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Business planning based on technological capabilities: Patent analysis for technology-driven roadmapping ☆

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ABSTRACT

This research responds to the needs of technology-driven business by focusing on how firms can find new business opportunities based on their technological capabilities. It proposes a technology-driven roadmapping processes that starts from capability analysis for technology planning and ends with business opportunity analysis for market planning. We suggest the use of patent data as a proxy measure of technological capability for this purpose and develop four analysis modules — *Monitoring*, *Collaboration*, *Diversification*, and *Benchmarking* — to support decision-making during the process. Various analysis techniques such as text-mining, network analysis, citation analysis and index analysis are applied to discover meaningful implications from the patent data, which are summarized in four maps — *Actor-similarity map*, *Actor-relations map*, *Technology-industry map*, and *Technology-affinity map*. For the purpose of illustration, RFID-related patents are collected and the 18 firms with the most patents used, focusing especially on the third biggest. We believe using roadmapping and patent analysis together can play complementary roles for each other. Putting roadmapping techniques together with patent analysis can increase the objectivity and reliability of technology roadmap, while using patent analysis restricted to technological information together with roadmapping techniques can ensure that a more valuable breadth of strategic information is extracted from patents.

1. Introduction

The recent decade has seen markets shifting rapidly and a seemingly unlimited proliferation of new technologies, resulting in product life cycles becoming ever shorter [1]. It has become the norm for successful companies to have consistently to develop new products if they are to gain or maintain a competitive edge in such a turbulent environment [2]. In this situation, firms are focusing more attention on innovation and increasing investment in R&D as a source of that innovation. However, while this intensive investment is currently yielding considerable results, many firms do not know how to use these outputs strategically. The main problem underlying this situation is that business planning and technology planning are isolated from one other [3]. Investigating how to connect them, especially so that the analysis of technology capabilities can lead on to the identification of business opportunities, is an urgent issue.

One of the tools that has been developed to address the issue is Technology Roadmap (TRM), which is known to be effective in connecting business and technology planning [4], where planning procedures mostly depend on the qualitative judgment of

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technical experts. A TRM can present the co-evolution of technologies [5], can support technology management and planning [6] and also a offer a visual description showing the relationships between research projects and development projects and their objectives and requirements [7]. However, most existing TRM approaches tend to be constrained by market-oriented perspectives: such an approach regards TRM as the set of activities beginning with the perception of a market opportunity and ending with R&D requirements [8]. Although customer needs and the competition situation are critical factors in a firm's success [9], it is unsatisfactory that, by contrast, technological breakthroughs are given such low significance that their value risks being overlooked. Since technology innovation can begin whole new business paradigms and uncover whole new markets, technology opportunity ought to be as thoroughly investigated as market opportunity. Central to the search for technology opportunity is technology capability analysis, highlighting firms' technological strengths and weaknesses, which can affect both the areas in which firms choose to do business, and how successful they will then be in such areas [10–12]. For example, if a firm needs to diversify its business area, a promising option would be to enter a sector where its existing technological assets enjoy high superiority, thus helping to ensure the most efficient use of its technological assets and increasing the possibility of business success.

This research responds to the needs of technology-driven business (and especially of high-technology firms) by focusing on how firms can find new business opportunities based on their technological capabilities. It proposes a technology-driven roadmapping process that *starts* from capability analysis for technology planning and *ends* with business opportunity analysis for market planning. Patent information is adopted as a proxy measure of technological capability for this purpose, and several analysis techniques are applied to discover meaningful implications from this data, and to visualize the results of patent analysis. The visualization results can be used subsequently to support decision-making at various points in the technology-driven roadmapping process. Patent analysis can assist the technical decision-making both of inventors and of firms performing R&D in related areas [13], as well as adding value to economic policy-makers' decision-making [14,15]. It has also been used to measure competitors' technology strengths and weaknesses [16] and to plan technology development activities [17], and is therefore seen as a suitable methodology for analysing business opportunities based on technological capabilities. We believe using TRM and patent analysis together can play complementary roles for each other. Putting roadmapping techniques together with patent analysis can increase the objectivity and reliability of TRM, while using patent analysis restricted to technological information together with roadmapping techniques can ensure that a more valuable breadth of strategic information is extracted from patents.

This paper is organised as follows. The basics of TRM and patent analysis are briefly reviewed in Section 2 and the research framework based on them is designed and introduced in Section 3, where the technology-driven roadmapping process which links technologies with business planning is introduced and described. Then, four kinds of analysis to support better decision-making in the analysis of technology-driven business opportunity are proposed for: 1) monitoring, 2) collaboration, 3) diversification and 4) benchmarking. The case of RFID (Radio Frequency Identification) is studied in Section 4, and Section 5 draws conclusions from our research and suggests directions for future studies.

2. Technology roadmap and patent analysis

2.1. Technology roadmap

Strategies in planning, acquiring and utilizing technological assets have become an important element in deciding how best to use today's limited resources and development capacity. TRM is one of the attempts to link strategy to technology [8]. Though there is no standard definition of TRM, it is generally known as a useful technique to help firms select technology alternatives or strategic fields that should be addressed to meet future market needs [18]. TRMs have various formats and are classified in several ways: for example, they can be 'expert-based' or 'computer-based' (i.e. classified by roadmapping process), 'retrospective analyses' or 'prospective analyses' (by time frame), and 'market-driven' or 'technology-driven' (by roadmapping drivers) [7]. TRM was initially developed by Motorola in 1970s, and the technique then spread to other advanced firms including Phillips, Corning, General Motors, Lockheed Martin and Intel in the USA, Erickson in Sweden, British Telecom in the UK, and so on. In addition, the Canadian Department of Industry, the Korean Ministry of Commerce, Industry and Energy, the US Department of Energy and Sandia laboratory et al. have used it for government policy-making, and industrial consortia such as the International Semiconductor and UK Foresight Vehicles for sector-level forecasting initiatives and standards setting [19]. However, since TRM has evolved as a management practice rather than management theory, most early research has dealt with case examples [3,20,21]. Recently, research on TRM as a theoretical methodology has started to appear, providing roadmapping guidelines [22,23] and linking TRM to other management tools such as TRIZ [24], scenario mapping [25], QFD [3] etc. Some research has also tried to extend the scope of TRM by suggesting its application to such areas as disruptive technology [26,27], knowledge management [28], new product development [29] and service planning [30] etc.

Though TRM has been identified with attempts to link strategy and technology, most of the effort has focused on market-driven roadmapping, aiming to identify necessary technologies from the analysis of market needs. Few attempts have addressed the challenge of using technology-driven roadmapping to find promising business opportunities from the analysis of existing technological assets. The market-objective-oriented technology development methodology that existing TRM approaches have emphasized is clearly very useful, but it may overlook the possibility of various valuable technology applications. Particularly for 6T industries — IT (information technology), BT (bio-technology), NT (nano-technology), ST (space technology), ET (environmental technology), and CT (culture technology) that are regarded as being the most high-tech, there exist great uncertainties at each stage of new technology development, application and diffusion. Using the technology-driven roadmapping approach as a decision-making tool can help reduce such uncertainties. In addition, though various TRM applications have been suggested, few of them