardware consultancy (721), software consultancy and supply (722), data processing (723), database activities 9724), maintenance and repair of office, accounting and computing machinery (725), and other computer related activities (729). It was found that largest number of firms (6,126) exists in the field of software consultancy and supply services.

<Table 3-2-2> Number of Firms in the CSS Service Sector

(Unit: each)

CSS Services	1996	1997	1998	1999	2000	AGR (96-00)
TOTAL	3,059	3,851	4,428	7,173	10,793	37.1
721: Hardware consultancy	127	139	135	444	384	31.9
722: Software consultancy and supply	1,867	2,413	2,741	3,918	6,126	34.6
723: Data processing	193	193	190	215	246	6.3
724: Database activities	268	294	257	487	1,278	47.8
725: Maintenance and repair of office, accounting and computing Machinery	547	735	1,077	1,980	2,648	48.3
729: Other computer related activities	57	77	28	129	111	18.1

Note: AGR indicates annual average growth rate.

Source: National Statistical Office, Republic of Korea (1996-2000), *Report on the Census on Basic Characteristics of Establishments*.

The number of firms in the CSS service sector from 1996 to 2000 has grown at the annual average rate of 37.1 percent. The highest growth rate appeared in maintenance and repair service for office, accounting and computing machinery showing 48.3 percent. There were 2,648 firms providing maintenance and repair services to a broad area of industries in 2000. They have exploited business opportunities generated by rapid expansion of office, accounting and computing equipment over the last decade. Many companies and organizations do not have permanently employed engineers to repair and maintain their computer facilities, but prefer to outsource necessary services from specialized firms when needed.

The results of our investigation also show that the number of firms doing database activities also grew at the annual growth rate of 47.8 percent over the last four years. According to the information released by Korea Database Promotion Center (KDPC), there were 1,195 organizations, including public institutes and newspaper companies, producing a variety of databases and providing database access services in 2000. The KDPC (2001) survey reveals that among databases, sports related databases, newspaper databases and life and culture databases appear to be the most popular.

<Table 3-2-3> Number of Organizations Producing Databases

(Unit: each)

1996	1997	1998	1999	2000	AGR (1996 -2000)
551	919	1,047	n.a.	1,195	21.4

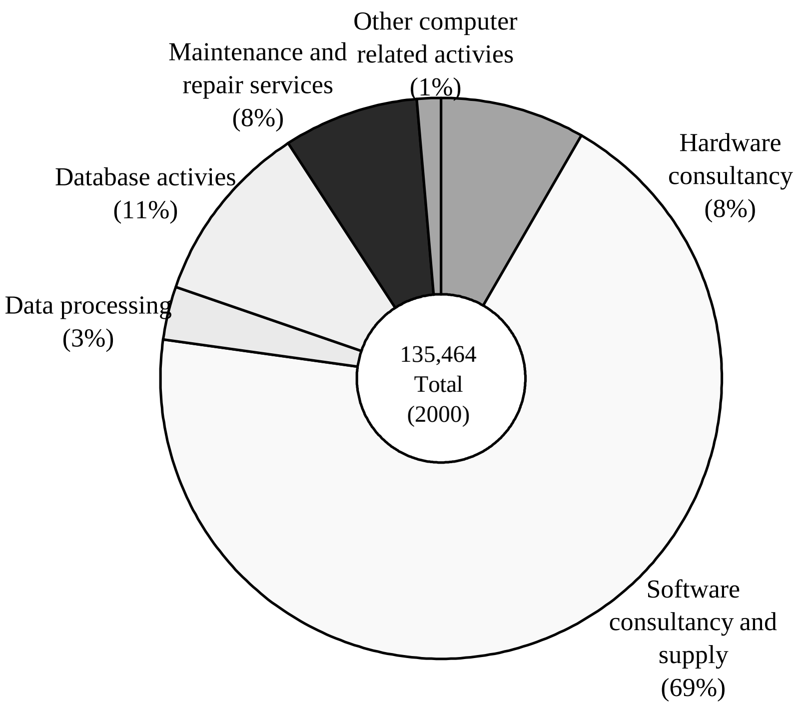
Notes: n.a. indicates “data not available” and AGR indicates annual average growth rate.

Source: Korea Database Promotion Center (http://ccis.dpc.or.kr/statics/d_condition.\htm)

2.2 Employment

An estimated 9.496 million persons were employed in Korea’s service industries. This accounts for 69.8 percent of the industry’s total, which is lower than that of France (71.4%), U.K. (73.1%) and USA (74.4%) (Preibl, 2000). While employment in the manufacturing sector decreased at the annual rate of minus 0.7 percent over last four years, the service sector has created 456 thousand jobs over the same period. That sector’s employment from 1996 to 2000 grew at the annual average rate of 1.2 percent.

The knowledge intensive service industries employed 2.313 million persons in 2000, accounting for 24.3 percent of the employment in the service industry as a whole. Its position in employment turned out to be lower than in turnover, 42.1 percent, indicating that labor productivity of knowledge intensive service industries is higher than that of other services. The annual average growth rate of knowledge intensive service industries from 1996 to 2000 was 3.6 percent, which is exactly three times higher than that of the service industry as a whole, which amounted to 1.2 percent.



[Figure 3-2-1] Employment Composition of the CSS Service Sector

<Table 3-2-4> Changes in Employment of KISA and CSS Services

(Unit: per million persons)

Classifications	1996	1998	2000	AGR (96-00)
INDUSTRY TOTAL (A)	14.007	12.417	13.604	-0.7
Service industries (B)	9.040	8.587	9.496	1.2
Knowledge intensive services (C)	2.006	1.944	2.312	3.6
CSS services (D)	.49	.57	.135	28.8
B/A (%)	64.5	69.2	69.8	-
C/B (%)	22.2	22.6	24.3	-
D/C (%)	2.4	2.9	5.8	-

Source: National Statistical Office, Republic of Korea (1996-2000), Report on the Census on Basic Characteristics of Establishments.

Employment growth in the computer software system (CSS) service sector appears to be impressive. Over the 1996-2000 period, the sector increased employment at the annual rate of 28.8 percent, reaching 135 thousand persons. Employment share of the CSS service sector out of the knowledge intensive service industry jumped from 2.4 percent in 1996 to 5.8 percent in 2000. These trends imply that computer related service activities are responsible for substantial job creation in Korea as in many other OECD countries. It also implies that the CSS service industry is one of main industries to hire experienced human resources that were discharged in the process of restructuring of firms in the manufacturing industry. Employment growth in the manufacturing sector has decreased from 14.0 million in 1996 to 13.6 million in 2000, as shown in Table 3-2-4. Some of the former employees that left the manufacturing sector may have become employed in the knowledge intensive service industries including the CSS service sector.

<Table 3-2-5> Number of Employees in the CSS Service Sector

(Unit: per person)

CSS Services	1996	1997	1998	1999	2000	AGR (96-00)
TOTAL	49,156	59,495	57,351	78,769	135,464	28.8
721: Hardware consultancy	1,467	4,486	11,746	9,753	11,252	66.4
722: Software consultancy and supply	31,751	42,479	35,052	51,789	93,358	30.9
723: Data processing	4,774	4,043	3,422	3,120	4,057	-4.0
724: Database activities	6,349	2,412	1,970	4,789	14,564	23.1
725: Maintenance and repair of office, accounting and computing machinery	3,350	4,127	5,090	7,792	10,480	33.0
729: Other computer related activities	1,465	1,948	251	1,526	1,753	19.7

Note: AGR indicates annual average growth rate.

Source: National Statistical Office, Republic of Korea (1996-2000), *Report on the Census on Basic Characteristics of Establishments.*

In the CSS service sector, software consultancy and supply was the largest service field as it employed 93,358 persons, accounting for 68.9 percent of total employment in 2000. The service that showed the fastest employment growth from 1996 to 2000 was hardware consultancy services. It grew at the annual rate of 66.4 percent for the period. This extraordinary trend of growth indicates that technical problems of computer facilities are to large extent associated with hardware, which generated substantial demand for consultancy. This explanation is also confirmed from the fact that the number of employees in the maintenance and repair services for office, accounting and computing machinery rapidly increased for the same period, at the annual rate of 33.0 percent as seen in Table 3-2-5.

2.3 R&D Activities

R&D activities perhaps more accurately indicate the innovative capability of the CSS service sector as well as the KISA sector more than any other activities, although R&D activities do not represent well the innovative performance of the service industry (Metcalfe and Miles, 2000). Active R&D work of service firms leads to accumulation of knowledge, increasing their capability to strengthen core competencies and better innovative performance. Service industry, however, has been notorious for having a low level of R&D activities compared with the manufacturing industry.

<Table 3-2-6> R&D Expenditures in KISA and Software Related Services

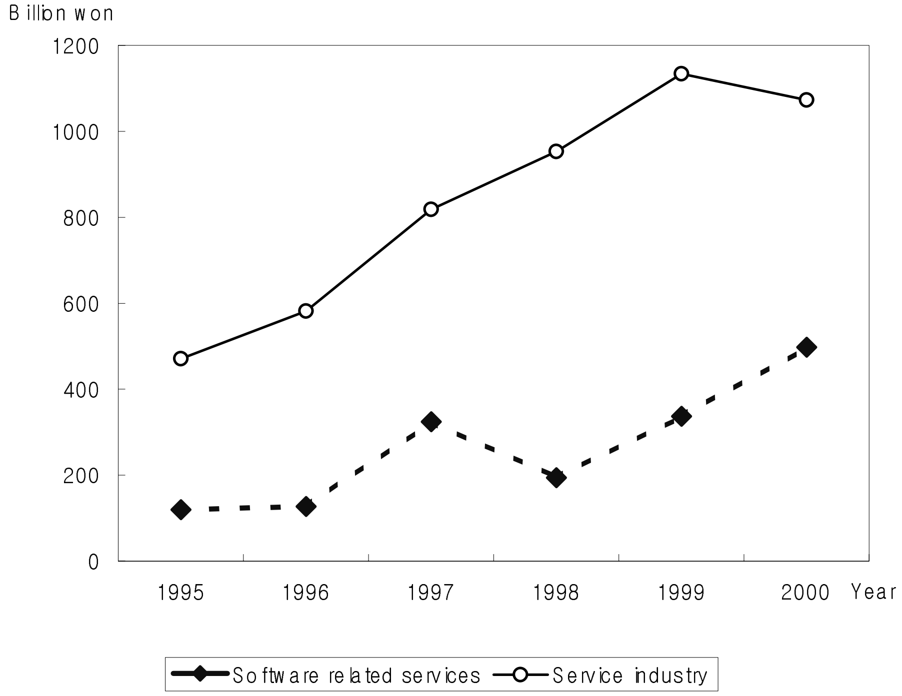
(Unit: US$ million)

Classifications	1998	1999	2000	AGR (98-00)
INDUSTRY TOTAL (A)	5.699	7.155	9.070	26.2
Service industries (B)	681	954	949	18.0
- Computer related services (C)	131	199	350	63.5
- Software related services *	139	283	440	77.9
B/A (%)	11.9	13.3	10.5	-
C/B (%)	19.2	20.9	36.9	-

Sources: MOST and KISTEP (1999-2001), *Report on the Survey of Research and Development in Science and Technology*; * the data for software related services were obtained from Electronics and Telecommunication Research Institute (ETRI) (2001), *Survey on Information and Telecommunication R&D Statistics.*

Korea's service industry R&D expenditure in 2000 amounted to US $949 million, accounting for 10.5 percent of that industry's total R&D expenditure. It grew from 1998 to 2000 at the annual rate of 18 percent, which was lower than that of the industry's total. The low growth of R&D expenditure may be one of the factors affecting the sluggish development of Korea's service industry. Due to low level R&D expenditure, the industry may not have employed high caliber human resources and accumulated less necessary knowledge to carry out innovations to strengthen its international competitiveness.

Contrary to the service industry as a whole, the computer related or software related service industry has rapidly increased its R&D expenditure. As shown in Table 3-2-6, the computer related service sector in 2000 invested US $350 million in R&D, amounting to 36.9 percent of the total R&D expenditure of the service industry. The software related service sector spent US $440 million on R&D in the same year. Growth of R&D expenditure in the software related service sector shrank after the foreign currency crisis took place in 1997. Since then it has continued to grow until recently as shown in Figure 2-2-2.



[Figure 3-2-2] R&D Expenditure Trends in the Software Related Service Sector

The data for R&D activities of the CSS service sector that are compatible with those of sales, number of firms and employees were not available in Korea. Instead, R&D expenditures of computer related services reported by MOST and KISTEP, and R&D expenditures of software related services reported by ETRI were collected and analyzed for this study. These two data suppliers may have different samples and sources, but contain many commonalities.

According to the survey carried out by the Korea Industrial Technology Association (ETRI, 2001), the software related service sector in 2000 invested 2.3 percent in basic research, 18.1 percent in applied research, and 79.5 percent in developmental work, revealing the characteristic of development oriented R&D. KITA also reported that 92.4 percent of R&D expenditure of the industry was self-financed, of which 8.2 percent was borrowed from venture capital companies, and 2.1 percent from banks. The public sector, including government support, amounted to 40.8 billion won, accounting for 7.6 percent of the total.

<Table 3-2-7> **R&D Personnel in KISA and Software Related Services**

(Unit: per person)

Classifications	1998	1999	2000	AGR (98-00)
INDUSTRY TOTAL (A)	87,169	93,438	115,026	14.9
Service industries (B)	9,463	9,845	17,952	37.7
- Computer related services (C)	4,649	5,323	10,626	51.2
- Software related services *	7,414	11,492	11,528	24.6
B/A (%)	10.9	10.5	15.6	-
C/B (%)	49.1	54.1	59.2	-

Note: AGR indicates annual average growth rate.

Sources: MOST and KISTEP (1999-2001), *Report on the Survey of Research and Development in Science and Technology*; *(Software related services) was obtained from Electronics and Telecommunication Research Institute (ETRI) (2001), *Survey on of Information and Telecommunication R&D Statistics.*

The trends of R&D personnel in the software related service sector slightly differ from what they are in R&D expenditures. Both the service industry and the software related service sector have rapidly increased employment. The annual average rate of employment growth of R&D personnel from 1998 to 2000 was 37.7 percent for the service industry as a whole, 51. 2 percent for computer related service sector, and 24.6 percent for software related service sector. The computer related service sector must have recruited R&D human resources so rapidly that its portion of R&D employment in the service industry continued to increase from 49.1 percent in 1998 and 59.2 percent in 2000. These trends imply that the computer related services sectors including software services have been major employers of R&D manpower in Korea, along with the information and communication industry.

3. Changes in Outcome Indicators

3.1 Sales Performance

Sales may best represent to what extent firms in KISA and the CSS service sector play an active role in markets. Although simple volume of sales does not indicate profitability, efficiency or innovativeness of firms, it reflects well market signals on demand size and opportunities. The larger sales volume is achieved, the greater opportunity and demands can be expected. From this aspect, sales statistics were collected that include the number of service users for reviewing changes in outcome indicators of KISA and the CSS sector.

In the previous section, the sales performances of the Korean service industry as a whole and knowledge intensive service industries were briefly reviewed in terms of their positions in national economy. In terms of sales growth, the service industry has grown faster than the manufacturing industry’s total. The sales growth of knowledge intensive industries is higher than that of the service industry as a whole. The sales growth of computer software system (CSS) services is far more impressive than knowledge intensive services as a whole.

Sales volume of the Korean CSS service sector in 2000 amounted to US $8.759 billion, accounting for 4.2 percent out of the knowledge intensive sector. It has grown over the 1996-2000 period at the annual average rate of 32.2 percent, which is remarkable despite the foreign currency crisis at the end of 1997. It reflects that the Korean economy overcame the economic hardship that took place in 1997 as a result of the booming information and telecommunication industry. The development of the Korean IT industry obviously induced the rapid growth of the CSS service sector.

<Table 3-3-1> Sales Performance of KISA and CSS Service Sector

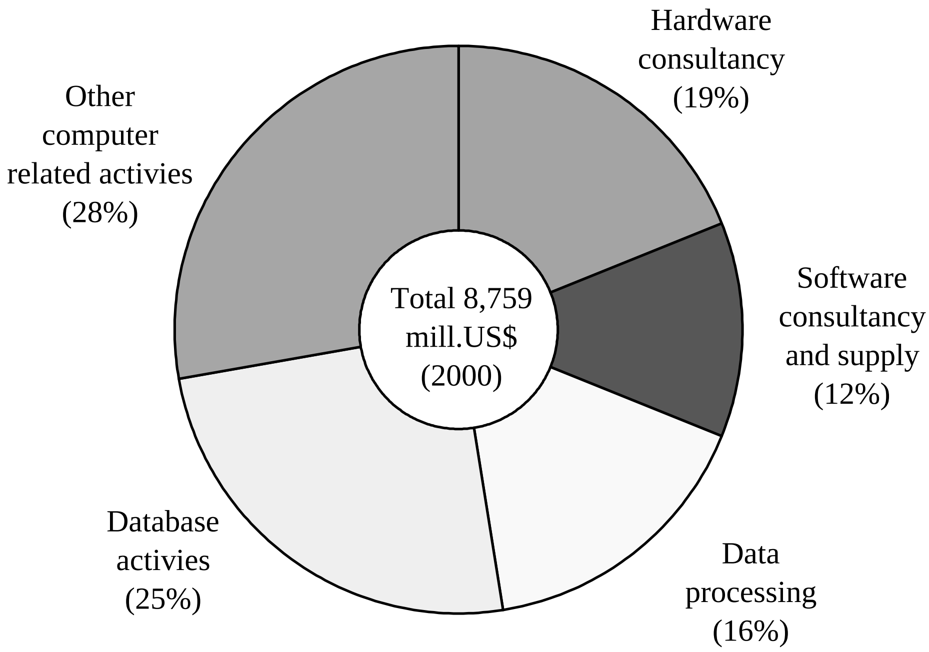
(Unit: US$ billion)

Industry Classifications	1996	1997	1998	1999	2000	AGR (96-00)
INDUSTRY TOTAL	982.586	n.a.	n.a.	n.a.	996.674	0.4
Service Industry	480.874	n.a.	n.a.	n.a.	495.587	0.8
CSS SERVICE SECTOR	2.870	3.840	4.624	6.457	8.759	32.2
721: Hardware consultancy	1.069	533	706	875	1.645	11.4
722: Software consultancy and supply	.648	.860	.857	.829	1.078	13.6
723: Data processing	.333	.946	1.378	2.092	1.429	43.9
724: Database activities	.645	.920	.721	1.042	2.178	35.6
725: Maintenance and repair of office, accounting and computing machinery	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
729: Other computer related activities	.175	.579	.962	1.620	2.428	92.9

Notes: 'n.a.' indicates "data not available"; and AGR indicates annual average growth rate.

Sources: National Statistical Office, Republic of Korea (1996-2000), *Report on the Census on Basic Characteristics of Establishments* (in Korean); Korea Association of Information and Telecommunication (1997-2001), *Statistical Yearbook of Information & Communications Industry* (in Korean) (http://www.kait.or.kr).

