Technological Forecasting & Social Change xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

# A structured approach to explore knowledge flows through technology-based business methods by integrating patent citation analysis and text mining

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ARTICLE INFO

*Article history:*
Received 1 January 2014
Received in revised form 13 April 2014
Accepted 16 April 2014
Available online xxxx

*Keywords:*
Knowledge flow
Business method
Patent citation analysis
Text mining
Technological classes

ABSTRACT

With information and communication technology (ICT) as an enabling platform, diversified new business methods (BMs) have been developed. These new technology-based BMs have played an important role in knowledge flow as they became a patentable subject matter. However, there are not many studies on knowledge flow through the technology-based BMs or BM patents in spite of its importance. As an attempt to provide a deeper understanding of technology-based BMs with regard to knowledge flow, this paper explores knowledge flows driven by the technology-based BMs through investigating both cited and citing patents. In order to explore the knowledge flows, this paper proposes an algorithm that utilizes both the citation and textual information of BM patents. In addition to citation information, text data in patent documents are used to measure the degree of knowledge flow in a more accurate way. A case study is conducted with the BM patents related to postage metering system and the analysis result is presented in a positioning map that shows different knowledge flow patterns of technological classes. Moreover, the technology-based BM patents as knowledge flow drivers are classified based on the amount of knowledge exchanged between the base BM patents and their patent citations.



## 1. Introduction

Business environment has been changing rapidly since the 1990s and companies have to constantly develop new business methods/business models to keep up with such changes and survive in the market. The most noticeable change among all is the substantial application of ICT in the business environment; ICT has become a new enabler for business communication and processing commercial transactions [1–6]. With ICT as a critical part of new BMs, BMs are now one of the patentable subject matters that gain special attention, and a growing number of companies try to seek patent protection for the new BMs [3]. As a result of that, the number of BM patents grew rapidly over a very short period [6,7].

Despite their importance in the business environment, it is difficult to find previous studies discussing about technology-based BMs with respect to their relationships with technologies, technology-based BMs of other kinds or knowledge flow. Recently, some researchers made attempts to study such topics. Kim et al. [8] identified between technology-based services, which are represented by the BMs, and ICTs. Some studies aimed to explore technology diffusion of BMs [1] and identify internal technological relationships among the BM patents and patterns of business model evolution [9]. Other studies merely focused on explaining the theoretical background of impact of technology on BMs/business model innovation [2–4,6].

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http://dx.doi.org/10.1016/j.techfore.2014.04.007
0040-1625/

There are different terminologies used for BMs that include ICTs, but there is no specific terminology or definition that is widely agreed upon among researchers or practitioners. Hunt [10] called such BMs "computer-implemented business methods." Wu [6] used two different terms which are "software-embodied business methods" and "internet business methods." Those BMs are also simply called "business methods" [11] and "business methods based on Internet technologies" [1]. In this paper, they will be called "technology-based business methods" and narrowly defined as "type of business methods limited to patentable subject matter classified in USPTO Class 705 which only includes business methods based on technologies."

The role of knowledge exchange is especially important in a knowledge and technology driven economy because it allows better penetration and diffusion of innovation and stimulates cooperation in R&D [12,13]. There have been extensive studies emphasizing the importance of knowledge flow/spillover. Glaeser et al. [14] suggest that knowledge flow/spillover is directly linked to three factors of economic growth, which are specialization, competition and diversity, and they are characterized by a higher intensity of intra-industry knowledge spillover, inter-firm innovation flows and inter-industry knowledge exchange, respectively. Also, Huggins and Johnston [15] argue that knowledge exchange through networking with various partners in different domains can open opportunities for novel combination and recombination of ideas or best-of-breed solutions that originate from different resource bases and knowledge bases. Such knowledge networks are thus an important aspect of the innovation process [15–17].

