

INVESTMENTS IN TECHNOLOGICAL INNOVATIONS: A LITERATURE REVIEW OF ORGANIZATION DETERMINANTS

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Abstract

The study of a complex phenomenon such as innovation requires different levels of interdisciplinary analysis. Assuming that the enterprise is the fundamental agent of economic change, this paper aims to analyse the literature in the field of technological innovation and determinants that stimulate organizations to engage in innovative process. The technological innovation is an instrumental factor in creating new forms of value in such a competitive environment as the current economic, social and politic world is. It favours the creation of new products which are accepted and sold worldwide, with a competitive price and quality. The technological innovation should be supported both by the public and the business enterprise expenditure. Results of the innovative process depend not only on product or process obtained, but also of its efficient management. Companies' managers should cultivate a pro-innovation attitude inside also in their relations with the outside world and to stimulate employees and collaborators by offering various incentives and create a favourable environment for shaping innovative ideas which on longer or shorter term could bring financial and / or competition benefits.

Keywords: Technological innovation, determinants, innovation process, innovation

Introduction

The evolution of human society is the result of technological innovation. Without major achievements, recorded over time in this regard, the economic and social progress would not have been possible. Innovative process is continuous, making its study to be always a topical subject on both theoretical and practical levels. Term innovation has been used in literature to describe both the process that uses new knowledge, technologies and the processes to generate new products as well as new or improved products themselves (Porter, 1990). Innovation is essential to the individual level and for organizations, countries and globally. The evolution of information and communication technologies, also a result of technological innovation, favours results dissemination speed increase of the innovative process from the geographical perspective. The organisations motivations to get involved by engaging investments in this process are varied and are studied in this paper.

The paper is organised as follow: In the next section are presented the innovation concepts and technological innovation, including their classification in different approaches, as treated in the literature. Than main determinants of technological innovation have been identified and presented. They are the result of empirical studies and purely theoretical approaches drawn from the literature, considered representative for the purpose of this paper by the author. For the study, we identified 165 papers in the field of technological innovation, of which 63 were selected because they relate to its determinants. Of these, 41 were excluded and remained 22 considered relevant, that examines the determinants of technological

innovation in general, without customize on specific areas of innovation. Their corresponding approaches are presented in the third section of the paper. In the final section, the conclusion and implications of the study are laid out.

Innovation concept

The innovation concept has experienced different approaches since the recognition of its importance by Schumpeter in 1934. All studies have recognized the role of entrepreneurs *who assume the risk of turning a new idea, an invention or a scientific principle into a commercially viable result* (Jessua, Labrousse, Vitry, 2006, p. 438). In the literature, innovation at the organizational level include besides invention + its exploitation, initially proposed, also the development and implementation of the invention (Miller, Miller, Dismukes, 2005-2006, pp. 63-69). The conceptual framework for data collection on innovation defines the innovation as the implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD and Eurostat, 2005, p. 46). This definition addresses two important aspects: (1) the “innovation” process comprises the technological development of an invention combined with the market entry of that invention to end-users through adoption and diffusion, and (2) the innovation process is iterative in nature and thus, automatically includes the first introduction of an improved innovation (Garcia, Calantone, 2002, pp. 110–132). At the macroeconomic level, the Green Paper considers innovation synonymous with the production, assimilation and exploitation of successful new solutions for the economic and social problems, addressing individual and society needs (European Commission, 1995, p. 1) and leads to transformations in global economy sectors (Jolly, 2008, p. 30). Innovation represents the enterprises source of strength and energy, all of them start from an innovative initiative, at least comparing with their competitors, and for surviving and development reasons need constant innovation (European Commission, 1995, p.10). Innovation involves anticipating market requirements, offering quality and subsidiary services, efficient organization and knowledge, technological progress becomes, from this perspective, insufficient to ensure success.