Dividing the sales of the CSS service sector into six categories, figure 2-3-1 shows that of the total sales in the CSS service sector, hardware consultancy accounted for 19 percent, software consultancy and supply 12 percent, data processing 16 percent, database activities 25 percent and other computer software related services 28 percent. The fact that almost one third of sales generated from other computer related services indicate the extent CSS services are diversified. Sales data on maintenance and repair of office, accounting and computing machinery (725) were not divided in Korea, but probably included in other computer related activities (729). A substantial portion of sales in the CSS service sector has been classified as other computer related activities and their contents are not known.



[Figure 3-3-1] Sales Composition of the CSS Service Sector

The ten largest firms in Korea in terms of sales in the CSS service sector are: Samsung SDS, LG CNS, IBM Korea, SICC, Thrunet, Daewoo Information Systems, Dreamline, KIRA Information & Communications, SQ Technologies, and Nanum Technologies. Samsung SDS, a sister company of the Samsung Group, as appears to be the largest supplier of CSS services with about a 1.3 trillion won value in sales. Samsung SDS has supplied such CSS services as consulting, business integration, packaged software, data center service, e-training, and so on. The second largest firm is LG CNS, established in 1987 as one of the LG Group companies.

Most of the ten largest firms were established after the 1980s, except for IBM Korea, which is a US based multinational company and established in 1967. Four firms (Dreamline, Thrunet, SQ Technologies, Nanum Technologies) were established relatively recently after the 1990s. Their entries into the CSS service sector seem to be concurrent with the booming of Korea’s information and communication industry that began at the beginning of the 1990s. Sales in CSS services may have rapidly grown along with the fast growth of Korea’s IT industry.

<Table 3-3-2> Ten Largest Suppliers of CSS Services in Korea

Unit: 100 million won

Rank	Name of Firms	Year Estab.	Sales (2001)	Main Business
1	Samsung SDS	1985	13,206	Consulting, business integration, packaged software, data service, etc.
2	LG CNS	1987	9,302	Consulting, system integration, e-biz, etc.
3	IBM Korea	1967	8,550	Server, software, solution, business service
4	Thrunet	1996	4,768	Leased line service, security service, web hosting, mail hosting, groupware, etc.
5	SICC	1981	3,645	System integration, S/W development, etc.
6	Daewoo Information Systems	1989	2,705	System integration, outsourcing, consulting, e-Biz, infra service, etc.
7	Dreamline	1997	1,397	Fiber optic network, leased line service, etc.
8	SQ Technologies	1996	584	National identification, civil/resident information system, billing system, etc.
9	KIRA Information & Communications	1987	479	Semiconductor, IT service, etc.
10	Nanum Technologies	1990	80	E-work, e-culture, etc.

Source: STEPI Field Survey (2002. 10)

3.2.Service Users

Responses to the provision of knowledge intensive services by service users are important outcome indicators of KISA. Users, not only at the firm level but also at the personal level, have been regarded as important players in the innovation process (Parkinson, 1982; Foxall, 1986; Rothwell, 1986; von Hippel, 1976, 1979, 1988; Lee, K-R, 1996). They may play a stronger role in the service industry than in the manufacturing industry because user-supplier interaction is generally more intense in service trade. In order to see how users responded to KISA in Korea, we analyzed two indicators: changes in the number of users and frequencies of KISA usage.

The number of users of various knowledge intensive services has rapidly increased over the recent five years. The number of internet users was 731 thousand in 1996, which further increased to 19 million in 2000. It has increased at the annual rate of 125.9 percent for the period. The emergence of internet technology provided opportunities to run on-line venture businesses, stimulated the usage of the internet and the number of their users as well as database activities. The growth trends of database users are also similar to that of internet users. The number of database users increased from 990 thousand in 1996 to 20 million in 2000, which grew at the annual average rate of 112.8 percent. The growth rates of users for the internet and databases have been higher than that of telecom users as seen in Figure 3-3-2.

<Table 3-3-3> Number of Telecom, Database and Internet Service Users

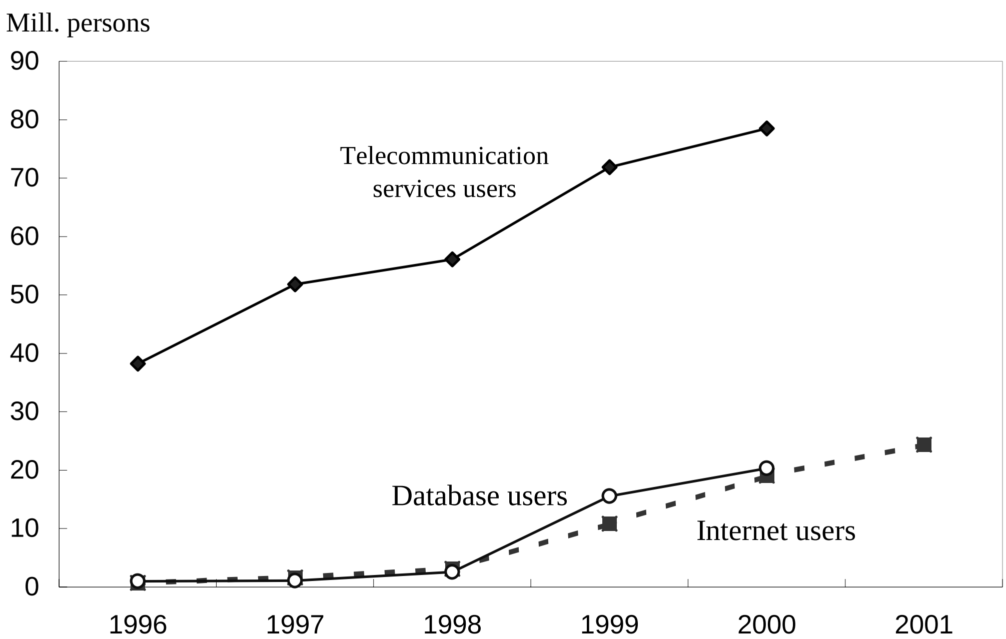
(Unit: per thousand persons)

Types of Services	1996	1997	1998	1999	2000	2001	AGR (96 -00)
Telecom services	38,213	51,829	56,099	71,873	78,512	n.a.	19.7
Database services	990	1,097	2,561	15,552	20,309	n.a.	112.8
Internet services	731	1,634	3,103	10,860	19,040	24,380	125.9

Note: AGR indicates annual average growth rate.

Sources: Korea Association of Information and Telecommunication (1997-2001), *Statistical Yearbook of Information & Communications Industry* (in Korean) (http://www.kait.or.kr); Korea Network Information Center (http://stat.nic.or.kr/iuser.html).

Such a rapid increase in CSS service users may be to a great extent attributed to the role of the Korean government with consideration given to Korea's current level of national E-readness (World Bank, 2002). The Korean government laid the foundation for a high level of E-readness by creating an underlying infrastructure, promoting the ICT industry, and beginning to optimize manufacturing through the use of digitally controlled technologies over the last ten years. According to the report "*e-Business Initiative in Korea*" released by the government (2001), Korea has envisions becoming an "e-Hub" for Asia, and has set numerical goals for the integration of ICT technologies into core manufacturing industries – electronics, automobile, shipbuilding, steel, machinery and textiles. This effort must have created a large volume of demands for CSS services so as to increase the number of users.



[Figure 3-3-2] Changes in the Number of Users for Internet, Database and Telecommunication Services

<Table 3-3-4> Frequency in the Usage of Telecom and Database Services

(Unit: per million cases)

ICT Services	1996	1997	1998	1999	2000	AGR (96 -00)
TOTAL	94,646	106,889	111,386	127,753	124,894	7.2
Telecom services	94,075	106,257	110,576	123,007	120,885	6.5
Database activities	571	632	810	4,747	4,008	62.8

Note: AGR indicates annual average growth rate.

Source: Korea Association of Information and Telecommunication (1997-2001), *Statistical Yearbook of Information & Communications Industry* (in Korean) (http://www.kait.or.kr);

Active usage of CSS service is also found by looking at the changes in frequency in the usage of telecom and database services. The number quantifying the usage of database activities reached 4.008 billion cases in 2000, which increased since 1996 at the annual average rate of 62.8 percent. The growth of database usage appeared to be much higher than that of telecom services at 6.5 percent annually. Use of CSS services may have been concentrated in the manufacturing sector, although we do not have information about frequency of use by sectors. Such types of users as farmers, fishermen, artisans and employees at traditional marketplaces lag behind manufacturers in using CSS services (World Bank, 2002). Small and medium sized firms also do not use CSS services as much as large firms do.

4. Changes in Trade Indicators

4.1 Service Imports

Service trade is carried out internationally through cross-border supply like commodity trade, consumption abroad, commercial presence, and presence of natural persons that may supply services in the territory of a foreign country (OECD, 1999). Service imports are identified as trade involving inward transfer of service from foreign countries, consumption of services in foreign countries by domestic people, and commercial presence of foreign companies that supplies services in domestic market.

Service imports obviously are less than commodity imports. In 2000, Korea’s service imports were valued at US$ 33 billion, amounting to 20. 8 percent of Korea’s US$ 160 billion in total imports. Knowledge intensive services amounted to 46.4 percent of the service imports, which equates to US $15.509 million. Since world imports of all commercial services were valued at US$ 1.3 trillion, Korea shared about 2.6 percent of the world import market.

Korea’s service imports have been growing faster than total industry imports, including merchandise and commercial service imports combined. As seen in Table 3-4-1, service imports grew from 1996 to 2000 at the annual average rate of 3.1 percent, while Korea’s total industry imports increased at the rate of 1.7 percent for the same period. Imports of knowledge intensive services grew even faster than that of service imports as a whole. The growth rate of the imports of knowledge intensive services was 6.8 percent for the same period, resulting in elevating their position from 40.3 percent of total imports of service industry in 1996 to 46.4 percent in 2000.

<Table 3-4-1> Imports of KISA and CSS Services

(Unit: US$ million)

CSS Services	1996	1997	1998	1999	2000	AGR (96 -00)
INDUSTRY TOTAL (A)	150,339	144,616	93,282	119,752	160,481	1.7
Service industry total (B)	29,592	29,502	24,541	27,180	33,423	3.1
Knowledge intensive services (C)	11,930	11,927	11,790	11,906	15,509	6.8
B/A (%)	19.7	20.4	26.3	22.7	20.8	-
C/B (%)	40.3	40.4	48.0	43.8	46.4	-
D/C (%)	2.9	3.4	1.9	2.9	3.6	-
CSS SERVICES TOTAL (D)	343	408	219	350	556	12.8
721: Hardware consultancy	n.a.	2	5	10	48	188.4
722: Software consultancy and supply	309	358	186	297	467	10.8
723: Data processing	2	1	3	13	1	
724: Database activities	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
725: Maintenance and repair of office, accounting and computing machinery	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
729: Other computer related activities	32	47	25	30	40	5.7

Notes: ‘n.a.’ indicates “data not available”.

Sources: Korea Association of Information and Telecommunication (1997-2001), *Statistical Yearbook of Information & Communications Industry* (in Korean) (http://www.kait.or.kr), and Bank of Korea (www.bok.or.kr).

Import volume of the CSS service sector seems to be trivial compared with that of knowledge intensive service industries in Korea. It amounted to US $556 million in 2000, accounting for just 3.6 percent of total import volume of knowledge intensive services. Comparing the positions of the CSS service sector in terms of turnover (4.2%), number of firms (4.4%), and employment (5.8%), the import share of CSS service sector was quite low. Out of the CSS services, software consultancy and supply dominated imports hold 84 percent of the overall CSS service with the remaining portions belonging to hardware consultancy and data processing. Import statistics of other services were not collected and arranged well, probably combined with other computer related activities.

In spite of small share in import volume, the speed of import growth of CSS services is remarkable. Imports of CSS services increased at the annual average rate of 12.8 percent from 1996 to 2000. Particularly imports of hardware consultancy grew at the annual rate of 188.4 percent, doubling every year. Their volume was US$ 48 million, still small compared with software consultancy and supply. It is worth monitoring further how they change in the future as import volume increases.

4.2 Service Exports

Service exports take place when local service producers supply their services to foreign countries. Service exports are such trade as outward transfer of service by domestic producers, consumption of services by foreigners in domestic market, and commercial presence of domestic companies that supply services in international markets. World service exports have been growing fast due to such global trends as “out-tasking” of functions to a foreign enterprise for performance offshore, reliance on a foreign enterprise to support a foreign subsidiary, establishment of a jointly owned subsidiary to provide shared services to affiliates, use of a multinational service enterprise to support a multinational customer’s operations in multiple countries, and so on (OECD, 1999).

Export sales in Korea’s service industry were US $30.534, which was 17.7 percent of the total industry’s exports for 2000. Export sales in the knowledge intensive service sector were valued at US $9.242 billion in 2000, accounting for 30.3 percent of service industry total, which is higher that that (46.4 percent) of service imports. Export sales in the service industry grew from 1996 to 2000 at the annual rate of 6.9 percent. However, export sales of knowledge intensive service industries appears to be stagnant since their growth rate turns out to be minus 1.1 percent for the 1996-2000 period. It has been pointed out by a report that international competitiveness of the Korean service industry, particularly knowledge intensive industries is weak (Kim, H-S, 2001).

Export data available for the 1996 to 2000 period reflect strong growth in exports of CSS service categories. Export sales of CSS services were valued at US $112 million in 2000, which grew at the annual rate of 82.9 percent since 1996. As shown in the imports trends, the portion of CSS services in exports was small, 1.2 percent of the exports of knowledge intensive services in 2000. However, it rapidly increased from 0.01 percent in 1996 to 0.6 percent in 1998 as shown in Table 3-4-2. Of CSS services, software consultancy and supply was the largest area in performing export sales with US $39 million in 2000.

<Table 3-4-2> Export Sales of KISA and CSS Services

(Unit: US$ million)

CSS Services	1996	1997	1998	1999	2000	AGR (96 -00)
INDUSTRY TOTAL (A)	129,715	136,164	132,313	143,686	172,268	7.4
Service industry total (B)	23,412	26,301	25,565	26,529	30,534	6.9
Knowledge intensive services (C)	9,661	10,397	8,284	7,701	9,242	-1.1
B/A (%)	18.0	19.3	19.3	18.5	17.7	-
C/B (%)	41.3	39.5	32.4	29.0	30.3	-
D/C (%)	0.01	0.5	0.6	0.8	1.2	-
CSS SERVICE TOTAL (D)	10	52	53	61	112	82.9
721: Hardware consultancy	n.a.	32	19	10	22	-11.7
722: Software consultancy and supply	9	9	8	24	39	44.3
723: Data processing	n.a.	1	7	10	5	71.0
724: Database activities	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
725: Maintenance and repair of office, accounting and computing machinery	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
729: Other computer related activities	1	10	20	17	46	160.4

Notes: 'n.a.' indicates "data not available" and AGR indicates annual average growth rate.

Sources: Korea Association of Information and Telecommunication (1997-2001), *Statistical Yearbook of Information & Communications Industry* (in Korean) (http://www.kait.or.kr), and Bank of Korea (www.bok.or.kr).

4.3 Balance of Payment in Service Trade

Korean service industry trade does not seem to be healthy because it continued to reveal a large volume of deficits. Deficits of service trade are mostly generated from the trade of knowledge intensive services. In 2000, the deficit of knowledge intensive service industries was valued at US $6.267 million, a 42 percent increase from the previous year, while that of the service industry totaled US $2.889 million in the same year. The trade deficit of CSS services amounted to US $385 million, accounting for 6.1 percent of the deficit of knowledge intensive services. Software consultancy and supply played the dominant role in making the trade deficit. The balance-of-payment statistics in service trade reveal that the international competitiveness of the Korea's knowledge intensive sector is very weak compared with its user sector, the manufacturing industry.

<Table 3-4-3> Balance of Payments in KISA and CSS Services

(Unit: US$ billion)

CSS Services	1996	1997	1998	1999	2000
INDUSTRY TOTAL (A)	-20.624	-8.452	39.031	23.934	11.787
Service industry total (B)	-6.180	-3.201	1.024	-.651	-2.889
Knowledge intensive services (C)	-2.269	-1.530	-3.506	-4.205	-6.267
B/A (%)	30.0	37.8	2.6	-	-
C/B (%)	36.7	47.8	-	645.9	216.9
D/C (%)	14.0	22.3	3.9	5.5	6.1
CSS SERVICE TOTAL (D)	-317	-341	-138	-233	-385
721: Hardware consultancy	n.a.	30	15	0	-26
722: Software consultancy and supply	-283	-333	-153	-218	-369
723: Data processing	-2	1	6	-3	5
724: Database activities	n.a.	n.a.	n.a.	n.a.	n.a.
725: Maintenance and repair of office, accounting and computing machinery	n.a.	n.a.	n.a.	n.a.	n.a.
729: Other computer related service	-32	-38	-6	-12	5

Note: 'n.a.' indicates "data not available".

Sources: Korea Association of Information and Telecommunication (1997-2001), *Statistical Yearbook of Information & Communications Industry* (in Korean) (http://www.kait.or.kr), and Bank of Korea (www.bok.or.kr).

5. Summary and Policy Implications

The Korean service industry appears to be lagging far behind other OECD member countries since the portion of the industry out of GDP (49.9 % in 1999) was lower than that of developed countries. The knowledge intensive service (KIS) sector grew rapidly, accounting for 42.1 percent of the total sales of the service industry in 2000. Computer software system (CSS) service sector took a small portion of the knowledge intensive services. However, it turned out to be one of the fastest growing areas in Korea.

The average annual growth rates of the knowledge intensive sector for the 1996 to 2000 period was

4.6 percent in the number of firms, 3.6 percent in employment, 2.6 percent in sales, and 6.8 percent in imports. As a result of high growth, the position of the knowledge intensive service sector in the service industry continued to increase. This sector accounted for 9.3 percent in the number of firms, 69.8 percent in employment, 46.4 percent in imports, and 30.3 percent in exports of the service industry in 2000.

It was found that the Korean CSS service sector grew rapidly in every aspect. Average annual rate of its growth for the 1996 to 2000 period was 37.1 percent in the number of firms, 28.8 percent in employment, 77.9 percent in R&D expenditure, 24.6 percent in R&D human resources, 32.2 percent in sales, 12.8 percent in imports, and 82.9 percent in exports. They are extraordinarily high rates in comparison with not only other manufacturing industries but also other service industries.

Although the knowledge intensive service sector and the CSS service sector have shown high growth trends, their international competitiveness seems quite weak as it resulted in a huge trade deficit every year. In 2000, the deficit of the knowledge intensive service sector was valued at US $6.267 million, while that of the service industry totaled US $2.889 million. The trade deficit of the CSS service sector amounted to US $385 million. The large volume of trade deficit may provide both opportunities and threats to the Korean firms engaged in the knowledge intensive service sector in the future.

