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Identification and evaluation of corporations for merger and acquisition strategies using patent information and text mining

Hyunseok Park · Janghyeok Yoon · Kwangsoo Kim

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Abstract This paper proposes a framework to identify and evaluate companies from the technological perspective to support merger and acquisition (M&A) target selection decision-making. This employed a text mining-based patent map approach to identify companies which can fulfill a specific strategic purpose of M&A for enhancing technological capabilities. The patent map is the visualized technological landscape of a technology industry by using technological proximities among patents, so companies which closely related to the strategic purpose can be identified. To evaluate the technological aspects of the identified companies, we provide the patent indexes that evaluate both current and future technological capabilities and potential technology synergies between acquiring and acquired companies. Furthermore, because the proposed method evaluates potential targets from the overall corporate perspective and the specific strategic perspectives simultaneously, more robust and meaningful result can be obtained than when only one perspective is considered. Thus, the proposed framework can suggest the appropriate target companies that fulfill the strategic purpose of M&A for enhancing technological capabilities. For the verification of the framework, we provide an empirical study using patent data related to flexible display technology.

Keywords M&A target selection · Technology acquisition · Patent analysis · Subject–action–object · SAO · Technological similarity

H. Park
Graduate School of Technology and Innovation Management, Pohang University of Science and Technology, 77 Cheongam-ro, Nam-gu, Pohang 790-784, Republic of Korea
e-mail: howgood@postech.ac.kr

J. Yoon
Department of Industrial Engineering, Konkuk University, 120 Neungdong-ro, Gwangjin-gu, Seoul 143-701, Republic of Korea
e-mail: janghyoon@konkuk.ac.kr

K. Kim (✉)
Department of Industrial and Management Engineering, Pohang University of Science and Technology, 77 Cheongam-ro, Nam-gu, Pohang 790-784, Republic of Korea
e-mail: kskim@postech.ac.kr

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Introduction

The primary objective of a corporation is to satisfy its customers (Drucker 2006). A corporation must make efforts to identify customer needs and to provide products or services that differ from those of its competitors to keep customers satisfied and to occupy an advantageous competitive position in the market. In today's turbulent business environment, customer needs have been changing fast and are becoming more complex and diverse, and market competition has become increasingly fierce (Lawson and Samson 2001). In these situations, to meet the customer needs and gain competitive advantages in the market, the top priorities of a corporation should be to develop innovative and advanced technological capabilities known as knowledge-intensive abilities to create or develop new configurations of product, process and service technology and to implement changes and improvements to technologies already in use (Porter and Stern 1999; Bell 2009; Prahalad and Hamel 1990; García-Muiña and Navas-López 2007).

To improve technological capabilities, corporations generally develop internal research and development (R&D) capabilities or acquire external sources of technological knowledge (Cassiman and Veugelers 2006). Although R&D is the basic and essential activity for technological innovation, relying solely on development of internal innovative capabilities is no longer sufficient to cope with the increasing cost, speed and complexity of technological developments, particularly in high-tech industries (Cockburn et al. 1999; Vanhaverbeke et al. 2002). Thus, in addition to developing internal R&D capabilities, companies are obliged to use alternative external sources of knowledge from within or beyond their technological boundaries (Rigby and Zook 2002). When enhancing their innovative capabilities, even the largest and most technologically self-sufficient companies require technological knowledge from beyond their boundaries. Strategies to acquire such knowledge can be distinguished into two broad types: embodied and disembodied technology acquisition (Cassiman et al. 2000). Embodied technology acquisition means that corporations use merger and acquisition (M&A) to obtain technological capabilities embodied in an asset that is acquired such as other firms or parts thereof. By its nature, M&A activity involves relatively high risk. However, M&A is an effective way to facilitate entry into new markets in that an acquiring company can exploit not only technological knowledge but also other resources of the target corporation (Helfat and Lieberman 2002). Disembodied technology acquisition means that the corporation enters technology alliances to acquire technologies. Technology alliances are mainly conducted with their competitors in the same technological field when the corporation needs to acquire only technological knowledge without other resources (Vilkamo and Keil 2003; Fosfuri 2006).

Recently, increasing numbers of companies have devoted effort to acquire external knowledge, and the volume of deals also has been steadily increasing. However, successful acquisition of external knowledge is not easy. Some studies pointed out that the failure rate of technology alliances is around 50 % (De Man and Duysters 2005), and these high failure rates may cause technology alliances to be perceived as problematic and risky. But the failure rate of M&A activity is far higher, between 70 and 90 % (Christensen et al. 2011); considering that over $2 trillion are spend on M&A transactions every year, this failure rate is extremely costly. M&A succeed or fail can be determined by various internal and external reasons, from planning M&A strategies to managing integration after the M&A

deal. However, the most fundamentally important step to increase the success of M&A projects is to select the right target companies which are well matched to the strategic purpose of M&A (Christensen et al. 2011; Kengelbach and Roos 2011).

As a preceding step for right target selection, an acquiring company should identify potential target companies that can fulfill the strategic purpose of M&A. In respect that effects of M&A have critical influence, potential M&A targets should be identified by careful analysis considering the internal and external situations from the various perspectives. Most of the previous studies on identifying or evaluating M&A targets concentrated primarily on development or application of financial and managerial variables such as firm size, market-to-book value ratio, cash flow, and debt-to-equity ratio as indicators for pricing and valuation, but did not consider the technological perspective (Ali-Yrkkö et al. 2005; Pasiouras and Gaganis 2007; Ragothaman et al. 2003; Xi-Liang et al. 2009; Reed et al. 1999). Considering that many M&A deals have taken place in high-tech industries and that technological capabilities of the target company are closely connected with the strategic purposes of M&A, technological variables should be considered for M&A target identification (Bower 2001; Wei et al. 2009). However, there are few studies considering technological perspective for the purpose (Ali-Yrkkö et al. 2005).

To provide detailed guidance for identifying potential M&A targets from the technological perspective, this paper proposes a framework to identify companies which can fulfill a specific purpose of M&A for enhancing technological capabilities by using a text mining-based approach. Patents are useful sources of up-to-date and reliable technological information, and corporations generally patent most of their technological knowledge, even their core and confidential technologies (Tseng et al. 2007). Therefore, the technological capabilities of a corporation can be represented by its set of patents (Gupta and Pangannaya 2000). Recently, the proliferation of patents worldwide has increased the demand for more-advanced quantitative patent analysis techniques to simplify experts' evaluation processes and to support experts' decision-making, and patent maps have been used for this purpose in various research (Lee et al. 2009; Yoon et al. 2002; Yoon and Kim 2012; Yoon et al. 2013; Park et al. 2013). A patent map is a snapshot of the technology landscape that represents complex information of technological relations among patents in an easily understood form. It is useful to analyze technological aspects such as technology trends and competitive interactions. To generate the patent map, we applied an approach based on subject–action–object (SAO) structures extracted using Natural Language Processing (NLP).

For evaluating technological capabilities of the identified companies, our second step provides patent indexes that evaluate both current and future technological capabilities and potential technology synergies between acquiring and acquired organizations. Furthermore, the method evaluates the companies from the overall corporate perspective and the specific strategic perspective simultaneously to increase the richness and depth of analysis. Thus, the proposed framework to identify and evaluate potential M&A targets from the technological perspective can provide valuable insights that can support the decision making for M&A target selection. For the verification of the proposed framework, we provide an empirical study using patent data related to flexible display technology.

This paper is organized as follows: the theoretical background is presented in "Theoretical background" section, the procedure of the proposed approach is described in "Research framework for identification and evaluation of M&A targets" section, the approach is illustrated in "Empirical study: the case of flexible display technology" section, and the discussion and conclusions are given in "Discussion and conclusion" section.

Theoretical background

M&A target selection from technological view

As one method of acquiring external knowledge, M&A has long received attention from corporations and academia. Merger is defined as the combination of two or more corporations to create a new entity or to form a holding corporation (Gaughan 2010; Jagersma 2005); Acquisition is defined as the purchase of shares in or assets of another corporation to achieve managerial and technological influence, whether by mutual agreement or not (Chen and Findlay 2003; Jagersma 2005). Although merger and acquisition are distinct types of transaction with different consequences, the term 'M&A' is generally accepted to mean transactions by which two or more companies combine their business and technology efforts (Gaughan 2010).

