

Effectiveness of Research & Development Capabilities and Organizational Creativity as Factors to Technological Innovation and Firm Performance success

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Abstract:

This study examines the relationships between Research & Development and Organizational Creativity as factors to Technological Innovation and Business Performance success and sheds light on the Technological Innovation concept through the creative idea adoption and R&D intensity, as the results of an interactive process between the two main issues. From the perspective of R&D enhancement to technological innovation opportunities successful control, both the R&D expenditure and the creative thinking process are explored in this paper, together with an analysis of the organizational success factors. Real Creative idea Antecedents, and Constraints, Technological innovation measurement and the creative idea interaction with the R&D activities; The economic concept of innovation, creativity and Knowledge acquisition and cooperation are defined and discussed in this paper.

Keywords: R&D; Creativity; Technological Innovation; Performance.

Résumé :

Cet article examine la relation entre la recherche et développement et la créativité organisationnelle comme facteurs du succès de l'innovation technologique et de la performance, et de jeter la lumière sur le concept de de l'innovation technologique à travers l'adoption d'idées créatives, comme résultat d'un processus interactif entre les deux principaux déterminants. Du point de vue de l'amélioration de la R&D pour un contrôle réussi des opportunités d'innovation technologique, le processus de l'innovation ainsi que le processus de la pensée créative sont explorés dans cet article, avec une analyse des facteurs de succès organisationnel. Les Antécédents de l'idée créative et ses contraintes, la mesure de l'innovation technologique et l'interaction de la pensée créative avec les activités de la R&D. Les concepts économiques d'innovation, créativité, acquisition de connaissances et de la coopération sont également définis et discutée dans cet article.

Mots-clés : R&D, Créativité, Innovation Technologique, Performance

I. Introduction:

By the end of the last century, economic organizations were based only on the production scale and classic social relations, when globalization forced businesses to survive the volatility of competitiveness in new economic basics. It was time to organizational innovation to begin with creative thinking that started changing the business managerial thoughts, by the implementation of new business models, or new manufacturing process, and by introducing new products, or services to the emerging markets. The objective was to catch-up quick developments happening all around the firm in the surrounding business environment especially with the technological advancements and change. That leads to implement new business strategies driven by innovation and research & development, which generated new ideas, and developing that new idea beyond its initial state. Starting by a traditional psychological approach to creativity, that focuses on the main characteristics of creative individuals (Barron, 1955; MacKinnon, 1965)¹. The chances of an organization to survive and to be successful are very dependent on its capability to innovate (Heunks, 1998)². Technological innovation is one of the main determinants of economic durable development, and we have to face that some of its most crucial aspects is still to know, and an exhaustive quantification of all dimensions of innovation activity is still unknown.

Creativity is one of the most challenging activities in the new business world and in the new global economy (Gaynor, 2002)³ which, despite a multitude of scientific theories beside published literatures, but remains unknown and attracts economics interest and thoughts, often difficult to be defined in a single paragraph; Modern organizations are facing a variety of internal and external constraints that on the surface seem to be a serious threat to their ability to create and innovate. The chances firms to prosper and to be more successful are becoming ever more dependent on their engagement in innovation. Not only product or service innovation is important to maintain the targeted market share, but also process innovation to produce below the standard price level at low cost, and social innovation to stay a long time in activity and to maintain sustainable competitive advantages and a durable organization. In several cases the new endeavor shows that the profits and growth. Did not really absorb company resources. However, in fact the company should grow faster for a long period of time and get profit from its development investment. If it is not the case then and not at a much higher earning, rate then the innovation is a complete failure (Drucker 2002)⁴.

The problem is that in the literature, firm performance and success is always related with accounting results and measured by the financial quantitative outcome, but can this success be measured by the input and not only the outcome, which means that we can consider the R&D capabilities and organizational creativity and technological innovation as measurement tools to a successful technological innovation and a better firm performance. Hence. How can a firm gain effectiveness from its R&D capabilities and Creativity to enhance its Technological Innovation and Performance?

2. Theoretical Framework and Hypothesis Development

2.1.R&D Capabilities

R&D has a crucial role, not only for companies but also for a country's economic growth and sustainable development by increasing competitiveness and social wellbeing. R&D knowledge is an important invisible asset of the firm. It has been argued that strategic control of such invisible assets is more difficult in a decentralized setting (Steele, 1989)⁵.