Based upon these findings from the general trends of knowledge intensive service activities and computer software system services, we can draw the following policy implications.

Firstly, Korea needs to strengthen the international competitiveness of its KIS sector. Rationales to increase the competitiveness of the sector are twofold: one is to prepare for a complete openning of the domestic service market and the other may be to reduce the large volume of trade deficit in knowledge intensive services. One of specific policy measures to strengthen the competitiveness of the KIS sector is to allocate more public R&D resources to knowledge intensive service activities (KISAs) so as to increase knowledge generation and diffuse it within firms engaged in KISA.

Secondly, Korea should continue to promote the creation of venture business, particularly in the KIS sector. Results of our analysis imply that there are great opportunities for ambitious entrepreneurs to enter into the KIS sector because it has been growing rapidly in every economic index, compared with other industries. Particularly, the CSS service sector that enjoyed the boom in the 1990s is likely to be the most prospective for venture creation in the future as well in Korea.

Lastly, the Government needs to collect and regularly publish data associated with KISAs, including CSS services. We found that statistics on KISAs are rare, and many kinds of data are missing so that it was difficult to obtain consistent information. Lack of data obviously was an obstacle to our in-depth analysis of KISAs in Korea. In order to collect consistent data on KISAs, we recommend that the Korean government support the establishment of an industrial association among firms engaged in the KIS sector or a public institute to conduct a project to collect data and publish it annually.

CHAPTER FOUR

Contributions of Public KISAs to Innovation of Computer Software System Services

It is widely accepted that we now live in the ``information society." In the information-based society of the 21st century, information becomes the vehicle for increased national competitiveness. The information society has rapidly formed as a result of computer hardware improvements and the underlying semiconductor technologies. But, the high cost and difficulties relate to software development have delayed the speed of informationization.

The level of software technology has come to be a dominant factor in determining national competitiveness. The American economic boom in the 1990s may have mainly been caused by the excellent software industry, even though Japan, Taiwan and Korea have caught up in the semiconductor industry. Therefore, many countries have made special national programs for supporting software development. In particular, governmental R&D has played an important role in catching up since CASE, demanding a massive amount of investment, dominated software industry in the 1980s. Important national programs include the fifth-generation (5G) computer technology program of Japan, the Alvey program of the U.K. and the European Strategic Program for Research on Information Technology (ESPRIT).

Korea’s computer software system (CSS) services have rapidly developed with the support of the government and its citizens having an understanding and mastery of the importance of information technology. However, its competitiveness is still very weak, so it faces serious threats from globalized foreign software companies.

This section looks at several issues concerning building the national capacity of the computer software system services in Korea. They are: “Why have public KISAs been provided to enhance the competitiveness of the software industry?” “What kinds of public KISAs have been established to improve the competitiveness of Korea’s CSS?” “How much have public KISA’s contributed to the innovation of Korea’s software-related firms?” and “How can the government improve the effectiveness of the public KISA?”

1. Rationales for the Government to Promote the Software Industry

Traded software has a tendency to become monopolized because of the first-mover advantages caused by two characteristics of the software industry: the economics of software production and the role of standards and network externalities. First, the economics of software production is related to the fixed costs of development. The cost to reproduce software is almost zero. Dominant software can cover the large markets without additional production cost.

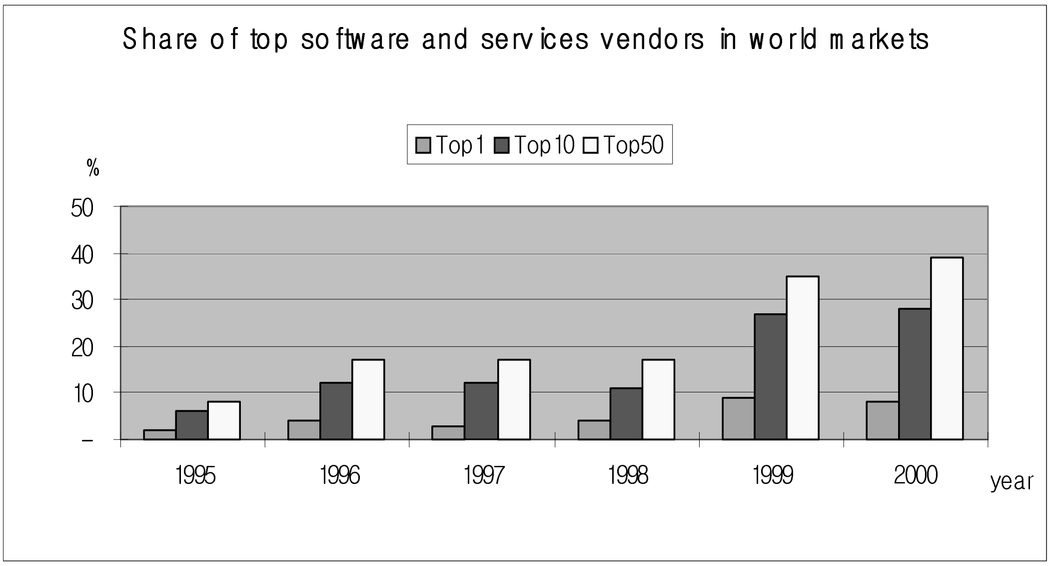
The second characteristic, the role of standards and network externalities, may make a new entrance into the market difficult. Once a first-mover is established, the methods adopted by the first-mover become standard. The more people that use a specific software, the greater is the first-mover's dominance over other people to use that software. In this case, users tend to lock in to a dominant software system so switching costs become larger.

Shapiro and Varian (1999) analyzed the underlying sources of switching costs along the types of lock-in: contractual commitments, durable purchases, brand-specific training, information and databases, specialized suppliers, search costs, and loyalty programs (see Table 4-1-1). Figure 4-1-1 shows that the market share of the top ten software and services vendors in the world increased from 6% in 1995 to 28 % in 2000.

<Table 4-1-1> Types of Lock-In and Associated Switching Costs

Types of Lock-in	Switching Costs
Contractual commitments	Compensatory or liquidated damages
Durable purchases	Replacement of equipment; tends to decline as the durable ages
Brand-specific training	Learning a new system, both direct costs and lost productivity; tends to rise over time
Information and databases	Converting data to new format; tends to rise over time as collection grows
Specialized suppliers	Finding a new supplier; may rise over time if capabilities are hard to find/maintain
Search costs	Combined buyer and seller search costs includes learning about quality of alternatives
Loyalty programs	Any lost benefits from incumbent supplier, plus possible need to rebuild cumulative use

Source: Shapiro and Varian (1999), Information Rules: a Strategic Guide to the Network Economy.



[Figure 4-1-1] Share of Top Software and Services Vendors in World Markets

Source: OECD (2002), *Information Outlook*.

These characteristics tend to lead to a monopolistic situation in the software industry, and so, make it very difficult for lagging countries such as Korea to enter into the world market's software sector with new products. Therefore, the Korean government has supported its software industry to catch up with advanced world-class firms. Countries that are rapidly catching up, such as India, Ireland, and Israel, have been implementing varieties of policy tools for supporting their own software industry since the 1980s.

2. Government Provision of KISAs in the CSS Services

Recognizing the importance of its own software industry, Korea enacted the "Software Industry Promotion Act" in 1987. The act includes basic guiding principles on software program development and promotion, legal framework and funding, and operating a software promotion committee. In order to enhance national competitiveness in 1994 through the information and telecommunication industry, which being in its formative stage could offer favorable windows of opportunity, Korea established a Ministry of Information and Communication (MIC).

The Software Industry Promotion Act requires that the MIC set up a long-term plan to promote the software industry in Korea. The Act defines the software industry as the development, production and distribution of software and related services and the development and operation of an information system. The MIC set up several institutes, including the Korea IT Industry Promotion Agency, Korea Software Financial Cooperative, and the Korea Software Industry Association.

The MIC has implemented direct and indirect support policies to promote the development of the software industry. Public KISAs that are involved in software development can be categorized as follows: human resource development, developing core software technologies, incubating software start-up firms, and expansion of the demand for software.

2.1 Human Resource Development

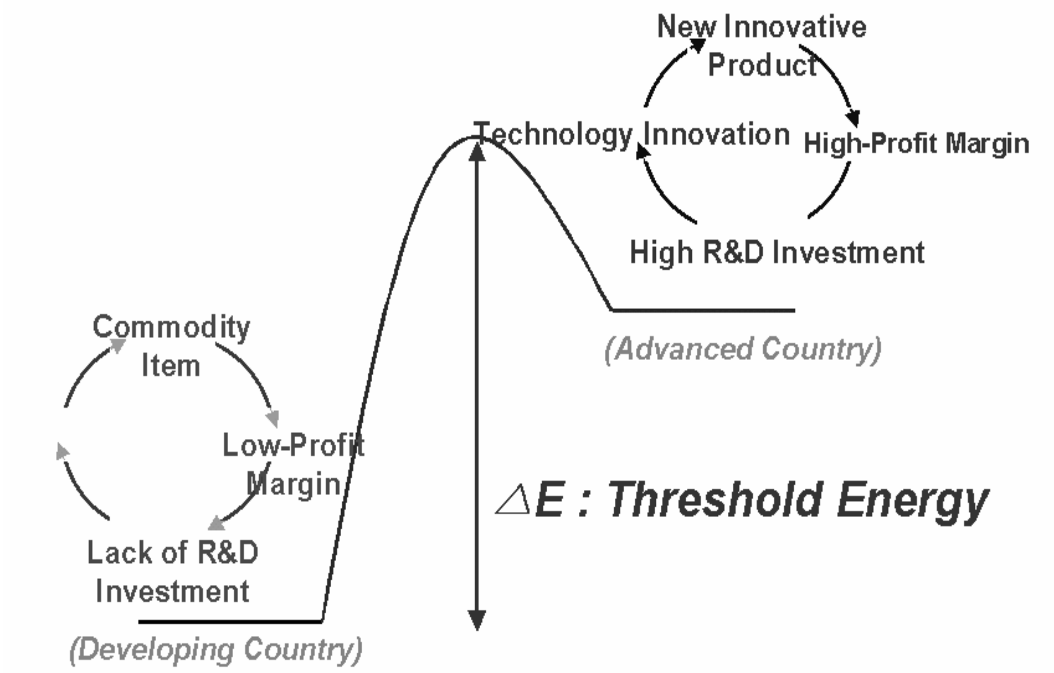
Producing a good quality of software is so dependent on highly skilled software engineers that the first priority of government policy has been placed on the development of highly skilled software personnel. In 1999, the government estimated that the software industry would be short approximately 100 thousand people at the bachelor degree level, 16 thousand at the masters, and 2 thousand at the Ph.D. level between 1999 and 2003. To overcome these projected shortages, the government invested 33.5 billion won in support of schools and teachers of information and communication, establishment and support of a technical high school specializing in software development, academic research, and basic university research in related subjects.

Furthermore, the government provides support for development of the University Information and Communication Research Center, the Information, Communication University Overseas Scholarship Program for ASIC design, and JAVA training. The government also sponsors information and communication re-training courses for the unemployed who have high academic backgrounds from traditional industries (see Table 4-2-1).

In addition, government support is provided for Professional Education Organizations for Information and Communication, a Cyber University for Information and Communication, the invitation and training of foreign IT specialists and experts, and New Venture Business Competition for Information and Communication.

2.2 Developing Core Software Technology

Although Korea has made good progress so far, it is facing a big challenge in the emerging new wave of the knowledge-based economy where innovation through exploitation of knowledge is a main driver of economic growth, because Korea's past rapid growth resulted mostly from imitating and absorbing technologies from advanced countries and making many incremental process innovations. So, the main aims of science and technology policy is to provide the threshold energy needed to escape from the low-level trap and attain the virtuous loop of high R&D investment, technology innovation, new innovative products, and high-profit margins (see Figure 4-2-1).



[Figure 4-2-1] Jumping from Imitators to Innovators.

In 2001, the total R&D budget of the Korean government was US $3.5 billion, and 30% of that was invested in developing information technology. The MIC since 1986 has developed national projects concerned with information communication technology. In 2001, the MIC funded US $ 0.7 billion for developing information technology.

Even though a huge amount of R&D budget was allocated to developing information technology, the trade deficit in the electronics sector has increased (see Table 4-2-2).

<Table 4-2-1> Human Resource Development in the Software Industry (2000)

Program	Content
Academic cooperation between Korea and Carnegie Mellon University for software professionals	Instituting re-training courses for Korean industrial, educational and R&D experts at Carnegie Mellon University
Establishing venture business courses in Korea and in Stanford University	Sending leading software professionals to Stanford University for intensive short term training
Developing JAVA professional personnel	Training in JAVA technology has become more important in the internet environment
Supporting training in software technology to low-income youth	Internet/multimedia software development by providing one to three months training of people

	from low income families, teenagers supporting their siblings, and low-income youngsters

Source: MIC (2001), Information & Communication White Paper.

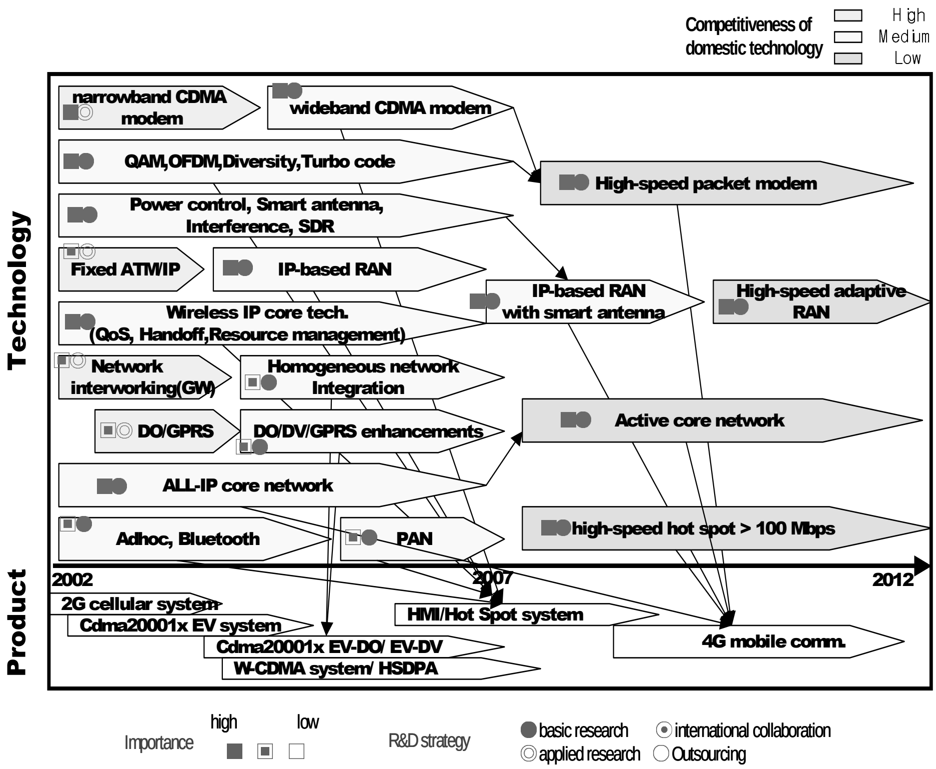
<Table 4-2-2> Technology Balance of Payment in the Electronics Sector

(Unit: US $ billion)

Year	1997	1998	1999	2000
Technology Import	1.251	1.216	1.492	1.839
Technology Export	.61	.49	.122	.145
Trade Deficit	1.190	1.167	1.370	1.694

Source: Ministry of Information and Communication.

For efficient utilization of the national R&D budget, the Korean government created a National Technology Road Map (NTRM) as a guideline for national R&D programs and firms' R&D strategies. The committee for making the NTRM looked ten years ahead in domestic and international industry development and national demand. Related with IT, it set the vision for meeting a variety of human needs in all areas of life by making IT service more intelligent, mobile, and user-friendly.



[Figure 4-2-2] Technology Roadmap for High-speed Wireless Multimedia / 4G Mobile Communication

Source: Ministry of Science and Technology(MOST).

Based on its foresight, the committee identified forty-nine strategic products and functions that would be critical to economic growth in the next ten years. Ninety-nine key technologies were selected from those forty-nine strategic products. In addition, the government laid out detailed development maps for each key technology area, and reported to them to the National Science Technology Committee in November 2002, whose chairman is the nation's president. Key technologies concerning software development include: the standard, design and reuse of software; information search DBMS technology; high-speed wireless multimedia/ fourth generation mobile communication; tera-bit optical communication elements technology; and others. The technology road map includes objectives of technology development, projected effects, and timetables to build the required technological capabilities and strategies to develop the technologies (see Figure 4-2-2).

The government intends to utilize the NTRM as a guideline for future strategies and the national technology development process so that R&D resources can be effectively utilized.

2.3 Incubating Software Start-up Firms

The MIC founded the center for supporting start-up software companies, and supplied the work places, intra-net, and expensive workstations in the center. Because over 60% of the companies dealing with software are small companies with less than thirty employees, this center performs an important role in providing information and equipment to small firms. After growing to the level of surviving the competitive international software market, these firms graduate from the center and are provided with separate office space and equipment.

Because private investors were reluctant to fund start-up software companies, the government initiated the formation of venture capital. In 2001, the sum of venture capital funded by the Ministry of Information and Communication, Ministry of Science and Technology, and the Small and Medium Business Administration was about US $50 million, which amounted to 90% of the total Korea's venture capital.

The government supports mutual aid associations, which grant loans at low-interest rates and without collateral to very small software firms not capable of borrowing money from ordinary financial agencies. The total assets of all mutual aid associations were about US $16 billion in 2002, about US $283 million of which was contributed by the government. The mutual aid software association provided SMEs with about US $2.109 billion in loans between 1998 and 2002.

2.4. Expanding Software Demand

The MIC has implemented a policy to expand the demand for software in order to overcome the small domestic market. The MIC encourages the public sector to use as many computers as possible and to make as many public services on-line as possible. Examples include setting up websites for almost all public institutes and issuing a national ID certificate for the website. Since 1996, the MIC has announced periodically the estimated public demands for software. The aim is to help small and medium sized software firms market their software. The MIC also helps with the distribution of software by setting up cyber markets and Soft Expos, where the MIC awards prizes to excellent software developers in order to encourage further development of high quality software. The government regulates illegal copy of software, and it contributes to sales of software.

This policy to expand the demand for software has contributed to the huge increase of domestic demand for software from US $2.416 billion in 1996 to about US $10.916 billion in 2002. The ratio of illegal software copy dropped from 70% in 1996 to 48% in 2001. In addition, there is an indirect policy tool that includes a tax deduction granted to companies concerned with software. The government allows tax deductions related to investment in SCM and CRM, purchase of computer hardware and software, and information processing.

3. Public KISA Usage

As explained above, the government provides support for KISA by implementing a variety of policies for enhancing Korea's software industry. In 2001, the government invested about US $1 billion in R&D to develop information technology. According to the MIC, the government fostered the training of 194,656 IT professionals and 1.740 million persons having low-level IT skills between 1997 and 2000. The center for supporting start-up companies founded some 1,750 software firms, and of them, 594 firms grew to become independent from the center between 1996 and 2002 (see Table 4-3-1).

