Text mining to gain technical intelligence for acquired target selection: A case study for China's computer numerical control machine tools industry

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ABSTRACT

Technology strategy plays an increasingly important role in today's Mergers and Acquisitions (M&A) activities. Informing that strategy with empirical intelligence offers great potential value to R&D managers and technology policy makers. This paper proposes a methodology, based on patent analysis, to extract technical intelligence to identify M&A target technologies and evaluate relevant target companies to facilitate M&A target selection. We apply the term clumping process and a trend analysis together with policy and market information to profile present R&D status and capture future development signals and trends in order to grasp a range of significant domain-based technologies. Furthermore, a comparison between a selected acquirer and leading players is used to identify significant technologies and sub-technologies for specific strategy-oriented technology M&A activities. Finally, aiming to recommend appropriate M&A target companies, we set up an index-based system to evaluate the acquired target candidates from both firms-side perspective and target firm-side perspective and differentially weigh for specific M&A situations. We provide an empirical study in the field of computer numerical control machine tools (CNCMT) in China to identify technology M&A targets for an emerging Chinese CNCMT company — Estun Automation under different M&A strategies.

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1. Introduction

Mergers and Acquisitions (M&A) continues to be a hot topic for today's commercial activities (Arora, 2013; Baker and Kiymaz, 2011). M&A obtains valuable resources, immediate access to products, and/or distribution channels, and, thus, it is functioned as an external source of innovation (Heeley et al., 2006). Since more and more M&A deals are taking place in high-tech and science-based sectors, technology-driven mergers and acquisitions (Tech M&A) has received increasing attention in recent years (He and Wang, 2014; Lin, 2012; Stahl, 2010). Tech M&A usually realizes values through a combination of technological assets (Jones et al., 2001), such as research and development (R&D) skills, experienced personnel, and specific technologies (Inkpen et al., 2002; Lehto and Lehtoranta, 2004). In this situation, technological variables start to occupy a larger proportion for considerations in M&A strategies, and would even be equal to financial and managerial variables, the leading factors of M&A in the past years (Wei et al., 2009).

Although the volume of M&A deals is steadily increasing, its failure rate is also very high — normally between 70% and 90% (Christensen et al., 2011). The selection of appropriate target companies to well-match the strategic purpose of M&A has become a core phase of M&A

(Kengelbach, 2011). In terms of the technological perspective, we summarize several issues that trouble M&A decision makers heavily as follows: 1) which technology is our target, which aspects of technical potentials are we looking for, and which company could be the acquired candidates (Park et al., 2013; Yurov et al., 2013); and 2) how to evaluate these candidates and select a suitable target for a successful M&A on technical integration (Yu et al., 2015).

Technical intelligence has always been applied for strategic decision making in high technology environments (Daim et al., 2011) to assess the fit between a technology and a firm's strategy (Walsh and Linton, 2011). Such intelligence would hold great capability to aid Tech M&A-oriented strategic management and decision making. Patent is considered as one of the most important science, technology, and innovation (ST&I) data for technical intelligence. New knowledge, technological capabilities, companies, and inventors reflect in patents as meaningful ST&I markers (Porter and Cunningham, 2004), and patent analysis is applied to help identify these markers for diverse ST&I needs, e.g. Tech M&A. For example, patent number, patent citation, inventor, and international patent classification (IPC) are employed as technological indicators to profile potential target candidates (Yang et al., 2014), and quite a few semantic approaches, e.g. co-word analysis and subject–action–object (SAO)-based analysis, are widely used to help investigate the concrete technological concepts of patents and the interactions among such concepts (Zhang et al., 2014b). Those efforts make great

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sense to explore the technology relatedness between different companies (Park et al., 2013).

In spite of a number of studies that have devoted efforts to engage patent analysis and text mining techniques to promote M&A target selection activities, real-world M&A needs are not as simple as what we imagine, where different acquiring companies have quite different situations, e.g., strategy, market position, and government policy (Brueller et al., 2014), and we could never use these quantitative approaches to take the place of expert knowledge and related decision-making actions. Therefore, how to further amplify the roles of patent analysis and text mining techniques and combine them with expert knowledge to explore meaningful technical intelligence to facilitate the M&A needs is still crucial. As an example, Tech M&A would hold interests on the target technologies, which are not only important from technological aspects but also promising for acquirers' long-term strategies. In this context, existing studies only pursued to set up comprehensive indexes to calculate technology relatedness and rank target technologies in a designed queue (Hussinger, 2010; Yang et al., 2014), but ignored to think about those numeric values with real-world M&A strategies, e.g. possibility and opportunities of post-M&A technological synergy, and combine them with necessary expert knowledge.

