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Keywords: *innovation management, technology management.*

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Strategic Management of Technology and Innovation

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Abstract- This paper discusses the importance and need of incorporating technology and innovation strategy into business strategy to achieve overall competitive advantage for the company. The use of technology and innovation in value creation system is highlighted in a way that it plays a pivotal role in productivity, economic growth, increasing wealth in socioeconomic environment, and evolution of entire industries. Strategy formation and execution in the context of technology is discussed that technology strategy should be aligned to corporate strategy in order to reap out benefits like performance and competitiveness for the company.

Furthermore, concepts like technology strategy, forces affecting technology strategy formation and execution, technology management, innovation management, and what benefits companies can get from these are highlighted and discussed in relation to corporate business strategy. As an example, Wal-Mart's case in becoming a market leader using technology strategy has also been discussed in this paper. All above highlighted aspects are justified with the help of literature findings already did by other researchers and provides guidelines for practitioners or companies to better understand the problem in hand. It will allow them to better incorporate technology and innovation management into their business model. This paper provides the basics of technology and innovation management in practice, and provides a need for further research to better understand the rationale.

Keywords: innovation management, technology management

I. Introduction

Rapid flow of information and accelerating technological advancements during the past century has made economy and social environments very complex and competitive. In 1911, Schumpeter (1961) concluded that technological advancements have brought about drastic changes in form of emergence, fusion, disruption and evolution of industries over time. Especially in highly technology-oriented industries, technological competition on global scale makes a significant managerial challenge for firms or organizations. The basic and absolute question is how firms can manage strategically their product offering, value chain system, product strategies and technology, competences and capabilities in complex changing business and technological environment.

Operating environment for businesses is considered as complex and ever changing, and technology plays a pivotal role in managing such environment for better productivity, innovation and business model development. Companies do struggle in adapting to new technological trends, and investments optimization process to cater for new opportunities in the market place. Therefore, fundamental need for companies is to be capable of creating and executing business and technology level strategies side by side to achieve sustained competiveness and value creation. Enterprises who had been managing and optimizing single function of the company at a time now manages multiple functions strategically. In order to achieve high return on investments and better performance as a whole, enterprises need to have strategic management capabilities. (Ansoff 1979, Ansoff 1987).

Strategic technology management is expected to provide means or ways to manage complexity, ambiguity and dynamic nature of businesses, caused by the technology. In this article, the term 'strategic' in relation to technology management emphasises the linkage of strategic management with technology management. Strategic management is a big umbrella, in which strategic technology management is one colour and food for thought in this article for various audiences. Furthermore, strategic refers to strategic technology management as being separate own disciple itself apart from other managements like innovation management and R&D management which surrounds technology management activities. Thus, strategic technology management is placed or considered apart from other types of management in practice. (Bleicher 2004).

II. Strategic Management

Company strategy as defined by Chandler (1962: 7), *"determination of the basic, long-term goals and objectives of an enterprise andthe adoption of courses of action and the allocation of resources necessary forthose goals"*. Strategic management is concerned with the policy that a company adopts to create, enhance and sustain its capabilities based on its environment and in achieving its objectives (Ansoff 1979). The concept of strategy and strategic management has evolved and matured over the years (Whittington 2001, Drejer 2004, Bigler 2009). Nag *et al.* (2007), amongst other scholars concluded the definition of strategic management as, *"The field of strategicmanagement deals with the major intended and emergent initiatives taken bygeneral managers, on behalf of owners involving utilization of resources,*

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toenhance the performance of firms in their external environments". The strategic manager of an organization develops and suggests company initiatives to be undertaken on behalf of its owner. This plan involves the efficient utilization of the available resources and enhancing the firm capabilities to meet the demands of its environment. According to this definition, strategic management covers aspects such as the current environment, society, organization, enterprise, management, people, knowledge, outcomes and value creation.

a) Value Creation And Business Model

An enterprise targets to create value throughout the value chain for customers, owners, personnel and society (Ansoff 1979). Considering economy on macro-economic level, the use of technology and innovation in value creation system play a pivotal role in productivity, economic growth, increasing wealth in socioeconomic environment, and evolution of entire industries. Apart from this, continuous change in technology and innovation has affected companies in changing their value creation systems, thus leading to evolution of entire new industries. The companies have to plan, define, and execute strategy in a way to develop required capabilities to meet customer and stakeholders' desires. The strategy creation and execution would eventually define the position of a company in the market and its value chain (Porter 1985). This position of the company is rooted from business model that a company pursues in completing its mission (Chesbrough 2006). If simply said, business model consists of value chain systems, product, offerings, and revenue model but existence of such models in practice in quite rare to be seen (Suikki et al. 2006, Makinen&Seppanen 2007).