<Table 4-3-1> Number of Centers for Supporting Start-up Software Companies

Year	1996	1997	1998	1999	2000	2001	Total
Center	1	4	2	4	3	2	15
Start-up	24	80	239	412	609	386	**1,750**
Graduate	-	-	37	130	185	242	594

Source: Ministry of Information and Communication.

We conducted field work for a period of two months, from September 2002 to October 2002, to find out how much public KISA suppliers of ICT services have used. Among the 250 questionnaires sent, fifty-eight questionnaires were collected. The number of ICT services suppliers amounts to forty, which is explained in Table 4-3-2. To deepen the findings of the questionnaire, we held semi-structured interviews with people from seventeen of the firms.

<Table 4-3-2> Classification of Respondents Related with ICT Services

Classification	No. of firms	Venture Firm		Organization		
		Yes	No	Independent	Subordinate	Others
Large Firms	4	2	2	3	1	
SMEs	36	29	7	34	1	1
Total	40	31	9	37	2	1

Source: STEPI Field Survey (October, 2002).

Although the government regards its policies to be successful, the survey results showed that the firms in the CSS service sector have not used public KISAs to any large extent. When they needed knowledge for solving their internal problems, they relied more on other private firms than on public KISAs. Only 13% of the surveyed firms solved their problems by asking public institutes and universities for information (see Table 4-3-3).

<Table 4-3-3> Methods of Solving Knowledge Shortage Issues

No. of respondents = 40

Items	SMEs	Large Firms	Sum	%
Employing external experts	15	2	17	44.7
Licensing from foreign firms	7	1	8	21.1
Strategic alliance with related firms	28	0	28	73.7
Foundation of oversea research lab.	0	2	2	5.3
Asking to domestic public institutes and universities	4	1	5	13.2
Asking to foreign counterparts	3	0	3	7.9
Total*	60	6	66	100.0

Note: Duplicate answers were allowed.

Source: STEPI Field Survey (October, 2002).

In case of using public KISAs, it was R&D service and ICT training that firms used most frequently (see Table 4-3-4). This is a reflection of the effort made by the government. In 2001, over 30% of the government's total R&D budget, which was the largest, was allocated to the information and communication technology. The MIC has supported programs to train graduates not yet employed. In 1999, the MIC educated 3,500 graduates in ICT switching, multimedia contents, start-up related with the Internet, etc., by providing some 7.7 billion won (see Table 4-3-5).

When comparing large firms and SMEs, while large firms used more ICT experts than SMEs, SMEs used more KISA in employing professionals and developing products and processes than did large firms.

<Table 4-3-4> Usage of Public KISAs by Suppliers of ICT Services

No. of respondents = 40

Public KISA	Average Score			χ^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 0.15 level, *: significant at the 0.05 level

Source: STEPI Field Survey (October, 2002).

<Table 4-3-4> shows that the average figures for R&D service and ICT training is 2.0, which means that companies in the CSS service sector use public KISAs ”a few” times. According to the semi-structured interview, the major reason why ICT suppliers did not use public KISAs as much was that the public KISAs were not relevant to their actual needs. Therefore, that implies that the government should closely interact with private firms in order to provide firms with relevant KISAs.

<Table 4-3-5> MIC Support for Training Courses in 1999

Courses	Budget (Billion Won)	No. of Trainees
ICT switching	4.0	2,000
Multimedia contents	2.1	700
International certificate	1.2	400
Start-up related with the Internet	0.2	400
Total	7.5	3,500

Source: Ministry of Information and Communication.

4. Contribution of Public KISA’s to Innovation-Capability Building in CSS Service Suppliers

4.1 Sources and Processes of Innovations in KIS Suppliers

As software has played an increasing role in the economic returns of computer-based hardware (Mowery, 1996) and information communication technologies (ICTs) are used in almost all industries, scholarly studies of software have recently been gaining popularity. Brooks (1974), who was the first scholar to look into the innovation process of software development, analyzed why programming was hard to manage. He argues that the main reasons included management problems of large programming projects due to division of labor and the difficulties of preserving the conceptual integrity of the product itself.

According to Brooks (1974), the complexity and communication costs of a project rise with the square of the number of developers, while the work done only rises linearly. This is known as "Brooks' Law."

Although Brooks' Law was widely accepted, Microsoft demonstrated many innovations in software development by publishing software such as Windows operating system, MS Excel and MS Powerpoint, Cusumano and Selby (1995) identified the routine of frequent synchronization and periodic stabilization as a major source of Microsoft's success. The synch-and-stabilize principle labeled by Cusumano and Selby is attributed to modularization and the intra-net. They described the essence of this principle by the following statement: "Continually synchronizes what people are doing as individuals and as members of teams working in parallel on different features, and periodically stabilize the evolving product features in increments as a project proceeds, rather than once at the end of a project."

Pavitt (1997) attributed the main source of innovation in software development to the close relationship with advanced users. He approached "software as an element of a classification typology." He identified software as "specialized suppliers" among five major technological trajectories. The main sources of technology are advanced users and the main tasks of technology strategy are to monitor advanced user needs and to integrate new technology incrementally.

Quintas and Millar (1992) identified the sources of innovation in the software sector as change in technical practice. He identified growth of high level languages, software engineering, computer-aided software engineering (CASE) tools, prototyping techniques, and objected-oriented design and programming. He also argued that changes in the organization and management of software development were important to innovation. According to him, demand for high quality software drove changes towards more formal management for software development.

With an aim to finding out what facilitated innovations of Korea's computer software system services, we asked the question, "What were the important factors to innovations of your company?" in the questionnaire. The important factors in innovation include innovative efforts of all parts of the firm, R&D, core skilled manpower, and close cooperation among internal and external parts of firms (see Table 4-3-1). These results show that Korea's CSSS followed similar innovation patterns with world-class software firms in advanced countries.

<Table 4-3-1> Factors Enabling Innovations

No. of respondents = 40

Classification	SMEs	Large firms	Total
Innovative efforts of all parts of the firm	17	3	20
R&D	19	1	20
Core skilled manpower	17	0	17
Close cooperation among internal and external parts of firm	14	1	15
R&D planning and marketing	11	0	11
High quality administration	8	3	11
Marketing suitable to user needs	10	1	11

Providing customers with good A/S and education	7	0	7
Others	1	0	1
Total*	104	9	113

Note: Duplicate answers were allowed

Source: STEPI Field Survey (October, 2002).

4.2 Rapid Growth of Korea's CSS Services

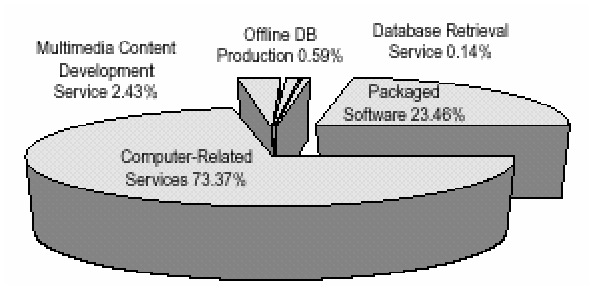
Several statistical indicators show that the software industry in Korea has grown rapidly. The total production of the software industry in 2000 grew to 7.897 trillion won, an increase of 21.5% compared to 1999 (see Table 4-3-2). Off-line database production showed an increase of 60.4%, the largest percentage increase in production in 2000. Computer-related services software constitutes 73.4% of the total software industry, and packaged software occupies 23.5%, placing it second behind Computer-related services software (see Figure 4-3-1).

<Table 4-3-2> Current Status of Software Production

(In millions of Korean won)

Classification	1995	1996	1997	1998	1999	2000
Packaged Software	727,593	987,747	1,260,606	1,259,450	1,320,413	1,852,972
Computer-Related Services	918,309	1,609,280	2,146,206	3,336,042	5,016,842	5,794,226
Multimedia Content Development Service	-	32,666	35,800	44,861	123,929	192,014
Offline DB Production	27,282	29,145	48,612	35,824	29,197	46,834
Database Retrieval Service	1,969	10,781	12,197	7,228	8,274	11,235
Total	1,675,153	2,669,619	3,503,421	4,683,405	6,498,655	7,897,281

Source: Ministry of Information and Communication.



[Figure 4-3-1] Current Status of Software Production in 2000

Source: Ministry of Information and Communication.

The total software industry export in 2001 grew to US $29 million, an increase of 38.7% compared to 2001. Furthermore, the entire domestic demand for software in 2000 grew to 8,395 trillion won, showing a growth rate of 22.7%. Was the upswing in Korean computer software system services enabled by public KISAs or not?

3.3 Findings from the Survey Results

In order to examine in detail innovations of KIS suppliers, we asked a question, “How much did public KISAs contribute to product, process and organizational innovations of your company?” in the questionnaire. We found that the scale of consulting service on product development and process engineering to product innovation was the largest, 4.7. In the cases of process innovation and organizational innovation, R&D service was the most important contributor to innovation. Among innovation types, public KISAs had the largest impact on product innovation. However, KIS suppliers did not regard public KISAs as having contributed much to their innovations. The average scale was under 3. Three means “much.”

<Table 4-3-3> Contribution of Public KISAs to Innovation

(Unit: Scale*)

KISAs	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 agencies	2.3	1.8	2.0
Others	3.0	2.0	1.7
Average	2.8	2.3	2.2

Notes: * Scale (never: 1, seldom: 2, a little: 3, much: 4, very much: 5)

Source: STEPI Field Survey (October, 2002).

5. Policy Implications

Even though the government has implemented many policies for facilitating the growth of the software industry, software firms do not think that actions by the government contributed to their technological innovations. The main reason is that the policies cannot reflect the requirements of software companies. For example, even though IT related curriculums have expanded in universities, the contents of teaching are not closely connected with actual skills required by the software firms. Nearly all graduate students have to take other courses arranged by the companies that initially employ them. According to another survey, only 34% of the software companies in Korea use the estimated software demand data provided by the government. They think that the data are not reliable.

That reminds us of Pavitt’s research (1997) that concludes that the main sources of technology in the software sector are advanced users and the main tasks of technology strategy are to monitor advanced user needs and to integrate new technology incrementally. Therefore, public KISAs related to Korea’s CSS services should take into account user requirements all the time.

Recently, South-East Asian and European countries have provided public KISAs to adopt open source software such as Linux and Apache as their standards in order to overcome the dominance of the specific world giant firm Microsoft. Likewise, Korea’s MIC drew up a plan to support open source software development, especially the localization of open source software. Hancom, one of our interviewees specialized in packing open source software and making the Korean Word Processor running on Linux, explained its energetic plan to provide high schools and universities with training based on open source software. That kind of effort may open a window of opportunity to other developing countries like Korea to catch up in computer software system services.

CHAPTER FIVE

Contribution of Private KISAs to Innovation of Computer Software System Services

This chapter looks at aspects of private KISAs related to innovation in the field of computer software system (CSS) services. On the basis of the field survey we conducted in 2002, we will present an assessment of how the private KISAs are received and used by CSS service suppliers. The main focus of our analysis is placed on the contribution of private KISAs to innovation-capability building in CSS service suppliers.

1. Private KISAs in CSS Services

As is the case with any other industries, computer software systems (CSS) services make use of various knowledge intensive service activities for innovation. In this chapter we are mainly concerned with CSS suppliers as users of KISAs. Notably the CSS service industry is both users of externally provided KISAs and producers of KISAs. In other words, CSS service suppliers can use not only those KISAs provided from the other sectors, but also those KISAs such as software and computing system services produced by the CSS service industry. Private knowledge intensive service activities (KISAs) refer to innovation services that include a major thinking or cognitive element provided by the private sector.

CSS service suppliers do not use private knowledge intensive service activities to the same degree. Which private KISAs are more used? In our survey, firms were asked to assess the frequency of using various private KISAs on a scale 1 to 5, where 1 indicates “never” and 5 “very frequently”. The mean scores of their assessments are given in Table 5-1. It was found that the most frequently used private KISAs were software package publishing services with mean score of 3.6. Those categories of KISAs that received above average mean score were intellectual property-related services (3.0), ICT related training services (2.9) and R&D services (2.9). From this, we can say that CSS suppliers made use of software publishing, IP-related professional services, ICT-related training services and R&D services more frequently than other categories of private KISAs.

<Table 5-1> Frequency of KISAs Usage among CSS Service Suppliers

KISAs	Private	Public
Software publishing (package)	3.6	1.6
IP-related professional services	3.0	1.6
ICT related training services	2.9	2.0
Research and Development	2.9	2.0
ICT Professional expertise (advice)	2.4	1.4
IT technical consulting services	2.2	1.4
Management consultancy	2.2	1.4
Agency supply of highly skilled personnel services	2.1	1.3
Engineering consultancy	1.7	1.2

Note: Figures denote means of ranked scores on a scale 1-5 (1 never, 5 very frequently)

Source: STEPI Survey (October, 2002).

When we compare the use frequency between private and public KISAs, it is evident that private KISAs were much more used by CSS service suppliers as shown in Table 5-1. Here again software publishing services exhibit the greatest gap in the use frequency between private and public KISAs. Firm size may be an important factor for the use of private KISAs. Table 5-2 presents a comparison between large firms and small & medium-sized firms in the use of private KISAs. Large firms seem to use KISAs more frequently than S&M firms, except the case of ICT professional expertise, though there are no statistically significant differences. In the case of R&D services, the difference by firm size is statistically significant at the 0.05 percent level.

<Table 5-2> The Usage of Private KISAs by Firm Size

Private KISAs	Mean Score	
	Large E	S&ME
ICT Professional expertise (advice)	2.25	2.41
ICT related training services	3.75	2.83
IT technical consulting services	3.00	2.10
Software publishing (package)	4.00	3.52
Research and Development	4.25	2.69
IP-related professional services	3.75	2.87
Management consultancy (organizational innovation)	2.75	2.10
Engineering consultancy (product or process development)	2.25	1.62
Agency supply of highly skilled personnel services	2.75	2.03

Note: Figures denote means of ranked scores on a scale 1-5 (1 never, 5 very frequently)

Source: STEPI Survey (October, 2002)

2. Contribution of Private KISAs to Innovation of CSS Services

2.1 Types of Service Innovation

As mentioned before, the CSS services sector not only use KISAs but also produce them. We can distinguish three types of innovation that involve knowledge intensive service (Pressl 2000, 129). As outlined in Figure 5-1, the first one is initiated by service producing firms towards an anonymous market. In the second type, innovation takes place by the demand of clients, who ask for a particular service to solve a problem they have. In order to meet the demand of clients, service suppliers have to render a new service through innovation.

The third type differs from the second one in that the service provider makes service offer and the service provided itself is not necessarily innovative but entails an innovation in the client's activities through interactions between service suppliers and their users. Bearing in mind these three different types of innovation, we will evaluate the contribution of private KISAs to innovation of the CSS service industry. .

Service Firms *User Firms*

(1) Innovation ->->-> Service provision ->->-> Use of service

(2) Service offer <-<-<- Service contract <-<-<- Problem identification
Innovation ->->-> Problem solution ->->-> Use of new service

(3) Service offer <-<-<- Service provision <-<-<- Innovation

[Figure 5-4] Types of Service Innovation

2.2 Private KISAs in Innovation

As Table 5-3 shows, CSS service suppliers that carried out innovation for the last two years tended to use private KISAs more frequently than those without innovative performance. This can be taken as evidence to expect that increased competences through the active usage of KISAs will entail increased innovation in CSS service suppliers.

In addition, CSS service suppliers were asked to evaluate the extent to which various private knowledge intensive service activities they used contribute to product, process and organizational innovation. As can be seen in Table 5-4, certain private KISAs such as software publishing services, R&D services, and ICT-related training services were found to contribute to product innovation for CSS service suppliers than the other private KISAs, whereas only two categories of private KISAs such as software publishing and R&D services were discovered to make above average contribution to process innovation.

On the other hand, no private KISAs were thought to make a considerable contribution to organizational innovation of CSS service suppliers. This is different from the survey results on public services. It was found that public services weakly contribute to the organizational innovation of CSS service suppliers.

<Table 5-3> Private KISAs and Innovation

Private KISAs	Innovation in the last 2 years	
	Yes	No
ICT-related professional expertise services	2.5	1
ICT training services	2.9	3
ICT SI hardware consulting services	2.3	1.5
Software publishing services	3.6	3.5
R&D services	3.0	1.5
IP-related services	3.0	2
Management consulting services	2.3	1
Engineering consulting services	1.7	1.5
Employment services	2.2	1.5
(N)	(36)	(2)

Note: Figures denote means of ranked scores on a scale 1-5 (1 ‘never’ and 5 ‘very frequently’). T-test has not produced statistically significant differences between means.

Source: STEPI Survey (October, 2002).

<Table 5-4> Contribution of Private KISAs to Product Innovation

Private KISAs	Types of Innovation		
	Product	Process	Organization
ICT Professional expertise (advice)	2.88	2.75	2.50
ICT related training services	3.25	2.79	2.52
IT technical consulting services	2.68	2.50	2.36
Software publishing (package)	3.38	3.40	2.57
Research and Development	3.30	3.08	2.60
IP-related professional services	2.88	2.33	2.33
Management consultancy	2.25	2.18	2.48
Engineering consultancy	2.17	2.05	2.05
Employment agency supply	2.52	2.29	2.17

Note: Means are of ranked scores on a scale 1-5 (1 not at all, 5 very great contribution).

Source: STEPI KISA survey, 2002

2.3 Sources of Service Innovation

For successful innovation, firms need to acquire and absorb various information sources. Table 5-5 shows an analysis of the importance of various sources of information for innovation. According to this, CSS service suppliers considered the most important sources of ideas or information for innovation is intra-firm followed by other firms and market. It is notable that intra-firm or other firms/markets were accorded importance far higher than other sources. As users and producers of KISAs, CSS service suppliers need to integrate various sources of information and knowledge in the intra-firm’s innovation process.

<Table 5-5> Importance by Sources of Innovation

Information Sources	Mean Score
Within the firm	4.08
Other firms and market	3.89
Professional meetings and exhibitions	3.17
News papers, TV and internet	3.14
Professional journals	2.94

Public research centers	2.19
Universities	2.14
Patent information	2.14
Intermediary organizations	1.78

Note: Means are of ranked scores on a scale 0-5 (0 insignificant, 5 crucial).

Source: STEPI Survey (October, 2002)

2.4 Learning through Networking

How do CSS service suppliers solve problems or lack of knowledge in the innovation process? As summarized in Table 5-6, they can adopt various strategies but a great majority of CSS service suppliers preferred to making strategic alliances with other firms for mutual benefits.

Innovation leads to knowledge creation. The process of knowledge creation is characterized by a more formal research and development process, integrating all kinds of tacit and explicit knowledge from vertical (suppliers) and horizontal (competitors), co-operation partners and other external knowledge sources. These different external sources underline the importance of KISAs in the innovation network.