The fundamental motive of M&A is to accelerate the growth of the corporation by obtaining required innovative capabilities as quickly as possible and with the least risk (Cameron and Green 2009). Therefore, most M&A deals have occurred in high-tech industries, in which company must acquire fresh innovative technologies continuously if it is to gain competitive advantages in the market, and in which technology changes so fast that a single firm's technological capabilities are insufficient to keep up (Cho and Yu 2000; Bower 2001; Inkpen et al. 2002).

In order to achieve the growth of a corporation effectively using M&A, technological aspects should be considered when developing an M&A strategy (James et al. 1998; Wei et al. 2009). The strategic purpose of M&A when acquiring technological capabilities can be classified into three types (Table 1). First, a corporation can decide to execute an M&A transaction to enhance or complement technological capabilities within its core technology area to achieve or maintain competitive advantage. The second purpose is to enhance or supplement technological capabilities related to the minor or sub-technologies in the technology portfolio of the acquiring company to strengthen its technology portfolio. The third purpose is to enter new and promising technology areas in which an acquiring company has not been involved, to (pre)occupy promising technological capabilities, or to expand the scope of its technology and business expertise. To choose an appropriate one of those M&A strategies, corporations consider their current capabilities and the nature of their competitors.

The process of M&A can be broadly divided into four phases (Fig. 1). After an M&A strategic direction is set, selection of M&A targets, execution of transaction, and integration of acquiring and acquired organizations are performed sequentially. To achieve a successful M&A, the corporation must carefully focus on every phase of the M&A process. However, the most important phase of M&A is selection of appropriate target companies that are well-matched to the strategic purpose of M&A (Christensen et al. 2011; Kengelbach and Roos 2011). Even if the other phases of the M&A process are performed perfectly, an acquiring company cannot obtain the expected financial and technological benefits from M&A if the selected target does not have assets that match the strategic purpose of M&A. Thus, for M&A to be successful, selection of appropriate targets is essential.

To select appropriate targets, an acquiring company should identify potential target companies that possess technological capabilities that match the strategic purpose of M&A, and then evaluate these targets. Despite its importance, few studies have been conducted to suggest a systematic approach for identification of potential targets, and most prior studies for M&A predictions focused only on the evaluation of target companies.

Table 1 Strategic purpose of M&A from technological perspective

Strategy	Definition	Purpose
Enhancement of core technology	Acquisition of targets that possess innovative and technological capabilities within the core technology areas of an acquiring company	To strengthen and complement the innovative capabilities within the firm's core technology area
		To achieve or maintain exclusive competitive advantage within the firm's core technology areas
Enhancement of sub or minor technology	Acquisition of targets that possess innovative and technological capabilities within minor or sub-technology areas of an acquiring company	To strengthen existing technology portfolio
		To supplement insufficient or less focused technological capabilities
		To prepare the next wave or core technology
		To transform the firm's core capabilities
Entry into the new technology areas	Acquisition of targets that possess innovative and technological capabilities in promising technology areas in which an acquiring company has not been involved	To expand the scope of technology and business area
		To (pre)occupy the future promising technology field
		To prepare the next wave or core technology
		To transform the firm's core capabilities

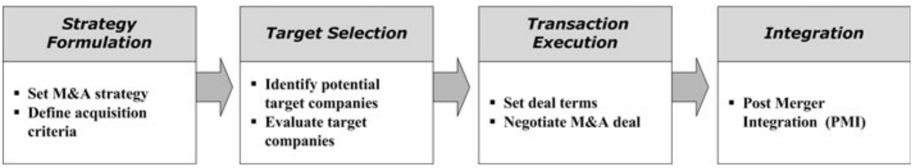


Fig. 1 M&A process

Although numerous studies have presented methods of evaluating M&A targets, most considered only financial and managerial perspectives and disregarded technological perspectives. In fact, proper assessment of the target's financial value and potential synergies is the important step, in that overvaluation of the target is one of the main causes of M&A outcomes that fall short of expectations. However, to select the appropriate targets to achieve the strategic purpose of M&A, the technological perspective must be considered when evaluating them, in that the strategic purpose of M&A is primarily to acquire their technological capability.

To properly evaluate technological aspects of M&A targets, the technological capabilities and potential technology synergy should be carefully considered. The technological capability is the most fundamental and critical factor for evaluation from the technological perspective and should be separately considered from the current and future technological capabilities (Venkatraman et al. 1993). The technological level of currently-developed technologies or patents can be a measure of the current technological capabilities which can directly assist an acquiring company, and the internal R&D capabilities can be a measure of the future technological capabilities, i.e., the abilities to create or develop future innovative technologies. Potential technology synergy between an acquiring and acquired company is also a critical factor because combining two or more organizations often results in conflicts which may lead to failed M&A transactions (Sirower 2000). Thus, potential technology synergy should be considered as an evaluation factor for selection of targets that can create technology synergies with an acquiring company.

Text-mining based patent map

Patents have long been considered to be up-to-date and valuable information sources in technology. Every patent, whether or not it is granted, and whether or not it has commercial value, is a result of R&D activity and thus includes technological insight that can offer inspirations or hints to subsequent developments in technology (Ashton and Sen 1988; Ernst 2001). Furthermore, careful analysis of patents provides information of not only technological competitiveness and R&D strategic directions of corporations, but also the overall technology trends and technological opportunity in the specific technology areas (Mogee 1991; Liu and Shyu 1997; Abraham and Moitra 2001).

Patent maps are used to arrange or visualize the calculated patent statistics or complex technological relationships from patent analysis in easily-understood forms. Most conventional patent maps consider only the bibliographic information of patents, such as title, patent number, patent citation, type of document, inventor, International Patent Classification (IPC), and date of application, because this information is simple and easy to use. In particular, the number of backward or forward citations of patents (patent citation information) is used to analyze the relative significance of the patent or the patterns of technological knowledge flow. Although these information could be useful to assess the technological aspects of companies, industries or nations using large patent data, the scope of analysis and the wealth of information presented in conventional patent maps are limited because they cannot consider the technological content of patent documents (Lee et al. 2009).

Recently, the development of text mining techniques has enabled extraction and analysis of technological information from unstructured textual data in patent documents (Kostoff et al. 2001) and to generate a new type of patent map in which patents are mapped into two- or three-dimensional space according to the technological proximities among them. Two approaches for analysis of the textual content of the patent have been widely adopted: the keyword-based approach and the SAO-based approach.

In early stages of research that adopted a content-analysis-based patent map, the keyword-based approach was widely used due to its ease of use and implementation. The keyword-based approach abstracts the technological information in the patent text into a structured form, keyword vector, which is organized frequency of keyword occurrence. Yoon et al. (2002) developed a self-organizing featured map based patent map, and Lee et al. (2009) suggested a keyword-based patent map that uses principal component analysis to identify new technology opportunities. However, the keyword-based approach has limitations in that the abstracted keyword vector is insufficient to fully represent the concrete technological key-concepts of the patent and the inter-relationships among technological components (Gerken and Moehrle 2012; Park et al. 2013; Yoon and Kim 2011) (Fig. 2). In recent years, in order to overcome these limitations, an SAO-based approach has been actively employed; this approach integrates more-diverse and better-developed text mining techniques than does the keyword-based approach.

