

Technological Innovation and Corporate Performance

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Abstract

This paper reviews studies that have been done in the area of technological innovation and performance of corporate enterprises. The specific areas covered are innovation, technological innovation, Models of technological innovation, adoption of technological innovation, new approaches to technological innovation, technological innovation process, factors affecting the adoption of technological innovation (firm's external potential sourcing and networking, firm-specific characteristics and firm's environmental condition), and technological innovation and firm performance.

Keywords

Innovation, Technological Innovation, Performance, Firm

I. Introduction

Rycroft and Kash (1999) claim that innovation requires a process of co-evolution between technology and cultural perspectives. Technology exerts a significant influence on the ability to innovate and is viewed both as a major source of competitive advantage and of new product innovation (Gunasekaran et al., 1996). Often, firms experience problems in this area, which is caused by lack of capital expenditure on technology and insufficient expertise to use the technology to its maximum effectiveness (Alstrup, 2000). Hammer (1990) stresses that organizations should "obliterate rather than automate" believing that technology is often introduced for technology's sake without contributing to the overall effectiveness of the firm's operations. However, firms' traditional lack of resources usually results in a compromise situation (Vossen, 1999). It is important to link technology to innovation in sustaining competitiveness. Organizations that can combine customer value innovation with technology innovation have an increased chance of enjoying sustainable growth and profitability (Kim and Mauborgne, 1999).

There are numerous definitions of innovation in the literature; however, most definitions share common themes relating to knowledge, which may be turned into new products, processes and services to improve competitive advantage and meet customers' changing needs (Nystrom, 2000). Carnegie and Butlin (2003) define innovation as "something that is new or improvement done by an enterprise to create significantly added value either directly for the enterprise or directly for its customer." Livingstone et al. (1998) refer to innovation as "new products or processes that increase value, including anything from patents and newly developed products to creative uses of information and effective human resource management systems".

II. Technological Innovation

Innovation is derived from the Latin word *novus*, meaning new. It is defined as "introduction of something new" or a new idea, method or device (Tornatzky and Fleischer, 1990). In this paper, the word innovation refers to technological innovation as opposed to any other form of innovation. Among the variety of definition, technological innovation is considered as a process which is science, technology and system based. This process includes several factors affecting and affected by the firm's internal

capabilities, its networking and its technological learning ability and influenced by its environmental factors. It would mobilize all existing potential resources to augment the firm's innovation capacities, ending with the introduction of a new or better product and/or production process.

The core concentration in this paper is not necessarily upon everything, which is new in the world or in time and place. Rather, the emphasis is placed on those minor or major changes in products and production processes that involve human activities and end to the new or better ones for the firm or its economy, regardless of their introduction before elsewhere. These changes include the adaptation, imitation and associated development efforts in technology evolution process.

Technological innovation and the appropriate implementation of new technologies are a fundamental part of development process of all nations. The literature evidence reveals that successful technologies in each nation are those which rooted in their own indigenization efforts. Indigenous technological innovation can originate just as much from a re-invention of historical techniques or an adaptation of local technology as from advanced industrialized countries.

Research on technological innovation, broadly defined, forms a huge body of research focused on problems of technology-based change in organizational and social settings (Rogers, 1995; Drazin and Schoonhoven, 1996). The popularity of the technological innovation approach in IS research testifies to its usefulness. Theories of innovation have been used to explain the adoption patterns of information technologies ranging from personal computers and spreadsheets to business computing and inter-organizational systems such as electronic data interchange (Iacovou et al., 1995). A body of research devoted specifically to IS adoption and implementation has developed (Swanson, 1994), using this literature as a base. It is fair to say that research on technological innovation, particularly on the adoption and diffusion of innovations, has become the dominant approach to adoption, implementation, and use issues in IS research.

While undeniably popular and useful, this traditional approach to innovation adoption and diffusion has well-understood limitations that have been identified by innovation researchers themselves (Rogers, 1995; Wolfe, 1994;).

III. Models of Technological Innovation

The early innovation models were the linear models of innovation. These simplistic models were replaced by the interactive model of technology push and market pull and later, by the value build up model by Jolly (1997). The models of innovation can be classified using, iteration in and adoption of the innovation, as the classifying variable. Iterative models look at the interactions of the people involved in the innovation process whereas adoptive models examine the feedback after the innovation has been adopted (Drazin and Schoonhoven, 1996). Innovation is viewed as an outcome of numerous organizational iterations in the technology push-market pull model and the value build up model. Two kinds of adaptive models are discussed in literature: static and dynamic models, based on feedback after the innovation diffusion. In static models there is no feedback after the user has adopted the innovation,

which is not the case with dynamic models of innovation. Chiesa et al. (1988) provides an excellent review of articles related to the technological innovation – more than 100 articles have been examined. Literature also indicates the demolition of the linear model of innovation (Freeman, 1996).

