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Identification and Comparison of Innovation Patterns of Firms in Four Service Industries by Analyzing Patents

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Abstract – **Innovation in the service sector has received a great deal of attention. Due to the industry specific characteristics, innovation types of service firms will vary among the different industries. The purpose of this article is to investigate innovation patterns of firms in the four South Korean service industries by analyzing patents which are accepted as outputs of innovation. The analyzed industries are information technology (IT) services, finance and insurance (F&I), medical and healthcare (M&H) services, and education (ED). Patent data are electronically collected using the patent search website, Korea Intellectual Property Rights Information Service (KIPRIS). In total, 13,722 of raw data were manually reorganized, and analyzed using a computing program of frequencies statistics and social network analysis (SNA). The findings illustrate that innovation patterns are distinct for each service sector.**

Index Terms – **service innovation pattern, service R&D, patent type, technological innovation, business model innovation**

1. Introduction

The service sector has become increasingly important. As the service sector grows, service innovation and research and development (R&D) activities are becoming important. The types of innovations in the service sector affect its innovation activities.

Service innovations can be classified into two types: technology, and service-oriented processes. As innovation types differ among service sectors, their innovation results can be also dissimilar. Therefore, innovation results can reveal the patterns in a sector's innovation activities. These innovation activities can be defined using the number and types of patents as a measure of innovation output. Patent data define innovation activities, and can be used to identify a service sector's innovation pattern.

The purpose of this article is to use patent information to find patterns in the relationship between service innovation and service sector. Especially, knowledge intensive service has become important and emphasized their innovation for growth. Therefore, analysis focused on knowledge intensive service such as information technology (IT) service, finance and insurance service (F&I), medical and health (M&H) service, and education (ED) service.

Patents can provide information on service innovation and R&D activities, and can be matched to the service sector's characteristics. The analysis will attempt to quantify innovation by the service sector and to identify characteristics of these innovations.

This article is divided into four sections. At first, discusses related works in services innovations and relationship between patent and innovation (section 2). Next section includes data and analysis method (section 3), and discussion of the data and results (section 4). Finally, the conclusion presents suggestions and further research plans (section 5).

2. Related work

2.1 Sectoral patterns of technological change in services

Generally, service innovation is classified into technology or service-oriented categories. Technological innovations can be further classified as supplier-dominated, production-intensive or science-based, in which different principal activities generate different technological trajectories (Pavitt 1984). These different trajectories can in turn be explained by sectoral differences in three characteristics: sources of technology, users' needs, and means of appropriating benefits (Pavitt 1984).

Soete and Miozzo (1989) attempted to extend with Pavitt (1984)'s taxonomy of technological activities, to attempt to align innovations in the service and manufacturing sectors. In particular, Soete and Miozzo (1989) distinguished four categories of service businesses; supplier dominated sectors, network services, scale-intensive services, specialized technology suppliers and science-based sectors.

Evangelista (2000) provided a comprehensive picture of the characteristics of innovation in services, using the results of the 1993-1995 Italian innovation survey in services. Process innovation, innovative investment, and the acquisition and internal development of software represent the most important ways by which service firms innovate. Sectoral analysis highlights the variety of innovative patterns, which should discourage any simple generalization about innovation in services. These approaches primarily considered technological activities in service innovation.

Otherwise, a different approach uses service-oriented models and focuses on non-technological forms of innovation. Gallouj (1997) proposed a model that can be used to interpret innovation processes type in the service sector. Research was grouped into six categories; radical innovation, improvement innovation, incremental innovation, ad hoc innovation, re-combinative innovation, and formalization innovation. Each category has unique characteristics (Gallouj 1997).

2.2 Relationship between patent and innovation

Empirical studies using patents can be conducted on the level of countries, sectors of industry, and technologies of firms (Pavitt 1988). Moreover, there is quite a strong relationship between R&D and the number of patents received at the cross-sectional level, across firms and across industries (Griliches 1990). For these reasons, the number of

patents has been used as a measure of rates of technical change and innovation. Many studies have used the number of patents to measure how innovations affect corporate performance. The number of patents is a successful measurement of innovation. Several research results have found a correlation between number of patents and corporate performance (Scherer 1965, Comanor and Scherer 1969, Austin 1993, Narin 1987, Ernst 1995).