<Table 5-6> How to Solve Lack of Knowledge/Information in Innovation Process

Methods	Count	Percentage of Responses	Percentage of Cases
Employing experts	17	25.8	44.7
Licensing from oversea firms	8	12.1	21.1
Strategic alliance	28	42.4	73.7
Setting up a lab overseas	2	3.0	5.3
Consulting with domestic research institutes/universities	5	7.6	13.2
Consulting with overseas firms	3	4.5	7.9
Others	3	4.5	7.9
Total responses	66	100.0	173.7

Note: Multiple responses; 38 valid cases.

Source: STEPI Survey (October, 2002).

3. Contribution of Private KISAs to Innovation-Capabilities

One of the key questions related to KISAs for innovation concerns whether and how private KISAs contribute to innovation capability of CSS service suppliers. In this study, we take ‘innovation capability’ to refer to “technological capability” or those activities which enable a firm to choose and use technology (knowledge) to create strategic competitive advantage. Those activities include

- Develop awareness of the need to change
- Search actively for threats and opportunities in its environment
- Identify and build distinctive core competence
- Develop and deploy a technology strategy which supports the business
- Seek out, assess and select appropriate technological solutions and the means for obtaining them

- Acquire and absorb such technologies (knowledge)
- Implement and use them effectively
- Learn and develop the capacity to manage technological change more effectively in the future

The concept of “dynamic capabilities” (Teece, Pisano and Shuen, 1997) highlights knowledge intensive service activities in terms of competence-supplying and competence-reproducing interactions between service firms and clients, and competence-increasing or competence-reproducing trajectories of firms and clusters within competitive environments (Hales, 2000).

Within a dynamic capabilities framework, it can be expected that knowledge intensive service activities contribute to technology capability through competence-supplying and competence-reproducing interactions between service producers and users. The result of our survey sheds light to some aspects of this issue. Let us first outline variables for technology capability before we proceed to test the hypothesis that there exist no relationship between the use of KISAs and technological capability.

Brief description of variables for technological capability is as follows. The first variable is awareness of the need to change (AWARE). In our survey questionnaire we investigated the extent to which firms were aware of the need to change for competitiveness. Our respondents were asked to assess their firm’s awareness of change on a 1-5 scale where 1 means ‘not at all’ and 5 ‘very much’. The mean score to this question was 4.36. This shows that CSS service suppliers seemed highly aware of the need to change.

The second variable is environmental search (SEARCH). We wanted to know about how often firms conduct trend survey to search for opportunities and threats in terms of technology or market environment. Respondents were asked to give score on a 1-5 scale where 1 denotes ‘not at all’, 2 ‘less than 0.5 times a month’, 3 ‘0.5 to less than 1 times a month’, 4 ‘ 1 to less than 2 times a month’ and 5 ‘2 times and more a month’. The mean score of the answer to this question was 3.85, indicating that CSS service suppliers conduct boundary spanning activities quite often (nearly once a month) in search for threats and opportunities in their environments.

The third variable is core competence (CORECOMP). A question was put about the extent to which their firms identify distinctive core competences and build them within the firm. Respondents were asked to answer to this on a 1-5 scale where 0 means ‘not at all’ and 5 ‘very much’. The mean score appeared to be 3.67. The fourth variable is technology strategies (TECSTRA). Respondents were requested to rate the importance their firms placed on technology strategies to support business on a 1-5 scale where 1 denotes ‘not at all’ and 5 ‘very much’. The mean score was 3.33.

The fifth variable is competitiveness of technological solutions (TECSOL). We put a question about competitive advantages of technological solutions that firms have acquired and absorbed. Respondents were asked to answer on a 1-5 scale. Here, 1 means ‘disadvantaged’, 3 ‘so and so’ and 5 ‘advantaged’. The mean was 3.15. An analysis of correlation between various private KISAs and variables for technological capability is presented in Table 5-7.

<Table 5-7> Correlation between Private KISAs and Technological Capability of CSS Service Suppliers

	Technological Capability

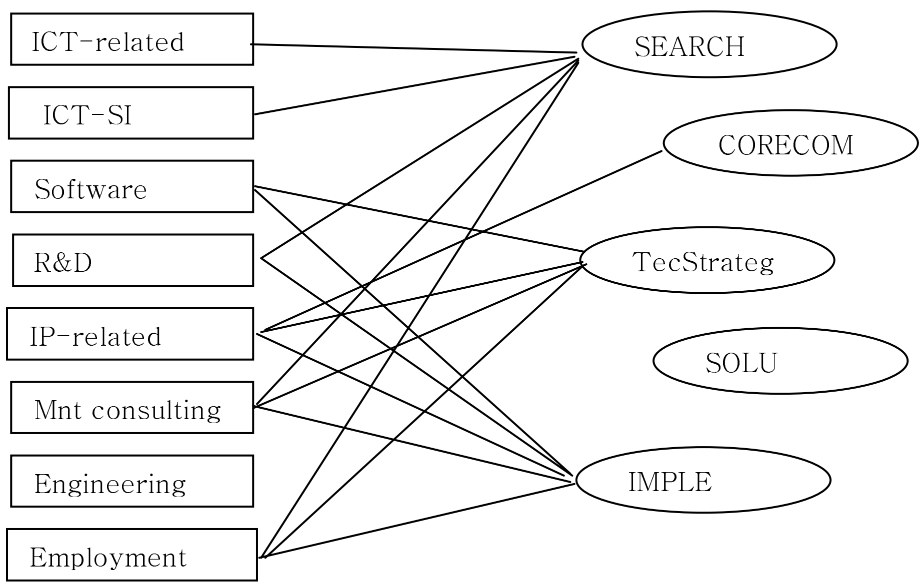
Private KISAs	Technological Capability				
	SEARCH	CORECOMP	TecStra	SOLU	IMPLE
ICT_PROF	0.303	0.237	0.293	0.113	0.196
ICT_TRAIN	0.379*	0.213	0.333	0.146	0.359*
ICT-SI	0.540**	0.145	0.303	-0.080	0.084
SOFTWARE	0.251	0.167	0.445**	0.118	0.464**
R&D	0.458**	0.364*	0.411*	0.116	0.471**
IP	0.308	0.350*	0.400*	0.296	0.639**
MNT_CONS	0.394**	0.227	0.390*	0.237	0.459**
ENG_CONS	0.236	-0.024	0.047	-0.049	-0.036
EMP	0.475**	0.221	0.487**	0.295	0.415*

Notes: Figures are correlation coefficients (Spearman's rho); * indicates that correlation is significant at the 0.05 level (2-tailed); **indicates that correlation is significant at the 0.01 level (2-tailed).

Source: STEPI Survey (October, 2002)

Statistically significant correlations are as follows. ICT_TRAIN exhibits a modest correlation with SEARCH (rho .379*) as well as with IMPLE (rho 0.359*). From this one can say that the more CSS firms made use of ICT-related training services, the more they were likely to have competence to search opportunities and threats in the environment and implement technological solutions they acquired for business.

We can also see a relatively strong correlation between ICT-SI and SEARCH (rho 0.540**). This implies that the use of ICT-related technical consulting services such as system integration tended to increase the user firms' competence to search opportunities and threats in the environment. SOFTWARE exhibits correlation with TECSTRA (rho 0.445**) and IMPLE (rho 0.464**).



[Figure 5-5] Private KISAs and Technological Capabilities

In addition, non-ICT related KISAs have been found to show a correlation with technological capabilities. For instance, the use of R&D services are related with competences such as SEARCH (rho 0.458**), CORECOMP (rho 0.364), TECSTRA (rho 0.411*) and IMPLE (0.471**). IP-related services also show correlations with competences such as CORECOMP (rho 0.350*), TECSTRA (rho 0.4*) and IMPLE (rho 0.639**). The usage of management consultancy services appeared to be associated with competences such as SEARCH (rho 0.394**) and IMPLE (rho 0.459**). The employment of skilled personnel services was clearly correlated with competences such variables as SEARCH (rho 0.475**), TECSTRA (rho 0.487**) and IMPLE (rho 0.415*).

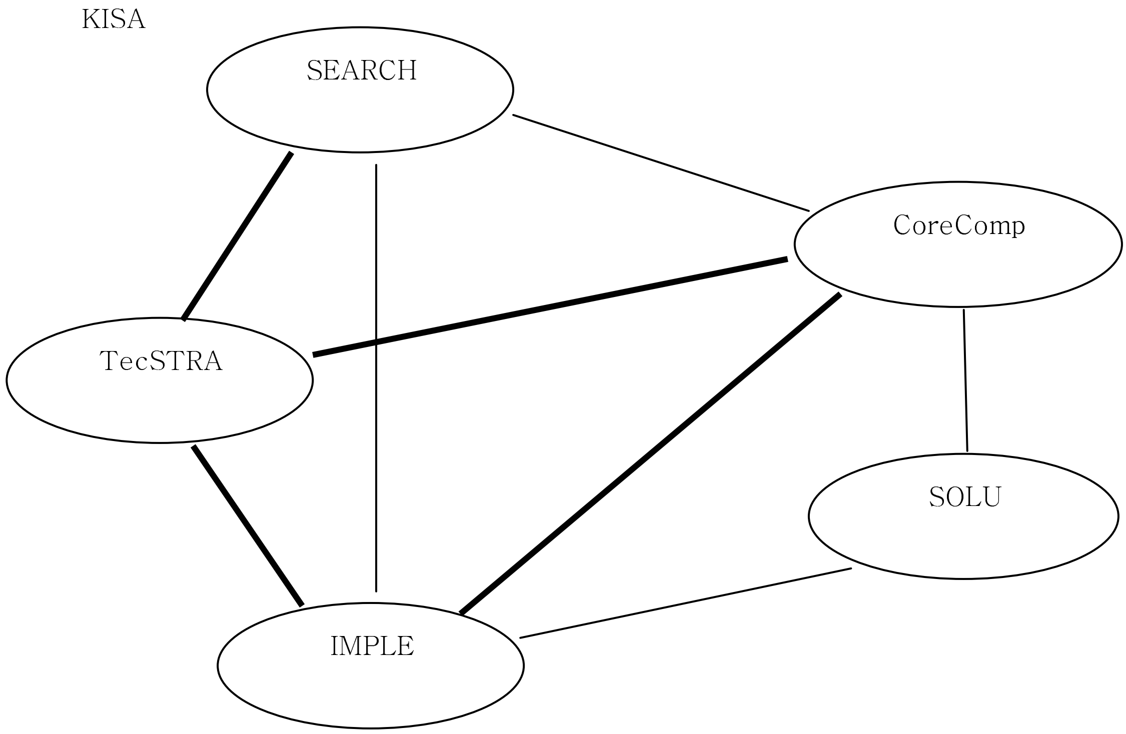
On the basis of correlation analysis thus far, we can tentatively draw a map to schematically show how various KISAs are related with technological capabilities of CSS service suppliers. As indicated in Figure 5-2, competences for environmental search (SEARCH), technological strategy (TECSTRA) and implementation of technological solutions (TECSOL) seem to be important factors in the way in which private KISAs contribute to technological capabilities of CSS service suppliers. These variables are not independent from each other, however. Table 5-7 presents an analysis of correlations between them. As illustrated in Figure 5-2

, there were strong correlations between them. Technological capabilities should be considered as ensemble of these competences.

<Table 5-8> Correlations between Variables for Technological Capabilities

Variables	AWARE	SEARCH	CORECOMP	TecStra	SOLU	IMPLE
AWARE	1.000	.312	.245	.187	.232	.397*
SEARCH	.312	1.000	.331*	.508**	.156	.329*
CORECOMP	.245	.331*	1.000	.566**	.424**	.501**
TecStra	.187	.508**	.566**	1.000	.199	.587**
SOLU	.232	.156	.424**	.199	1.000	.435**
IMPLE	.397*	.329*	.501**	.587**	.435**	1.000

Notes: * indicates correlation is significant at the .05 level (2-tailed); ** -- indicates correlati on is significant at the .01 level (2-tailed).



Note: a thick line denotes correlation coefficient over .5

[Figure 5-6] Linkages between Variables

4. Conclusions and Policy Implications

We have considered the use of private knowledge intensive activities in computer software system services with a particular focus on its contribution to innovation capabilities. Let us pull together major findings and draw implications for national science and technology policy.

Our analysis of empirical data drawn from CSS service suppliers has shown that the use of private KISAs is likely to lead firms to innovation. In considering whether and how private KISAs contribute to innovation capability of CSS service suppliers, we have highlighted the concept of “dynamic capabilities”. Within a dynamic capabilities framework, knowledge intensive service activities are seen in terms of interactions between service providers and service users. Certain patterns of relationship between private KISAs and technological capabilities of CSS service suppliers have been identified. Our analysis was based on a limited number of cases. Whether such patterns reflect peculiarities of the CSS service industry needs to be further studied.

Policy implication from our analysis is that the need of shifting foci in science and technology policy towards taking private KISAs as important elements of the national and sectoral innovation system of Korea. There should be a right balance in the private and the public KISAs for better management of the national innovation system. In addition, it should be noted that small and medium sized firms can be disadvantaged in the use of private KISAs on account of lack of resources. This implies that government should support small and medium sized firms in the CSS service industry too.

CHAPTER SIX

CSS Services Integration and Capability Building in User Firms

1. Introduction

User firms utilize computer and software system (CSS) services more and more intensively in this era of “rapid response.” Increasing interests in detecting customers’ tastes and optimizing the flow of materials requested by firms to coordinate diverse information and to measure and calculate complex parameters. The importance of CSS services can be easily recognized because they have continuously contributed to the information intensive manufacturing sector by adding higher value. The significant role of adding value can be categorized into the following purposes: 1) helping the automation of manufacturing, 2) providing better communication with other sectors and customers, and 3) extending the functions of products. For these purposes, CSS services become integrated to or loosely coupled with manufacturing firms.

This chapter analyzes the usage of KISAs by user firms in the manufacturing sector, and especially focuses on the service inputs from CSS service suppliers. It also aims to find a pattern of user firms’ efforts to integrate knowledge intensive services. The level and rationale of integration provides valuable insight to building a fair anti-trust policy on vertical integration. In addition, this study aims to comprehend the capability building of user firms through the usage of CSS services.

For these purposes, this chapter discusses the usage of CSS services by user firms in the manufacturing sector, and subsequently analyzes a case of CSS services usage in the automobile sector. It suggests a plausible form of CSS services integration based on the model of “encapsulation.” It reviews general level of CSS services usage by user firms in the manufacturing sector, and investigates the pattern of CSS services usage, focusing on the level of in-house and level of recognized complementary. Lastly, it describes the benefit of utilizing CSS services and KISAs respectively, and argues that the capability building of user firms in the manufacturing sector depends on the degree of the usage of KISs in broad term.

In this study, the service encapsulation of manufactured products is reviewed by looking at the case of the automobile sector. Manufacturing activity is so diverse it is difficult to capture its characteristics from a single sector study, but this study intends to find some clues for understanding general trends and policy implications.

2. Encapsulation of CSS Services

CSS services can be divided into two major user sectors: the manufacturing sector and the service sector. The absorption of computer equipment in the financial and administrative services sector has been usually taken into account as the case of services innovation (Barras, 1986). Service innovations involve transformation, i.e. automation and rationalization of services into software products. If manufacturing firms master CSS services for controlling material flow, it is possible for them to apply the same software modules to the logistic services of product distribution. Therefore, CSS services function as a launch pad for the diversification of manufacturing firms into other knowledge intensive service sectors.

2.1 Content of CSS Services

User firms of CSS services in the manufacturing sector diversify into non-hardware services for customer care, such as arranging capital for the rent of product and for installation policy. As user integration of CSS services is important for their diversification, the characteristics of CSS service matters. CSS services are highly technology intensive, and division of labor is poorly defined.[2] For both service suppliers and their users in the manufacturing sector, knowledge intensive services can be easy targets for future business. CSS services suppliers independent of both parties may also emerge. Large manufacturing firms easily absorb and access general CSS competences.[3]

As CSS services become more specialized and sophisticated, user firms need to tap into outside competencies. A caveat is that integration of CSS services by user firms does not hamper the existence of independent CSS service suppliers as internal and external knowledge intensive services (KISs) is complementary (Mowery and Rosenberg, 1989). To understand the pattern of integration, we introduce the "encapsulation model" that describes the manufacturing core surrounded by services. The case of half integrated service by user firms in the manufacturing sector in the encapsulation model implies most vigorous and productive external usage of KISAs.

The second factor that affects integration appears to be the type of CSS services. CSS services that are usually delivered with software have a vague boundary as software can be purchased either as a packaged product or as a service subject to hardware configuration. This is especially true when firms like IBM bundled software services with expensive mainframe computers. As software has developed into an independent product, the characteristics of services have also changed dramatically. Software is embedded in services almost ubiquitously, especially in the financial sector. The disintegration of software also created further favorable conditions for user firms in the manufacturing sector to create internal software services. Distributed software competence over all sectors, including manufacturing, created a condition for half integration.

The final factor turns out to be level of user capability. Firms that lack software capability hire a customized programming service to produce firm-specific software, but large users in manufacturing, finance, and retail have internal resources to produce customized software. Furthermore, CSS services innovation needs the participation of capable users, which is a rare case of another KIS. The common developer of software suite called Software Development Kit (SDK) is especially devised for users with a supplier-level capability.

These differences between other KISAs and CSS services are expected to cause different patterns of usage by user firms. CSS services may cause more intense collaborative arrangements, which is productive, considering that CSS service innovation demands a tighter producer-user linkage than do other KISs.

2.2 Encapsulation Model

Table 6-2-1 demonstrates diverse forms of user firm engagements in KISs. The share of service activities is increasing in general. Firms using KISs have reinforced their customer relations management, which indicates essentially a diversification into services (a in Figure 6-2-1). KIS suppliers that previously

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2 Research and development services demonstrate the similar characteristics from this perspective.

3 Many software engineers work in manufacturing firms. For example, Panasonic mobile phone factory hires about 300 software engineers (Author's interview in Japan, 2000).

sold and provided after-service have also diversified into upstream production (b in Figure 6-2-1). Increasing contact with service suppliers created the need to establish a division within user firms that deals with service activities, regardless of their objectives.