The SAO-based approach abstracts technological information from the patent text into sets of SAO structures. An SAO structure is the canonical form of the language; the structure can express the precise meaning, and can thus represent technological key-

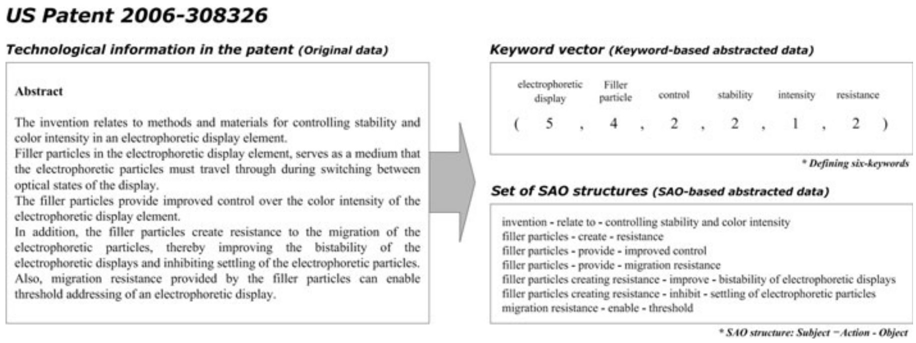


Fig. 2 Sample of text mining based patent document abstraction: keyword-based and SAO-based abstracted data

concepts and key-findings in the patent. Furthermore, inter-relationships among technological components are fully reflected by considering the 'Action' (verb), which precisely depicts relationships between words or phrases (Fig. 2). By employing an SAO-based text mining approach, the patent map has several advantages compared to the previous patent maps. First, in the SAO-based patent map, technological distances, which are critical factors to determine the relative position of patents on the patent map, are measured by considering technological key-concepts of patent and semantic similarities among the key-concepts. However, technological distances in the previous patent map are measured based on the differences of occurrence frequencies of identical keywords from different patents. Second, technological characteristics of the identified technology areas on the patent map can be easily obtained by analyzing SAO structures from patents in each technology area. By these advantages, much research adopted the SAO-based patent map approach. Yoon and Kim (2012) suggested using the patent-map-based method to detect new technological opportunities. Moehrle and Geritz (2004) proposed a framework for M&A target identification based on SAO-based patent map. Park et al. (2012) and Bergmann et al. (2008) used semantic patent maps to identify potential infringement patents. Moehrle et al. (2005) proposed a method of using patent-based inventor profiles to guide human resource decisions.

This paper also adopted an SAO-based patent map for M&A target identification from the technological view. Although Moehrle and Geritz (2004) proposed a framework for M&A target identification based on patent map, this previous approach is insufficient to recommend companies that are appropriate to the strategic purposes of M&A (Table 1) from the perspective of acquiring technological capabilities. First, the previous approach interprets two different strategic purposes of M&A, enhancement of core technology related capabilities and minor technology related capabilities, as one strategy, i.e., the lack of concreteness in interpretation. Second, if an acquiring and a certain company on the patent map commonly have any similar technological capabilities, the previous approach allows only one M&A strategy 'strengthening the existing technological capabilities', even though the target company could be an appropriate target for another M&A strategy 'acquiring new technological capabilities'. For example, if a patent map has three technology clusters, and an acquiring company (A) is involved in cluster.1 (core technology area for A) and cluster.2 (minor technology area for A) and a company (B) is involved in cluster.2 (minor technology area for B) and cluster.3 (core technology area for B), when A is intended to enter to new technology area (cluster.3), B has to be recommended as potential target company, even though A and B commonly has some similar technological capabilities in cluster.2, which may be not strategically required for A. However, the previous approach cannot recommend B as a potential M&A target. Thus, to overcome the limitations, we proposed the modified interpretation of patent map to recommend target companies that fulfill the specific strategic purpose of M&A.

Research framework for identification and evaluation of M&A targets

The overall procedure of the proposed approach consists of two phases: identification and evaluation of M&A targets (Fig. 3).

During the identification phase, patents in a technology industry that includes technologies related to the acquiring company are collected and a patent map is generated; then patents on this map are analyzed to identify specific technology areas in the industry and companies that participate in each technology area.

During the evaluation phase, technological capabilities and potential technology synergies of the companies are assessed from the overall corporate perspective and specific strategic perspective by using three technological indicators: technological level, internal R&D capability and potential technology synergy. Evaluation from the overall corporate perspective considers overall technological capabilities and potential technology synergies, whereas evaluation from the specific strategic perspective considers only technological capabilities and potential technology synergy of the specific parts of the target company that possess capabilities that fulfill the strategic purpose of M&A. In fact, evaluation from the overall corporate perspective is important because M&A is basically aimed at integrating the whole of a target company. However, because the strategic purpose of M&A is primarily related to specific parts of a target company, evaluation from the specific strategic perspective is far more important than, and thus should be more carefully considered

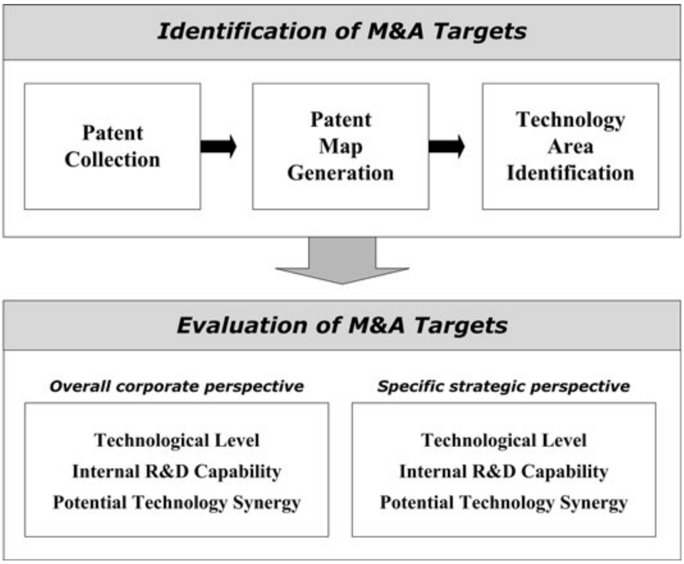


Fig. 3 Overall procedure of the proposed M&A identification and evaluation method

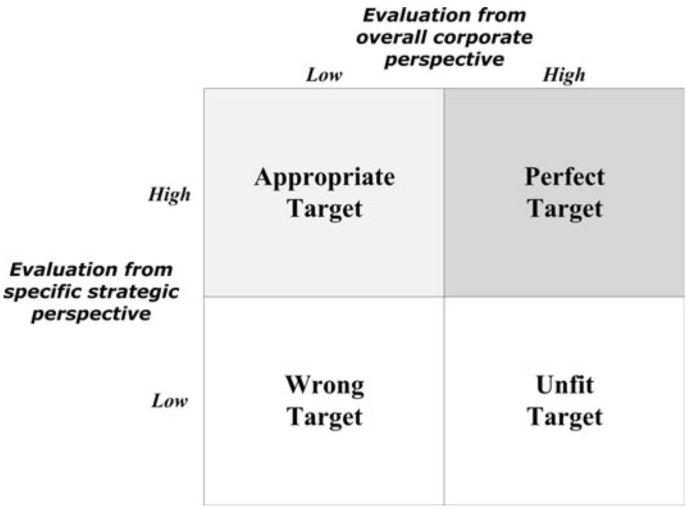


Fig. 4 Evaluative categorization of potential M&A targets

than, evaluation from the overall corporate perspective. The proposed method considers both perspectives simultaneously, and thus obtains target-selection decisions that are more successful and more thorough than when only one perspective is considered.

Potential M&A targets are evaluated in four categories (Fig. 4). Companies highly evaluated from both the overall corporate and the specific strategic perspectives can be recognized as the most appropriate targets, and companies poorly evaluated from both perspectives can be recognized as inappropriate targets. Companies poorly evaluated from the overall corporate perspective and highly evaluated from the specific strategic perspective can be recognized as strategically appropriate targets. However, if the size of the target company is relatively large, acquiring it may lead to high risks, so the acquiring company should either reject it as an M&A target or consider acquiring only specific parts of it. Companies highly evaluated from the overall corporate perspective, but poorly evaluated from the specific strategic perspective can be recognized as strategically incompatible or inappropriate targets. Although these companies may seem to be attractive targets, the goal of the M&A cannot be met because targets cannot fulfill the strategic purpose of M&A.

Identification of M&A targets

Patent collection

During the first step of the identification of M&A targets, patents are collected and a patent set for analysis is constructed. In general, these collected patents are involved in the technology industry, which broadly covers the technological fields in which an acquiring company has been participating. Patents that meet the requirements can be collected by using IPC and keyword retrieval from online patent databases, such as the United States Patent and Trademark Office (USPTO) and the European Patent Office (EPO).

Generation of patent map

After the patent documents are collected, an SAO-based patent map is generated in three successive phases: SAO structure extraction, technological proximity measurement and visualization (Fig. 5).

At first, each collected patent is abstracted as a set of SAO structures. NLP tools are used for this purpose. NLP is a text mining technique that can conduct syntactic analysis of natural language; various NLP tools such as Stanford parser (Stanford 2013), Minipar (Lin 2003) and Knowledgist™ 2.5 (www.invention-machine.com) are available.