Researchers found that firms that devote more effort to both basic and applied research are mostly known for their higher levels of patenting than other firms. (Peeters and de la Potterie, 2006)⁶.

2.1.1. Definition of Research and Development

The OECD defines Research and Development as “creative work undertaken on a systematic basis in order to increase the stock of knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.” While the National Science Board (NSB) classifies and defines research as: (Science and Engineering Indicators, 2008)⁷:

Basic Research: Basic research also known as fundamental research has as its objective “a more complete knowledge or understanding of the subject under study, without specific applications in mind.” considering industrial objectives. “It is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view”⁸.

Applied Research: Applied research is directed toward gaining “knowledge or understanding to determine the means by which a specific, recognized need may be met.” In industry, applied research includes investigations directed “to discovering new scientific knowledge that has specific commercial objectives with respect to products, processes, or services.”

Development: Development is the “systematic use of the knowledge or understanding gained from research, directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes.”⁹

2.1.2. Globalization of R&D

Intense global competition has necessitated that contemporary businesses search for knowledge and capabilities beyond their home markets. As such firms have emphasized the internationalization of their research and development (R&D) activities (Criscuolo, 2009; Davis & Meyer, 2004; Dunning & Lundan, 2009)¹⁰.

The R&D spending continues to expand on a global basis, worldwide spending and performance, in 2006 R&D spending exceeded one trillion dollars, and continues to expand at a substantially higher rate than most countries' inflation rates. R&D growth continues in all geographical regions as well. (The Global R&D Report, 2008)¹¹.

Since transnational corporations (TNCs) are playing a major role in global R&D¹², several studies have examined foreign direct R&D investment (Dunning & Narula, 1995) the literature suggests that foreign direct R&D investment is a relatively small component of overall scientific and technical activities¹³. Multinational enterprises have established an increasing number of R&D laboratories in offshore locations¹⁴. Most existing researches, still investigate the globalization of R&D at the functional level, by analysing location decisions and integration mechanisms for geographically dispersed R&D laboratories, it is a traditional view of R&D globalization. Reliable and accountable R&D system measurement has been in place for long time in OECD member countries, the data cover a long period nearly twenty five years (OECD, 1981-2005)¹⁵ and revealed data on R&D expenditure, shows that it is consistent in performance and support or in the distribution of resources among the financing or performing sectors and industries. Large multinational organizations are having difficulty in keeping pace with the rude 'R&D race' especially in the global economy, in term of financing from private sources extremely high ratios of R&D. Most large firms were emphasizing corporate restructuring, business process redesign and cost efficiency and this has resulted in severe restrictions for R&D investment and innovation and led to the help of joint venture collaboration, and has resulted in business-unit oriented models (Roussel et al., 1991; Gerybadze et al., 1997)¹⁶.

2.1.3. R&D Categories

Several studies have categorized R&D activities by indicators, to provide a better focus on these activities in the organisation. In order to provide functional and understandable measurement for various research activities advances

- Research: directed to the development of fundamental knowledge.
- Exploratory development: directed to the development of new techniques, methodologies, and criteria.
- Advanced development: concerned with design, development, and hardware (material) items for experimentation.
- Engineering development: directed to testing and demonstration of new techniques or methodologies, and to technical systems equipment
- Management and support: directed to the support of installations for their operations and maintenance and for the procurement of special purpose equipment.

2.1.4. Research Partnerships and Cooperative R&Ds

R&D activities are often unstructured and intangible (Clark, 1987) and require a lot of peers communication (Allen, 1977)¹⁷. Such communication becomes difficult if it has to be organized over thousands of kilometres of distance. The modern business environment is more than ever forcing businesses to build strong and durable technical alliances, where competitor cooperation have to coexist with rivalry, The cooperative R&D analysis is based on relevant economic literature, which has indicated a set of potential benefits from cooperative R&D. the Potential benefits to participating organizations in these cooperatives generally include:¹⁸

- R&D cost sharing and Access of new R&D resources and skills;
- Risk and uncertainty reduction;
- R&D duplication reduction and internalization spillover;
- Continuity of R&D effort and access to finance;
- strategic flexibility, easy market access and creating investment and boosting research synergies;
- Effective deployment of extant resources, and development of resource base;

- Technical standards promotion and market power; coopt competition;
- Research institution oriented to private sector interests.