Technological innovation represents the creativity implementation which gives rise to inventions. These concepts are found in different stages of the innovative process comprising the following steps: generate ideas, the development of the product or service and it’s trading. All three steps involve investments in general. These fall into the offensive strategic investments and aim to keep the organization at the technological vanguard in its area of interest and to increase market share from traditional managerial approaches and also fall into investments corresponding to bets on the future characterized by high risk and through which companies realize projects in similar areas with their competition, but at different cadences (as geography, processes, products) (Pârnu, 2003, pp. 20-21). Regarding the classification of innovation, the literature offers different viewpoints. Among the most prominent types of innovation that have been described in the literature belong to the authors Marquis (1969) and Henderson and Clark (1990). Marquis proposes the following classification of innovations:

- *Radical innovation* – ideas that have impact on or cause significant changes in the whole industry;
- *Incremental innovation* – small ideas that have importance in terms of improving products, processes, and services;
- *System innovation* – ideas that require several resources and many labour-years to accomplish. Communication networks and satellite operations are good examples.

Henderson and Clark define types of innovation as:

- *Incremental innovation* – refines and extends as established design, but underlying concepts, and links between them, remain the same;

- *Architectural innovation* – involve the reconfiguration of an established system to link together existing components in a new way;
- *Modular innovation* – that changes a core design concept, without changing the product’s architecture or primary function;
- *Radical innovation* – establishes a new dominant design and hence a new set of core design concepts, embodied in components that are linked together in a new architecture.

Other authors have used other classification criteria and have identified the following types of innovations: administrative and technical (Damanpour, Evan, 1984, pp. 329-403), open and closed (Cândida and Ramos, 2011, pp. 2099 -2110), emerging, adopted and enforced (King, Andersen, 1992, p. 142).

Determinants of investments in technological innovations

Potential motivations inciting a company to engage into the innovative process are varied *from the benefits of obtaining a temporary monopoly positions that will bring an additional potential profit until obtaining long term property rights which will offer protection against potential imitators*. Achieving a dominant position is an important determinant of investment in innovation, popularized by Schumpeter as *creative destruction* (O’Sullivan, Sheffrin, Perez, 2008, p. 177). This is encouraged by government organizations by granting patents to encourage innovation and protect the rights of innovator. Finally, from the point of view of the investor, financial results are essential. They are given by the relationship between the three “e”:

$$Efficiency(e) = \frac{Effect(e)}{Effort(e)}$$

Another important determinant of technological innovation is represented by the readiness to allocate funds for research and development at both public sector level, but mostly for companies.

In the context of technological and economic evolution, innovation has become a collective process. It is hard to imagine it at the individual level, especially because of financial and human resources and infrastructure requirements. Recent acceptance of innovation, promoted by Nelson and Winter (1982) assimilates it, in many cases, to a learning process with the following characteristics: *is located and partly tacit, with features irreversible and in dependency relation to the chosen trajectory and differs by activity areas*. Innovation becomes a complex process involving mostly intangible, non-formalized and non-transferable resources. It has as determinants competition, size of dominant enterprises, nature of industrial research and development. (Jessua, Labrousse, Vitry, 2006, p. 439)

Cabagnols and Le Bas (2011, pp. 112-149) believe the main determinants of technological innovation are: (1) company addressed demand characteristics (price elasticity, level, evolution, homogeneity, etc.), (2) the entrepreneur ability to anticipate making a profit through innovation, (3) sources of technological knowledge (from consumers, users, etc.), (4) company characteristics, (5) the pursued strategy (towards quality, marketing, etc.).

Innovation requires investment both material and immaterial which proved to be very important for the growth and competitiveness of the company, because if it is not maintained in a dynamic process, the intangible asset will depreciate (Jessua, Labrousse, Vitry, 2006, p. 450). The capacity to focus on successful innovations is a merit of the enterprise management. According to a study conducted in 2006, attended by 1070 directors from companies with different areas of activity from 63 countries, 48% of them were not satisfied with the results obtained from investments in innovation invoking the following reasons (Andrew, Sirkin, 2011, p. 4):

1. “We have made exaggerated estimates of the benefits the new product could bring.”
2. “We have not established a satisfactory level of performance, covering both directing and delaying of the financial factors.”
3. “We follow too many things simultaneously and we cannot execute them all.”
4. “We do not have the right people or the right capacity.”
5. “Our market rhythm is too slow.”
6. “Our sales employees focus on our traditional business.”
7. “Senior managers do not finance new products because they find them too risky.”
8. “Innovation is not a priority for the Board.”
9. “We have a bottleneck in our way of thinking.”