Scherer (1965) and Comanor and Scherer (1969) found a positive relationship between patents granted, patent applications and sales (Scherer 1965; Comanor 1969). The market value is also positively influenced by the number of patents granted, and key patents have a strong influence on market value (Austin 1993). Among 50 firms form the machine-tool industry in Germany, firms with many high-quality patents are significantly more successful those which have few such patents (Ernst 1995). However, the effect of patent applications may not affect a company's subsequent sales two to three years from the year of priority (Ernst 2001).

3. Research methodology

3.1 Patent Data collection and analysis method

Patents are organized according to the International Patent Classification (IPC) which identified the types of technology that they represent. The IPC is based on an international multi-lateral treaty administered by the World Intellectual Property Organization (WIPO). It provides for a hierarchical system of language-independent symbols for the classification of patents and utility models according to the different areas of technology to which they pertain. The classification represents the whole body of knowledge in eight section (WIPO 2009).

Patent data can be collected electronically beyond countries, times, and industries using patent search websites, such as WIPO, the United States Patent and Trademark Office (USPTO), and the European Patent Office (EPO). In this article, only Korean's patent data have been analyzed because over 97% of patent application by Korean inventors are only filed in Korea (OECD 2008).

The Korea Intellectual Property Rights Information Service (KIPRIS) provides Korea's patent data and search system. It covers publications of Korean intellectual property rights applications, legal status information and trial information. KIPRIS is designed to promote the use of patent information such activities as R&D, corporate mergers and acquisitions, and resolution of patent disputes, KIPRIS consists of a basic search function for entry-level users and an advanced search function for experienced users. KIPRIS also provides an online download function, so KIPRIS was used for data collection in this study.

Table 1.Data collection conditions

Category	Search key word
IT	IT service
F&I	finance, insurance, finance and insurance related service
M&H	medical service, health service, social welfare service
ED	education service

Patent data were collected for IT services, financial and insurance (F&I) services, medical and health (M&H) services, and educational (ED) services. These services have known as knowledge intensive service and expect to very active on their innovation activities. Therefore, four sectors have chosen for research, and each service's patents were searched using key words connected to their service (Table 1).

The data search considered only patents registered during the twenty year period from 1989 to 2008. Unidentified data and unregistered data were discarded. Patents were then classified by application date and registration date.

3.2 Analysis method: Social network analysis (SNA) for measuring relation

Social network analysis was used to analyze the relationships among the four service sectors. Social network analysis used to characterize social structures. The social structure is created by connecting nodes which consists of individuals (or institutions) and their specific relationships (Hanneman 2005; Kim 2007). Properties that connect nodes include internet links, financial exchange, friendship, and flights. Recently, social network analysis has become important in various fields such as sociology, anthropology, social linguistics, and pharmacy. Science and technology sector use social network analysis with bibliographic information. Typical examples that meet these conditions are theses and patents. For example, theses contain research purpose, methods, results, and influences, so databases which include all information about these are a good source of science and technology bibliographic information. Continuous publication of journal papers can be used for long-term analysis of trends. Furthermore, journal articles cite numerous research results, and international journals publish papers from around the world; this allows them to be used as an international standard of comparison. Consequently, bibliographic information sources which include literature information can be a source of basic data (KISTEP 2008).

4. Data results

4.1 Service sector data result

4.1.1 IT service

The IT service sector obtained 11,588 patents in the 20-year search window; this is the highest number among the four sectors compared. Of these patents, the 47% were granted to government-funded research organizations, and universities in Korea. Over 50% of the patents were granted to individual and firms. Over 95% of IT service patents were for innovations falling into IPC sections H and G, more than 65% were in section H (electricity) (Fig. 1). This result is clearly related to the direct connection between electricity and information technology. This means that the IT service sector performs innovation and R&D based on science-technology knowledge and that it develops mainly new technology.