In addition to that, an important socioeconomic growth assistance, which is the creation of social benefits, that accrue to non-cooperating organizations and the rest of society due to cooperative R&D. the social benefits are in general the result of the following elements:¹⁹ like Knowledge spreading to non-participants; More efficient establishment of technology standards; Industrial competitiveness Increase; Competition levels increase and Favorable changes in investment behavior;

2.1.5. Knowledge Acquisition from R&D Cooperation

A critical innovation factor is knowledge (Hjalager, 2010)²⁰, R&D has long been considered the primary producer of new knowledge, both scientific and technological knowledge and sector-specific knowledge.

The R&D cooperation is important for knowledge acquisition and training methods, R&D is often used as an evaluation criterion for innovation process input, as result of many empirical researches and theoretical in business administration field. Such researches of R&D cooperation essentially aims at understanding the role of the cooperation in the organizational success. Many theoretical papers in this field trying to explain this cooperation strategy (Kaiser 2002) (De Bondt 1996) and (Aspremont & Jacquemin 1988)²¹.

Hypothesis (1a): R&D intensity positively influences Technological Innovation

Hypothesis (1b): R&D intensity positively influences Firm Performance

2.2. Organizational Creativity

Various aspects of creativity written by experts in several recent published books and journals especially the recent publication discussing the creativity concept by a cognitive perspective such as the books of (Tschmuck, 2012; Weisberg, 2006; David, Mowery & Nelsons, 2005; ternberg, 1999; Runco, 1997; and Shavinina, 2003) that summarized the study of creativity thinking.

2.2.1. Definition of Creativity

Peat defines creativity as “a free-flowing play of the mind in which new ideas constantly surface and interact with each other. Ideas are like patterns in a kaleidoscope which move and transform until some new pattern swings into perception²².” Britannica Encyclopaedia defines creativity as “the ability to produce something new through imaginative skill, whether a new solution to a problem, a new method or device, or a new artistic object or form²³”.

Creativity is an important issue in management research (Shalley et al., 2004)²⁴, and until now, the definition of organizations' creativity is not as simple to be defined. because creativity is complex and multifaceted in nature, there is no single, universally accepted definition. (Treffinger, 1996)²⁵.

Organizations' creativity is a function of creativity of individuals working together as group members or team within a company following a high organized and structured set of rules, conducted by the organization strategy and a precise goal (Griffin, Sawyer, and Woodman, 1993)²⁶. They give the definition of organizational creativity as “the creation of a valuable, useful new product, service, idea,

procedure, or process by individual working together in a complex social system". While (Amabile, 1988, 1996)²⁷ defined Creativity as the production of solutions or ideas that are new and useful. She said "It refers to both the process of idea generation or problem solving and the actual idea or solution" (Amabile et al., 2005)²⁸.

Creativity within the firm is "the creation of useful and valuable new product, service, idea, procedure or process by individuals working within a complex social organization". (Woodman, 1995)²⁹. There are generally three main types of creativity which are: individual creativity, teamwork creativity and the most important is the organizational creativity.

We have to consider that there is luck in this issue, so Organizational Creativity calls for more theories and researches on organizational creativity in groups rather than examining individuals. The empirical study conducted by Anderson & West in 1996, which concluded that the clearer an organization goal was, the higher individuals creativity level achieved. Then, leaders give the necessary intellectual and emotional stimulation to their subordinates (Tang, Chen, & Li, 2009). Therefore, it is clear here the role of the leader and the strategic planning.

2.2.2. Creative Thinking as a Process

Creativity is convergent, important, critical and thought, there has been variety of theories concerning creativity as a method or a process, it was a challenge matter to specialists within the field to cross-fertilize ideas and give insights into the new concept of creativity. The creative attitude requires the ability to be puzzled and the capacity and flexibility to concentrate (E. Fromm, 1959). Allen Hurlburt (1981)³⁰ thinks that creative people absorbed in finding solution and new ideas to solve problems, are generally influenced by a wide range of personality and characteristics accumulated their level of awareness. Graham Wallas, author of one of the first classic studies the creativity, outlined the creative process in four major steps:

- Preparation: is to detect the problem and collect data,
- Incubation: to stay far away from the problem and wait for new ideas,
- Illumination: a new solution or idea emerges, sometimes unexpectedly,
- Verification: the new idea or solution is examined or tested.