The interest in the technological innovation process still continues in response to capitalize the tremendous opportunities offered by new technologies. It is now also well acknowledged that the process of technological innovation is a complex process and many actors hold a role in it (Afuah, 1998). The presence of the various actors and champions is a necessary condition for innovative output but not sufficient enough. Questions of organizational integration, environment assessment and the development of technological capabilities are crucial to the process.

IV. Financial Performance

Performance is the outcome of all of the organization's operations and strategies (Wheelen and Hunger, 2002). Measuring financial performance accurately is critical for accounting purposes and remains a central concern for most organizations. Performance measurement systems provide the foundation to develop strategic plans, assess an organization's completion of objectives, and remunerate managers (Ittner and Larcker, 1998). Although assessment of performance in the marketing literature is still very important, it is also complicated (Pont and Shaw, 2003). While consensual measurement of performance promotes scholarly investigations and can clarify managerial decisions, marketers have not been able to find clear, current and reliable measures of performance on which marketing merit could be judged. Two approaches have been adopted in the literature to measure financial performance. Longer term performance has been chosen for two reasons: firstly because that is what the customers of "retail" products such as unit trusts might be expected to be looking at, particularly in view of the charging arrangements which make shorter term investment unwise. Secondly, one of the attractions of looking at "real" products rather than theoretical studies is the question of how administrative costs contribute to the results. In principle, such costs might appear in either front-end, or regular annual management charges.

Financial performance is essential to the survival of firms in the competitive and uncertain environment. Management is eager to learn how the effort of service quality improvement is related to an organization's performance (Sousa and Voss, 2002). Financial performance ultimately reflects whether or not service quality is realized in a firm. Financial performance is conceptualized as the extent to which a firm increases sales, profits, and return on equity. These are indicators of financial performance and manifest the wellbeing of a firm collectively (Barnett and Salomon, 2006).

Traditionally, the financial performance of firms has been measured using a combination of conventional accounting measures and risk and return measures. Further analysis of financial performance has used methodologies such as financial ratio analysis, benchmarking, measuring performance against budget or a combination of these. Financial statements published commonly include a variety of financial ratios designed to give an indication of the institution's performance.

As with any method of analysis designed to measure business performance, there are limitations and imperfections associated with the use of financial ratios, particularly the use of very few ratios in isolation (Goh, 2003). Hence this paper endeavors to bring together several performance measures, financial ratios, and linear programming techniques and investigate the interplay

between them rather than focusing on any individual measure in isolation.

Simply stated, much of the current firms' performance literature describes the objective of most firms as that of earning acceptable returns and minimizing the risks taken to earn this return (Pont and Shaw, 2003). There is a generally accepted relationship between risk and return, that is, the higher the risk the higher the expected return. Therefore, traditional measures of firm's performance have measured both risks and returns (Swanson, 1994).

V. Technological Innovation and Financial Performance

Technology is one of the key elements that define a society or civilization. The critical role of technological innovation in the development of a company and its contribution on the economic growth of firms has been widely documented. Ayres (2008) identified technology as the wealth of companies. According to Abernathy and Utterback, (2005) the primary role of technological innovation is to assure the survival of the entity, as well as the business ecosystem, which in turn is based on achieving sustainable financial performance.

Gerstenfield and Wortzel (2007) analyzed the relationship between the usage of Internet-based innovation technologies, different types of innovation, and financial performance at the firm level. Data for the empirical investigation originated from a sample of 7,302 European enterprises. The empirical results show that Internet-based innovation technologies were an important enabler of innovation in the year 2003. It was found that all studied types of innovation, including Internet-enabled and non-Internet-enabled product or technological innovations, are positively associated with turnover and employment growth. Finally, it was found that innovative activity is most of the time associated with higher profitability.

