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Identifying Relationships between Technology-based Services and ICTs: A Patent Analysis Approach

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***Abstract*—**A variety of new technology-based services have emerged with the development of Information and Communication Technologies (ICTs). Since technology-based services have technology-driven characteristics, the identification of relationships between technology-based services and ICTs would give meaningful implications. Thus, this paper proposes an approach for identifying the relationships between technology-based services and ICTs by analyzing patent documents. First, business model (BM) patents are classified into relevant service categories. Second, patent citation analysis is conducted to investigate the technological linkage and impacts between technology-based services and ICTs at macro level. Third, as a micro level analysis, patent co-classification analysis is employed to identify the technological linkage and coverage. The proposed approach could guide and help managers and designers of technology-based services to discover the opportunity of the development of new technology-based services in emerging service sectors.

***Keywords*—**Technology-based Services, Information and Communication Technology (ICT), Business Model (BM) Patent, Patent Analysis, Technological Relationship

I. Introduction

RECENT years, service industries encounter rapid changing environments with diversified customer requirements and technological development. Especially, the development of ICT such as internet and mobile technology has accelerated the emergence of a variety of new technology-based services which are the new type of services enabled by ICT. Accordingly, a lot of studies of technology-based services have been carried out not only in the commercial field but also in the academic field. In commercial field, many business model patents have been applied to protect the companies' business models related with technology-based services. In the academic field, amongst others, the analysis of technology-based services and the establishment of service innovation models have been studied. For example, in case of mobile services, characteristics [1], [2], classification [3], [4], and evaluation [5]–[7] of mobile services have been studied most actively.

First, little research on BM patents has been conducted. BM patents contain the vast information on services as well as technologies, and therefore they can play a role as data sources for analyzing technology-based services. Therefore, BM patents describe the details of real-world services based on new technologies, and thus the analysis of them could give a lot of implication previous research has not proposed.

Second, there is a lack of studies on the technological relationships between technology-based services and ICTs. The traditional offline services have market-driven characteristics, whereas technology-based services have technology-driven characteristics [8]. Thus, the creation and dissemination of technology-based services are heavily dependent on the development of ICTs. If the technological relationships between technology-based services and ICTs are analyzed, we can obtain useful implications on the development direction of technology-based services as well as on emerging and potential areas. Therefore, the identification of technological relationships between technology-based services and ICTs could be an important research topic.

In response, this paper suggests an approach to identify technological relationships between technology-based services and ICTs by analyzing patent documents. First, BM patents are classified based on their contents and the existing service categories with public confidence. Second, the technological relationships between technology-based services and ICTs are identified through the patent analysis. Specially, citation analysis is employed to analyze technological linkage and impacts between technology-based services and ICTs at macro level, and co-classification analysis is applied to identify technological linkage and coverage at micro level. In addition, time series analysis is conducted to investigate the technological trends between technology-based services and ICTs.

The remainder of this paper is organized as follows. A general background of patent analysis and BM patent is introduced in Section II. The proposed approach of this paper is explained in Section III. The result of patent analysis is presented in Section IV. Finally, Section V offers our conclusions.

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II. Background

A. Patent analysis

Patents are regarded as an ample source of technological and commercial information for the following reasons. First, an extensive volume of patents has been accumulated for a long time. Over 6,000,000 patents have been applied to the United States Patent and Trademark Office (USPTO), and an average of 150,000 patents is steadily registered every year. Second, each patent contains detailed information on the developed technology. Patents also include a lot of information such as inventors, assignee, issue date, claims, references, and so on. Third, patents can be regarded as valuable inventions because it takes much time and cost to obtain the rights to patents. Finally, patent documents are public so that they can be easily accessed through public and commercial databases, and they have standardized and structured forms [9].

Due to the above mentioned advantages of patents, patent analysis has been considered as a useful analytic method for technology monitoring. In particular, patent analysis provides the opportunities to satisfy the need for conceptual or qualitative analysis of technological change [10] and empirically explains most aspects of technological innovation [11]. Furthermore, patent analysis has been used in various research areas such as identification of economic effects of technological innovation [12], investigation of effects of technological change on performance [13], and exploration of technological opportunities [9].