2.2.3. Determinants of the Organizational Creativity

Amabile (1997)³¹ has illustrated the interdependence between organizational innovation and individual creativity, While Sawyer, Woodman and Griffin (1993) have demonstrated that there is a strong relationship between organizational, teamwork and individual aspects of the creativity. Peters thinks that there is a survival strategy for both individuals and the organization that lead to organizational creativity and forge it by addressing what he called the 5 Ps; projectisation, professionalism, provocation, partnership and performance (Peters, 1997)³². However, the most spread literature that explains the concept of organizational creativity is by reviewing the literature review given by Andreopoulos that highlights five major organizational determinants that enhance creativity (Andreopoulos, 2001)³³. The five major organizational factors are: Organizational climate; Leadership style; Organizational culture; Resources and skills; and the Structure and system of an organization.

There is several publication and studies discussing the positive correlation between r&d activities and a organizations' innovative performance. (Cameron, 2000) research concluded that there is a positive impact of R&D intensity on the factor productivity growth, but this impact varies significantly

in its effect from an area to other, and depending on the nature of industry. (Kafouros, 2005) studies concluded to the same result and described a positive direct effects of R&D on the factor productivity growth, though the effect depends on the size of the firm, the higher the size is, the bigger the effect. Although the positive effects of R&D activities on innovative performance is clear and accepted by all, but the impact of the deferent R&D activities does not have the same effect level on innovative performance.

2.2.4. Antecedents of the Creative Idea

Creativity is an important issue in management research (Shalley et al., 2004)³⁴, and the quality of human life is greatly influenced by the creative contributions of certain individuals (Albert, 1983)³⁵. When studying examples of a phenomenon that are often seen in the creative thinking cases that are discussed in literatures: Creative ideas, even the completely new case studies, are firmly planted on those ideas that came before the creative thinking process. It is clear that there are antecedents to that creative idea. However, the reason why it always seems that the idea comes out of nothing is because when we see it we do ignore the knowledge base of the individual - the source of that the new idea. If we know the individual knowledge base, then we can tell where the new creative idea antecedents. It is the case of Albert Einstein's creative thinking that epitomized most people's idea of genius, about the knowledge based creative thinking "If at first, the idea is not absurd, then there is no hope for it" (Albert Einstein).

This phenomenon should be emphasized, because we will face it every time, in every case and in every field we study, some observers do not see the specific examples as being genuine creative ideas, and assume that we have to look for the real creative thinking that generates new ideas elsewhere. because, they conclude that Picasso drawings were not a creative work some, or that creative people were not creative. While some people conclude that to demonstrate creative idea antecedents, means that there is no such thing as creativity itself, saying that everyone is just taking ideas from other people and nothing in that is a new³⁶.

The creative individual is someone who frequently solves problems (Gardner, 1993)³⁷. Creative thinking designates a special class of activities (Newell, Simon and Shaw, 1959)³⁸ and to be creative in problem solving must satisfy one or more of the criteria such as: The output and result of the thinking is new and valuable; The idea is unique and original and it requires adjustment of previous accepted thoughts; The thinking requires high inspiration and determination, occurring either over a an extensive traverse of time, ceaselessly, discontinuously or at high level; and the issue as at first postured was vague and not well defined, so that one of the solution results is to define the issue it self.

When describing and comparing the relationship between the creative thinking process and the problem solving, the creative thinking process would just meet all the above listed criteria to different levels, but it is hard to find more specific characteristics to separate the real creative thinking process from non-creative one.

2.2.5. Creative work environment dimensions

Factors that affect individual adoption of innovation are multiple, and employees' adoption of innovation is driven by their social environment³⁹. There are few scholars' attempts to assess quantitatively the work environment for creativity, although there are some psychometrically instruments that assess perceptions of organizational environments, such as The (OAI) Organization Assessment Instrument by (Van de Ven & Ferry, 1980) providing a reliable comprehensive assessment

of the functions, design, and structures within the organization (Van de Ven & Drazin, 1985). Before that another measurement tool called The (WES) Work Environment Scale by (Moos & Insel, 1975), they tried an assessment of workers' perceptions of many broad dimensions of the workplace environment. Nevertheless, none of these measurement instruments focuses on the real organizational environment for creativity.⁴⁰

Later another psychometric instrument designed for creative organizational environment assessment was first proposed by (Ekvall, Arvonen, & Lindblad, 1983), based on the (SSSI) Siegel Scale of Support of Innovation (Siegel & Kaemmerer, 1978) which assesses the leadership and ownership perceptions, diversity norms, consistency and continuous development. (Dul & Ceylan, 2010)⁴¹ developed an instrument, which is a checklist for analyzing the creativity support of the work environment the (CDQS) Creativity Development Quick Scan.

