

# Effects of Technological Innovation on Knowledge Acquisition Inside the Organization: A Case Study

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**Abstract:** This paper examines the effect(s) of technological innovation in companies' key relationships on knowledge acquisition and knowledge exploitation. We propose, building on and contributing to the existing views of knowledge-based theories, that knowledge acquisition stimulates firms' activities, transforming internal processes and creating competitive advantage. It presents the main premises of a conceptual model for understanding the processes and the impacts of knowledge transfer, acquisition and dissemination inside the organization. This is demonstrated within a case study approach, which explores the successful introduction of technological change within an enterprise setting. The case study is conducted in a high-technology company, on the technology information sector, based in Portugal. The results indicate that technological innovation seems to be associated with indirect effects on knowledge generated in companies and increased network connections, which, in turn, are associated with increased knowledge-based innovation. Knowledge acquisition, in turn, is positively associated with knowledge exploitation for competitive advantage through new product development and technological uniqueness. The study explores the impact of the introduction of an innovation, under the aegis of a government innovation stimulus programme, and its ensuing impacts on the firm's trajectory of technological change. The study is particularly interested in the so called indirect impacts of innovation, especially on the effects on knowledge acquisition and its exploitation. Knowledge is an intangible asset and its dynamics are difficult to evaluate. The paper intends to contribute to the development of a new assessment approach, based on the consideration of appropriate indicators and variables collected through the case studies. The impacts of innovation go beyond the introduction of tangible products or processes, but methodologies for the evaluation of those (indirect) impacts are scarce. However, assessment of these impacts is fundamental to fully apprehend the consequences of innovation and technological change, and, as a consequence, to improve the decision processes regarding the design and implementation of projects or programs that stimulate innovation.

**Keywords:** knowledge-based economy; absorptive capacity; evaluate programs; SME

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## 1. Evaluation of programs – introduction

The evaluation has been necessary in the social and economic development. The experience and knowledge acquired is fundamental for planning, to take decisions about continuity, to make possible adjustments or even to cancel the project and/or the program. It also justifies to society in general the financial and human resources investment.

The assessment allows the systematization of knowledge for a policy decision on processes, through economic, social and scientific instruments, in order to identify the direct and indirect impacts, predictable and unpredictable policies already completed, existing or planned, as perceived by the various actors. This is the point that should be consolidated and should converge to a single evaluation system for the purpose of respond and contribute to society justification about the efficiency and effectiveness of these programs.

In countries or regions where there is not a consolidated assessment culture, it is natural that the idea remains regarding supervision and inspection. The evaluation is sometimes identified as a mere set of monitoring procedures, both physical, checking implementation of the planned actions, such as financial, to check the costs and funding provided. In both cases a narrow view prevails of what was or not done, or what should or not have been done.

The term evaluation in practice seems still to have a negative role in the traditional functions of supervision and inspection. Some authors emphasize that Portugal is among the countries that adopt this position to make assessments with a role of monitoring the programs/projects, and functional contributions to meet the achievement of the goals demanded by the European Union (Mourato; 2007).

However, some Portuguese firms have been given relevance to innovation as a driver of growth and differentiation. In the same segment, the Portuguese government has adopted policies to encourage,

increasingly, organizations to innovate (Navarro e Dinis; 2005), to achieve the goal of reproducing a new motivation to innovation, facilitating the adaptation of the productive sector to the challenges of globalization through the diffusion, adaptation and use of new processes and forms of organizing “new” products and services. The Government has supported the start-ups’ innovation and high-technology, through new lines of encouragement in the National Strategic Reference Framework (NSRF), to provide a greater interaction between the business, science and technology system (Mateus, 2008).

In this sense, the program aims to encourage companies to innovate. The Portuguese Government reinforces the importance of evaluation in order to encourage the promotion of innovation in the country. Through their findings, the assessment can bring clarity regarding what were the difficulties, identifying the stronger and weaker areas, and the sectors deserving more investment.