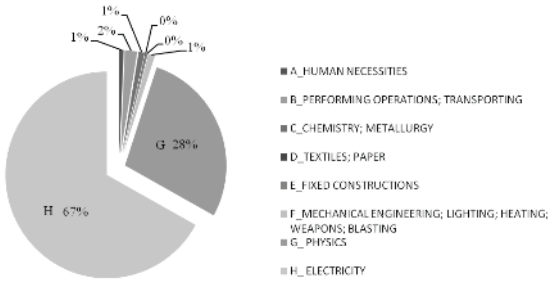

Figure 1.Proportions of IT service patents in each IPC category

4.1.2 Finance and insurance service

The search located 426 patents granted to the F&I service sector. Over the 80% of these patents were classified into IPC section G (Fig. 2). Among them, most were in subclass G06Q, which includes data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes. It covers systems or methods that involve significant data processing operations, i.e. data processing operations that need to be performed by a technology (e.g., computing, system or device). Almost G06Q section patents were granted to banks. The fact that most patents granted to the F&I sector are for processes indicates that in this sector, the main service is not a 'product'; it is, the service itself. Therefore, innovators in this sector focus on developing processes for new services that use technology.

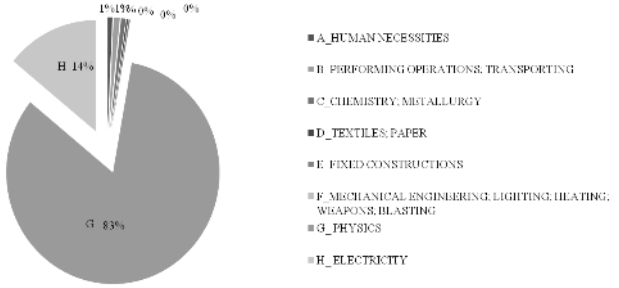

Figure 2.Proportions of Financial and insurance service patents in each IPC category

4.1.3 Medical and health service

M&H services produced only 107 patents; this was the fewest in the four sectors considered. Compared to the number of patents by the IT sector, this number is remarkably small. Moreover, patents were granted individuals and there are no specific characteristics. A great deal of basic research is underway to develop new medical treatment, and other innovations. However, such innovations would be attributed to the medical care sector, whereas the research in this article focuses on the medical and health services as sector. The shortage of data can be a limitation, but also it shows that the M&H service sector does not focus much on innovation or on retaining their service process priorities through patent applications. Nevertheless nearly 50% of the patents granted to this sector are in IPC subclass G06Q (Fig. 3). This result has the same meaning as in the F&I service sector; that patents are primarily for processes.

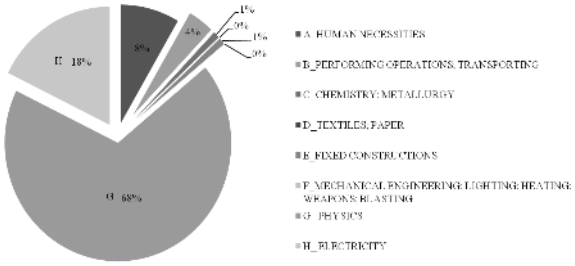

Figure 3.Proportions of Medical and health service patents in each IPC category

4.1.4 Education service

The ED service sector obtained 1,601 patents; this is more than the F&I service sector and the M&H service sector. IPC section H and G together include almost 100% of patents granted to the ED service sector (Fig. 4). Most of these patents were for innovation in subclasses G06F and G06Q, which are both concerned with electric digital data processing. This result shows that the educational service sector focuses on providing processes. However, the significant number of patents granted in, section H show that the ED service sector also develops technology. Unlike the other service sectors considered in this article, the ED service sector develops and uses the technology as a technology user for processes. Currently, many educational services are provided remotely, using such resources as the internet. The educational service sector's patents reflect this situation.

