A STUDY ON THE SUSTAINABILITY FOR THE TECHNOLOGY MANAGEMENT

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ABSTRACT

Firms have recently strived to improve their corporate sustainability in response to the increasing demands from their stakeholders for environmental, social, and economic responsibilities. This research has explored the sustainability issues associated with the processes of technology management (TM), and examined the impacts of sustainability on the TM performance through an empirical study. From a path analysis, it is found that a corporate sustainability management strategy will influence the TM strategy, and in turn the TM strategy requires TM activities to comply with sustainability requirements. Consequently, the performance of TM is positively affected by implementing sustainability management at the TM level.

INTRODUCTION

Recent "Greening" demands and activities driven by firm's stakeholders (e.g., consumers, regulators, politicians, NGOs, and environmental activists) have impacted firm's strategies for marketing, product development, operations, etc. towards corporate sustainability balancing economic growth, environment protection, and social responsibility. Many research attempted to show how companies strive to improve sustainability performance [1], develop a framework of sustainability criteria for assessing the sustainability performance [2], and identify the factors affecting corporate sustainability performance through empirical study [3]. Most of the past research focused on the sustainability achievement at the corporate level, and needs for changes of corporate strategies for sustainability. From the viewpoint that corporate sustainability strategy should reach down to operations of marketing, technology development, manufacturing, purchasing, logistics, etc., further research should investigate how the corporate sustainability strategy will affect operations strategies of various functions of a firm, and whether the changed operational sustainability strategies of those functions will improve their functional performance. This research is particularly interested in studying on a causal relationship between corporate sustainability strategy and technology management performance.

Technology innovations are critical for a company to develop and sustain competitiveness in the market since the technological changes developed can lead to new business opportunities. Effective and efficient management of technology has emerged as an imperative and distinctive managerial discipline due to changes to the business, political and social environments, the growth in R&D spending, the restructuring of organizations, and managerial concern for core competence and competitive advantage [4]. Such technological improvement and innovation, however, should appeal to, and be accepted by consumers and society who have been increasingly demanding corporate sustainability as a corporation's

new role in a society [5] [6] [7]. Although there has been much research on defining sustainability and addressing needs for sustainability at the global, national, and corporate levels, few research have studied the impact of corporate sustainability initiatives on the performance of TM through changes of the TM strategy towards the sustainability. Thus, this research is to investigate the sustainability issues associated with the processes of technology management, develop some hypotheses for impacts of the corporate sustainability on the performance of TM through the sustainability implementation during the TM processes, and then test hypotheses using a path analysis based on a survey from Korean manufacturing companies.

LITERATURE REVIEW

Sustainability and its Relationship with Corporate Performance

Sustainability has now become a fundamental principle of smart management [8]. It is not simply a matter of good corporate citizenship to earn a better corporate image from society by reducing noxious emissions at factories or providing generous fringe benefits to employees. These signals linking public sustainability to corporate sustainability are awakening the business community to revitalize sustainability-driven "win-win-win" strategies that Elkington [9] pointed out 15 years ago to simultaneously benefit the company, its customers, and the environment. A concept of the triple bottom line developed by Elkington [10] [11] considers and balances economic, environmental and social goals from a microeconomic standpoint. The term “sustainability” as defined in the literature and viewed in industry, however, varies widely in its scope. Some focus strictly on economic and environmental considerations, while others encompass equity, various definitions of justice, and other social criteria [12] [1]. Many past researches studied the relationship between sustainability and their economic performance. Lee et al. [3] presented a summary of major selected studies that examined the links between sustainability and the economic performance in the different dimensions of accounting and market-based performance. Their summary of past research showed that there have been inconsistent conclusions on the relationship between corporate sustainability and performance. Some researchers (e.g., [12] [13]) asserted a negative effect of sustainability management on corporate financial performance while other studies (e.g., [14] [15] [16]) presented a positive relationship between them.