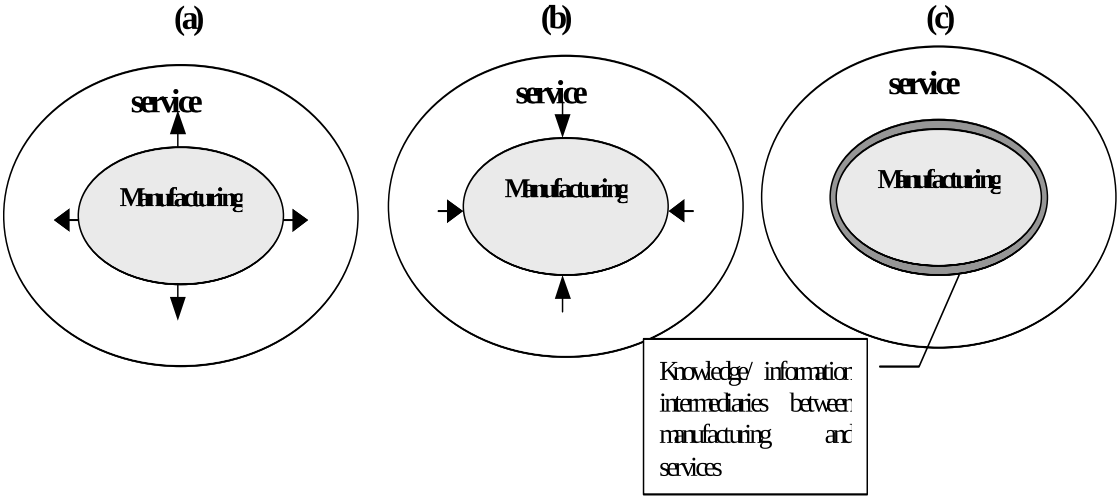
The rampant rise of IT (information technology) influenced and started far earlier than people can imagine. In fact, the numerical control (NC) revolution in machine tools caused an unexpected rise of a new profession that specialized in creating tool-path programming (Fleck, 1988). This fact signifies a merge of tacit knowledge and information technology in software. Derived service activities have expanded with further inclusion of software in the manufacturing sector. Engineering consultants have to possess knowledge on the integration of manufacturing process with the software packages that govern production process (*e.g.* MRP- Material Resource Planning). The consequence of packaged software has not only enhanced existing engineering consulting but also created a new service sector, such as CAD file converting services or rapid prototyping services (Wohlers, 1998).

<Table 6-2-1> Encapsulation Cases and Their Sources

Companies	Manufactured Products	Service Encapsulators	Final Offer and Consumption
AstraZeneca	Cancer drug	Cancer healthcare (Salick Health Care)	Cancer treatment
Fiat	Cars	Financial and insurance service for car customers (Toro Assicurazioni)	Car travel
Ford	Cars	Car travel services: financing and leasing (Ford Finance), maintenance (Kwikfit); in-vehicle service (Wingcast); Web retailing (Fordjourney.com)	Car travel
General Electric	Aerospace engines	Leasing or selling hours of flight	Air travel
General Electric	Medical equipment	Medical analysis and diagnosis	Diagnostics
Liebherr	Cranes	Special software programming to control and run the machines: remote running and testing	Lifting
Pacific Power Int. /RioTinto Energy resources	Coal	Power plant design and operating expertise and environmental advice	Power/ Energy
Rolls Royce	Aerospace engines	Leasing or selling hours of flight (minus time on ground due to faults)	Air travel
Xerox	Reprographic equipment	Maintenance and leasing	Photocopying

Source: Howells (2001)

In Korea, type (a) in Figure 6-2-1 below is the dominant pattern since conglomerates have strong backgrounds in manufacturing and abilities to retain human resources to explore new CSS services. The service suppliers for user firms in the manufacturing sector perform either upstream consulting or downstream marketing. In general, upstream services have high value-added business models and have been dominated by advanced countries. As the cheap production facilities in East Asia becoming readily available, opportunities emerge for the service suppliers to include manufacturing activity by subcontracting major production, fabless manufacturing. This kind of firm is virtually a service supplier that engages in design, planning, and own-brand packaging.



Source: (Howells, 2001)

[Figure 6-2-1] Encapsulation Model

In Korea, it is quite rare for design firms to diversify into production. Such cases are confined to the localization of products. Some of Korea's marketing firms that imported and sold foreign products went into a localization business after accumulating technological capability through after-service business. As transaction costs have decreased due to efficient information and communication technology, new services that manage supply chain and material purchase become prevalent. Interfacing services have been active in the estate and financial markets, where credible brokerage and wider information is highly evaluated.

In the manufacturing industry, OEMs (Original Equipment Manufactures: large end assemblers) have had the power to wield at their will without much concern about credit, so their role of interfacing appears to be narrow. Hence, the major role of interfacing lies in solving problems of coordinating diverse, specialized, and even unfamiliar partners. Therefore, interfacing services play a positive role, especially when the field is new to OEMs.

All the models above imply that new services tend to complement core manufacturing activities. Full integration of services by user firms needs other conditions, such as familiarity to coordinate (Silver, 1984). Therefore, similar and complementary activities are likely to be incorporated as happened in (a) model in Figure 6-2-1, dissimilar but complementary activities are likely to be consolidated as model (c) in the same Figure (Richardson, 1972).

Hitherto, we reviewed basic theoretical aspects to examine the hypothesis that manufacturing firms either use or integrate CSS services in different ways according to their previous path of capability building. The background of the hypothesis lies in the belief that user firms integrate certain CSS services due to cumulated effort of previous automation, where integration of hardware and software is requested for computerized production.

2.3 Responses of Korean Automobile Makers

The surging trend of digital electronics within the automobile sector has changed from the previously simple non-systemic inclusion of audio components to systemic control of engine and brake operation, even to digitally guided vehicles. New technology diffusion compelled automobile firms to absorb relevant knowledge. However, incorporation of computer control by automakers differs from that of communication. To see how automakers responded to new opportunities in service, it is necessary to review their historical paths.

Capability building of Hyundai Motor Co (HMC) has enhanced from assembly to product design (Kim, 1997). At the transitional stage, HMC not only built design capability but also improved understanding of new trends of computer-control mechanisms. HMC faced familiar and less familiar CSS service challenges. When firms are in a transitional period with high uncertainty and change comes from outside, firms are likely to strengthen collaboration (Gemser et al., 1996; Lambe and Spekman, 1997). Three contrasting responses emerged from HMC regarding CSS service as follows.

Case I: Integration and Conventional Build-up

At the early stage of its own design implementation, the firm used British consulting firms and its engineers heavily. HMC designed its own engine through the late 1980s and early 1990s. HMC extended its capacity to fully comprehensive research and development in the automobile sector. The company integrated computer control to core component (*e.g.* engine) when it started the Multi-Point-Injection engine project. The simultaneous injection of gasoline aerosol demands sophisticated electronic control (Kim, 1994). Based on its mechatronics capability, HMC assimilated other ICT related innovations. Simulation and virtual prototyping were smoothly absorbed by automakers because the purchase of the simulation package was compatible with the cumulated competence of the company.

The software for controlling the engine was imported from Mitsubishi, but HMC did own research to produce optimal software.[4] The engine is a strategically important core component where in-house research and production serves. The same case can be found in Mando, a supplier firm to HMC, producing ABS (Anti-lock Brake System) components. The firm subscribed to the control software service from Lotus engineering of UK, but it increased the research effort to internalize the service. In 2000, the firm fully substituted the external service for KT awarded in-house software. As the built in-house CSS capability opens option to further innovation in other core products, such as the traction control system, it was necessary to internalize. It is CSS services that are strategically important, provided by the same automobile firms.

Case II: Sophistication of Conventional Relationship

Increasing needs for wider base of supplier with proper catalogues and communication created the e-marketplace, such as CommerceOne. Unlike the pan-industry market place, automobile makers created cooperative supply market place like Covisint. As for industry-specific communication channels (including technical information) between OEMs and suppliers, the Unified Automotive Network Exchange (ANX) appeared.

Expansion of automobile firms' services can be either direct inclusion as a division or creation of separate firms. The cases of supply chain management appear to be disintegration. Covisint, the largest on-line auto-parts supply channel, is a joint venture between the "big three," and increasing its size as French Renault and Japanese firms affiliate. Therefore, the transition from encapsulation type (a) to type (c) is witnessed in the Covisint case. Development of Covisint is inter-linked with the standardization of automobile parts, where Korean firms lag behind other foreign automakers.[5] Table 6-2-2 confirms that less

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[4] About substitution of foreign CSS and technology, please see (Kim, 1994).

[5] Oh (1999), "Enhancing Knowledge Competitiveness in the Automobile Sector," KIET Report on

specific trading information tends to be open, and industry specific information is exchanged rather than a closed network.

<Table 6-2-2 > Supply Chain Management with CSS services

Categories	Level	Examples	Notes
Open-Internet Purchase Market	Disintegrated, Independent IT firm	CommerceOne, Ariba	
Industry specific –online Purchase Market	Coalition of automakers (OEMs)	Covisint,	Open-
Industry specific –networking	Automotive network exchange	ANX, J-ANX, *K-NX(Korean)*	The case of Korean (italic)
Firm specific communication channel	Value added network	*HVCS (Korean)*	

In the case of Korean automobile makers, previous experience in factory automation helped smooth absorption of electric enterprise resource planning. Korean OEMs like Hyundai and Daewoo already built ERP, and expanded the system to supply chain management (SCM).[6] HMC started in communication with seventeen vendor firms by creating HVCS (Hyundai Vendor Communication System) in 1987. As the first program aimed to include middle and large component suppliers, further extension was needed to coordinate the supply channel as a whole. Previous experiences of HVCS helped further development in internet-based supply channel communication. To achieve economies of scale, sharing common components became a trend in the global automobile industry. Korean OEMs decided to cooperate to build an integrated external network, named K-ANX (Korean Automotive Network Exchange), which connects OEMs and all different *Chabol* component suppliers through a hubbed data channel.

To integrate software solutions, HMC used Webmethod-Korea™ to build a coherent supply chain management (SCM) system that connects with an electronic market management system (e-Market place).[7] The e-customer market for manufacturing is weak, only 10% of the customer relation management (CRM) system market ascribes to the manufacturing sector.[8].Since the capabilities of service suppliers were weak in building an electronic system, the OEMs played a critical part in pushing and leading them in that direction.

Compared to global automakers, Korean OEMs remained in the type (a) encapsulation of services as internally existed services were reinforced by ICT, but the (c) type is mixed frequently. K-ANX indicates a possible disintegration of service for impartial supply coordination. There is no indication for optimal CSS service for supply chain management. Case II demonstrates a transitional state of encapsulation types (a) and (c). It depends on the extent of parts sharing achieved for automobile OEMs. Either integrated or disintegrated, the initiative is that of the automakers.

[6] Source: IT business 1st July 1999, http://www.itbiz.co.kr/news/cover/1999070103.htm

[7] Digital Time 7th September 2001

[8] Sisa computer April, 2001

Case III: Disintegration and Collaboration

"Telematics" became more and more important in CSS services as automobiles became a mobile office.[9] Unlike the previous case, the OEMs have played only a partial role in promoting telematics. As the technology comes from telecommunication and electronics firms, automobile firms decided that subcontracting or alliance were realistic options to implement best performance. To process massive information for driving (*e.g.* navigation map), a computer is installed in the automobile for controlling and displaying information.

Inherent characteristics of telematics lie in three dimensions of interaction between contents provider, automobile technology, and telecommunication. UBS Warburg predicts that the telematics portion could be separated or loosely connected from major automobile assemblers as the system can be mostly exploited by an open architecture. A report forecasts that there will be 11 million users in the telematics market. As happened in the car audio system, it will be a standard component of the automobile.[10] GM created OnStar in 1997, which is a standard for automobile telematics. Ford later followed GM with WingCast, and Toyota now proceeds with MoNet (USBWarburg, 2000).

In Korea, HMC has tried to build a telematics capability, but immediate service is delivered through vendors.[11] The timetable of the event is: 1) the early setup of subsidiary firm, e-HD; 2) subsequent withdrawal of GPS receiver unit and hand over the technology to Techmate, Co. (a KOSDAQ company);[12] and 3) strategic alliance with LG electronics to provide the telematics receiver. This plan implies that HMC relies on the hardware components of other firms, but concentrates on software and service instead. The figure below shows collaboration with small firms (lower part) through e-HD and with large firms directly or through HyundaiAutoNet.

HMC further deepened its telematics collaboration by co-developing a telematics solution with IBM.[13] The overall collaboration level with large firms is coordinated directly rather than using AV supplier HyundaiAutonet or using subsidiary firm e-HD. As shown in <Figure 6-2-2> the collaboration is multi-layered as direct/indirect through subsidiary/affiliated firms and strategic alliance /simple memorandum of understanding (MOU) are used.

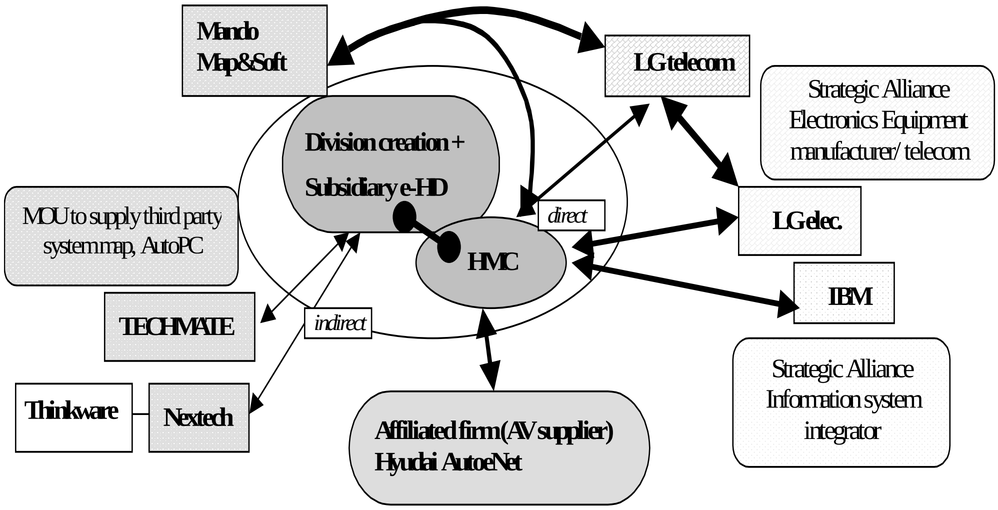
[9] Toyota announced its goal "Total mobility solution provider" in Annual Report 2001. In Korea, Hyundai launched a special taskforce "Car &Life" to catch the future market of after-car service that is estimated to reach 2.5 billion won (2 billion EURO) (15th Jan. 2003, Hankyung).

[10] Source: www.rolandberger.com, cited in UBS Warburg report (Aug. 2000)

[11] HMC does not explain its strategy but it denies subcontracting the audio module style to telematics service and equipment. Interview, Jan. 2003

[12] MOU in 6th Nov. 2001, e-HD transfer the developed technology to Techmate and Press

[13] 20th November, 2002, HMC press release.



[Figure 6-2-2] Development of Loose Coupling of Telematics in HMC

A major aim of telematics is to provide navigation information. Global automakers are confused on the integration of a navigation system. BMW rather depends on outsourcing contrary to US automakers (USBWarburg, 2000). A navigation system innovated by Toyota was later dominated by consumer electronics producers like Matsushita (Panasonic). Toyota increased its engagement in the electric map by itself.[14] This exemplifies continuous service provision from automakers, as an upgrade of geographical maps for navigator is an essential feature of automobile navigators.

HMC in partnership with Mando currently tests comprehensive telematics services.[15] Location-based services are wide, and can be applied outside of the automobile area. The government is pushing telecommunication service suppliers to provide a Global Positioning System (GPS) chip in mobile phones.[16] The possibility of wider GPS services from telecommunication service suppliers is therefore evident. This wider use of GPS may increase disintegrated usage of combined the Geographic Information System (GIS) with GPS technology.

<Table 6-2-3 > Telematics Services in Korea's Automobile Sector[17]

Firms	Equipment Provider	Service Provider	Communication Network Provider
GM-Daewoo	Daewoo Dreamnet client	GM OnStar	KTF
HMC & KIA	ITSMAN, Hyundai Autonet, Hyundai Mobis, Nextech	HMC-subsidiary	LG telecom
Samsung-Renault	Specialized handset	SK Entrac	SK
SK	Samsung (GPS mobile-phone), Cyberbank etc.	SK Entrac	SK Telecom (Nate Drive)

[14] Interview with K, general manager of Telematics, HMC, 18th Jan., 2003

[15] 9th July 2001, Digital Times, a similar arrangement exist between Daewoo and Thinkware

[16] Kookmindaily 23th Jan. 2003

[17] Source: Hankyung autoshinmun, 17th Oct. 2001, cited in Um (2000)

Competition in computer controlled automobile components used to be among auto-makers only, but new competition in telematics involves firms from other sectors. In fact, market entrants come not only from automobile sectors, but also from service providers like NTT DoCoMo. That firm transplanted i-mode success into auto-information system.[18] This intrusion from the telecommunication sector is evident in Korea. SK Telecom provides full telematics services with brand name of “SK entrac.” By using SK entrac, it is possible to check and supervise the location of vehicles with GPS installed and combine it with general information on traffic flow. This company is testing the web based monitoring of public transports to identify the location of each vehicle.

Why do automobile makers choose loose coupling? The reason behind the movement is system integration through information. User firms of KISs in the manufacturing sector recognize that the recent rise in outsourcing service is different from conventional outsourcing of parts for car assembly. The most contrasting difference can be found between previous purchase of audio components and current installations of new multimedia systems in passenger cars. The full control system that displays air-conditioning, audio/visual, and navigation information caused automobile makers to increase their capability in “system integration” through information. The concept of system integration includes some design capability to coordinate outsourcing partners effectively.

Disintegrating a business depends on complementarities, externality, and variety of usage. From the automaker’s point of view, telematics shows a mixed picture since it may benefit from rapidly changing external innovation, but the complementary aspect is high, and the need for specialized GIS on surface information of urban areas causes integration. The picture is an all mixed form of encapsulation models (a), (b), and (c). Therefore, HMC set up a subsidiary firm that specialized in telematics. HMC is likely to use the subsidiary firm for joint development with other telecommunication suppliers. This subsidiary plays an intermediate role that connects manufacturing firms and telecommunication service suppliers.

In sum, the encapsulation type (c) of user firms’ engagement in KISs is found in telematics,[19] indicating a creation of new technology and new service in the sector. This integration of automobile makers caused the diversification of their business into unfamiliar territory. In comparison with the first type (a) of service integration, the third type (c) shows greater cooperation, building a new organization to exploit the benefit of CSS services.

3. Recognition and Usage of CSS services

The usage patterns of CSS services can be different amongst firms and sectors. Some users focus on organizational innovation, and others may utilize CSS services intensively for the sake of process innovation (*e.g.* automation). The utility of CSS services will be reviewed by analyzing the survey results on the usage level of the services. User firms of CSS services are distributed amongst the financial service, telecommunication and manufacturing sectors. This study focuses on the mechanical sector and the digital device sector so that sample firms were chosen in the machinery sector (*e.g.* ship-building and machine tools) and the digital device sector. Some 150 questionnaires were sent and fifteen responses were obtained from the mechanical sector and five from the digital device sector. All of them are local Korean firms. Our hypotheses for this survey was that the level of services integration differs among various CSS services (H1), and that innovative user firms are likely to use CSS services more intensively than less innovative

[18] Um (2000), STEPI Policy Research report series No. 2000-12

[19] Telematics is an amalgamation of the German words that means “telecommunication” and “information.”

users (H2).