The use of technology in elements of each business model defines the objects and aspects of a strategic management in an enterprise context. In both micro and macro levels, use of strategic technological management is concerned with the proactive use of technology of an enterprise to achieve sustained value creation and survival amongst business models changes and the industry evolutions enabled by advancements in technology.

b) Strategy Formation And Execution

For companies survival, value creation, and to achieve long-term success strategy formation and execution is very crucial. However, it is not sure what corporate strategy would be and how a successful strategy would be established in such a dynamic environment now a days. Strategy formation constitutes distinctive characteristics related to strategy creation process, its rationale, and the direction of its focus. Whittington, (2001) stated that meta-schools of strategy are coherent, evolutionary, and systemic in nature. Minztberg et al. (2005) gave different school of thoughts for strategy in relation to prescriptive and descriptive sense. According to him, there exist three prescriptive (design, planning and positioning) and seven descriptive (entrepreneurial, cognitive, learning, power, cultural, environmental, configuration) schools of strategy. However, there exists no observed evidence which strategy formation technique best meets the requirement of a company in terms of outcome and how company can actually create a better strategy for them.

Porter (1985) stated that technology is involved in all activities of value creation process of a company so technology aspects must be considered properly during strategy formation. Therefore, companies do need to cater for technology matters in line to product and business strategy. For instance, technology strategy should be aligned to corporate strategy in order to reap out benefits like performance and competitiveness for the company, or the other way, technology strategy is to be derived from corporate strategy (Mei &Nie 2008, Dodgson et al. 2008). Creating a successful business strategy is a complex managerial milestone to achieve for a company. And yet adding the abstract element of technology in strategy formation makes complexity and uncertainty even more. Companies' main concern in strategy formation related to technology is to deal with complex and dynamic nature of technological developments. Another challenge faced by companies is management control of firms' technological evolution in such fast changing and unpredictable technology and business environment (Ansoff 1987). Considering the expansion of technology and innovation, as well as strict involvement of these in every business process of a company, conduct and role of strategic technology management is inevitable.

c) Technology Strategy

Technology strategy is one of the basic ingredients in strategic technology management. Characteristics and capabilities of a technology need to be developed and evaluated across the company. Considering the importance and relation of technology with the firms' broad competitive strategy, technology should be connected and aligned to business strategy. Moreover, firms' strategy on products, services and processes must be devised in relation to technology throughout the value chain process (Dodgson et al. 2008).

In current era, technology strategy has become a key factor in devising business strategy and to sustain a competitive advantage. Burgelman et al. (2001), studied this fact and concluded that it helps to answer questions such as, which competences and technologies are to be adopted for competitive advantage, what should be the investment level on technology development, and how to organize technology development and its management etc. Although, scope and importance of technology strategy is defined in companies, but the extent to which such strategy is incorporated into business strategy and the

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existence of an explicit technology strategy varies even in technology oriented firms (Kropsu-Vehkapera et al. 2009). Moreover, there exist forces, both internal and external that do shape the formation and execution of technology strategy and these forces are integrative and generative in nature. In this regard, Determinants of technology strategy are presented in the Figure 1, showing different forces affecting the formation and execution of technology strategy.

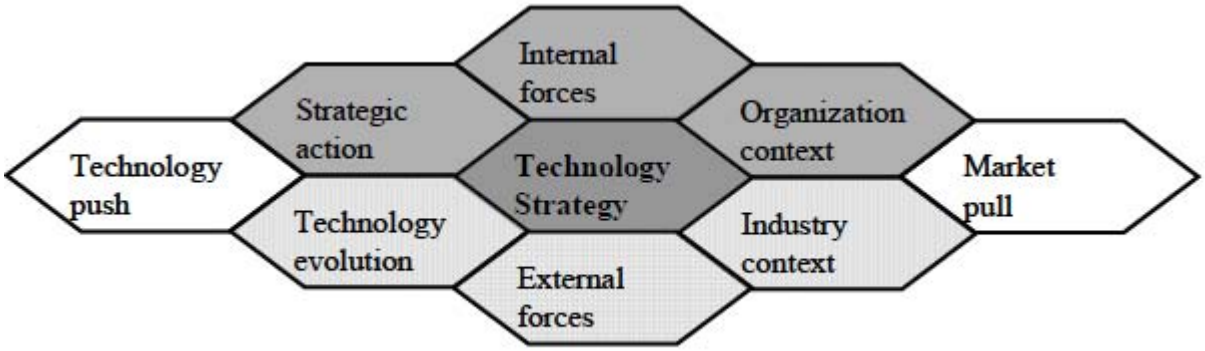

Figure 1 : Determinants of Technology Strategy (Sahlman k. 2010)