Sustainability Issues in the Technology Management

Technological innovations have been regarded as one of the key drivers for firms to sustain competitive advantage in existing businesses, and to explore new business opportunities [17] [18]. Sustainability, however, has been only applied to limited extent and scope in TM [18]. Traditional innovation management has focused on the economic value from innovations, and had lower priority into environmental and social issues. Industry managers in the TM have passively reacted to government’s regulations and demands from environmentalists and consumer activists for protecting the natural environment, reducing energy consumption, pollution emission, and eliminating hazardous raw materials and byproducts in product development and manufacturing processes. In addition, managers have thought that the development of environment-friendly products and processes increase overall costs in products due to costly materials and manufacturing processes with more complex and expensive equipments.

Contrary to a manager’s conjectures on negative impacts of eco-friendly innovations on the firm’s performance, some empirical studies have shown that there are positive relationships between the commitment to green management and financial performances [19] [20] [21]. In addition to the

improvement of processes for green operations, companies have recently increased their attention on environmentally friendly products. They develop energy efficient products and eco-innovations by substituting materials with green materials.

SUSTAINABILITY-ORIENTED TECHNOLOGY MANAGEMENT AND HYPOTHESES DEVELOPMENT

Sustainability in the Technology Management Process

The core process of technology management includes four sub-processes: technology strategy, value creating process, value capturing process, and performance. We briefly introduce key arguments and recent understandings related to each process, and then suggest how sustainability issues can be aligned with TM.

***Technology Strategy*:** Recently, managers have increasingly tried to align corporate strategy with its technology strategy through portfolio management and close relationships between business units and R&D departments or corporate research center. The R&D projects considering sustainability may require significant changes in a part of all of the value chain processes. These changes in business operations should be determined by the solid corporate strategies on sustainability issues. Thus, TM strategies should comply with the corporate sustainability strategy, and provide a concrete guideline to sustainability-oriented TM processes, such as technology choice, technology transfer, technology acquisition, technology alliance, technology implementation which are governed by sustainability policies and culture.

Value Creating Process in TM: Technological innovations have contributed to create more value through product and process innovations. There is an increasing interest in more radical innovations to surpass incumbents according to technology progresses, or to create and dominate whole new product markets over late-entering competitors. Some empirical studies have shown that environmental technologies, including product, process, system innovations, have positive relationships with financial performances. Even though there are many barriers to imbedding sustainability into value creating processes in the TM, the effects of sustainability are profound and immeasurable for a firm when it encounters these environmental and social challenges during production, marketing, sales, and after-sales operations. Thus, companies should make sure that all activities in the value creating process have taken into account sustainability-related issues as many in factors and much in depth as possible.

Value Capturing Process in TM: To maximize benefits from technological innovation, industrial firms build strong patented-technology portfolios and complementary assets, such as distribution channels and state-of-the-art manufacturing facilities. Under the environment with a high level of uncertainty on sustainability, experiments on unexplored areas and risk management on sustainability are another critical mechanism to capture value from technological innovations. Before the enforcement of sustainability issues and public pressure, firms themselves have opportunities to explore high level of uncertainty and prepare specific action plans on how to capture values from the external changes on sustainability. In addition, sustainability issues are involved not only in a focal firm's boundary, but also over diverse value chains from upstream to downstream activities.

Performance under Sustainability Issues: When environmental issues or social responsibilities are emerged into sustainable problems, corporate managers have tended to react passively to the issues rather than proactively handling them as strategic issues, because most of these issues may increase overall costs and negatively impact corporate level performance. However, it should be noted that there is a great amount of costs to be incurred from sustainability-related problems. Technological innovations on sustainability would contribute to identifying potential business opportunities and develop new

products and services for unmet customer needs ahead to competitors only in economic valued current businesses.