Technological proximities among abstracted patents are measured by using a similarity coefficient, which quantifies the size of the part of that is common to two samples; the technological proximity between patents can be determined by the number of semantically-identical SAO structures that occur in both patents (Moehrle 2010; Moehrle and Gerken 2012). In order to identify the semantic identicalness of SAO structures, a semantic knowledge base such as WordNet (Miller 1995), Cyc (Matuszek et al. 2005) or ConceptNet (Liu and Singh 2004) can be used to identify the similarity between two words or phrases in the SAO structures, and a sentence similarity measurement method is used to measuring the similarity between them.

Measured technological proximities among patents are visualized into a two-dimensional space, i.e., a patent map. To this end, multidimensional scaling (MDS), which is a statistical technique used to visualize similarities in data (Schmoch 1995; Kruskal 1964), is adopted; many statistical software packages such as SPSS (Field 2009), UCINet (Borgatti et al. 2002) and NetMiner (Moehrle and Geritz 2004) provide MDS algorithms. The critical concern in MDS is the reliability of the MDS results, so this reliability should be evaluated using one of several validity tests, and an acceptable stress value is 0.2 or less (Wickelmaier 2003).

The generated SAO-based patent map is not a newly suggested in this paper, but it is adapted for the purpose of M&A target identification from the technological view. Thus, we described only the essentials for the process of generating the patent map, and the detailed description of the process of an SAO-based semantic patent map generation can be referred to our previous research (Park et al. 2012).

Technology area identification

In general, a technology industry consists of various specific technology areas. The proposed patent map is the visualized technological landscape of a technology industry and

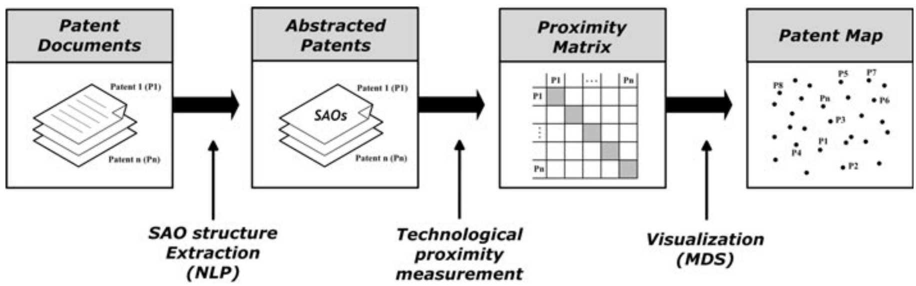


Fig. 5 Process of patent map generation, redrawn from Park et al. (2012)

thus specific technology areas can be identified on the map. Each technology area includes similar technologies which perform similar functions for similar objectives. Thus, patents that are near each other on the patent map can be judged to be similar technologies, and the territory in which those patents are located can be recognized as a specific technology area. To identify the technology area, cluster analysis which assigns a set of similar objects into groups can be adopted; statistical software such as SPSS and UCINet can perform this analysis. The technological characteristics or properties of each generated cluster (technology area) can be defined by analyzing the patents in it.

After of specific technology areas are identified on the patent map, appropriate technology areas that are closely connected to the strategic purpose of M&A should be selected. Companies that participate in the selected technology area can be potential M&A targets, and the patent assignee information is used to identify them. The technology area on the patent map can be classified into three types according to the technological capabilities that the acquiring company focuses on: major, minor, and untapped technology areas (Fig. 6). Thus, companies involved in the major technology area which contains the core and competitive technologies of an acquiring company can be selected as potential M&A targets when the strategic purpose of M&A is to enhance and complement the capabilities related to the core technologies of an acquiring company, and companies in the minor technology area can be potential targets when the purpose of M&A is to enhance and supplement the capabilities related to the minor or sub-technologies of an acquiring company. Companies in the untapped technology area can be potential targets when the purpose of M&A is to obtain the technological capabilities that are unrelated to the existing technological capabilities of an acquiring company.

Evaluation of M&A targets

In order to recommend appropriate M&A target companies from the technological view, the companies are evaluated by three technological indicators from the overall corporate perspective and the specific strategic perspective. Although the two perspectives use same indicators, the range of the patents used of the evaluated company is different. As an input patent data for the indicators, the overall corporate perspective uses all patents the evaluated company has, even though the patents are not in the patent map, and the specific

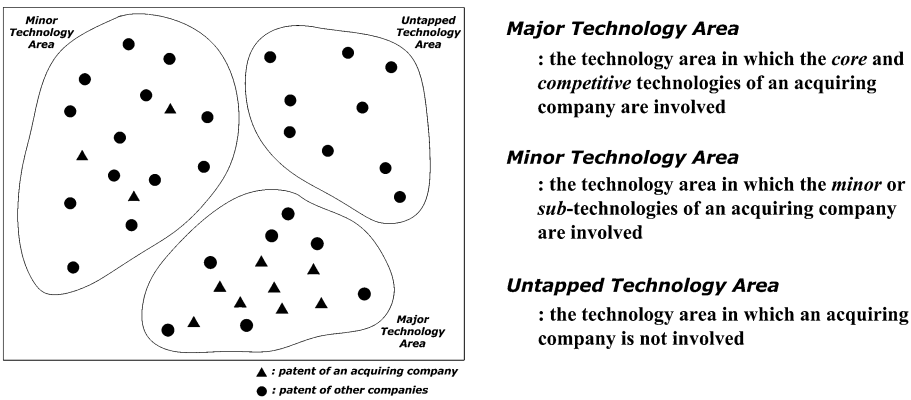


Fig. 6 Interpretation of technology areas on the patent map

strategic perspective uses the evaluated company's patents in a specific technology area on the patent map.

Technological level

Technological level is the measure used to evaluate current technological capabilities of the potential target companies, and the degree of technological level is measured by two indices: Technology quality and Technology quantity (Table 2). Technology quality can be represented by the number of citations the patents received. Patent citation is strongly related to economic value or importance of a patent, and thus an average citation frequency of all or parts of a target company's patents can evaluate its technology quality (Engelsman and van Raan 1994; Hall et al. 2000). Technology quantity measures the number of qualified technologies that the target company possesses. Because a granted patent is generally accepted as a qualified technology that is protected as an intellectual property, the number of patents granted can reflect technology quantity (Geiger and Makri 2006; Guellec and van Pottelsberghe de la Potterie 2000).

Internal R&D capability

Future technological capabilities of companies can be evaluated by assessing their internal R&D capability, which is measured by two indices: R&D achievement and R&D human resources (Table 2). R&D achievement can be assessed by the percentage of advanced and proven technologies out of all developed technologies by R&D activities (Nelson 1982). In general, although an output of R&D activity is the number patent applications regardless of their value, only technologies in the granted patents which have technological novelty and contribute to scientific progress are recognized as measures of the practical achievement of R&D activities (Gupta and Pangannaya 2000; Basberg 1987). Thus, the percentage of patent applications that were granted can be a reliable proxy of a company's R&D

Table 2 Technological indicators for evaluation of M&A targets

Purpose	Index	Definition	Meaning
Technological level	Technology quality	Average citation frequency of patents	Economic value and technological quality of technologies of a target company
	Technology quantity	Number of granted patents	Volumes of retention of qualified technologies of a target company
Internal R&D capability	R&D achievement	Percentage of granted patents out of all patent applications	Capability of development of qualified technologies of a target company
	R&D human resource	Number of inventors of all patents	Degree of retention of key researchers for R&D activity
Potential technology synergy	Compatibility of national culture	Nationality of target company	Identification of M&A with a target company is either domestic or cross-border deal
	Global corporate culture	Number of nationalities of patent inventors	Degree of cultural diversity of a target company

achievement. R&D human resources, usually researchers or inventors, who possess various explicit and tacit knowledge constitute an important factor to evaluate R&D capabilities (Ernst 2003). In particular, key researchers who can develop and produce patents are the most critical human resource required to achieve successful R&D results (Griliches 1998), and thus the number of patent inventors can be a clear indication of the strength of a company's R&D human resources.