Patent data contains much information for analysis. At the beginning, bibliographic fields of patents were utilized to analyze and organize a huge amount of historical data [14], [15]. Among various bibliographic indicators, the most used ones are the citation frequency, the number of claims, the number of classes, and the size of patent family. The citation frequency has been employed as a measure of technological linkage [16], technological importance [17], and competitiveness and social value of invention [18]. The number of classes shows the technological scope and applicability [19], [20].

B. BM Patent

With the development of information technology, especially dissemination of the internet, BMs have been paid attention to significantly. In early period, BMs for computer-mediated electronic commerce or e-commerce have been paid attention to. Thereafter, the focus of BMs has moved to mobile and ubiquitous commerce. As the importance of BM is growing, many BM patents have been issued and applied to protect the companies' BMs.

BM patents are defined as the methods of administering, managing or otherwise operating an enterprise or an organization, including techniques used in doing business [21]. In particular, BM patents contain a way of providing services and generating revenue, hence BM patents are highly related to new methods or systems for technology-based services [22]. BM patents in the USPTO are classified into the class 705 which contains five major groups directed to specific and general business data processing machines and methods. They are business processing using cryptography, electronic negotiation, automated electrical financial or business practice or management arrangements, for cost/price, and miscellaneous. Due to the increasing importance of BM patents, USTPO announced a plan including the way to improve the quality of the examination process of patents related with electric commerce and BMs in 2000 [23]. Consequently, BM patents have been managed thoroughly and their quality has been enhanced.

Up to now, little study on BM patents has been conducted in spite of their importance. Most of them focus on the descriptive statistics of BMs [24] and the analysis of patenting activities [25]–[27]. In addition, there is a lack of studies which employ quantitative analytic methods using BM patents.

III. Research Framework

A. Research process

The overall research process consists of four steps as shown in Fig. 1. First, ICT and BM patents are collected from USPTO database. ICT patents are affiliated to specific technological fields that are defined by grouping related technologies.

Second, BM patents are classified into relevant service categories based on their contents. For this aim, the definitions of class 705's subclasses are examined and matched up to Services Sectoral Classification of WTO (World Trade Organization) [28].

Third, the overall relationships between ICT and technology-based services are identified with respect to knowledge flows at macro level. To measure knowledge flows, patent citation analysis is employed. The existence of knowledge flows between two different technological fields represents the technological linkage, and the amount of knowledge flows, that is, the citation frequency indicates the degree of technological impact of a cited technological field on a citing technological field.

Fourth, the technological interrelationships between technology-based services and ICTs and the technological coverage of ICTs are examined at micro level through patent co-classification analysis. If a patent is classified into both an ICT-related class and a technology-based service-related class,

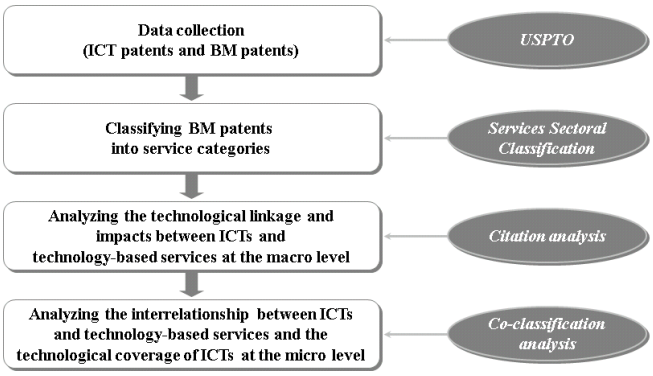

Fig. 1 Overall research process

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these two classes have a technological interrelationship. Thus, the number of patents classified into both areas indicates the strength of technological interrelationship between them. On the other hand, if an ICT-related patent is classified into two or more services, this technology can cover multiple services. Thus, the number of services covered by a certain ICT field can represent the technological coverage of it.

B. Technological fields of ICT

The USPTO categorizes US patents based on own classification scheme, USPC (US Patent Classification). Among USPC classes, 33 classes were selected as ICT-related classes, and then they were divided into nine technological fields as shown in Table 1.