Although it is not difficult to conceptualize a phenomenon of knowledge flow, it is very difficult to measure the degree of knowledge flow [12]. The two main methods are direct and indirect [18]. The main direct method is to use information in patent citations. The indirect method of measuring knowledge flows typically regresses total factor productivity (TFP) growth on factors thought to be potentially causing information flows, such as the presence of multinational enterprises (MNEs) or international-trade status. [18]. They both have advantages and disadvantages, but we decide to use patent citation as a measure of knowledge flow due to the following reasons: patent citation is a certified evidence of previous knowledge used by the inventor [19], data can be obtained easily and International Patent Classification (IPC) corresponds with the purpose of our study.

Since BMs have been disclosed to the public in the form of a patent, meaning they are more exposed to knowledge flows, it is worth studying important implications of the BM patents in terms of knowledge flow. The BM patents enable effective measurement of knowledge flow of BMs, with citation and other information. Knowledge flow is stimulated by the BM patents through active cited (backward citation) and citing (forward citation) patents. There exist some previous studies showing the empirical evidence that the BM patents not only cite a significant number of previous patents but are also cited by a substantial number of subsequent patents [11,20].

Both cited and citing patents represent knowledge flow in a similar manner, but the underlying economic rationales of these two processes differ [21,22]. Cited patents (backward citations) have been used to measure technological knowledge acquired by the patenting entity and thus regarded as knowledge utilization; on the other hand, citing patents (forward citations) have been interpreted as a measure of the knowledge diffusing outward from the patenting entity and thus regarded as knowledge dissemination [21,22]. The more frequently a patent is cited by patenting entities, the greater the related technology may have influenced, implying that the technological knowledge is more widely disseminated. Since the BM patents have a substantial number of both cited and citing patents, it can be interpreted that they play an important role in utilizing and disseminating knowledge.

Although there are numerous studies using patent citation information as a proxy for knowledge flow between technologies or actors, and patent citations encapsulate important information about knowledge flow, there are still some drawbacks to use citation information. Patent citations, which are linked to the patenting procedure itself, capture only the knowledge flows, thus underestimating the actual extent of knowledge flows [23]. Also, they could be biased by incorrect citing of sources; thus supplementary investigation is required to allow citation information to be confidently applied [21].

In order to overcome the drawback of citation based approach, text mining, using textual data to discover useful pattern, can be applied along with citation analysis. Co-word analysis is mainly utilized to explore the concept network in different fields since the nature of words, on which co-word analysis is based, can act as the important carrier of knowledge [24]. Words and co-occurrences of words cover a much broader domain than citations [25]. Words occur not only as indicators of links among documents but also internally within documents. Thus, the text data can be used to measure a degree/amount of knowledge transferred by measuring text similarities between patents while patent citation is used to measure a path of knowledge flows.

As an attempt to provide a deeper understanding of technology-based BMs with regard to knowledge flow, the paper proposes a framework for exploring knowledge flows driven by technology-based BMs from their utilized technologies to disseminated technologies, by investigating both cited and citing patents. The proposed approach integrates patent citation analysis and text mining to explore the knowledge flow through technology-based BMs. First, knowledge flow path is traced using citation links between technology-based BM patents and their cited patents, which represent utilized knowledge sources, and between technology-based BM patents and their citing patents which represent disseminated knowledge. Then, co-word analysis as a text mining is integrated with the citation analysis to verify the degree of knowledge transferred between BM patents and cited/citing patents by measuring the text similarity between BM patents and their utilized/disseminated knowledge source. The integrated approach will lead to a better measurement of knowledge flow in terms of the degree of knowledge flow.

## 2. Proposed approach: integrating patent citation analysis and text Mining

### 2.1. Overall research process

In addition to the fact that patent information is better protected from data disruption than other database, citation information provides citation links which can be used to analyze technological diffusion, valuation or impact, among

Please cite this article as: H.J. No, et al., A structured approach to explore knowledge flows through technology-based business methods by integrating patent..., Technol. Forecast. Soc. Change (2014), http://dx.doi.org/10.1016/j.techfore.2014.04.007