3.1 General Level of KISs Usage

At first, the relationship between size of user firms and the level of KISs usage was investigated. Sample firms are distributed normally in terms of sales, but their employment is rather bifurcated (middle size is rare) as shown in Table 6-3-1.

<Table 6-3-1> Size Distribution of Sample Firms

Firm Size (employment)	No. of Firms	Size (sales in billion won)	No. of Firms
.01-.10	0	.01-.500	3
.11-1.0	9	.501-10.0	3
1.01-3.0	4	10.01-100.0	9
3.01-	6	100.0-	4
N.A.	0	N.A	1
Total	20	Total	20

Source: STEPI Survey (Oct., 2002).

Firms that used KISs are likely to retain moderate size to afford to outsource services. Small and medium sized firms tend to purchase standard software and add modifiable modules. Large firms have the internal capability to produce services. This implies there is a possible difference between firms in terms of using external services. The level of KISAs usage and size of firms is related. The usage level of KISs in large firms is slightly higher than that of small firms. Unlike the biotechnology case, CSS services innovation is spearheaded by the private sector (public sector[20] does not lead innovation). Therefore, the usage of privately supplied KISs is mainly higher than that of public KISs.

The usage of public CSS services mainly concentrates on education and training services. Private suppliers provided software packages and related services because the public sector rarely provides commercial software. The intensive use of R&D services is distinctive in the manufacturing sector. It must be noted that many R&D services entail auxiliary software production. The usage of CSS services by service suppliers does not reflect simultaneous usage of software packaging and consulting and production engineering.

[20] Including universities

<Table 6-3-2> Intensity of KISs Usage by User Firms

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 using the Likert scale (None: 1, Occasionally: 2, Average: 3, Frequently: 4, Very Frequently: 5). ICT: Information and Communication Technology, IP: Intellectual Property.

Source: STEPI Survey (Oct., 2002).

3.2 Usage Patterns of CSS services

Although the contribution level of using external data processing is higher, the level of data processing internalization is high. Its incorporation of the tacit knowledge of the manufacturing process often forces firms to carry on by internalizing the process because firm-specific operation procedure and relevant “data processing” are too specific for manufacturing firms to explain to outside CSS service suppliers.

Software-based consultancy that provides a customized package is rather highly complementary and less internalized. It could be not as efficient if supplied in-house because the process involves rather standardized administration procedures. Software providers know solutions better just as commercial firms produce better advertisements. This indicates the consolidated position of software consultancy that provides customized software.

<Table 6-3-3> Complementarities and Internalization of CSS Services

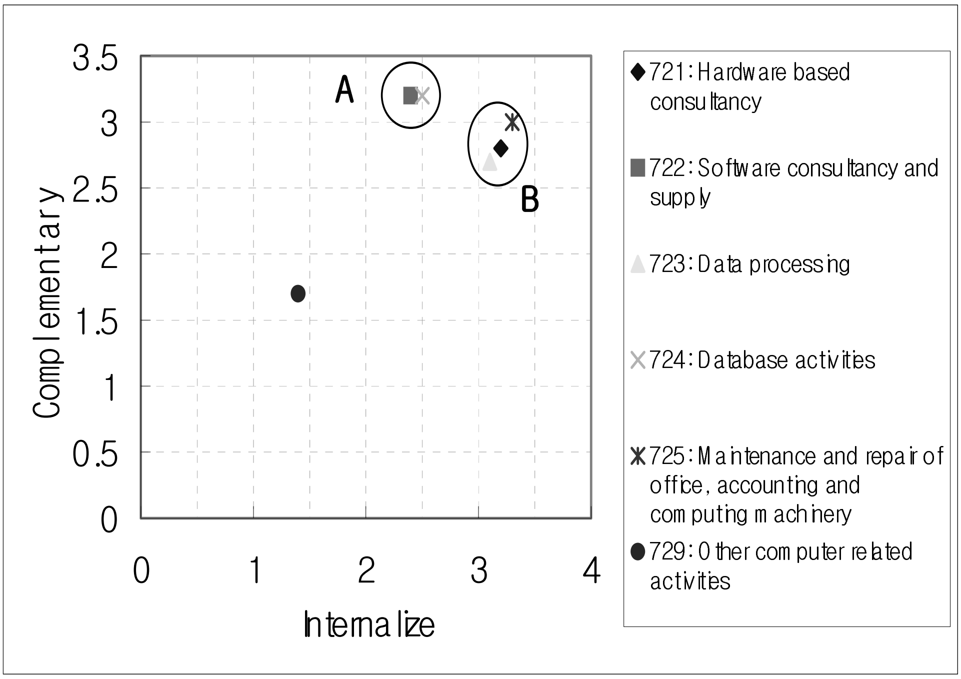
CSS Services	Level of Internalization and Complement		
	In-house	Complement	Relation*
Average	2.7	2.8	-
721: Hardware based consultancy	3.2	2.8	ALL
722: Software consultancy and supply	2.4	3.2	OUT
723: Data processing	3.1	2.7	IN
724: Database activities	2.5	3.2	OUT
725: Maintenance and repair of office, 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 (Oct., 2002).

User firms in the manufacturing sector show a lukewarm attitude toward using outside consultancy as the level of internalization is high in the <Table 6-3-3>. The reason can be ascribed to small firms that purchase software and servers without consulting the hardware providers to complete networking service. Recent server markets have become user-friendly, and even provide easy installation guides for making available home networking. They do basic hardware installation and basic database setup by themselves. In addition, user firms try to learn the basic maintenance procedures to minimize the interruption of operation, which causes a relatively high level of internalization.

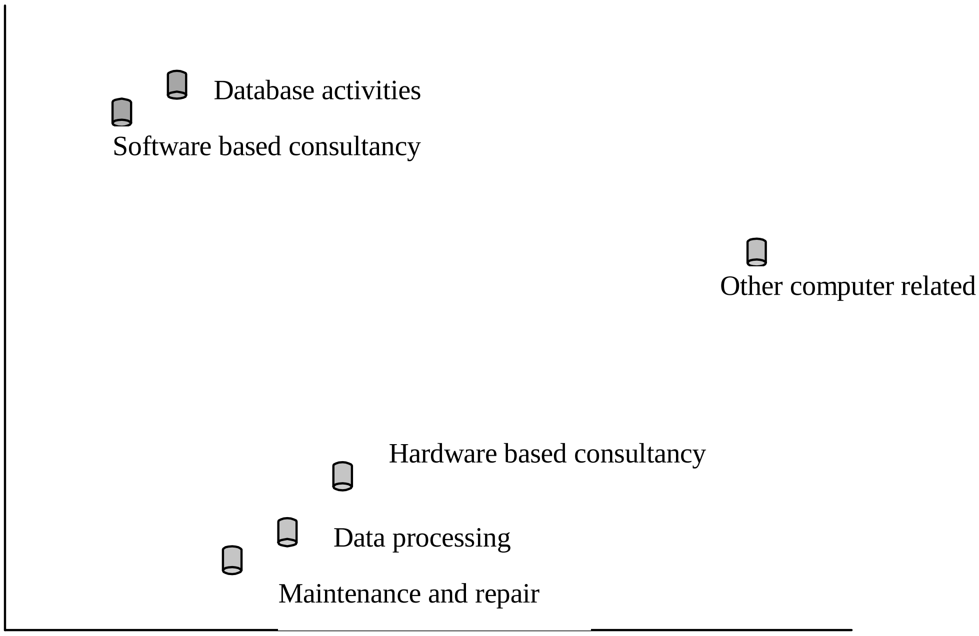
Two clusters appear clearly, indicating a contrast of the hardware-based production process to software-based communication solutions. Group A (software type CSS services) shows highly complementary but less internalized but group B (hardware type CSS services) shows more strong internalization.



Source: STEPI Survey (October, 2002).

[Figure 6-3-1] Usage Patterns of CSS Services

Level of internalizing CSS services differs among users. The MDS (multi-dimensional scaling) map based on internalization of CSS services clearly shows that a firm internalizing data processing does not internalize software based consultancy (long distance between the two). In addition, relatively close distance from hardware based consultancy and data processing can be interpreted as firms internalizing hardware-based consultancy tend to internalize data processing. The second map in Figure 6-3-2 confirms the complementary relationship between software based consultancy and database activities. It was expected that user firms considering software-based consultancy complementary were likely to evaluate database activities to be highly complementary.



[Figure 6-3-2] MDS (Multi Dimensional Scale) Map on the Complementarity of CSS Services

Unlike heterogeneous pattern of internalization (no bundle internalization), firms show homogeneous pattern in evaluation of complementary level of CSS services. In general, firms that evaluate "software based consultancy" highly also evaluate "database activities" [21] highly (as if they are a bundle). The second map in Figure 6-3-2 confirms a homogeneous pattern. It implies that complementary effect can be maximized by using "software-based consultancy" and "database activities" together (A type) or "hardware-based consultancy" and "data processing" together (B type). In fact, these two groups appear very clearly in Figure 6-3-2. The map indicates the contrasting usage of hardware-based production process versus software-based communication solutions.

These facts lead us to conclusion that there is no single answer to the integration way of CSS services. This conclusion is consistent with the first hypothesis, and the previous case studies on the HMC. Although internalization does not occur in bundle, CSS services are complementary as bundle. This implies that firms tend to internalize some CSS services and purchase other CSS services although the services are complementary. Then user firms mix and integrate them later within the firms because the CSS services are complementary

4. Contribution of CSS Services to Innovation - Capability Building of User Firms

4.1 General Benefit of Using CSS Services

Using knowledge intensive services increases the possibility for user firms to innovate. As shown above, increasingly efficient interface helps absorptive capacity (Cohen and Levinthal, 1989), and consequently increases the success rate of innovation. This fact is once again valid for CSS services. By and large, the users with a high level usage of CSS services show a higher innovation rate that is statistically significant (at 10% level).

[21] *e.g.* internet provider and database on internet

<Table 6-4-1> Level of KISs Usage 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) Response = 20, 2) the difference is statistically significant at 10% level. (χ2=2.96).

Source: STEPI Survey (Oct., 2002).

Table 6-4-1 provides a confirmation that the role of using ICT related KISs, and chi-square result shows a statistically significant difference at the 10% level. In the same token, user firms with a high level usage of ICT related services tend to innovate more vigorously as demonstrated in the <Table 6-4-2>. ICT related KIS services are equivalent to CSS services, so the hypothesis that “innovative user firms are likely to use CSS services more intensively than less innovative users” is confirmed.

<Table 6-4-2> Result of Using ICT Intensive KISs

Innovation in recent 2yr.	ICT related KIS use			Total	%
	Low level	High level	N.A.		
NO	3	1		4	20
YES	8	7	1	16	80
Total	11	8	1	20	100

Source: STEPI Survey (Oct., 2002).

4.2 Contribution of CSS Services Usage

The contribution of CSS services may be relatively similar to that of either product or process innovation. Those who appreciate hardware based consulting service are likely to evaluate software based consulting and other computer related service highly. The major contribution of CSS services comes from two sources, data processing and database activities (incl. internet). Manufacturing firms associate data processing with customized software. The contribution to organization mainly comes from data processing, which is inherently linked with manufacturing process, such as automation of production process.

<Table 6-4-3> Contribution of CSS Services to User Innovations

CSS Services	Contribution			
	Product	rocess	Organization	Average
Average	2.3	.8	1.7	1.90
721: Hardware based consultancy	1.7	.4	1.5	1.53
722: Software based consultancy and supply	2.3	.7	1.2	1.73
723: Data processing	3.0	.5	2.8	2.77
724: Database activities	3.4	.5	1.9	2.60
725: Maintenance and repair of office, accounting and computing machinery	1.4	.2	1.3	1.30
729: Other computer related activities	1.9	.2	1.3	1.47

Source: STEPI survey (Oct., 2002).

From the table 6-4-3, database activities contribute to product innovation most. Data processing is highly recognized in every aspect of the innovation of user firms. This is well reflected in the effort to internalize service supply. Manufacturing data is accumulated as data processing activity continues to produce the set of datum. The result is an in-house database especially designed to firm-specific manufacturing process. Database activities frequently request software-based consultancy to supervise the overall scheme. The trio appears to be most prominent in contribution to product-process innovations.

Hardware based consultancy did not have a great impact on innovation of user firms in the machinery sector. This owes to the fact that the small and medium sized firms rarely use expensive system integration suppliers. As described above, software consultancy and supply provides contents and linkage between telecommunication and database activities. However, its influence on organizational restructuring is not high.

5. Conclusions

This chapter delineated the case of the Korean automaker HMC by applying the encapsulation model, and identified three different responses in face of CSS services. The first is full integration along the path of mechatronics, *e.g.* engine control; the second is about supply chain management; and the third is loose coupling of telematics. Telematics demands strategic alliances with an information system integrator, like IBM. More familiar CSS services understood within sector context tend to be integrated, and less familiar CSS services to loose coupling and strategic alliances.

In the second part of this chapter, we demonstrated that the integration of CSS services is not simple but mixed and different among firms. Firms that use external KISs frequently show a higher rate of innovation. Accordingly, firms that use CSS services frequently also achieve innovation more than those that do not. CSS services reinforce the information monitoring that can be used for channeling knowledge into real production.

A policy implication from these findings is that building a flexible institutional structure for joint ventures between manufacturers and service firms is important. In order to obtain more precise information about the contribution of CSS services, collection and diffusion of success cases should be encouraged. Future research on this issue must evolve into “how firms transform external KISs into applicable knowledge,” as transformation has been identified as the most complementary internal process for using CSS services.

CHAPTER SEVEN

Conclusions and Policy Implications

1. Summary and Conclusions

This study explored and provided an understanding of the innovation activities of knowledge intensive service sectors in the context of Korea. Reviewing pertinent literature, both manufacturing and service sectors, external and internal services, and public and private service inputs to user firms were analyzed. Various statistics on KISAs and CSS services were collected and analyzed in chapter three. We also analyzed specific cases of Korean KISAs with focus on CSS, and presented the results in chapters four and five. In addition, the benefits of using KISAs are analyzed by investigating the user firms of KISs based on a survey questionnaire.

After careful review of the literature and a field survey in the Korean context, we found that the difference between innovation in the service sector and that of the manufacturing industry is narrower than expected. We conclude that the key factor of convergence of innovative pattern owes to ICT, which is vastly applied to the development of various KISAs. Integration of ICT into many knowledge intensive services (KIS) has led to a new paradigm of service innovation.

The number of firms and sales in KISA and CSS Services sectors appeared to be increasing rapidly in Korea. The knowledge intensive service (KIS) sector accounts for 42.1 percent of the total sales of the service industry in 2000. CSS service accounts for 9.3 percent of the service industry's total. Although the number is small, the KIS sector employed 2.313 million persons in 2000, accounting for 24.3 percent of the employment in the service industry as a whole (69.8 percent in employment). The employment share of CSS services to KISAs jumped from 2.4 percent in 1996 to 5.8 percent in 2000.

However, the trade deficit of the KIS sectors remains at serious level of concern in Korea. The deficit of service trade (US$ 2.889 billion) was mostly generated from KIS trade (US$ 6.267 billion). Even worse, the imports volume of KISs, including CSS services, grew faster than that of service imports as a whole. The trade deficit of CSS services amounted to US $385 million, accounting for 6.1 percent of the deficit of knowledge intensive services.

In the analyses of specific cases, we found that dominant software covers the large markets without additional production cost. This causes the concentration of the software sector in a few large firms. If the government does not provide support at an early stage, the dominance of foreign software firms becomes consolidated. Based on the "Software Industry Promotion Act," a law enacted in 1987, the Ministry of Information and Communication pursues such policy measures as setting up institutes (*e.g.* an agency and associations) and promoting the development of the software industry through human resource development, developing core software technologies, incubating software start-up firms, and expanding the demand for software. The government regulates illegal copying of software and it contributes to the sales of software.

The results of our analyses on user firms of KISs, particularly the CSS services, we discovered that they could function as a launch pad for user firm diversification into other knowledge intensive service sectors. CSS services become integrated to or loosely coupled with manufacturing firms. The HMC has implemented both tighter integration of familiar CSS services and loosely coupled collaboration of unfamiliar CSS services. Telematics services are a rather mixed or partial integration using many external services.

According to our survey, large manufacturing firms having an internal capability to build a service division are also active in the external use of CSS services and KISAs. Usage patterns of CSS services indicate no homogeneous solution for internalizing CSS services. We confirmed that the contribution of CSS services to the innovation capability of user firms is significant. User firms that intensively utilized CSS services proved to be more innovative than those that did not. Heavy users of CSS services also entertained benefits of capability enhancement as they improved monitoring and achieved efficient application of knowledge asset into product and process innovation.

2. Policy Implications for Boosting the Innovation of KISAs

Few studies have set out to systematically survey how innovation policies affect services and explicitly seek to take them into account. Little attention has been given to services in innovation policy in general. However, this is not to say that policy measures have no relevance to services innovation. There are some general policies applied to many areas of services that are important for the innovation of KISAs. Innovation policies that are not specifically designed involving use of KISAs may have substantial implications for services innovation.

Given the preponderant focus on manufacturing sector innovation in the past, there is clearly room for much more attention to innovation policy for KISAs. If the private KIS sector is working effectively, then there may be dangers in seeking to intervene in it. Government support for innovation in public services might be unfair for private suppliers. Specific policies, therefore, should be carefully designed in light of such arguments.

Ultimately, the need to distinguish services from other sectors of the economy will probably disappear. All sectors will be seen as involved in innovation in different ways. Nevertheless, at present a focus on KISAs is salutary because they have been widely neglected in policy analyses and practices. The role of KISAs should be taken into account in innovation programs of all sorts. The heritage of a manufacturing orientation needs to be critically scrutinised so that elements of the structure and content of programs that may limit participation of KIS suppliers can be reduced.

Policies to support innovation in KISAs confront some generic features of services innovation. The diversity of different services needs to be recognized. Great caution is required in generalizing from the problems of one sector to policies for all sectors. What is appropriate for a service may be totally inappropriate for another service. Equally, regional diversity needs to be recognized in policymaking. Policy needs for innovation vary dramatically across regional clusters, and policies that fail to recognize this may fail.

The results of our previous analyses imply that innovation of KISAs can be designed and boosted mainly by forming networks among service firms. Governments can play a role in developing or sponsoring innovation networks focused on services. They aim to advise about best practice, identify common pitfalls, etc. Firm-level benchmarking, so as to identify and communicate good practices in innovation, and the organization and management of innovation-related activities are also an important element of knowledge transmission for service suppliers. They can use events like conferences and workshops, web sites to provide information and contacts online, and such techniques as competitions and awards to raise awareness and reward excellence.

Governments utilize or establish a specific kind of R&D institution that can fit the service innovations and be service innovation centers or RTOs oriented to KISAs. They can be more industry-based associations aimed at raising awareness, consolidating standards, and influencing government policies. The notion of service innovation centers can be developed in many other service areas on a regional and national basis. Such service innovation centers can perform technical functions, such as standards-development and compliance testing. Moreover, the scope for existing innovation centers also can be reoriented to take more services issues into account.