Potential technology synergy

Potential technology synergy between an acquiring and an acquired company is assessed by two indicators regarding national and corporate culture: Compatibility of national culture and Global corporate culture (Table 2). Compatibility of national culture identifies the congruity between the national cultures of the two organizations. The significance of cultural compatibility between an acquiring and an acquired company has long been understood to be an important factor that can amplify potential synergies when implementing M&A (Cameron and Green 2009; Cartwright and Cooper 1993). However, combining two companies which are of different nationalities is difficult to be performed without cultural conflicts. In fact, even though U.S. and Europe many common social and cultural aspects, merging a U.S. and a European company can occur serious cultural conflicts because the two regions have distinct management styles and management structures (Drucker 1997; Chen 2001; Carey and Ogden 2000). Thus, by combining only organizations from the same nation, the risk of cultural conflicts can be avoided; to simplify the analysis, we set the value of compatibility of national culture as 1.0 when the acquiring and target company are of the same nationality and 0.5 when they are of different nationalities; values of the compatibility of national culture index from both the overall corporate perspective and the specific strategic perspective are the same, because this index is related to the nationality of the company. Global corporate culture also related to cultural compatibility, but at the corporate-level. A multicultural company whose employees are of diverse ethnicities and have different backgrounds are more flexible in adapting to a change of organization such as M&A than are single-culture companies (Gutierrez et al. 1996; Cox and Blake 1991), and thus the number of nationalities of patent inventors can measure the cultural diversity of the technological human resources of a company.

Empirical study: the case of flexible display technology

In general, patents related to technology industries in which an acquiring company is involved are collected as a patent set. However, because the purpose of this empirical study is to verify the method, we began by selecting a technology domain, and then, from this domain we selected an acquiring company, which applies to all scenarios of the M&A strategies.

We examined patents related to flexible display technologies. These are among the most cutting edge technologies, and are expected to have a significant influence on the display market. Numerous corporations, both new and established, have made efforts to develop the technological capabilities internally or to acquire them externally; thus flexible display technology is suitable for illustrating the proposed method to guide M&A strategies.

Identification of potential M&A targets

Patent collection

The patent set was constructed that consists of 318 patents chosen by referring to the patent trend report of flexible display technologies from the Korean Intellectual Property Office (KIPO) (KIPO 2008), and the patent documents were collected from the USPTO database. The set covers the period from 1996 to 2008 and ranges from U.S. patent application number 1996-611318–2008-971191. The actual patent application numbers are too long for analysis and display purposes, so serial numbers from 1 to 318, sorted by the application date, were assigned to each patent for convenience and simplification.

Patent map generation

As the first step of patent map generation, patents were transformed into SAO structures (Table 3). To this end, we used commercial NLP software, Knowledgist^{TM} 2.5. Technological proximities among the sets of SAO structures were calculated using the Sorensen similarity coefficient and WordNet. Patents were visualized into a two-dimensional patent map by using the technological proximities and the MDS algorithm in NetMiner software. The resulting patent map of flexible display related technology (Fig. 7) had a stress value of 0.1444, so the reliability of the result can be assessed as 'fair' (Wickelmaier 2003).

Table 3 Sample of extracted SAO structure from a patent (US 6,885,146)

Subject	Action	Object
Active layer	Contain	Organic semiconductor material
Barrier layers	Include	Inorganic insulating material
Connecting electrodes to TFTs	Change	Reflectivity or microcapsules
Display device	Include	Pixel unit
Electrically charged particles	Change	Reflectivity
First barrier layer	Comprise	Inorganic insulating material
First barrier layer	Comprise	A thin film transistor comprising
Active layer	Comprise	Semiconductor
First substrate	Comprise	Plastic
Insulating layer	Have	Opening portion
Insulating layer	Meet	Gate electrodes
Microcapsules	Contain	Electrically charged particles
Organic material	Form	Channel portion
Organic semiconductor material	Form	Channel
Pixel unit	Include	Contrast media
Pixel unit	Include	TFTs
Plastic substrates	Sandwich	Pixel unit
Second barrier layer	Comprise	Inorganic insulating material
Second substrate	Comprise	Plastic
Semiconductor	Comprise	Organic material

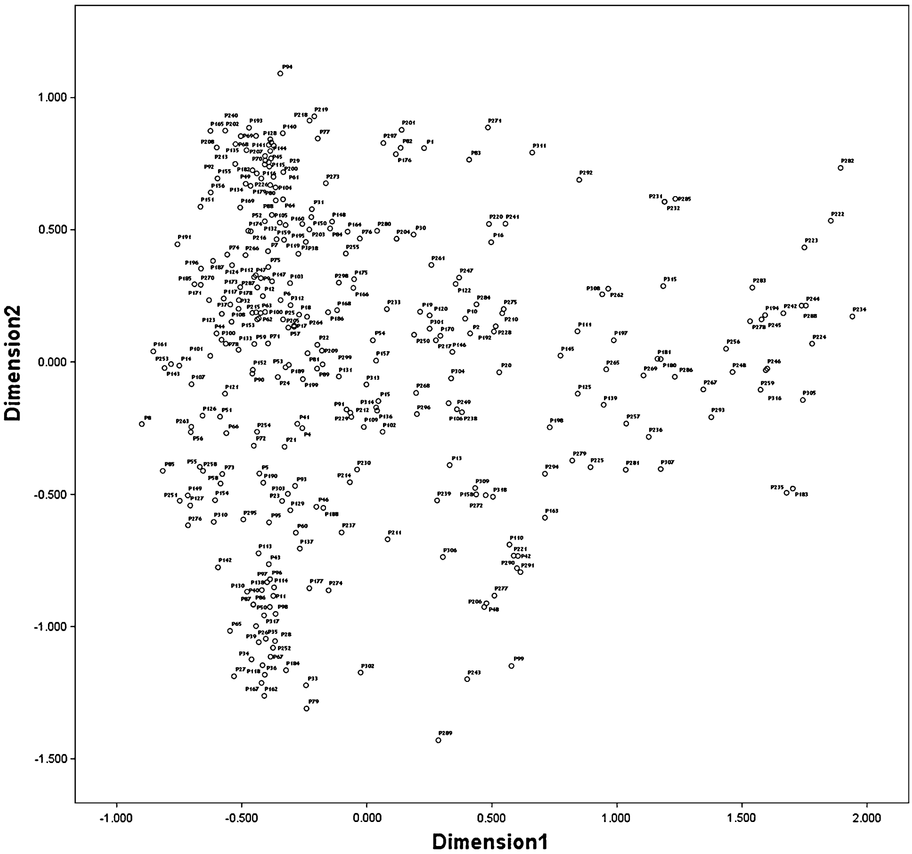


Fig. 7 Two-dimensional patent map of flexible display related technology

Identification of technology area

To identify technology areas on the patent map, we adopted the *K*-means clustering algorithm and used SPSS software package to conduct the clustering operation. The number of clusters depends on the value of *K*. Increasing *K* increases the specificity of the technological scope of each technology area. An appropriate value of *K* can be determined with the aid of an expert's knowledge of the domain; we set *K* as five by referring to an expert's report of flexible display technology (KIPO 2008). The five generated technology areas were identified on the patent map (Fig. 8) and summarized (Table 4).