From the previous affirmations, we may identify the following determinants of the technological innovation: *management vision and willingness of involving in the innovative process* (3, 4, 6, 7, 8, 9), *financial results* (1, 2) and *market position* (5, 6).

In close connection with management's vision and desire to be involved in the development of innovations is its *willingness to assume the inherent risk associated with them*. Innovations fall into investment projects with very high degree of risk and uncertainty. They are based on new technology solutions, by constructions offered by scientific research, untested in practice aiming to launch new products, the results of which are usually uncertain (Pârnu, 2003, p. 22). At market level, this is reflected in the *potential loss arising from adverse changes in market prices of financial assets, including interest rates, foreign exchange rates, equity prices, and commodity prices, which reflect currently the most advanced method for risk measurement* (Batlin, Schachter, 2000). In the same category, of risk taking, we consider *forecasts on economic development* an important determinant of engagement companies in the investment process especially when it comes to technological innovation. In a stable political and economic environment, the desire and willingness of companies to financially support innovation are superior to the situations where there are significant fluctuations as evident from charts provided by World Economic Forum (Schwab, Sala-i-Martin, 2011, p. 22) and INSEAD (Dutta, 2012, p.8). First achieved a ranking of countries according to their competitiveness, in which one of the analysed pillars is *innovation*. According to this component, the top of most innovative countries consists of: (1) Switzerland, (2) Sweden, (3) Finland, (4) Japan, (5) USA, (6) Israel, (7) Germany, (8) Singapore, (9) Taiwan, China and (10) Denmark. Innovation evaluation was made based on the following components: *innovation capacity, quality of scientific research institutions, investments made by companies in research and development, collaboration between universities and industry in research and development, government procurement of products incorporating advanced technology, availability of scientists and engineers, utility models granted / 1 million inhabitants*.

In another ranking, conducted by INSTEAD, the first two places are occupied also by Switzerland and Sweden, followed by (3) Singapore (4) Hong Kong, (5) Finland, (6) Denmark, (7) USA, (8) Canada, (9) Netherlands, (10) United Kingdom. Global innovation index is calculated, in this case, as an average between the inputs providing favourable environment to innovation and outputs measuring actual achievements. In the first category have been included in the following sub-indicators: *institutions, human and research capital, infrastructure, market sophistication, business sophistication*, and the second category includes *scientific results and outputs with creative character*.

There are some differences between the two rankings, as can be seen, justified by the use of different indicators. But countries that dominate innovation are about the same in both statistics, some of larger group of countries considered stable economically and politically.

In another approach, targeting exclusively information and communication technologies (ICT) the following determinants are considered significant: *economic structure* (sectoral composition of the economy), *human capital*, *additional spending on technology and environmental regulations* (Guerrieri, Luciani, Meliciani, 2010, p. 393).

If we consider the benefits targeted by companies through involvement in innovation, determinants of innovations and investments related to their implementation identified by White and Burton (2007, p. 93) are:

- increase control over processes and results;
- increase level of understanding the technologies and the procedure of applying them;
- increase ability to develop next generation technologies;
- increase potential profit due to temporary monopoly.

Empirical studies conducted in developed countries have identified the involvement of companies in technological innovation determinants that influence the willingness to allocate financial resources on the following levels of analysis: companies, industries and national system (Tabelul 1.2).