3. Policy Implications for Human Resources Development

Service innovation is typically more about mobilizing human intellectual resources. Our analyses implied that employees are more deeply involved in the provision and delivery of the outputs of services than is typical in manufacturing. The knowledge and skills of employees are of crucial importance to the competitiveness of KIS suppliers. Service workers are often dealing with customers, and having to fuse their knowledge with customer requirements. Consequently, the need for a well-educated workforce is fundamental, and policies need to take this into account. We consider aspects of training service workers and employment of paramount importance.

Training should enable service workers to work better with innovations, and it could also help the staff of service suppliers be more proactive with innovation. Firms should be encouraged to train their workers to take advantage of new technologies and to stimulate innovation more generally. Our field survey in Korea showed that most KIS suppliers have to some degree invested in training. It also revealed that public incentives for training, for example, training subsidies, the provision of tax breaks for training are important for inducing training. Public organizations can be encouraged to play roles in training and stimulate indulgence in training where demand seems to be low, for example by charging the trainees little or no fees.

As a result of training manpower in KISAs, the quality of knowledge intensive services increases. High-quality services contribute to the quality of life by enhancing environmental conditions and public health, by providing pleasurable, reliable and efficient services. This may have economic benefits, too, rendering particular regions more desirable places in which to live, work and invest. More generally, KISAs play an important role in addressing many of the problems facing the Korean economy. Some KISs, like CSS services, may contribute to organizational change, labour mobility, social innovation, achieving sustainability, providing solutions to problems associated social changes such as ageing populations, etc.

4. Policy Implications for Improving Public Services

Public services not only include government activities but also the informal service sectors such as non-profit foundations, voluntary organizations, etc. Providing improved efficiency, effectiveness or quality of public services recently have become important political issues. The policy scope for the innovation of KISAs may well go beyond the areas of social need that are conventionally identified. There may well be numerous opportunities to combine public functions and technological innovation to generate new public services that can enhance the quality of life and economic capabilities.

Our survey results revealed that public R&D services are the most effective among public services for the innovation of both KIS suppliers and their users. This implies that government R&D programs should be available not only to manufacturing firms but also to service suppliers. Since manufactured products are often entwined with services, it therefore makes little sense to support the development of products without services. R&D programs should involve knowledge intensive service suppliers. KIS suppliers involving in such R&D programs are manifold.

There are many other public services that are useful for fostering the innovation of firms except for R&D services. The establishment of common standards is an important public service, providing level fields for service firms to develop their innovations. Standards encourage competition and a standard setting is becoming more closely entwined with R&D itself. Professional standards are at least as significant as technical standards in many services, particularly in such professional services as accountancy, law or health care. It is important to develop standards that can allow innovation to proceed rapidly, along with the participation of stakeholders in the process. There is also an important role to be played by collective action among services.

Some regulatory measures are associated with services, especially in areas like environmental monitoring and remediation. Public services emerge to aid user organizations in meeting regulatory requirements, and technological innovation may be part of this. They are related to providing advice about technical solutions and how to configure these to fit particular circumstances. Many business services also respond to regulatory requirements. They include health and safety, training services, internet filtering, e-commerce, security services, etc.

Although regulations and standards are often seen as a barrier to innovation, they are more generally factors shaping innovation, fostering its development down certain paths. However, relatively heavy regulation does impede innovation in some areas of services. Regulatory authorities should encourage examining the impacts on innovation of regulatory decisions. On the other hand, regulations that maintain quality standards while facilitating such developments are generally desirable. And, regulatory authorities need to be able to respond rapidly to change.

Similar explanation can be applied to intellectual property protection. The protection of intellectual property in services is a complex issue. There are strong opinions within industry and society at large about the need to, or not to follow the route of developed countries in expanding the scope of patents. Nevertheless, balancing between rewarding inventors and encouraging diffusion and competition must remain a policy goal. Government authority may require designing new forms of IP protection for services, taking into consideration the facts that services sectors are different in terms of their IP needs and strategies.

5. Policy Implications for Innovation-Capability Building of Firms

We discovered that international competitiveness of Korean KIS suppliers is weak, implying the need for policies to strengthen it through boosting the innovation of KISAs. The most effective way of activating innovation is enhancing systematic absorption capacities on the part of KIS suppliers or user firms so as to increase their innovation capability. Perhaps the most important features of innovation capability have to do with human resources, which we treated separately in the previous section. Along with human resource development, a framework for the sort of firm-level innovation benchmarking might be necessary.

Innovation capabilities of service suppliers and their users could be improved by providing training courses in service management, innovation management in services, and so on in business schools. Further benefits could emerge from the provision of guidance information, training materials, awards for good practices, and even demonstration programs. Both private initiatives and public authorities could have a role to play. Service innovation centres, suggested earlier, could play a role as communication centres in support of such activities. They could generate and disseminate knowledge about the trajectories of service innovation, alternative modes of organizing innovation activities, etc.

Another policy to enhance innovation capabilities of KIS suppliers and their users could be enhancing the application of IT technologies or CSS services. The use of IT technologies for the provision of knowledge intensive services, *e.g.* through the combination of standard modules in service packages, should be encouraged. Many new service products, and elements of many existing services could be developed, supported and delivered via IT networks.

The application of IT technologies could be enhanced through various policy measures. For instance, the provision of high quality access to IT networks and services, and standard setting to achieve critical mass for new modes of service access are types of policies to be put into effect. KIS suppliers need to be able to anticipate IT developments. Service innovation centres mentioned previously can play roles in monitoring, and fostering awareness of trends in these technologies and their applications.

Lastly, governments should be concerned with small and medium sized firms (SMEs). Most KIS sectors are dominated by SMEs. However, they often fail to recognize that they are eligible for programs that support innovation and training, or for their invitations to join innovative networks. Governments may fail to address their messages to such firms. Policy measures can support SMEs through such measures as underwriting some of the costs, providing quality-assured specialists, and demonstration of user communities to appropriate services.

6. Policy Implications for Other Issues

There are many other policy issues for which the results of this study can provide implications. One issue meriting attention is the competitiveness of the Korean KIS sectors and their innovativeness. An important question is the ability of Korean KIS suppliers to compete globally in technology-related areas. Overseas KIS suppliers could be sources of good practices from which Korean firms can learn. The government may release information about foreign suppliers obtained from the experiences of public procurement.

The development of regional KISAs too could be an important policy issue. A growing spatial division of labor has been leading to a concentration of the highest value-added service activities in Seoul and its surrounding areas. This can overburden the infrastructure and overheat the wage levels and housing markets in the area and their environments. It may prove disadvantageous to other regions in various ways. Provincial regions lack adequate access to KISs, and lack the spillovers and skill development that are associated with KISAs. Regional development policies should explore strategies for encouraging high-value services to locate in provincials.

<Appendixes>

Appendix 1: Classification of ICT Services

1. Telecommunication and program distribution services

－ CARRIER SERVICES

- Fixed telephony services
- Mobile tele. services
- Private network services
- Data transmission services
- Other tele. services
- Program distribution services

2. On-line access services
- Internet backbone services
- Internet access services
- Internet tele. services

3. ICT professional expertise (consulting)
- IT technical consulting services
- IT design and development services
· custom application design and development services
· web site design and development services
· database design and development services
· customization and integration of packaged software
· network design and development services
· computer systems design, development and integration services

4. Hosting and IT infrastructure provision services
- Web site hosting services
- Application service provisioning
· application service provisioning with integration services
· application service provisioning without integration services
· business process management services
· collocation services
· data storage services
· data management services

· video and audio streaming services

· other IT infrastructure provisioning services
- <u>Rental and leasing of ICT products</u>

5. IT infrastructure and network management services
- Network management services
- Computer system management service

6. IT technical support services
- IT technical support services
· software-related technical support services
· hardware-related technical support services
· combined software and hardware technical support services
· other IT technical support services
- Auditing and assessing computer operations
· data recovery services
· disaster recovery services (business continuity services)
· other IT technical support services
- <u>ICT related training services</u>

7. Information and document transformation services
- Imaging and other data capture services
- Data conversion and migration services

8. Software publishing
- System software publishing
- Operating systems software publishing
- Application software publishing

Appendix 2: Code Match of CSS Services between Korea and

OECD Classification

OECD Classification		Korea (정보통신산업협회)		Korea (통계청: 산업체 기초통계조사보고서)	
841	Telecommunication and program distribution services			64	통신업
8411	Carrier services	1112 1115	전용회선서비스 전신,전보서비스		
8412	Fixed telephony services	1111	전화서비스		
84121	Fixed telephony services – access and use				
84122	Fixed telephony services – calling features				
8413	Mobile telecommunications services	1121 1122	이동통신서비스 위성통신서비스		
84131	Mobile telecommunications services – access and use				
84132	Mobile telecommunications services – calling features				
8414	Private network services	12	별정통신서비스		
8415	Data transmission services	132	데이터네트워크서비스		
8416	Other telecommunications services	131 13311 13312 13314 134 135 136 137	고도팩스서비스 종합정보제공서비스 단독정보제공서비스 기타정보제공서비스 온라인정보처리서비스 음성전화정보서비스 주문형정보서비스 기타부가서비스		
8417	Program distribution services	1116	기타 유선 통신서비스		
(842)	ON-LINE ACCESS SERVICES			724	데이터베이스 및 온라인 정보제공업
8421	Internet backbone services	1113	종합정보통신망서비스		

8422	Internet access services	1114 13313	접속서비스 인터넷 접속 서비스		
8423	Internet telecommunication ser	1332 1333 1334 1335	전자우편서비스 신용카드검색서비스 컴퓨터예약서비스 전자문서교환서비스		
(843)	ICT professional expertise			721	컴퓨터시스템설계 및 자문업
8431	Information technology (IT) technical consulting services	3211	컨설팅 및 기획		
8432	Information technology (IT) design and development services				
84321	Custom application design and development services				
84322	Web site design and development services				
84324	Customisation and integration of packaged software	322	프로그램개발서비스		
84325	Network design and development services	3212	설비 및 네트워크구축		
84326	Computer systems design, development and integration services				
(844)	Hosting and information techn Infrastructure provisioning ser			729	기타 컴퓨터 운영관련업
8441	Web site hosting services	325	기타 컴퓨팅 서비스		
84411	Web site hosting services(without integration if related applications)				
84412	Web site hosting services with integration of related applications				
8442	Application service provisioning				
84421	Application service provisioning with integration services	3213	S/W개발		
84422	Application service provisioning without integration services				
84423	Business process management services	3132	기업관리 S/W		
84424	Collocation services				
84425	Data storage services				
84426	Data management services				
84427	Video and audio streaming services				
84428	Other IT infrastructure provisioning services	3127	기타 응용 개발도구		

(845)	**IT infrastructure and network management services**			7232 (7230)	컴퓨터 시설 관리업
8451	Network management services	323	시스템관리 및 유지보수		
8452	Computer systems management services	3215	기타 시스템 통합서비스		
(846)	**IT technical support services**				
8461	IT technical support services	3214	H/W 개발서비스	9212 (725)	컴퓨터및 사무용기기 수리업
84611	Software-related technical support services				
84612	Hardware-related technical support services				
84613	Combined software and hardware technical support services				
84614	Other IT technical support operations				
8462	Auditing and assessing computer operations				
84621	Data recovery services				
84622	Disaster recovery services(business continuity services)				
84623	Other IT technical support services n.e.c				
(847)	**Information and document transformation services**			7231 (7230)	자료처리업
8471	Imaging and other data capture services	33 34	멀티미디어컨텐츠개발 서비스 데이터 베이스 제작		
8472	Data conversion and migration services	324	자료처리		
(848)	**Software publishing**			722	소프트웨어 자문, 개발 및 공급업
8481	System software publishing	3111	운영체계S/W		
8482	Operating systems software publishing				
84821	Network software publishing	3112 3113	통신 S/W 유틸리티 S/W		
84822	Database management software publishing	3125	DBMS		
84823	Development tools and programming languages software	3121 3123 3122 3126	정보엑서스도구 개발관리용S/W 프로그램개발용S/W 인터넷 개발용 도구		
84824	Other systems software publishing	3114	기타 시스템 S/W		
8483	Application software publishing				

84831	General business productivity and home use applications publishing	3131 3135	일반사무용 S/W 교육 및 게임용 S/W		
84832	Cross-industry application software publishing	3133	과학용 S/W		
84833	Vertical market application software publishing	3134	산업용S/W		
84834	Utilities software publishing	3124	컨텐츠 개발용 S/W		
84835	Other application software publishing	3136 314	기타 응용 S/W 기타 패키지 S/W		
(849)	OTHER ICT SERVICES				
8491	Rental and leasing of ICT products.				
8492	ICT related training services				

자료원: ①OECD (2001), *Working Party on Indicators for the Information Society – A Classification of ICT Services,* Paris; OECD.
②한국정보통신산업협회 (www.kait.or.kr).
③통계청, 사업체기초『통계조사보고서』.

APPENDIX 3

OECD Questionnaire Protocol

Name of firm/organisation:
Name of respondent: **Contact details:** **Date:**

This questionnaire contains four questions related to the use and access of your firm/organisation to knowledge-intensive services such as research and development, expert advice or software publishing for **the purposes of innovation only,** not just normal improvements in operations.

Question 1: Which of these services did you use (whether provided by public or private sources) when **planning and implementing your most important innovative activity of the last three years** and how often**?** Please tick **one** box only for each line.

SERVICES	None	Occasionally	Average	Frequently	Very frequently
1. ICT professional expertise (advice)	(	(	(	(	(
2. ICT related training services	(	(	(	(	(
3. Information technology (IT) technical consulting services (systems development, customisation and integration)	(	(	(	(	(
4. Software publishing (packaged software)	(	(	(	(	(
5. Research and Development Services	(	(	(	(	(
6. IP-related Professional Services (legal and accounting) related to innovation	❑	❑	❑	❑	❑
7. Management consultancy related to organisational innovation	❑	❑	❑	❑	❑

8. Engineering consultancy related to product or process development	❑	❑	❑	❑	❑
9. Employment agency supply of highly skilled personnel services for innovation purposes	❑	❑	❑	❑	❑
10. Other:	❑	❑	❑	❑	❑

Question 2: Where did you access the following services for that **same innovative activity?** Please tick all boxes that you need for each line.

SERVICES	Public Sector	Universities	Private Sector	Mixed (public and private)
1. ICT professional expertise (advice)	(	(	(	(
2. ICT related training services	(	(	(	(
3. Information technology (IT) technical consulting services (systems development, customisation and integration)	(	(	(	(
4. Software publishing (packaged software)	(	(	(	(
5. Research and Development Services	(	(	(	(
6. IP-related Professional Services (legal and accounting) related to innovation	(	(	(	(
7. Management consultancy related to organisational innovation	(	(	(	(
8. Engineering consultancy related to product or process development	(	(	(	(
9. Agency supply of highly skilled personnel services for innovation purposes	(	(	(	(
10. Other:	(	(	(	(

Question 3. In location terms where did you access the following services for the same innovative activity as above? Please tick as many boxes as you need for each line.

SERVICES	Local	Regional[22]	National	International
1. ICT professional expertise (advice)	(	(	(	(
2. ICT related training services	(	(	(	(
3. Information technology (IT) technical consulting services (systems development, customisation and integration)	(	(	(	(
4. Software publishing (packaged software)	(	(	(	(
5. Research and Development Services	(	(	(	(
6. IP-related Professional Services (legal and accounting) related to innovation	(	(	(	(
7. Management consultancy related to organisational innovation	(	(	(	❑
8. Engineering consultancy related to product or process development	❑	❑	❑	❑
9. Employment agency supply of highly skilled personnel services for the purposes of the innovation	❑	❑	❑	❑
9. Other::	❑	❑	❑	❑

[22] Each country to define what it means by local and regional

Question 4. In location terms again where would you **prefer** to access the following services for your innovative activities? Please tick **one** box only for each line.

SERVICES	**Local**	**Regional**	**National**	**International**
1. ICT professional expertise (advice)	❑	❑	❑	❑
2. ICT related training services	❑	❑	❑	❑
3. Information technology (IT) technical consulting services (systems development, customisation and integration)	❑	❑	❑	❑
4. Software publishing (packaged software)	❑	❑	❑	❑
5. Research and Development Services	❑	❑	❑	❑
6. IP-related Professional Services (legal and accounting) related to innovation	❑	❑	❑	❑
7. Management consultancy related to organisational innovation	❑	❑	❑	❑
8. Engineering consultancy related to product or process development	❑	❑	❑	❑
9. Employment agency supply of highly skilled personnel services for innovation	❑	❑	❑	❑
10. Other:	❑	❑	❑	❑

Open Questions:

1. Does your company have any IPR (Intellectual Property Right) policy restricting use by others of your own KISA? Which one/s?
2. Have you found any IPR limitation in accessing KISA? Which ones?

Semi-Structured Interview Protocol

The aims of the interviews are to understand:

- the use that firms made of KISA in relation to one of their most important innovations;
- how firms integrated different sources of KISA for that innovation; and
- how firms built innovative capability through the use and integration of KISA to improve their capability for **future** innovations.

The set of questions below explores each of these aims. We suggest targeting a sample of the companies that reply to the questionnaire. We suggest doing face-to-face or telephone interviews with Senior Managers, notably those responsible for product, process or organisational innovation. A clear definition of KISA should be stated in the questionnaire and at the beginning of the interview.

(1) Questions to explore the **use** that firms made of KISA in relation to one of their most important innovations

Q1. In relation to your most important innovation (product, process or organisation) of the last three years, what was or were the most important KISA that you used and needed to obtain externally? Did you get them from one or more public, hybrid or private sector organisations? Why these particular choices?

Q2. Why did you look externally rather than internally? Next time such a service is needed will you have the capability internally? Why not?

Q3. Did you receive from the external service provider what do you expected/ needed? If not, what would have been needed to improve the services actually received?

Q4. Do other companies on your sector provide innovation services to your company?

(2) Questions to explore **more generally how firms integrate** different sources of KISA

Q5. Does your company usually seek KISA from one external provider or from more than one? why?

Q6. When your company needs KISA do you seek different services from different providers and mix them to get the desired results? Why?

Q7. How do you decide whether to rely on your existing internal capabilities or to go outside for the KISA needed?

Q8. Does your company have a specific procedure for learning related to innovation and for mixing KISA from different sources? If yes, please explain where and how you get your learning. If no, why no?

(3) Questions to explore how firms **build capability** through the use and integration of KISA to improve their capability for future innovations

Q9. How significant are government programs/policies for the innovation capability of your company and why? Provide detail on the most valuable program(s) or publicly provided information services used for the specific innovation discussed in the first question above [we could have a potential list here drawn from the stage one background study of the industry].

Q10. How significant are private industry support group activities for the innovation capability of your business and why?

Q11. What is more useful for the *general* learning process of your company: government KISA programs/sources or knowledge acquired through private companies and why?

Q12. How important to your firm is geographical proximity to KISA providers in order to improve your innovation capability and why?

APPENDIX 3

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