Hypothesis Development

The literature review and analysis of the present TM practices in industry have left a number of possibilities related to the industry's sustainability practices, leading corporate sustainability strategies to implementation of sustainable management at the level of TM, resulting in higher performance of TM. It may be possible that sustainability management (SM) at the corporate level will lead people working for management of technology (MOT) to recognizing the importance of SM as much as their company's corporate sustainability strategy. Although employees working at the TM level may think that practicing sustainability will result in longer time and higher cost of product development, promoting sustainability as their strategic vision at the corporate level and reporting their sustainability efforts to stakeholders may help them recognize the real importance of sustainability for the company as well as various stakeholders and environments. Once people at a TM level understand the importance of sustainability and stand on the same track of sustainability vision as the corporate, they may incorporate sustainability into the strategy of sustainable MOT. It is also conjectured that once the sustainability is incorporated into the strategy of sustainable MOT, the TM team/department/division would develop some action plans to implement the sustainability strategy for technology and then the action plan driven by sustainability will govern the TM operations. Finally, it may be possible to see higher performance of MOT caused by SM activities in the technology management function. Theses inferences lead to the following hypotheses:

H1: Sustainability management strategy at the corporate level will influence people working for the management of technology (MOT) to recognize the importance of SM.
H2: Once people at a TM level understand the importance of sustainability, they may incorporate sustainability into the strategy of sustainable MOT.
H3: The strategy for sustainable MOT affects SM activities in the TM operations.
H4: sustainability-oriented TM operations/activities results in higher performance of MOT.

RESEARCH METHODOLOGY

Survey

To test the hypotheses developed in the previous section, an empirical methodology is used through a survey from industry practitioners in an electronics goods manufacturing industry in Korea. A survey form was designed in Korean. The survey was emailed to approximately 150 industry practitioners from October 2010 to December 2010, and 89 usable responses for statistical analysis were collected. All measures used in this research were developed through literature review and conjecture described in the previous section. They were also pre-tested through face-to-face in-depth interviews with two practitioners in the TM field. Each item in the five latent variables of corporate SM strategy, Awareness of SM importance in MOT, SM strategy in MOT, SM implementation in MOT, and MOT performance was measured on a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree".

Analysis

Two analyses were conducted using SPSS 18-AMOS to ensure the reliability and convergent and discriminant validity of five latent variables in this research. The first analysis, i.e., exploratory factor

analysis checked the purification of survey items. Items were deleted during the preliminary scale purification process. Confirmatory factor analyses was used as the second analysis to ensure dimensionality and convergent and discriminant validity of the structural equation model (SEM). The result of hypothesis tests shown in Figure 1 indicates that the SEM is fitted well. The hypothesized model has an acceptable fit and the completely standardized path estimates indicate significant relationships among latent variables. All modification indices are at acceptable levels. In view of the results of the path analysis, all hypotheses are supported.

Figure 1. Sustainability Technology Management Path Model

** $p < 0.01$, χ^2=9.687, d.f.=86, GFI=0.872, TLI=0.979, NFI=0.809, CFI=0.982, RMSEA=0.030.

DISCUSSION AND CONCLUDING REMARKS

This paper attempts to address the importance of sustainability in the TM area and bring attention to the need for research on sustainability-focused TM. A new framework of TM aligned with sustainability is presented to link currently neglected issues of sustainability to the TM processes. An empirical research using a survey was carried out with TM practitioners in Korea to test four hypotheses regarding impacts of sustainability consideration during the TM on TM's performance. From the hypothesis test results, the following managerial implications can be interpreted: First, once sustainability management is imbedded into corporate strategy, the voice of sustainability is most likely spread out to the management of functional levels, and employees in the area of TM consider that sustainability management will be beneficial to the company; second, after TM practitioners perceive the corporate vision to the sustainability for their company, society, and environment, they also incorporate sustainability perspectives into the TM strategy to make sure that sustainability would be practiced during the TM operations; third, regular education and training for the sustainability management, and sufficient investment in sustainability are necessary for successful implementation of sustainability; and fourth, implementing sustainability in the activities of TM could result in increasing the success rates of technology development and commercialization, reducing emissions of environment pollution wastes, using more environment-friendly, and increasing the ratio of recycling used materials and components.
This study needs to be expended with more data from industry, and can be extended for future research to other regions to see whether there may be difference in sustainability perspectives among different regions.

Acknowledgment

This study was supported by Lucas Graduate School of Business, San Jose State University, under the Lucas Research Fellowships grant. The supports are gratefully acknowledged.

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