Since the Lisbon Agenda in 2000, the evaluation approach began to receive a greater emphasis, especially by policy makers who have to reveal the evaluation results. As a consequence, it resulted in new assessment tools and new qualitative and participatory approaches, and an emphasis on institutionalization of evaluation.

This paper analyzes the indirect impact considered as knowledge acquisition through the implementation of the NITEC (Research and Technological Development Nuclei in Companies), in a company working in the information technology sector. The structure of the paper is the following: in the first sections a literature review is made, and in the following sections the development of the process of implementation of NITEC in a specific company is presented. Subsequent sections report the description of the study and its results, and present the main conclusions, limitations and questions for future research.

## **2. Knowledge economy**

The intangible factors have assumed an increasingly importance for the analysis of economic development, having been included in various approaches to intangible assets, when previously it was only considered capital, labour and technological change (in its component material) as the only contributors for economic development. This transition to a new state, characterized by greater integration of knowledge in order to reconcile means to assess impacts of economic competitiveness, and the quality of life associated with it, is called knowledge-based economy.

The relevance of this issue was increased since the nineties, when the OECD re-launched the concept that was already being discussed by scientists in the field of social sciences. This concept aimed to enshrine the idea that the most advanced economies were progressing to a new level of development. It was this process that provoked a greater interest in the mechanisms of interaction between universities and industry (Stewart and Ruckdeschel; 1998).

The development of high value-added activities requires the existence of skilled human resources, as well as a body of accumulated knowledge, much of it present and produced in universities. Europe was an example, which, by modifying the structure of the framework programs for research and technological development, realized the importance of capturing the relevance of a set of elements of the production, accumulation and dissemination of knowledge, presenting estimates of intangible investment, to win a new stage of economic development (Godinho; 2007).

In this context, it occurred an expansion of higher education and greater pressure to improve the performance of public universities to increase the skill levels of staff and emergent sources of financing investment projects in R&D. The increase and qualification of human resources in R&D activities were essential to the development of the Science & Technology system, which involved a continuous and increased investment in intellectual capital.

Consequently, new indicators of Science & Technology, innovation and knowledge were developed, proposing new forms of statistics to measure the effort devoted to investment. The OECD has contributed with some norms, through the *Frascati Manual* and more recently, through the *Oslo Manual*, for the construction of methodologies to establish rules for statistical evaluations.

It is difficult to follow the transformative processes of innovation, the market and knowledge, especially informal learning activities, such as tacit knowledge, which the companies consider relevant sources of knowledge.

In this case, the knowledge economy reinforces the interest in economic analysis, since it was essential to improve the opportunities for innovation. For the OECD, the knowledge-based economy is referential to define policies of member countries, but also for the formulation of statistics, since it derives from the understanding of knowledge networks and their relationships with the more traditional economic analysis, and the operation of the National Innovation System (Lundvall; 2005).

It is important to understand that the National Innovation System is not an economic theory in the sense that neoclassical or evolutionary economics is, but the concept integrates theoretical and practical perspectives based on decades of research (Lundvall; 2005). The system involves several skills, such as suppliers, customers, research and educational institutes and policymakers, who must be articulated. The quality of this interaction is important for evaluating its results.

To understand the various implicit aspects in the concept of National Innovation System, new publications and new statistical indicators were developed. The remarkable factor in this new configuration is the population and the investment in higher education in the sciences and engineering, but also the interest in comparing indicators of Science & Technology and Innovation across countries.

The latter is one of the components of the learning cycle which is of high importance for national companies, since most of existing knowledge is tacit and resides in each one of its employees. However, it is important to differentiate tacit knowledge from explicit knowledge. The former refers to a set of values difficult to describe due to its subjective nature, since it belongs to the individual's innate abilities. The second is visible and is an integral part of the organization, and can be easily applied.

European policy has evolved, especially after the Lisbon Agenda, where the role of social and human capital was discussed, the importance of the information society and the knowledge-based economy aiming to achieve greater competitiveness.

### **3. Absorptive capacity**

There is an inter-organizational knowledge flowing in a way that companies do not materialize automatically. This is called absorptive capacity, i.e. the ability to assimilate and replicate innovative new knowledge from external sources. To understand and use it, it is necessary to develop skills for the use or exploitation of sources external to the company.