III. Management of Technology and Innovation

Technology management is essentially concerned with the interface of the organization and the external technological environment. Technological items include licensing, acquisition, technological status, R&D and technological policies. While innovation management areas are new product development, new process development and innovation policies.

a) Technology Management

Burgelman*et al.* (2001: 4) defines technology as*"technology refers to theoretical and practical knowledge, skills and artifacts thatcan be used to develop products and services as well their production anddelivery systems. Technology can be embodied in people, materials, cognitive andphysical processes, plant, equipment, and tools".*

Figure 2 demonstrates the variousdisciplines that can influence the management of technology andinnovation.

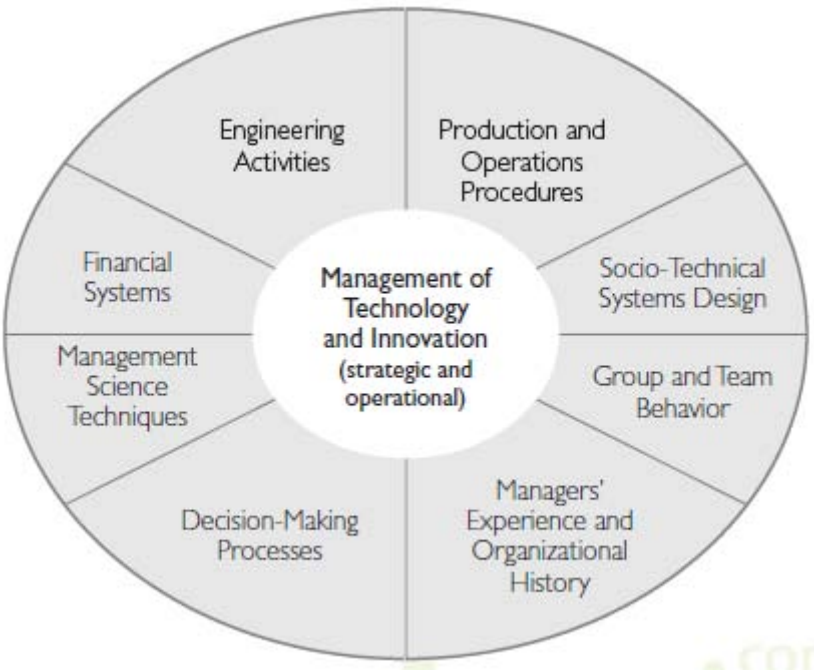

Figure 2 : Areas Influencing the Management of Technology and Innovation
(Margaret A. White & Garry D. Bruton.2007)

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b) Innovation Management

Innovation management is defined as a "*comprehensive approach to managerial problem solving andaction based on an integrative problem-solving framework, andan understanding of the linkages among innovation streams, organizational teams, and organization evolution".* It is aboutimplementation—handling politics, control, and individualresistance to change. The manager is an architect/engineer, politician/network builder, and artist/scientist. (Margaret A. White & Garry D. Bruton.2007)

Effective innovationmanagement depends on the organization's top managementinclination to commit the resources to allow individuals and groups torecognize "newness" and respond accordingly. This commitment by thetop management to innovation, in turn, requires their recognition ofseveral realities. These realities are as follows:

1. Management of technology incorporates the management of innovation.
2. It requires encouraging an environment where innovative thought and work are encouraged.
3. It involves leading a firm from existing processes and products to something that is "better" and more valuable.
4. It is proactive and encourages creativity and risk taking.

IV. Importance of Technology and Innovation to Business

In many industries technological innovation is most important driver to gain competitive advantage. The companies are adopting new technology advancements and innovations due to the globalization of markets. Not only are innovation and technology imperative to the economy, but they are clearly worth arguing over. This can be illustrated by fact ten years ago pricing on many machinery and commodity products were done very inefficiently. It was very hard to know exactly what each firm would charge for its product and what the other firm would charge for the same product.

The result was that widely different firms charge different prices for the same product. Purchasing agents found so different and spent a lot of time looking for the best price. However, new technological advancements have eliminated this inefficiency. Especially the Internet has resulted in more transparent and efficient means of pricing for both capital goods and commodity products.