Table 1.2 Determinants of investment in technological innovation by analysis levels

Analysis level	Determinant	Observations
Company level	Dimension	Probability of investing in innovative activities increases proportionally with the company size. (Cohen and Klepper, 1996, pp. 925-951)
	Diversity	Companies whose business is diversified, through areas of interest, assumes more easily the risks of being involved in innovation projects. (Baldwin, Hanel, Sabourin, p. 120)
	Absorption capacity	The ability to recognize the value of new information and to assimilate them and their implementation for commercial purposes favourably influences innovation. (Veugelers, 1997, pp. 303-315)
	Age	Companies that employ young people are more prone to technological innovation because the related changes are easily accepted.
	Owners affiliation: local or foreign	In most countries, foreign companies operate activities with higher proportion of innovations compared with local companies, and the difference is inversely proportional to the technological level of the host country. (Molero, 2001, pp. 305-341)
Sectoral level	Demand	There is a favourable relationship and directly proportional between demand and innovation. (Schmookler, 1962)
	Technological opportunities	Access to technology favourably influence involvement in the innovative process. (Baldwin, Hanel, Sabourin, p. 10)
	Concurrency level	Innovation is stimulated in highly competitive markets. (De Mel, McKenzie, Woodruff, 2009, p. 11-12)
	Environmental factors governing an innovator's ability to benefit from the profits generated by an innovation.	The existence of a legal framework through which property rights are protected and ensure optimal conditions for innovators to benefit from their work is an important determinant and an incentive to engage in the innovative process. This is reflected in the use of patents, market secrets and other innovator related rights. (Baldwin, Hanel, Sabourin, p. 20)
At the national innovation system	Environment	Economically and politically favourable and stable conditions favour innovation.
	Public support	Public sector plays an important role for involvement in

Analysis level	Determinant	Observations
		innovative projects, by providing a legal environment and financing projects. It turned out that valuable innovation is given by the private sector involvement, the public sector having only intended to provide the general beneficial framework.
	Cooperation	Collaboration between firms and between firms and institutions is considered a critical aspect to successful innovation. (Albornoz, F., Milesi, D. and Yoguel, G. in Milesi, Petelski, 2011, p. 6)

Investments in innovation are, by excellence, the qualitative development investment, depending on magnitude, can cause according to Druker's view (1993, p. 56), major changes in global economic level: *innovation triggers changes in the production structure which, in turn, leads to changes in the structure of demand for goods and services, and these, in turn, triggers changes in market structure in the sense the appearance of new markets for the new products.*

The existence of financial resources, but also the willingness to allocate them to research and development activities and also the native intelligence or educational attainment of each country / region is defining other determinants of technological innovation and between them exist explicit and implicit dependencies. Involvement of the state is not enough in this case, as shown by statistical studies the most innovative countries are those where the private sector invests more than public sector. The results of research and development, which will be reflected in further innovations, can lead to *cost savings* reflected primarily by reducing the amount of resources used. This represents another important determinant of the innovation known as the *innovation induction*.

Conclusion

This paper has reviewed existing articles which examined determinants of technological innovation in organisations. In the relationship investment - technological innovation we find that investments play an important role in promoting technological progress, representing the primary means of exploitation of research results, their transmission from the theoretical area to the applied one through dissemination to consumers. They also have an important role in eliminating or easing restrictions on natural resources and classic production factors, from the perspective of those intended for innovation in the breeding of natural resources, in increasing production capacity of new types of energy and unconventional materials. Companies use investments to respond favourably to environment, regulations and technological developments, for progress assimilation and exploitation of business opportunities.

Based on literature review the author identified the most important factors that determine the management companies to be actively involved in the development of technological innovations. From the perspective of those presented in this paper, we consider financial motivations the most important, whether manifested by obtaining direct and indirect gains, resulting in the improvement of market position, competitive advantages etc. In the same time, innovation capacity is conditioned by economic and political environment in which the company operates organizational culture and social context and the financial resources available.

The present study has limitations. Complete coverage of all the articles in the field may not been achieved. Also, analysing distinct determinants of technological innovation on each field of activity is sometimes necessary due to their specific issues.

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