According to Adam and Farber, (2000), in the organizational context, technological innovation may be linked to performance and growth through improvements in efficiency, productivity, quality, competitive positioning and market share, among others. They also found that technological innovation is positively related with performance. During the last few decades, developing countries (DCs) have strived to be successful in the process of technology development. For technological development purposes, it is necessary to develop the four inter-related components of technology named human ware, orgaware, inforware and technoware at the same time and in parallel. However, most of researches on technology development process in DCs have focused on sequential analysis as acquisition, absorption and diffusion of technology. This sequential approach assumes that all technology innovations occur in the same way in all companies and does not distinguish between the kinds of technologies as products and processes, each of which may follow a different path (Abernathy and Utterback, 2005). Further, technology development process in relation to the in-firm characteristics as well as extra-firm's situation is much more complex and dynamic. Historical evidence shows that DCs were pioneer in innovation. United Nations (1991) reckons that there have been three distinct epochs in the technological innovation of DCs.

Regarding the importance of technological innovation, there is a huge body of knowledge. Technological innovation is a means of survival and growth of industrial sectors or technological innovation is recognized as a major contributor of economic growth and a dominant factor of business success not only in developed countries but also in developing countries (Pack and

Westphal, 2006; Wilkinson, 2003). Gerstenfield and Wortzel (2007) suggested that one of the requirements for economic and industrial development of DCs is their ability to innovate successfully. According to Tefler (2002), a company must innovate or die, the process of innovation is fundamental to a healthy and viable organization. Those who do not innovate ultimately fail. Hill and Utterback (2009) identified technological innovation as a major agent of development and change in societies which has been linked to rising productivity, employment growth and a strong position in export markets, trade and improved quality of life. However, the inherent complexity of the process of technological innovation and its involvement in interaction with different environmental as well as industry-specific factors, made studies of the characteristics of technological innovation seem difficult to carry out. However, Lall (1980) stressed that a significant amount of technological innovation is taking place in the modern sectors of developing countries, particularly in those with relatively long experience of manufacturing and with broad-based capital good sectors. To Lall, these innovations include changes in broad sense. They encompass increase in productivity and efficiency from simple learning by doing, advances in the designing, constructing and managing complex and advanced industrial processes and a manifestation of the ability to innovate technologies in the areas of medium to high.

VI. Approaches to Technological Innovation

The social shaping of technology approach investigates how organizational, political, economic, and cultural issues shape the process of technological change (Williams and Edge, 1996). In this tradition, social groups with particular visions, interests, and interpretations of reality form complex networks of practice which create and sustain socio-technical systems (Bijker and Law, 1992). This approach takes particular issue with the pro-innovation bias of traditional innovation studies, arguing that technological success has to be explained rather than assumed. It also considers technology to be flexible and open to reinvention during key periods.

The economics of technological innovation approach studies the role of technological change in economic growth and efficiency (Rosenberg, 1994). This literature is interested in challenging and expanding economic theory to include a better account of the technological change process. It is very much concerned with population-level dynamics and the economic consequences of innovation.

The technology and business strategy approach focuses on how technological change influences the structure of industries, and the success of businesses (Utterback, 1994). In this literature, technological change cycles between periods of radical and routine innovation, as companies struggle to position themselves relative to the dominant technological designs that emerge through a complex interaction of strategic intent, technological advance, and regulation.

Finally, the literature on technology and organizational structure studies how technological change influences the structural aspects of organizations, such as hierarchy and formalization (Brown and Eisenhardt, 1997). This approach also contributes to an understanding of the consequences of innovation.

VII. Technological Innovation Process

The literature is developing arguments about the technological innovation process that challenge traditional adoption and diffusion theory. While it would be naive to suggest that one

set of assumptions about innovation is “right” or “wrong” for all possible research projects, enough work has been done to suggest that the traditional approach to innovation research should not automatically be seen as the source of correct assumptions. Other claims about the technological innovation process are worth explicitly considering, particularly for IS research. Three of the more significant claims are described below:

Han, (2001) indicates that some innovations are built on existing products, services, or procedures, and are incremental in nature. Others involve greater degrees of difference and are more radical than incremental. Some innovators aim to be first, others aim for second place. He adds that a different dimension of innovations is the degree to which they imitate something already familiar.

The middle portion of the framework, creativity and ideas management, selection and portfolio management and implementation management, comprises the processes necessary for carrying out or developing an innovation. The process used in carrying out an innovation task requires an understanding of how firms manage the process of developing new products and services. Development includes the process of generating, selecting, and transforming ideas into commercially viable products and services (Barnett and Salomon, 2006). Several studies suggest that firms with high performance in innovation usually have a formal process for developing new products and services.