To address the above concerns, this paper attempts to propose a methodology, based on patent analysis and text mining techniques, to extract technical intelligence to identify Tech M&A target technologies and evaluate the possibility of technological synergy between relevant target companies to facilitate M&A target selection. We apply a term clumping process and a trend analysis together with policy and market information to profile present R&D status and capture future development signals and trends in order to grasp significant domain-based technologies. Furthermore, a comparison between an acquirer and leading players is used to identify significant technologies and sub-technologies for specific strategy-oriented Tech M&A activities. Finally, aiming to recommend appropriate M&A target companies, we set up an index-based system to evaluate target candidates from both firms-side perspective and target firm-side perspective and differentially weigh for specific M&A situations. A case study in China's computer numerical control machine tools (CNCMT) industry – China's key technological field with high technical barriers and difficulties for a new competitor to enter – is used to demonstrate the feasibility of our methodology. We specifically select an emerging Chinese CNCMT company — Estun Automation (ESTUN) as a given acquiring company to engage all the considerations that would happen in a real M&A decision-making process into our empirical analysis, and the results would be utilized by the company for real Tech M&A activities.

The main contributions of this paper include: 1) an adaptive analytic method for Tech M&A target selection, which combines both quantitative and qualitative methodologies; 2) focusing on specific M&A strategies, a text mining-based approach is applied to analyze both technical terms and IPCs to help identify significant technological components; and 3) an evaluation index is built up to investigate and measure the relationships between target firms and an acquirer, and target firms themselves, where both technical and strategic aspects are involved.

In next section, we review the literatures on Tech M&A and related patent analysis techniques. We detail the research design and methods in the Methodology section. The Empirical study section offers a case study of the CNCMT field in China to demonstrate the feasibility of our method. Finally, we discuss insights gained from our method and the case study, and address concerns on limitations and future studies.

2. Literature review

2.1. Technology-driven merger and acquisition

Williamson (1975) defined Tech M&A as the efforts to acquire small firms to obtain technological knowledge. Follow-up studies first investigated the characteristics and preferences of Tech M&A activities (Granstrand and Jacobsson, 1983; Granstrand and Sjölander, 1990), and, then, research concentrated on Tech M&A performance. Hitt et al. (1991) summarized net negative effects on R&D and patent productivity via a 191-acquisition study. Then, research showed diversifying development, multiple processes, and mixed performance (Gomes et al., 2013; Lin, 2012; Ranft et al., 2012; Tsai and Wang, 2008).

We categorized the literatures on Tech M&A into two parts: strategic decision-making (Elango et al., 2013) for pre-acquisitions, and performance evaluation (Le et al., 2014) and integration processes (Wang et al., 2013) for post-acquisitions. By comparison, there are rare studies focusing on the pre-acquisition phase (Gomes et al., 2013), however, Al-Laham et al. (2010) suggested that direct pre-acquisition alliances, as well as sector familiarity between the acquirer and the target, expedited post-acquisition integration.

The selection of the Tech M&A target should entail screening in search of potential candidates that will meet with the acquiring firm's strategic and organizational model and complement their technology portfolio (Chakrabarti and Mitchell, 2013). Park et al. (2013) classified the strategic purpose of M&A into three types when acquiring technological capabilities, e.g. enhancement of core technology, enhancement of sub or minor technology, and entry into the new technology areas. Kaul and Wu (2015), considering specific strategies, argued that acquirers pursued low capability targets in existing contexts to deploy existing capabilities and high capability targets in new contexts to acquire new capabilities. Some scholars also tried to look back at the pre-acquisition stage, especially the selection of the Tech M&A target, to identify reasons for M&A failure (Kaul and Wu, 2015).

Previous studies provided sufficient analytic approaches and understandings to Tech M&A, and also highlighted the importance of the target selection for M&A. However, there is still a gap between technological variables, which hold capabilities to heavily influence M&A activities, and acquired target selections. In the context, this paper explores a tailor-made and systematic analyses framework addressing Tech M&A problems via tech mining and patent analysis techniques.

2.2. Patent analysis for Tech M&A

Patent analysis has been widely applied to many domains and its importance in strategic planning has become increasingly apparent (Lee et al., 2009). However, previous related studies on Tech M&A are not as many as what we imagine. Most researchers introduced patent analysis for the innovation evaluation of post-M&As both on the target firms and acquiring firms via bibliographic information, e.g., whether Tech M&A affects target firms' innovation activities (Kaul and Wu, 2015); what happened with cross-border M&As or domestic M&As on innovation (Bauer et al., 2016; Miozzo et al., 2015; Zhu et al., 2015); what are the key technical determinants affecting post-acquisition invention performance (Makri et al., 2010); and how key technical determinants affect post-acquisition R&D outputs (Miozzo et al., 2015).

Unfortunately, there are few studies paying attention to employ textual content-based patent analysis to support Tech M&A target selection (Liu and Shih, 2011; Yang et al., 2014). Park et al. (2013) applied subject–action–object (SAO)-based analysis to explore the technology relatedness between different companies, in which not only nouns but also nearby verbs are fully considered to identify in-depth relationships between textual elements, and the main objective of this paper is to measure the relationship between two firms and decide whether it makes sense for M&A or not. This attempt provides a novel direction for investigating Tech M&A by textual content-based patent analysis. One understanding here is: an SAO structure contains the full detail of a technological component, and sometimes the "verb" included in an SAO structure even greatly helps delve into the detailed interactions between two technological components. However, in some cases of Tech M&A, we might only need to stand at a more macro level to identify such relationships since technology similarity and complementarity is only one part of our framework. At this stage, our study blends statistical