The influence of technology on business typically is not one-dimensional but rather new technology has a cascading effect within firms. To illustrate consider the previous example; in economic theory price is a function of supply and demand. But the technology resulted in both more demand and lower prices. Advancements in technology have made consumers more knowledgeable and they are more aware of opportunities to obtain and use products. This leads to greater demand and precise information leads to pricing being more systematic. As a result, technology leads to better pricing. A similar cycle has taken place in other markets, people use internet to buy automobiles, books and other products. This leads to greater number of buyers but also building pressure on firms in terms of lower prices.

V. Wal-Mart - Case Study

a) Wal-Mart and IT

Wal-Mart is the largest retail company around the world, using information technology to improve its operations and to gain competitive advantage. Wal-Mart is designed on a strategy to provide a broad assortment of quality merchandise and services at everyday low price. Information technology plays an important role in Wal-Mart's business success and they must pay continual attention to technological advancement to sustain competitive advantage. Wal-Mart looked into RFID technology to improve its operations and make further progression such as reducing labour cost, improving inventory control and evolving marketing intelligence. In the mid 1980s, Wal Mart invested in Central database, store-level POS systems and a satellite network. Wal-Mart developed Retail Link, was a largest civilian database in the world. Retail Link contained every data of sale that a company made over a past two-decade period. In 1990, Wal-Mart was an early adopter of Collaborative Planning, Forecasting and Replenishment (CPFR), an integrated approach to planning and forecasting in which they share the critical information regarding Supply Chain.

b) Benefits Wal-Mart experienced by RFID

In June 2009, the CEO of Wal-Mart announced that company had decided to deploy RFID (Radio Frequency Identification) along its supply chain and revealed that its top 100 supplies would be required to put RFID tags carrying EPC on pallets. In 2005, Wal-Mart employed more than 1.6 million associates in more than 6200 facilities around the world which included 3800 US stores and 3800 international units and in that year Wal-Mart makes US$ 418,952 billion. Heinrich (2005, p.25) states that RFID systems improve the flow

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of supply chain. The author states that RFID provides many benefits to Wal-Mart such as in logistics operations, it enables supply chain visibility and its impact on Supply chain facilities such as warehouses is foreseeable. This new technology will place a small tag on each item at the manufacturer and will allow the product to be tracked from the time it leaves the manufacturer until it leaves the store. This ability helped the Wal-Mart to have a better control of shrinkage or loss. This also helped the Wal-Mart to improve inventory in the stores because Wal-Mart will know immediately if there is a shortage of any product in any store or a surplus in another store. And Wal-Mart will be able to know if the transfer of goods will be possible and profitable to them.

The RFID technology helped the suppliers to better manage their production to serve Wal-Mart more efficiently and effectively. For example, RFID is used by Wal-Mart suppliers, Procter & Gamble to obtain instant data on what is sold and where is sold. This information helped the suppliers to adjust their production according to the needs of Wal-Mart. It is estimated that RFID implementation could save Wal-Mart US$ 8.4 billion a year in costs when it is fully deployed. Wang et al. (2011, p.571) mentioned research conducted by University of Arkansas on 24 retailers of Wal-Mart and divided into two groups. The one group consisted of 12 retailers, the one not using RFID and the other using RFID technology. The results of this research showed that the group that used RFID along supply chain had a 16% decrease in the OOS rate compared to the other group not using RFID technology into supply chain system. (Massuod O & Hassan S. 2012)

c) Drivers of Implementing RFID

The main drivers that persuaded Wal-Mart to deploy RFID technology were following:

- Getting high visibility, accuracy and efficient productivity of supply chain operations;
- Optimizing Inventory levels, minimize stock levels;
- Creating more value to customers;
- Optimizing promotion management competences;
- Increasing Product availability.