A company which is US-based and concentrates primary on two technology areas (TA3 and TA4) and to a lesser extent on one technology area (TA5), was selected as the sample acquiring company. Each TA can be interpreted as major, minor or untapped according to the degree to which the acquiring company concentrates on it. TA3 and TA4, in which the acquiring company mainly concentrates, can be interpreted as the major TA; TA5, in which the acquiring company is partly involved, can be interpreted as the minor TA; TA1 and TA2, in which the acquiring company has never been involved, can be interpreted as untapped TAs. Depending on the M&A strategy of the acquiring company, an appropriate

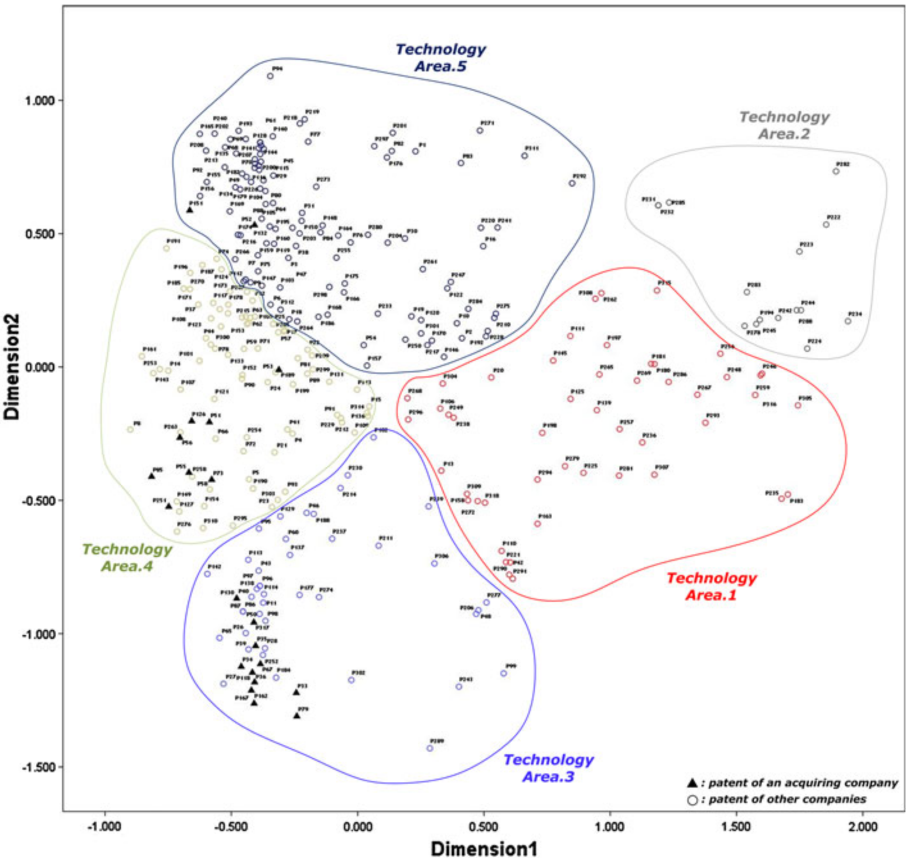


Fig. 8 Technology areas on the patent map

Table 4 Summary of technology areas

Technology area (TA)	Description of technology area	Number of entities
TA1	TFT array organic–inorganic gate dielectrics related technologies	12
TA2	Solution-based semiconductor materials technologies for TFT	4
TA3	Organic–inorganic hybrid substrate technologies	22
TA4	Plastic and ceramic based flexible display substrate material technologies	41
TA5	Wiring material technologies for flexible display	64

TA and potential targets are determined. Although all companies in the TA could be potential targets, we only considered companies which have at least three patents in the TA as potential M&A targets to disregard companies that have relatively low technological capabilities in the TA. With respect to each strategic purpose of M&A, relevant TAs and a list of potential targets in the technology area were organized (Table 5).

Table 5 Identified potential M&A targets

Strategic purpose of M&A	Technology area (TA)	Potential M&A targets
Enhancement of core technology	TA3	Avery Dennison Corporation, Battelle Memorial Institute, Micron Technology, Samsung Electronics, Samsung SDI, SI Diamond Technology
	TA4	3M Innovative Properties Company, Samsung SDI, Seiko Epson Corporation, SiPix Imaging
Enhancement of sub or minor technology	TA5	IBM, Matsushita Electric Industrial, Merck Patent GmbH, Samsung Electronics, Samsung SDI, Semiconductor Energy Laboratory, SiPix Imaging, Universal Display Corporation
Entry into new technology areas	TA1	AU Optronics, Samsung Electronics, Samsung SDI, Semiconductor Energy Laboratory
	TA2	Samsung SDI

Evaluation of potential M&A targets

Each potential target company was evaluated using three technological indicators: technological level, internal R&D capability and potential technology synergy, from both the overall corporate perspective and the specific strategic perspective. For example, evaluation of AU Optronics from the overall corporate perspective uses all patents of AU Optronics as an input data for the three technological indicators, and evaluation of AU Optronics from the specific strategic perspective uses AU Optronics' patents in TA1 as an input data for the indicators.

In general, the strategic purpose in general M&A situation is a definite one. However, this case study is a virtual M&A scenario, which has no fixed M&A purposes, to illustrate the usefulness of the method. Thus, we provided all types of M&A strategies and for each, selected one TA that includes enough potential targets to be evaluated. The selected TAs were TA1, TA3 and TA5.

Evaluation results

Companies in TA3 were evaluated as potential targets for enhancing core technological capabilities of the acquiring company, companies in TA5 were evaluated as potential targets for enhancing its minor technological capabilities, and companies in TA1 were evaluated as potential targets for entry into the new technology area. To facilitate the evaluation efficiently, the analysis results were normalized to a proportion of the maximum value of each index of each TA; the range of the normalized value of each index is from 0 to 1. Analysis results were obtained from both the overall corporate perspective (Table 6) and the specific strategic perspective (Table 7).

Evaluation result of each company from each perspective is measured by the weighted sum of values of three indicators; the weights can be flexibly assigned and we assigned the same weight to each indicator. Value of each indicator is measured by the weighted sum of the normalized values of two sub-indexes; the weights can be flexibly assigned and we assigned the same weight to each index. To adjust the range of evaluation result of each company from 0 to 1, we assigned 0.5 to the weight of each index and 0.333 to the weight of each indicator. Thus, the evaluation result of each company from each perspective is measured by 0.167 $\times$ (sum of values of each index). For instance, value of technological

Table 6 Analysis results from the overall corporate perspective

Overall corporate perspective	Technological level				Internal R&D capability				Potential technology synergy			
	Technology quality		Technology quantity		R&D achievement		R&D human resource		Compatibility of national culture		Global corporate culture	
	Raw	(Normalized)	Raw	(Normalized)	Raw	(Normalized)	Raw	(Normalized)	Raw	(Normalized)	Raw	(Normalized)
(*TA1*)												
AU Optronics	0.70	(0.117)	753	(0.035)	40.267	(0.403)	1094	(0.067)	TW	(0.5)	6	(0.200)
Samsung Electronics	2.51	(0.421)	21278	(1.000)	44.698	(0.447)	16366	(1.000)	KR	(0.5)	30	(1.000)
Samsung SDI	0.98	(0.165)	1353	(0.064)	55.840	(0.558)	1833	(0.112)	KR	(0.5)	9	(0.300)
Semiconductor Energy Laboratory	5.97	(1.000)	2914	(0.137)	48.269	(0.483)	565	(0.035)	JP	(0.5)	3	(0.100)
(*TA3*)												
Avery Dennison Corporation	5.49	(0.781)	562	(0.026)	83.881	(0.839)	696	(0.043)	US	(1.0)	13	(0.433)
Battelle Memorial Institute	5.47	(0.779)	399	(0.019)	65.950	(0.660)	1142	(0.070)	US	(1.0)	19	(0.633)
Micron Technology	7.03	(1.000)	15509	(0.729)	78.842	(0.788)	2810	(0.172)	US	(1.0)	20	(0.667)
Samsung Electronics	2.51	(0.357)	21278	(1.000)	44.698	(0.447)	16366	(1.000)	KR	(0.5)	30	(1.000)
Samsung SDI	0.98	(0.140)	1353	(0.064)	55.840	(0.558)	1833	(0.112)	KR	(0.5)	9	(0.300)
SI Diamond Technology	4.08	(0.580)	65	(0.003)	72.222	(0.722)	38	(0.002)	US	(1.0)	3	(0.100)
(*TA5*)												
IBM	6.63	(1.000)	33742	(1.000)	56.056	(0.561)	22526	(1.000)	US	(1.0)	41	(1.000)
Matsushita Electric Industrial	3.23	(0.486)	18105	(0.537)	68.259	(0.683)	13808	(0.613)	JP	(0.5)	26	(0.634)
Merck Patent GmbH	2.40	(0.362)	952	(0.028)	75.978	(0.760)	1343	(0.060)	DE	(0.5)	20	(0.488)
Samsung Electronics	2.51	(0.379)	21278	(0.631)	44.698	(0.447)	16366	(0.727)	KR	(0.5)	30	(0.732)
Samsung SDI	0.98	(0.148)	1353	(0.041)	55.840	(0.558)	1833	(0.081)	KR	(0.5)	9	(0.220)
Semiconductor Energy Laboratory	5.97	(0.900)	2914	(0.086)	48.269	(0.483)	565	(0.025)	JP	(0.5)	3	(0.073)
SiPix Imaging	5.34	(0.805)	81	(0.002)	85.263	(0.853)	80	(0.004)	US	(1.0)	4	(0.098)
Universal Display Corporation	4.50	(0.678)	51	(0.001)	87.931	(0.879)	56	(0.002)	US	(1.0)	2	(0.049)

