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Technology roadmap development process (TRDP) for the service sector: A conceptual framework

Hilary Martin, Tugrul U. Daim*

Dept of Engineering and Technology Management, Portland State University, Portland OR 97207, USA

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ABSTRACT

This paper provides a decision making framework for development of technology roadmaps by integrating emerging technology intelligence with established decision making and product development methods. This paper integrates the following methods: technology mining, analytic hierarchy process, and technology roadmapping Specifically the emphasis is pointed towards service industry where research has indicated major differences exist when compared to the manufacturing industries. The framework is detailed in the paper providing a platform for practitioners to adopt for their own decisions to make and for researchers to expand by applying it to different service industries.

1. Introduction

Innovation is required to develop new business opportunities, remain profitable and in some cases sustain or enhance the quality of life. We move from one economic cycle to the next because of the introduction of disruptive technologies and both small businesses and large businesses both need to understand the technology environment in order to make successful strategic decisions [61]. Investment in disruptive technologies with a long-term focus enable companies to remain dominant [4]. Technology intelligence using techniques such as data mining is not a new concept in the management of technology. With the introduction of the information age of the 1990's and the vast amounts of data made available through web and data warehousing, over ten years ago it was identified that intuition alone would not suffice and a system built around collecting, analyzing and applying technology intelligence would be a requirement for all technology managers [30]. Yet in a time where we have access to more research and development data than ever, we still struggle with integrating data mining sources into technology decision making and planning. Technology forecasting has a specific relationship with product planning and service planning. In any example, total customer value is said to be comprised of the sum of the product and service value. In health care services the integration between the product technology and service systems is what provides this value. Organizations that provide services need to understand and strategically plan to this product/service integration that is based on technology.

This paper introduces a framework for integrating data mining and expert analysis methods to construct an integrated product-service roadmap. By analyzing "bottoms-up" research activities as well as "tops down" market and business drivers, this roadmap will identify where gaps exist in the overall technology landscape.

2. Literature review

As a pioneer in the "service sciences" and the organization that is driving the definition of SSME [1], IBM calls out that the economies of the world are becoming more and more service drive [51]. An NSF symposium was held in 2007 focusing on technology management in the service sector emphasizing the need for research in managing the integration of technology and service planning [2]. A service

* Corresponding author. Dept of Engineering and Technology Management, Portland State University, 1900 SW 4th Suite #50, Portland OR 97207, USA.
E-mail address: tugrul@etm.pdx.edu (T.U. Daim).

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is “a provider/client interaction that creates and captures value” [39]. It can also be thought of as “economic activity whose output is not physical product or construction”. Another definition of service is “what supports activities of people or organizations to achieve their goal” [21]. Any customer value can be defined as a sum of “product value” and “service value”. The percentage of service value to total customer value is growing. In many environments, such as health care, products are of no value to the customer without a skilled service provider to use those products. This creates a complexity for the organizations that provide these services and the organizations that develop the products. The two must be aligned in order to deliver customer value. This co-dependency and integration is critical in emerging technology development.

Services make up a larger and larger percentage of GDP each year in most developed countries and a large portion of this is in health service sectors. Most organizations that provide health services do not have a good way to stay engaged with technology under development that may significantly impact their strategic model or enable new or enhanced services that need several years of planning. Converging technology areas of nanotechnology, biotechnologies and information technologies are especially critical to comprehend in health service planning for upcoming decades. Models have been introduced that integrated services with the standard technology roadmap process but a systemic way to develop that roadmap is required in order to analyze “bottoms-up” research activities as well as “tops down” market and business drivers and identify where gaps exist.

3. Methodology

Although there are differences in opinion of the trends for technology forecasting techniques, experts agree that complex and converging technologies required the need for forecasting methods that incorporate multiple techniques and combined forecasts [9,38]. It is also apparent that techniques resulting from advancement in computer and information sciences such as bibliometrics and other data methods are gaining popularity and credibility. Bibliometrics is a technology forecasting technique gaining popularity and momentum with the aid of advanced database systems that have been made widely available in the past decade [9,11,20,34,45,55,63]. Sometimes referred to as scientific literature analysis, this method analyzes data of publications to look for insight to technologies that are being developed and what institutions and companies are working on them. A variety of techniques can be used from simple publication count to advanced network analysis. Some argue that since not all patented technologies are published, bibliometrics is most useful for technology monitoring or scanning. The time lag between publication and technological development can vary from one discipline to another and the useful horizon can only be estimated [18, 62, 108, 156]. Patent analysis is complementary to bibliometrics but uses patent data trend analysis to monitor technology activity. Since patents are public record and improved database systems that provide public access to this data are available, patent analysis is a useful method in monitoring and anticipating technology development [12,37,45,46]. Many basic patent analysis techniques were developed by Battelle in the early 1980’s and Japanese and European groups have continued to advance these methods [38]. Lee et al have developed a model using patent data that develops a keyword list and constructs a product-technology map to produces a semi-automated technology roadmap [31]. Patent analyses range from basic lists of fields and frequencies to more advanced analyses that map related terms to identify patterns, develop list comparison to identify new hot topics or build co-term or co-inventor diagrams that give insight to where who and what is being patented [46]. Expert analysis can be defined as the assertion of the future "derived from information and logic by an individual who has extraordinary familiarity with the subject at hand" [38]. Ultimately, the quality of all expert analysis methods is fundamentally based on the quality, experience, and knowledge of the participants. While such a definition includes intuition theory as well as the "hunches" of a "futurist guru" there is a more structured expert analysis-based method that has long been used for foresight: the Delphi method. The Delphi method calls upon a number of experts on the technology under investigation, asking them when they expect a certain important breakthrough to occur or other such questions [60]. The method follows a protocol of questioning which gives the experts objective feedback from the group's responses to a first round of questions, and then asks them the same questions again. This pattern is repeated until a general consensus of the outcome is developed. Technology forecasting experts agree that models should be used in combination [36,38]. The primary reason for combining forecasts of the same technology is to attempt to offset the weaknesses of one forecasting method with the strengths of another. In addition, the use of more than one forecasting method often gives the forecaster more into the processes at work which are responsible for the growth of the technology being forecast. Using multiple techniques can span multiple perspective (organizational, technology, personal) resulting in a richer analysis [11].

Technology intelligence (TI) is about bridging the gap between information and data. It complements and supports direct human intelligence gathering [25]. It generates new insights and new perspectives but does not generate absolute solutions or answers. One definition is defined as “business-sensitive information about external scientific or technological developments that can affect a company’s competitive position” [42]. Motorola was one of the first companies to set up a formal technology intelligence program. This was done with the belief that multinational companies can benefit from intelligence programs just as many government organizations do. These TI efforts at Motorola help to understand the competitive environment and to identify alternative approaches under development. In several companies research portfolios have been successfully reshaped as a result of various TI techniques. Although many companies use TI today, most focus on protecting current competitive positions and have not been successful in using TI techniques to seek out technology opportunities [42]. Technology intelligence and more specifically technology mining treats text as data to