TABLE I
TECHNOLOGICAL FIELDS OF ICTS AND RELEVANT USPC CLASSES

Technological fields of ICTs	Relevant USPC classes
Mobile telecommunication and telematics (MOT)	340, 375, 379, 701
Broadband and home network (NET)	370
Signal processing (SIG)	345, 353, 367, 381, 382, 386
Electrical Computing (ELC)	235, 361, 365, 700, 708, 710, 713, 714, 719
Intelligent robot (ROB)	318, 706
Radio frequency identification and ubiquitous sensor network	342, 343, 455
Information technology system on chip and united parts (SOC)	438, 711, 716
Embedded software (ESW)	341, 712
Digital contents and software solutions (SOL)	705, 707, 715, 717

C. Classification of BM patents

To classify BM patents into service categories, the subclass of class 705 of USPC are matched to relevant Services Sectoral Classification. Services Sectoral Classification was addressed in the GATS (General Agreement on Trade in Services), a treaty of the WTO. The treaty was created to extend the multilateral trading system to service sector. Services Sectoral Classification has 11 service sectors and each sector has its sub-sectors. On the other hand, the class 705 of USPC has over 200 subclasses and each subclass defines a specific business method and applicable areas. With careful examination of the concordance between subclasses of 705 and Services Sectoral Classification, subclasses were classified into relevant service sectors.

IV. CASE STUDY

For the illustration of the proposed approach, we conducted a case study in which only the technological linkage between technology-based services and ICTs at macro level were analyzed through the patent citation analysis for 2006, 2008, and 2010.

A. Data collection

We collected patent documents including citation and classification information from the USPTO database. First, ICT-related patents which were classified to the classes in Table I were collected. Since the technology cycle time of information science is perceived to be less than eight years [29], we collected ICT-related patents issued from 2000 to 2010, which could contain most patents cited in 2006, 2008, and 2010. Next, we collected BM patents (class 705) issued in 2006, 2008, and 2010. The numbers of collected patents for each period are 471, 1,019, and 2,314 respectively. The yearly number of issued BM patents is rapidly increasing and this could imply the fast growth of technology-based services.

B. Classifying BM patents into service categories

After collecting BM patents, we classified them into service categories. For this aim, we thoroughly examined the concordance between subclasses of class 705 and Services Sectoral Classification and, eventually, we classified most subclasses into relevant service sectors except subclasses for general purpose. In addition, two service sectors (construction and related engineering services & recreational, cultural, and sporting services) were excluded due to the absence of relevant subclasses. The classification result is represented in Table 2.

TABLE II
SERVICE SECTORS AND RELEVANT SUBCLASSES OF CLASS 705

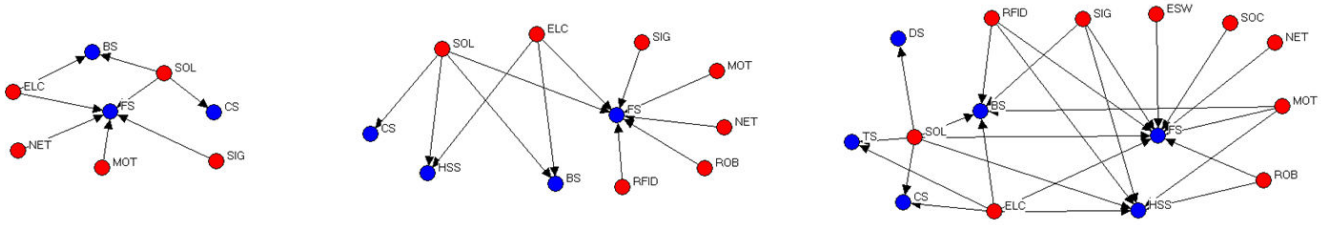
Service sectors	Subclasses of class 705
Business services (BS)	7.11~7.42, 12, 14.4, 14.5, 14.6, 14.41~14.68, 14.72, 14.73, 18, 19, 30, 31, 32, 33, 34, 57, 63, 304, 307, 311, 312, 313, 314, 315, 316, 344, 412, 901~912
Communication services (CS)	60, 61, 62, 319, 401~411
Distribution services (DS)	26.1, 26.2, 26.35, 26.4, 26.41, 26.42, 26.43, 26.44, 26.5, 26.61, 26.62, 26.63, 26.64, 26.7, 26.8, 26.81, 26.82, 26.9, 27.1, 27.2
Educational services (EDS)	326, 327, 328
Environmental services (EVS)	308
Financial services (FS)	4, 17, 35, 36R, 36T, 37, 38, 39, 40, 41, 42, 43, 44, 45, 53, 68, 70, 77
Health related and social services (HSS)	2, 3
Tourism and travel related services (TTS)	15
Transportation services (TS)	13, 330~341