The concept of absorptive capacity was first proposed by (Cohen & Levinthal; 1990), as one of the assumptions for effective learning, and reflects the ability that the organization has to absorb the endogenous knowledge from abroad. According to the authors, this ability is associated with two factors: the company's knowledge base and the intensity of effort.

The intensity of effort is a measure of the energy expended by the organization for solving problems. It is not enough just to put up a set of external knowledge available to the firm. There must be adequate incentives for absorb this knowledge and use it to solve concrete problems.

The existence of a strong knowledge base in the enterprise is a necessary condition for the absorption of new knowledge, since it is through the existing knowledge that the company can understand, assimilate and utilize new forms of knowledge (Bojica and Fuentes; 2012).

The evaluation aims to check, on the one hand, the knowledge that the company has on its base of technological knowledge, which is one of the pillars of absorptive capacity, and on the other hand, to assess the degree of codification of knowledge in the company, through formalized knowledge that the company has in the resources invested on their technology (Cohen and Levinthal; 1990).

These activities generate new information; they also increase the ability of firms to assimilate and exploit existing knowledge, or improve their absorptive capacity and learning. The absorptive capacity includes the ability to imitate new products and processes, and the possibility to exploit external knowledge, the results of basic research that underpin applied research and development. In this sense, it is justified to carry out R&D activities within the industry (Cohen and Levinthal; 1990).

The level of absorption capacity of the company will determine the actual extent of transfer. To check the level of absorptive capacity of a firm, the literature uses the indicators of investment in R & D, number of researchers (Masters and PhDs), number of patents, the existence of partnerships with research institutes and universities (Mangematin and Nesta; 1999).

The benefits of knowledge acquisition will depend on the amount of knowledge to be assimilated and the ease with which acquisition may occur. Therefore our study focuses on the acquisition of knowledge after the NITEC programme was concluded. The NITEC was an initiative of the Portuguese 3rd Framework Programme supported by the European Union.

#### **4. Methodology proposal**

In order to achieve the proposed goals of this research, it was first made a brief theoretical review, which supported the development of the methodology, and on its turn it will also be based on the results of some case studies. This paper presents briefly the results obtained during a pilot study in a medium-sized enterprise, in the information technology sector. The data was collected in November 2012, carrying out an interview to the Head Manager of Innovation of the enterprise.

The criterion followed to select this enterprise was due to its participation in NITEC. This programme was conceived to address a key problem in the National Innovation System (NIS) in Portugal: the low level of in-house technology and innovation capabilities in Portuguese firms. The NITEC programme supported the implementation within the firm of a permanent team, with a maximum of three workers, fully dedicated to technology internalization and development activities, according to a project-based action plan. Those activities lead to the design of new products, processes and/or systems, or to the introduction of significant improvements in some other already existing products.

On the other hand, this specific programme was selected because of its features: 1. the funds are governmental; 2) promotes activities related to R&D; 3) the people involved are expert in the working and research area; 4) the project-base has a limited period of time (maximum five years); 5) each company has its own project. These features are essential to identify the knowledge acquisition in the firms which participated in the programme, as a main topic being evaluated in the results.

The scope of this work does not include the results of quantitative research, once it has not been completed yet. At this stage it is only considered as a partial implementation, through the application of interviews, which have been considered during the pilot project as part of a doctoral research.

The method used in this research consisted of semi-structured interviews using an interview guide. This guide was elaborated to capture the impacts of NITEC programme. The guide follows the variables listed below: 1. Network capacity in R&D; 2. Business affairs; 3. Organizational capacity; 4. Exchange capacity; 5. Capacity building in science and technology; 6. Human resources and capacity building.

#### **5. Results**

The pilot study was made on a medium sized firm, in the TI sector, which had as motivation, and through the NITEC program, the implementation of a research unit with dedicated resources in exclusivity to R&D tasks. This R&D unit or nuclei was dimensioned to work with a team of three elements (analysts/programmers), and for which it was designed an activity plan for a minimal time of three years.