Table 7 Analysis results from the specific strategic perspective

Specific strategic perspective	Technological level				Internal R&D capability				Potential technology synergy			
	Technology quality		Technology quantity		R&D achievement		R&D human resource		Compatibility of national culture		Global corporate culture	
	Raw	(Normalized)	Raw	(Normalized)	Raw	(Normalized)	Raw	(Normalized)	Raw	(Normalized)	Raw	(Normalized)
(*TA1*)												
AU Optronics	6.00	(1.000)	2	(0.133)	66.667	(0.667)	6	(0.176)	TW	(0.5)	1	(0.500)
Samsung Electronics	0.25	(0.042)	2	(0.133)	50	(0.500)	10	(0.294)	KR	(0.5)	1	(0.500)
Samsung SDI	0.07	(0.012)	15	(1.000)	53.571	(0.536)	34	(1.000)	KR	(0.5)	2	(1.000)
Semiconductor Energy Laboratory	2.00	(0.333)	4	(0.267)	80	(0.800)	8	(0.235)	JP	(0.5)	1	(0.500)
(*TA3*)												
Avery Dennison Corporation	8.33	(0.657)	2	(0.500)	66.667	(0.667)	4	(0.222)	US	(1.0)	1	(1.000)
Battelle Memorial Institute	12.67	(1.000)	3	(0.750)	100	(1.000)	7	(0.389)	US	(1.0)	1	(1.000)
Micron Technology	0.67	(0.053)	3	(0.750)	100	(1.000)	1	(0.056)	US	(1.0)	1	(1.000)
Samsung Electronics	0	(0.000)	2	(0.500)	50	(0.500)	16	(0.889)	KR	(0.5)	1	(1.000)
Samsung SDI	0.33	(0.026)	4	(1.000)	66.667	(0.667)	18	(1.000)	KR	(0.5)	1	(1.000)
SI Diamond Technology	3.00	(0.237)	1	(0.250)	33.333	(0.333)	1	(0.056)	US	(1.0)	1	(1.000)
(*TA5*)												
IBM	3.75	(0.750)	3	(0.375)	75	(0.750)	6	(0.162)	US	(1.0)	1	(0.333)
Matsushita Electric Industrial	3.00	(0.600)	3	(0.375)	100	(1.000)	7	(0.189)	JP	(0.5)	2	(0.667)
Merck Patent GmbH	1.33	(0.266)	5	(0.625)	83.333	(0.833)	20	(0.541)	DE	(0.5)	2	(0.667)
Samsung Electronics	0.25	(0.050)	5	(0.625)	62.5	(0.625)	37	(1.000)	KR	(0.5)	3	(1.000)
Samsung SDI	0.13	(0.026)	6	(0.750)	75	(0.750)	19	(0.514)	KR	(0.5)	2	(0.667)
Semiconductor Energy Laboratory	1.13	(0.226)	8	(1.000)	100	(1.000)	16	(0.432)	JP	(0.5)	2	(0.667)
SiPix Imaging	0.67	(0.134)	3	(0.375)	100	(1.000)	8	(0.216)	US	(1.0)	2	(0.667)
Universal Display Corporation	5.00	(1.000)	3	(0.375)	100	(1.000)	1	(0.027)	US	(1.0)	1	(0.333)

level of AU Optronics from the specific strategic perspective is measured to be 0.189 by 0.167 × [1.0 (the normalized value of technology quality index) + 0.133 (the normalized value of technology quantity index)]. Evaluation results of target companies from both perspectives are shown in (Table 8).

The analyzed results are mapped onto a 2 × 2 matrix to facilitate comparison among potential targets and to simplify the selection of appropriate M&A targets (Fig. 9).

Potential target companies were categorized on the matrix according to the evaluation results. Companies which are mapped on upper right quadrant (high evaluation results from both perspectives) and the upper left quadrant (low results from the overall corporate perspective, high results from the specific strategic perspective) of the matrix can be suggested M&A targets. Selection of appropriate targets depends on the goal of the M&A.

First, if the goal of M&A is to enter the TFT array organic–inorganic gate dielectrics related technology area, which is a new technology area for the acquiring company, Samsung SDI is the suggested target company (Fig. 9a). Although the evaluation results of Samsung SDI from the overall corporate perspective were mostly insufficient, results from the specific strategic perspective were mostly good, particularly internal R&D capability and potential technology synergy were impressive. Although Samsung SDI is not attractive in its entirety, the size of Samsung SDI estimated approximately by its number of patents is not relatively large, and thus this company can be a suitable M&A target.

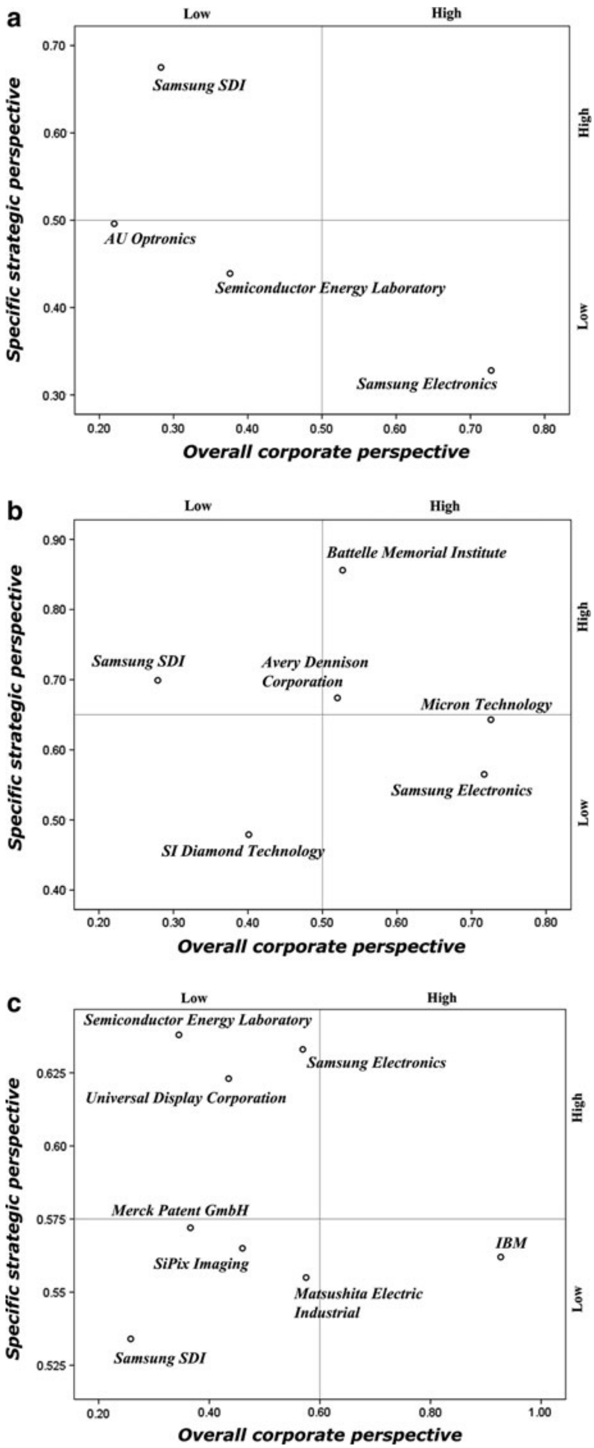
Second, if the goal of M&A is to enhance core technological capabilities related to organic–inorganic hybrid substrates, Battelle Memorial Institute and Avery Dennison Corporation are the most suitable M&A targets, and Samsung SDI also can be an appropriate target (Fig. 9b). Battelle Memorial Institute had the highest levels of technological capabilities and potential synergies; its technological level in particular is far more advanced than its competitors as measured by the specific strategic perspective and fairly high evaluation results from the overall corporate perspective. Avery Dennison Corporation can be suggested as the next most-appropriate M&A target in TA3; although this company had almost the same caliber of results from the overall corporate perspective as did Battelle Memorial Institute, the technological level and internal R&D capability from the specific strategic perspective were lower than those of Battelle Memorial Institute. Samsung SDI is mostly insufficient from the overall corporate perspective, but evaluation results from the specific strategic perspective are fairly high, in particular their internal R&D capability and potential technology synergy with the acquiring company from the specific strategic perspective were evaluated as very high. Although Samsung SDI is less recommended as an M&A target than Avery Dennison Corporation in regards to the evaluation results from the overall corporate perspective, if the actual size of Samsung SDI is not relatively large, and thus the results from the overall corporate perspective can be stipulated as negligible, Samsung SDI could be considered as a more appropriate M&A target than Avery Dennison Corporation.