This formal process includes creativity and ideas management, selection and portfolio management and implementation management. Creativity and ideas management is the stimulation of ideas addressing customer requirements. The scope of ideas should be wide and all employees should be involved and ideas from customers cultivated. Selection and portfolio management provides an efficient means to select from the many ideas generated and choose the best ideas for implementation (Barnett and Salomon, 2006). Implementation is the fundamental capability to turn new ideas. The Human resource management element of the framework deals mainly with people and organization climate issues: the underlying impetus of innovation management is the need to create an environment where employees are motivated to contribute to innovation. An effective human resource policy that supports innovation and encourages the development of an innovative organization is needed. Von Stamm, (2003) suggest that firms should focus on norms that support creativity and implementation in order to build an innovative culture. Rewarding employees for their innovation effort is one way to build an innovative culture. Studies have confirmed that the type of reward mechanisms that best practice firms offer to their employees have been based on financial and non-financial rewards.

Technological innovation is fundamentally competitive and conflictual. Management researchers, sociologists, and economists all agree that, despite the need for cooperation in technology development and diffusion, technological innovation fundamentally takes place within a competitive and conflictual atmosphere. For the social shaping of technology theorists, different social groups are inevitably involved in technological innovation (Bijker, 1992), each with their own interpretation of what the technology is, and what problem it is trying to solve. For technological innovation to happen, networks of interest groups must be attracted into a new technological system, and their commitment to it preserved (Bijker and Law, 1992). For the economists of innovation, technological innovations compete for scarce resources and have uncertain returns (Rosenberg, 1994). Within the firm, each stage of the innovation process – expressing the idea, exploring the feasibility, building prototypes – can be

seen as a separate hurdle where a number of ideas are in fierce competition with each other (Jolly, 1997). Between firms, the rapidity of technological innovation puts organizations under severe pressure to innovate effectively (Brown and Eisenhardt, 1997) and to maneuver strategically within their industries to establish commercially lucrative positions for themselves in the face of technological change (Utterback, 1994).

Technological innovation is underdetermined – there is no single “best solution”. To state that technological innovation is underdetermined is to say that “technical principles are insufficient by themselves to determine design” (Feenberg, 1995). The research traditions mentioned above subscribe to the view that the “natural attributes” of technology are not sufficient to explain technological innovation, though they differ in the importance they attach to this belief. For the social shaping of technology theorists, the belief that technological innovation does not unfold according to some predetermined technical logic is critical (Williams and Edge, 1996). The particular path that technological innovation takes is something to be explained, rather than simply adjusted to. Studies of the management of innovation, and innovation adoption, acknowledge that the seemingly “best” technology does not always become the most widely accepted (Utterback, 1994). While the economists of innovation believe that technological “trajectories” make some innovation paths more likely than others (Dosi, 2005), the complex interplay between technological supply and market demand cannot be captured strictly with reference to the characteristics of technology. Even in the literature on technology and organization structure, which has argued for the strongest links between the nature of technology and organizational forms, there is a recognition that technological change serves as an occasion for restructuring (Barley, 1990), and the same technology can occasion quite different organizational outcomes.

Technological innovation cycles between periods of stability and change. A wide range of technological innovation research suggests that the innovation process fluctuates between periods of relative stability and periods of relative change. Research on innovation and business strategy in particular has argued that the nature of innovation changes over time. Periods of more incremental innovation, in which technology appears to develop along well understood paths, are then abruptly followed by periods of more radical innovation, in which the certainties of the past era are abandoned (Utterback, 1994; Tushman and Rosenkopf, 2002). Eventually, a radical innovation becomes more widely accepted, and settles back into relatively well understood incremental innovation. The economists of innovation refer to waves of change, in which the nature of technological innovation changes over the “lifecycle” of a technology (Freeman, 1990). The social shaping of technology theorists see the “firming up” of technology – the process of stabilizing interpretations and relationships around a technology – as one of the key processes to be explained (Bijker et al., 2007). While technology can become more “closed” over time for the social shaping theorists, the contingency of social life ultimately works to reopen previous controversies and pursue new opportunities. Each of these three claims offers an alternative starting point for the investigation of information systems as technological innovation.

The process of technological innovation at the firm level depends upon a number of inter-related factors which range across all sections of a firm and is strongly influenced by the interplay of many components in the firm’s external environment. In this respect, the major focus of this study was to analyse the influence of various factors on cultivating technological innovative activities

within manufacturing firms. Boland, (2007) model shows how technological innovation behaviour is influenced by three elements: the firm-specific characteristics, its external technology-based relationships and its environment including the impact of national and international factors.