People's creativity can be affected by various attributes including individual personality (Amabile, 1996)⁴². "All innovation begins with creative idea" Teresa M. Amabile (1996)⁴³, designed an assessment tool for organizational environment for creativity called [KEYS] in the form of questionnaire, stating from a traditional psychological approach to creativity, she argued that Successful organization depends on developing the idea of person or a team beyond its initial state. Her Conceptual Model for Assessment of Perceptions of the Work Environment for Creativity is based on five categories:

- 1) Encouragement of Creativity: This kind of Encouragement includes three perception levels, The social-organisational context can be described at three levels, the level of the entire organisation such as the culture, human resources management, and the organization policy, and the team level like the team composition, and at individual level, like the complexity and hardness of the tasks, autonomy, supervisory support (Shalley & Gilson, 2004).⁴⁴, however, Amabile (1996)⁴⁵ stated the three levels as: Organizational encouragement: At this level of perception, the aspects perceived are purely psychologic with regarding to individual beliefs about the value of their generated ideas, it is considered as an important source of motivation: encouragement of risk taking and of idea generation; fair, supportive evaluation of new ideas; reward and recognition of creativity; and the collaborative idea flow.
 - Work group encouragement: The diversity in teamwork or group itself can be an encouragement to the group like the background, knowledge level, ideas challenge and mutual openness (Payne, 1990).
 - Supervisory encouragement: Many approaches in economic, business and psychologic literatures discussed the role that plays the managers and supervisors in the creative thinking process: the clarity of objectives; open interactions between supervisor and subordinate; supervisory support of a team.
- 2) Freedom or Autonomy: Several empirical studies concluded that the autonomy of individuals or groups conducts to increase the sense of responsibly, self-control and ownership among the team work, and this researches also revealed that individuals produce more creative work when perceiving themselves to have choice in doing their task (Amabile & Gitomer, 1984).⁴⁶
- 3) Resources: Resources and skills are the basic tools an organization has at its disposal to complete its business⁴⁷. Resource allocation is primordial to creative projects,
- 4) Pressures: Time is the most valuable element in scientific researches, and pressure was always associated with creativity in R&D activities, excessive workload pressure would undermine creativity.
- 5) Organizational Barriers to Creativity: Kimberley (1981)⁴⁸ mentioned that internal strife, conservatism, and rigid, formal management structures will have a negative influence on creativity.

Hypothesis (2a): there is a positive effect of Creative Idea Adoption on Technological Innovation

Hypothesis (2b): there is a positive effect of creative idea adoption on Firm Performance

2.3. Technological Innovation

A short investigation of economic history, will demonstrate that industrial technological innovation and advancement has led to substantial economic advantages for the innovating firms. Therefore, the industrial revolution of the last century was pushed by technological innovations that have likewise been a consistent part in the advance of human social orders⁴⁹.

2.3.1. Definition of Technological Innovation

Josef Schumpeter (1912) was the first to introduce the concept of innovation to economic theory. Then Chamberlin (1933) defined the strategic dimension of innovation by initializing a new model that expanded the perfect model of competitiveness by incorporating the notion of product differentiation. Due to the complexity of understanding the context of the concept of innovation many literatures suggested a definition of Innovation, it is defined as 'the successful implementation of a creation' (Heunks & Roos, 1992)⁵⁰. This innovation seems to foster growth, profits and success (Hyvärinen, 1990). We define success of a firm as 'any sign of economic profitability, like growth, increasing productivity and profits'.

The economic concept of innovation was firstly identified by Schumpeter. According to him, innovation is "the discovery of technical improvement or new sources" (Schumpeter, 2000).⁵¹ Drucker identified innovation as "a change that creates a new aspect in productivity" (Drucker 2002) and "It is the act that endows resources with a new capacity to create wealth"⁵². Discussing the Paradigm of innovation, "Innovation is an art. Innovation cannot be learnt. Innovation has no system, or basic principles. Only gifted people can create. (Hitcher, 2006)⁵³, concluded in the end of his book that the old paradigm has no validity. Because "Innovation is a science and it is reproducible at will". One definition of the term "Technological innovation" by (Jason Vaughan, 2013) when we divide the original Latin term 'innovare' into three dimensions, so making something new is to do the following⁵⁴:

- Generating or realizing a new idea "invention" or "creativity"
- Developing that specific idea into a real new product or new service "realization"
- Implementing into the market that new product or service "implementation"

When 'making something new' refers to the replacement of the old product with a new product, and continuously updating and improving it. Then introducing the technology into the innovation, to make what we call 'Technological Innovation', the following changes to the above occur⁵⁵:

- Generating or realizing a new idea, using technology, capability or knowledge "Invention"
- Developing that new idea into a new product "realization"
- Diffusing and implementing this new idea into the market, using technology, capability or knowledge "implementation"

Many definitions of the concept of technological innovation in literature can only refer to one of the three main concepts Implementation, realization or Invention.