C. Analyzing the technological linkage at macro level

To analyze the technological linkage between technology-based services and ICTs at macro level, we identified the technological fields of ICT-related patents that BM patents have cited through the citation analysis. The results of analysis are as follows.

1) Technological linkage for 2006

Fig. 2 (a) shows the result of citation analysis for 2006 with the cut-off value set to 20. The red nodes represent technological fields of ICTs and the blue nodes represent service sectors of technology-based services. Fig. 2 indicates that the ELC, MOT, NET, SIG, and SOL fields were triggering the developments of technology-based services in BS, CS, and FS sectors. These technological fields encompass data processing and signal technologies, computing technologies,



(a) 2006 (b) 2008 (c) 2010

Fig. 2 Result of citation analysis (cut-off=20)

and communication technologies including mobile phone-related technologies. Particularly, the SOL field influenced three service sectors and the FS sector received the technological impacts from five ICT fields.

2) Technological linkage for 2008

The result of citation analysis for 2008 is represented in Fig. 2 (b) and the cut-off value is the same as that of 2006. At this time, two technological fields, the ROB and RFID fields were added against 2006. This implies that the communication functions and the degree of automation in technology-based services had been enhanced in comparison with 2006. On the other hand, one service sector, the HSS was included. Similarly, the SOL field influenced all four service sectors and the FS sector received the technological impacts from all seven ICT fields.

3) Technological linkage for 2010

Fig. 2 (c) illustrates the result of citation analysis for 2010, which is more complex than others. In 2010, all technological fields of ICTs were influencing the development and the diversification of technology-based services. Especially, six service sectors including DS and TS sectors can be identified in the result. In the same manner, the SOL field influenced all six service sectors and the FS sector received the technological impacts from all nine ICT fields. Although some service sectors did not have significant linkages with ICTs in 2010, the continuous development of ICTs would bring us more technology-based services of new service sectors.

V. Conclusion

This paper proposes an approach for investigating the technological relationships between technology-based services and ICTs. The technological fields of ICTs were selected and relevant patent documents were collected from the USPTO database. As data for technology-based services, BM patents registered in USPTO were collected and classified into service categories according to the Services Sectoral Classifications published by WTO. Patent citation analysis is employed to identify the technological linkage and impacts between technology-based services and ICTs at macro level, and the patent co-classification analysis is suggested to analyze the technological linkage and coverage at micro level. Finally, the time series citation analysis for investigating technological linkage was provided.

The contribution and potential utility of this study is that the proposed approach can monitor the change of the technological relationships between technology-based services and ICTs. In other words, it could show us not only the development paths for technology-based service sectors but also the emerging service sector and the most influential technology-field. Consequently, the proposed approach could guide and help managers and designers of technology-based services to discover the opportunity of the development of new technology-based services in emerging service sectors.

Despite these substantial contributions, this paper has some limitations that should be clearly solved. First, a more suitable service classification scheme for technology-based services should be suggested. No subclass was assigned to some service sectors of Services Sectoral Classification, whereas the business service sector has over 90 subclasses. Thus, the data-centered approach for the classification of technology-based services such as applying factor analysis to the contents of BM patents could be a future research topic. Second, we have investigated the relationships between a service class and a technological field. However, more than two technologies could be involved in relationships. Thus, future research could include an in-depth investigation of multiple technologies for service-technology relationships.

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