VIII. Firm-specific Characteristics

This refers to the most important determinants that explicitly influence the firm’s technological innovation behavior. These are a combination of factors including firm’s Contextual Variables (CVs), Managerial and Employment Structures, Organizational Structure (OS), Technological Infrastructure and Staff-Skill Development (TI.&SSD). The firm’s contextual Variables, here, refer to its ownership structure, size, production location, age, experience and its industrial sector (Mansfield, 2001; Andriessen, 2001).

The adoption and diffusion approach to technological innovation has many attractive features for IS research. Adoption is conceived as a social change process, in which an innovation is communicated over time among members of a social system (Rogers, 1995). While accounting for the nature of social systems and social relationships, this theory focuses on perceived attributes of a technology, such as relative advantage, compatibility, and complexity (Moore and Benbasat, 1992). This approach has created a cumulative research tradition that allows us to place IS research in the context of other technology-based social changes.

The adoption and diffusion approach to technological innovation has well-understood limitations, however, that have been identified by innovation researchers themselves. Some of these limitations are methodological, and have to do with defining technology characteristics that allow cross-study comparisons (Wolfe, 1994), the difficulties of recalling past adoption decisions accurately (e.g. Rogers, 1995), and the related inconsistency of previous research findings (Wolfe, 1994).

The more important limitations for IS research, though, are the conceptual assumptions imposed by the theories themselves. One extremely important assumption of this kind is the pro-innovation bias of adoption and diffusion research (Rogers, 1995). The adoption and diffusion approach has a strong bias towards assuming that a technological innovation is positive, and will be adopted by a target population over time. This bias tends to lay the “blame” of poor adoption on adopting individuals and organizations, rather than on systems or situations, and does little to help IS research understand the crucial problem of trying to learn which innovations will be beneficial, and which will not. Another fundamental limitation is the lack of attention to community- and population-level dynamics (Drazin and Schoonhoven, 1996). The adoption and diffusion approach is poorly equipped to understand how different groups interact in the production and provision of innovation, including the influence of consumers on producers. Other limitations have been identified with respect to the relative lack of attention to the adaptation and reinvention of innovations by users, and to the relative neglect of the consequences of adoption and diffusion, again stemming from the original conceptualization of fixed, unchanging innovations being diffused from producers to adopters. These limitations are potentially worrying for IS research, which must cope with a technology that has blind alleys as well as glittering successes, where the industry dynamics are extremely complex, where the technology is flexible and reconfigurable, and where the consequences of adoption are both important and uncertain.

IX. Firm's Potential Sourcing and Networking

This refers to its networking configuration. This network consists of firm's technological relationships including technological collaborations (TC), technology transfer (TT) relationships and technical feedback (TF), with other firms, institutes, organizations, customers and agents (Kelly and Brooks, 2008; Mansfield, 2001).

Literature continually advocates that evaluation is a necessary process to establish whether innovation has been effective in meeting individual and organizational priorities. This enables judgments to be made, about cost effectiveness and to aid organizational learning and improvement. Despite innovation absorbing real and substantial costs, and considering Culkin and Smith (2000) conclusion that the clarity of organizational objectives in terms of innovation has led to an increased emphasis on the evaluation of return on investment, Ekvall, (1999) observes that systematic evaluation rarely occurs within organizations. Making causal connections between investment in innovation, and future management performance and organization success is externally difficult. Francis (2000) highlights the difficulty in establishing a statistical link between the incidence of innovation and company performance. Similarly, Tidd, Bessant and Pavitt (2001), found that the literature tends to focus heavily on training and education, and is primarily concerned with measuring the inputs, process and immediate outcomes rather than the longer-term impact of innovation.

Firm's environmental condition points to the factors, which indirectly influence technological innovation process of the industrial sector. In this research, the effects of government policies and the role of financial systems as initiatives for cultivating innovative activities are explored (Adam and Farber, 2000; Nelson, 1995).

X. Conclusion

The available literature shows that there exist a strong relationship between technological innovations and performance of firms. As noted by Ayres (2008) technology affects the wealth of companies. Use of various aspects of technological innovations is thus expected to have great effects on the performance of firms. There is, however, need to investigate the specific effects of these technological innovations with a specific reference to firms. This is due to the research gap that exists as no study has been done to investigate the effects of technological innovations on performance of firms despite the firms' strategic positioning to adopt technological innovations. The available literature provided insights on how different technological innovations are adopted in different contexts. Due to contextual, sector, and managerial differences among the organizations, issues of technological effects on performance gained from these studies may not be assumed to explain effects of technological innovations the on Performance of firms in Kenya.

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