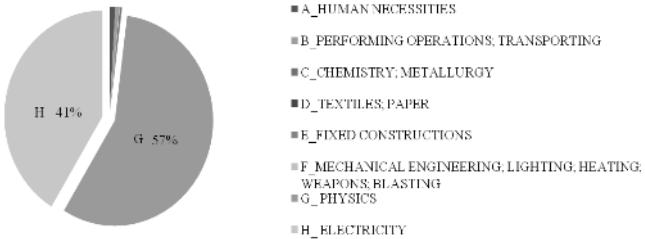

Figure 4.Proportions of Educational service patents in each IPC category

4.2 Relationships among the four service sectors

Social network analysis views social relationships in terms of nodes (or actors) and ties (or relations, edges). Nodes are the individual actors within the networks, and ties are the relationships between the actors. Social network analysis focuses on the relations among actors, and not on individual actors and their attributes. This means that the actors are usually not sampled independently as in many other kinds of studies. Most graphs of networks are drawn in a two-dimensional "X-Y axis" space. Where a node or a relation is drawn in the space is essentially arbitrary (Hanneman 2005). In this article, social network analysis to analyze the relationships among the four service sectors was conducted using the UCINET6 social network analysis program.

The four services show different characteristics. On the basis of the distribution of their patents among IPC classes, these sectors can be grouped into three categories 1) IT; 2) F&I plus M&H; and; 3) ED. The IT service sector has the most patents in section H, and most of these were granted to

technology-based companies. Sector in category 2) focus on developing business models for processes, and the ED service develop both technology and processes. Network analysis, will be used to determine, how the four service sectors are different and how they connect to each other.

For social network analysis, the data describes ties between two sets of nodes at two different levels of analysis. Data like these involve two modes of analysis. Both the Service sector and the IPC section are defined as nodes, and lines are used to show the connections of service to IPC. All nodes are located on a plane, and ties connect the nodes to show their relationships. Data were visualized using NetDraw, which is a network visualizing program in UCINET (Fig. 5).

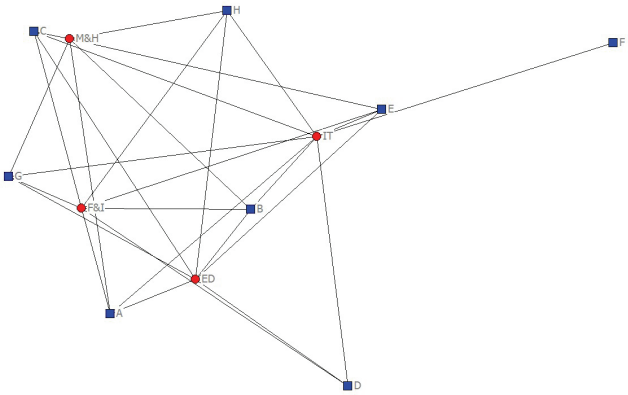

Figure 5.Two mode network of service sector and IPC by NetDraw in UCINET 6
(i) IT: IT service, F&I: finance and insurance service, M&H: medical and health service, ED: education service
(ii) Labels nest to blue squares correspond to IPC section

Points were located on the plane using Multidimensional Scaling of geodesic distances (MDS). MDS reflects the observed distance between nodes as correctly as possible. There are many ways of doing MDS, but the default tools chosen in NetDraw can often generate meaningful renderings of graphs that provide insights. NetDraw has several built-in algorithms for generating coordinates based on similarity (Hanneman 2005).

All service sector nodes and IPC nodes are related but are not connected to the same nodes (Fig. 5). For example, H can connect to IT but not to B. Generally, the IT sector is located on the right side and the ED sector is near the middle. The M&H and F&I sectors, are on the left side. The ED, M&H sector and F&I sectors are closer to each other than any of them is to the IT. This shows that the IT service sector has distinct characteristics and can be categorized separately from the other three services. Service sectors that are closely connected have similar IPC profiles.

Euclidean distance was used to calculate dissimilarities and to observe more-specific relationships. The M&H and F&I sectors are the closest of all of the pairs of sectors; this result means that the patent application patterns of M&H and F&I are the most similar among four service sectors considered. Dissimilarity data can be used for hierarchical clustering. In the cluster diagram, groups are connected in order of decreasing similarity. The F&I and M&H sectors are tied together first, then these are tied to the ED sector, and finally they are all tied to the IT sector (Fig. 6). The diagram shows three groups 1) the IT sector, 2) the F&I plus M&H sector, and 3) ED sector.