Finally, if the goal of the M&A strategy is to enhance minor technological capabilities related to wiring material for flexible displays, Samsung Electronics, Universal Display Corporation and Semiconductor Energy Laboratory are suitable M&A target companies (Fig. 9c). Samsung Electronics had remarkable evaluation results from the specific strategic perspective and fairly high results from the overall corporate perspective. Thus, Samsung Electronics can be recognized as a suitable target. However, the number of patents granted to Samsung Electronics is extraordinarily large; this suggests it is a very large company, and is therefore not an appropriate M&A target. In this case, the acquiring company should conduct detailed analysis from the financial and management perspective to make a careful target-selection decision and if possible, plan to acquire only departments

Table 8 Evaluation results of potential M&A targets

Company by TA	Overall corporate perspective				Specific strategic perspective			
	Technological level	Internal R&D capability	Potential technology synergy	Total	Technological level	Internal R&D capability	Potential technology synergy	Total
(TA1)								
AU Optronics	0.025	0.078	0.117	0.220	0.189	0.141	0.167	0.496
Samsung Electronics	0.237	0.241	0.250	0.728	0.029	0.132	0.167	0.328
Samsung SDI	0.038	0.112	0.133	0.283	0.169	0.256	0.250	0.675
Semiconductor Energy Laboratory	0.189	0.086	0.100	0.376	0.100	0.173	0.167	0.439
(TA3)								
Avery Dennison Corporation	0.135	0.147	0.239	0.520	0.193	0.148	0.333	0.674
Battelle Memorial Institute	0.133	0.122	0.272	0.527	0.292	0.231	0.333	0.856
Micron Technology	0.288	0.160	0.278	0.726	0.134	0.176	0.333	0.643
Samsung Electronics	0.226	0.241	0.250	0.717	0.083	0.231	0.250	0.565
Samsung SDI	0.034	0.112	0.133	0.279	0.171	0.278	0.250	0.699
SI Diamond Technology	0.097	0.121	0.183	0.401	0.081	0.065	0.333	0.479
(TA5)								
IBM	0.333	0.260	0.333	0.927	0.188	0.152	0.222	0.562
Matsushita Electric Industrial	0.170	0.216	0.189	0.575	0.163	0.198	0.194	0.555
Merck Patent GmbH	0.065	0.137	0.165	0.366	0.149	0.229	0.194	0.572
Samsung Electronics	0.168	0.196	0.205	0.569	0.113	0.271	0.250	0.633
Samsung SDI	0.031	0.107	0.120	0.258	0.129	0.211	0.194	0.534
Semiconductor Energy Laboratory	0.164	0.085	0.096	0.345	0.204	0.239	0.194	0.638
SiPix Imaging	0.135	0.143	0.183	0.460	0.085	0.203	0.278	0.565
Universal Display Corporation	0.113	0.147	0.175	0.435	0.229	0.171	0.222	0.623

Fig. 9 M&A target evaluation matrix. **a** M&A for entry new technology area (TA1). **b** M&A for enhancing core technological capabilities (TA3). **c** M&A for enhancing minor technological capabilities (TA5)



of Samsung Electronics that are related to TA5. Universal Display Corporation had relatively low results from the overall corporate perspective and high results from the specific strategic perspective. In fact, this company, from the specific strategic perspective, has the highest technological level, but has relatively unsatisfactory internal R&D capability. Thus, if the acquiring company has sufficient R&D human resources but an insufficient technological level, Universal Display Corporation can be the most appropriate M&A target. Semiconductor Energy Laboratory had fairly low results from the overall corporate perspective; especially internal R&D capability and potential technology synergy with the acquiring company were very low. However, the results from the specific strategic perspective were all relatively superb, and the estimated size of the company also not large. Thus, Semiconductor Energy Laboratory can be suggested as the most appropriate M&A target in TA5.

Discussion and conclusion

This paper presents a framework to identify and evaluate companies from the technological perspective to support M&A target selection decision-making. First, potential M&A target companies that are closely connected to the strategic purpose of M&A are identified by using SAO-based patent maps. Because patents are visualized onto a two dimensional patent map that represents the technology landscape, technological similarities among patents are easily understood and latent meanings in the patent data are easily detected. Particularly, using an SAO-based text mining approach instead of a keyword-based text mining approach enables to extract the technological key-concept and key-findings in patents. Companies that have patents in the specific TA related to the M&A purpose on the patent map can be identified as potential targets.

Second, in order to suggest the most appropriate targets for the strategic purpose of M&A for enhancing technological capabilities, the identified companies are evaluated using three technological indicators: technological level, internal R&D capability and potential technology synergy, from both the overall corporate perspective and the specific strategic perspective. Since the proposed evaluation indicators can comprehensively consider not only the current and future technological capabilities of the target company, but also potential technology synergies between an acquiring company and target company, various technological aspects of the target can be reasonably assessed. Furthermore, although the strategic purpose of M&A is closely related to specific parts of the target company, previous studies of M&A target evaluation have neglected to consider the specific strategic perspective by regarding only the overall corporate perspective due to the tendency of M&A deals generally acquiring the entirety of a target organization. This neglect of the specific strategic perspective can cause disagreement between the selected M&A target and the strategic purpose of M&A, and thus numerous M&A cases have resulted in negative outcomes or failure. However, the proposed method considers the overall corporate perspective and specific strategic perspective simultaneously. It enables the evaluation and selection of M&A targets to focus on the strategic purpose of M&A while assessing the potential risks from the M&A.

Finally, this paper verified the usability and practicality of the method by applying it to patents related to flexible display technologies. By using the proposed method, companies which intend to execute M&A can successfully identify strategically appropriate M&A targets. Conversely, small companies that have high technological capabilities and intentions to sell it at high value, can also use the proposed method to identify potential acquiring companies and thereby to prepare effectively for imminent or prospective M&A deals.

However, this paper needs further extension and complementation in terms of the methodology and its application. Future research may consider the following factors. First, the specific variables of the evaluation indicators could be extended. We developed or used only two variables for each technological indicator, because the specific variables were not the main focus of this paper. However, to increase the credibility and validity of the evaluation results, additional variables should be developed or used. For instance, the number of Patent Cooperation Treaty (PCT) patent applications or family patents can be used as variables for evaluating technological levels, and the number of IPCs shared between an acquiring and acquired company can be adopted as a variable for evaluating potential technology synergy. Second, in actual M&A situations, evaluation indicators can be assigned different weights by exploiting the knowledge or opinions of experts. In the empirical study in this paper, we simply assigned equal weight to each technological indicator for the evaluation. However, more-flexible and -situational evaluation results can be obtained by assigning different weight to each evaluation indicator. In particular, the indicators from the specific strategic perspective should be carefully considered and can be assigned higher weight values in that these are closely related to the strategic purpose of M&A. Third, financial and management aspects should be considered after applying the proposed method for the final selection of the target company. The scope of this research was to suggest the strategically-appropriate M&A targets from the technological aspect. However, in order to select final targets for M&A, evaluations from financial and management perspectives such as firm size, cash flow, return, and tax burden, are necessary. Thus, if the proposed method can be enhanced by additionally adopting prior evaluation methods that consider both financial and management perspectives, the acceptability and credibility of the M&A target suggestion can be increased. Finally, the overall procedure needs to be systemized and automated. Although we developed and employed some automated analysis tools for each part of the procedure, they are independent and still require burdensome manual labor to organize the data. Thus, developing an integrated system to implement this method would significantly reduce the amount of labor that it requires, and will increase its efficiency.

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