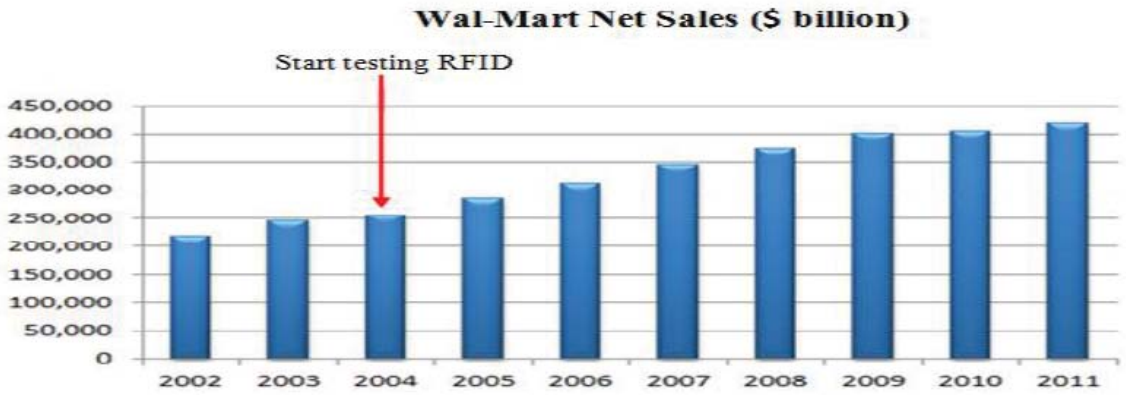

Figure 3 : Wal-Mart Net Sales (Wal-Mart Annual Reports 2002-2011)

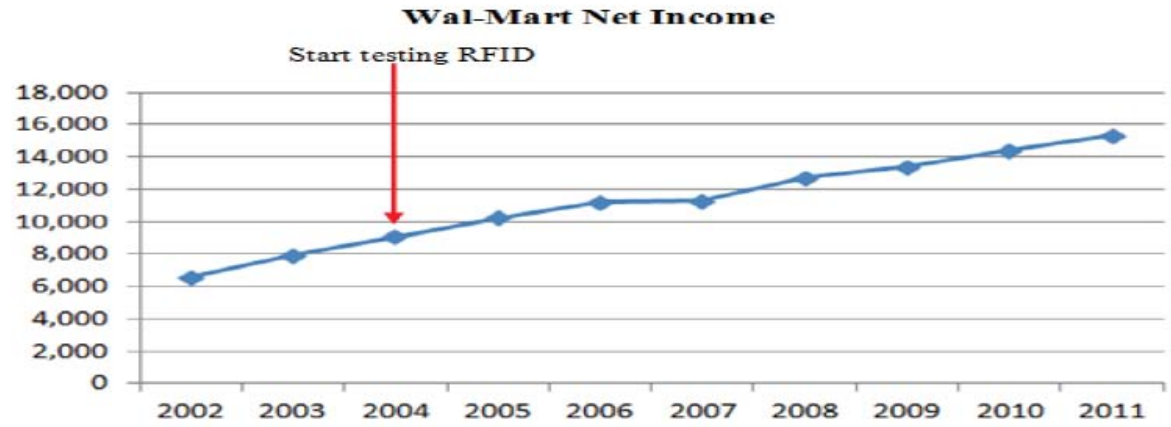

Figure 4 : Wal-Mart Net Income (Wal-Mart Annual Reports 2002-2011)

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As shown in above figures, with the implementation of RFID the net sales and net income raised this means that implementing RFID technology had key role in increasing net sales and net profit. (Massuod O & Hassan S. 2012)

VI. Conclusion

In today's era, roots of a business are derived from technology and innovation. In near future, business success will be largely dependent or driven by these two salient factors. Companies would have to take technology and innovation as a strategic objective of the company to sustain their competitive advantage. Moreover, technology and innovation causes a cascading effect on an organization, meaning use of technology in one domain will eventually lead an organization to make greater changes in technology in other areas. Technology and innovation has not only affected the businesses but the society as a whole. It is a process of push and pull i.e. technology is pulled by society or society is pushed by technology. So, organizations do have to undergo technological developments and innovations to cater for economically complex and dynamically changing social environments. In order to achieve such objectives, need for strategic technological and innovation management becomes inevitable.

Technology strategy in being a key ingredient in technology management has become a primary factor in devising business strategy and to sustain a competitive advantage, so companies do need to connect and align technology strategy with business strategy. Portfolio of technological evolution in a company should be managed strategically by taking into account technology during strategy formation and execution process of a company. Companies have to plan, define, and execute strategy in a way to develop required capabilities to meet customer and stakeholders' desires. And for this to happen, technology and innovation management should be incorporated into value chain system of a company.

No commonly agreed frameworks are available that can define how technology and innovation can be integrated into value chain model of a business. Reason might be due to complex and dynamic nature of economy, and globalization effect on business processes as a whole. So, it is important to highlight basic aspects related to value creation and business model, strategy formation and execution, technology strategy, technology management, innovation management, and interface between technology and innovation strategy. This would allow companies to better understand concepts and intermediary steps, required to formulate a technology and innovation framework for them to develop and sustain technological capabilities. With this, organizations will be able to benefit from their internal strengths, overcome their weaknesses, exploit external opportunities and minimize their external threats.

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