This plan consisted in a series of activities involving experimentation of the latest technologies, which were launched in the areas on which the company operates, namely those related to next generations of operative systems and the architecture oriented to services of data processing mobile devices (pocket PC, smart phones, tablets PC), and future evolutions of development environments.

The activity of this nucleus focused also on the conception of a multilanguage platform to support future products of the firm, following its plan of internationalization. This kind of activity aimed to keep always alive the process of technological watch, which maintains the innovative character of the presented solutions and it represents one of the firm's most important competitive advantages.

This nuclei participated on important activities at the end of the innovation process, namely in product development, allowing to incorporate the new systems inside the development process and, consequently, in the developed products. The segmentation of these activities and the empowerment of this unit filtered the pressure of the market, focusing their attention on R&D activities and allowing for more long range planning of the products.

Before the implementation of NITEC the enterprise was dealing with situations where many people were producing different documents for the same product, the same information was produced by many different areas within the organization. This situation caused the repetition of the same task with different information about the same subject. For instances, the technician working in the enterprise spent too much time answering to the same problem coming from different workers, sometimes in the same enterprise. After the implementation of the NITEC the team working in the programme were aware of the importance of standardizing the information. Thus some descriptive documents were made to describe the activity of each unit or department. It was also elaborated a set of new tools to optimize the access to the information about the services in the working area of the enterprise. These initiatives lead to an efficient way of managing and organising internally the enterprise, as well as externally improving customer satisfaction. This new policy based on the NITEC's implementation brought up "Innovation News Technology".

*"The NITEC programme has allowed to create a research and development team and has launched the basis to the creation of a development framework, which will support the new generation of software produced by the firm, in the next years. The first new products based on this framework are during this year being produced (2012), then they will be launched to the market as new versions of brand new products in 2013, based on these tools." (Head Manager in Innovation)*

At this stage the company does not have the original expert team from NITEC working, but meanwhile a technology innovation and research department was created to substitute the NITEC team. But it is important to highlight that the innovation dynamics, as NITEC involved multiple feedback routes between processes, functions and people both internal and external to the firm, where not only by technological advances and market forces but also by users and consumers.

The relationship with external sources are particularly important for accessing tacit knowledge, the knowledge that is not codified in documents and that embodies know-how, skills and expertise. Tacit knowledge is not only important for its own sake but it is often an essential supplement to codified knowledge.

It is important to emphasize that knowledge and innovation capabilities are cumulative, building and growing over time and internal business R&D, while not universal, increases a firm's absorptive capacity (Cohen and Levinthal; 1990). Firm's that do R&D internally are therefore also better equipped than others to make use of external knowledge.

## **6. Discussion**

Taking into consideration that the project is a pilot project, the goal was to obtain information from the company about the indirect impacts due to NITEC's implementation. The applied methodology was just a starting point for the construction of a methodology which has been structured, and that it will indicate some ways that can be explored, since it aims to consider the absorption of knowledge, translated in codified results, but also those with a more tacit nature, in order to contribute for the understanding of the transformation process in economic terms. The economic impacts were not possible to be evaluated at this stage.

According to the authors (Cohen, Daniel and Levinthal, 1989), the idea of codifying knowledge and investing it by commercializing, was a result observed in the case study. Thus, the company in question initiated a successful internationalization process due to the transformation of tacit knowledge in codified knowledge that leads to commercialized technology.

In addition, the identification and diffusion of “best practices” in partnership is a very important element, once it reflects acquired knowledge. This process has the potential to shorten the aggregated learning cycles, by transferring successful experiences, methods, and tools between partnerships.

Building on the NITEC programme design lesson, the intention is to improve the way that mechanisms and funds for search activities are built, when new partnerships initiatives are designed. Indeed, it has been possible to identify a set of best practices that appear to influence outcomes from NITEC’S partnerships (Shapira, 2001).

This programme has resulted in several positive external effects, such as the increase of employees, reinforcement of clusters, increased expenditure with R&D, development of new products. Therefore some other companies are investing time and money in this kind of programme because of its successful results.

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