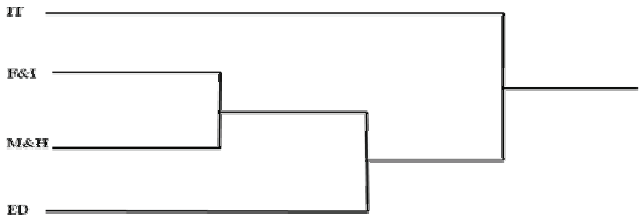

Figure 6.Dissimilarities cluster diagram by UCINET 6

4.3 Discussion

The patents' IPC classifications show that the information technology service sector develops mostly electrical technology. The finance and insurance, and medical and health sectors primarily patent business models. This result demonstrates that finance and insurance, and medical and health sectors are technology users to develop process and that their core focuses is the service process. The education service sector has both technology-related patents and process-related patents; therefore, the pattern of innovation in the education sector is intermediate between the information technology service sector and the group composed of the finance and insurance, and medical and health sectors. Currently, education services are adapting to broadcasting and using the internet. The patent patterns of the education sector reflect this situation.

To understand the relationships among the four service sectors, social network analysis was used to graph and analyze dissimilarities. The social network analysis results show groups these sectors into three categories 1) information technology, 2) finance and insurance, plus medical and health, and 3) education. The patent patterns of the finance and insurance, and medical and health sectors are more similar to each other than to the other sectors. The patent pattern of the information technology service sector is very distinct from those of the other services. This difference can be explained by the information technology service sector's focus on technology.

The entire service sector has broadly similar characteristics, but innovation activities are specific to each subsector. The finance and insurance, and medical and health sectors provide services to clients, so interaction between provider and client is very important in these sectors. To improve the service interaction, the innovations by the finance and insurance, and medical and health sectors focus on developing processes. In contrast, the information technology service sector provides technology-oriented service to clients. This sector mainly develops technology to provide better service. Lastly, innovations by the education sector have characteristics similar to those of the finance and insurance, and medical and health sectors. In the education sector, the method of providing service has been changing and the internet and broadcasting are increasingly used to deliver services. These changes affect the education sector, so innovations by this sector focus on developing the technology for providing service. Consequently, each service sector's innovation activities and output are different because the sectors focus on different primary businesses even though they are all lumped into the 'service sector'.

This research shows that each service sector needs to concentrate on appropriate innovation activity, and it can be

increase competitive power. Especially, information technology is very strong in Korea, and they have been developed much quickly than any other sector. Finance and insurance, and medical and health sectors can do more radical innovation using information technology.

5. Conclusion

In this study, the quantity and types of patents have been used to measure innovation activities. Analyzing patent patterns helps to describe relationships between service sectors and service innovations. Furthermore, the analyses reveal the presence of service innovation characteristics.

Korean patent data form the years 1989 ~ 2008 were collected electronically from a patent search website, Korea Intellectual Property Rights Information Service (KIPRIS). Patents granted to information technology, financial and insurance, medical and health, and educational service sectors were identified using selected appropriated key words.

These findings present that innovation patterns are distinct for each service sector. The results show that the information technology service sector obtained mainly technology patents, whereas the finance and insurance, and medical and health service sectors obtained mainly business model patents. The education sector obtained both technology patents and business model patents. Innovation activities and output differ among service sectors, because each sector innovates in ways that are useful in their primary business.

One possible limitation of this paper is that patent granted based on technology, may not be sufficient to assess innovation by the service sector. A patent does not contain all of service innovation, so it can be a limitation to explain whole innovation activities in four service sectors. Moreover, patent data for the information technology sector and the medical and health sector differ widely in quantity.

For further research, data need to be more various and specific. This research data collected and analyzed in quantity. It could be difficult to identify innovation patterns with only quantitative analysis. Therefore, the data need to be analyzing analyzed more specifically in details. For example, particular analysis of patent claim content and applied patent to service or process practically can be a topic for further research. Also, additional service sectors should be considered. Still, some limitations remain and further research is necessary for development of this subject. There are few research about service innovation and service industry's patents. Consequently, this research has importance that it shows the relationship between service sector and service innovation.

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