2.3.2. The Five Generations Of Technological Innovation

Rothwell (1994) mentioned that there are five main generations of innovation behavior, explaining the evolution of innovation through an analysis of economic theory, industrial and technological change and advances, and organizational behavior response to new economic development and evolution.⁵⁶

- 1) First generation: based on the industrial revolution. The production facilities and new technologically advanced products.
- 2) Second generation: focusing on the market and customer, the focus was on the customer needs and responding by production technology, where marketing was a pivot in new ideas generating
- 3) Third generation: by combining the first-generation and second-generation models of innovation. Let customer expresses the new needs, and then production technology refined them. Alternate with new ideas developed by R&D then refined with marketing feedback.
- 4) Fourth generation: in this innovation model, R&D activity and marketing were oriented to lead the customer and building strong and durable links with the supplier.
- 5) Fifth generation: seen as a systems integration and networking model, managed by expert systems, building strategic partnership with customers and suppliers, and collaborative marketing focusing on the quality.

2.3.3. Sources of Innovation

Innovation is a crucial process for the wellbeing of an organisation. In the pursuit of it, organizations face strategic choices on the focus of resources. One method of categorizing the strategic options is on the basis of product-market analysis (Ansoff & McDonnell, 1987)⁵⁷. The literature framework of using new tools to measure the developed over the last century is defined by "the death of the innovation's linear model" (Rosenberg, 1994). That notion of linear model is gone, place now to the fact that innovation activity is becoming an interactive process in its different phases, opportunities perception and technological change sources are interdependent and not hierarchically structured. Thus, in the past all the attention was attached to the Research & development activity, seen as the main innovation source, in the new economy the focus has changed gradually to the importance given to other more important and easier innovation sources.⁵⁸

The Seven Sources for Innovative Opportunity by Drucker in his paper (The Discipline of Innovation - 2002)⁵⁹ concluded that Innovation can spring from a flash of genius – means creativity- But most innovations, especially the successful ones, result from a conscious, purposeful search for innovation opportunities, which are found only in a few situations. Four such areas of opportunity exist within a company or industry like an unexpected occurrences, incongruities, process needs, and industry and market changes. Other additional sources of opportunity to innovate exist outside the company in its surrounding social and intellectual environment such as demographic changes, changes in perception, and new knowledge. Drucker's Sources of innovation are:

- The inside Sources: like Unexpected Occurrences; Incongruities; Process Needs like the adaptation of a new method; and Industry and Market Changes: when a newcomer challenges the company by changing the market.
- The outside sources: such as Demographic Changes; Changes in Perception: is about the way of thinking "The glass is half full or is half empty"⁶⁰ ; New Knowledge: innovation.

2.3.4. Forms and Categories of Technological Innovation

The work of Arthur D. Little from the Stanford Research Institute (RSI) led to elaborate specific technological matrixes to determine companies' strategic positioning, based on criteria such as the differentiating potential of technology and the degree of technology control, according to him technological life cycle and products life cycle are similar, Arthur D. Little distinguish three types of technologies: Basic technologies: mastered by most companies, Key technologies: based on the distinctive skills of certain companies.; and Emerging technologies: new, rare and generally protected by patents.

In the Schumpeterian linear model of innovation, J. Schumpeter (1911) distinguished five main categories of innovation, a new product, a new market opportunity, new source of raw materials, new production method, creating a new market opportunity and a new organizational method. The definition of innovation clearly reflects that innovation is not just a product or process innovation (Bloch, 2007)⁶¹. The OECD (Oslo Manual - 2005) suggests a recent description; ⁶²that defines four types of innovation which are:

- 1) **Innovation of product:** "the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics." (Oslo Manual -OECD, 2005, p. 48);⁶³
- 2) **Innovation of process:** implementation of a new or significantly improved product or delivery method. Here, improvements indicate changes in technical, equipment or software.
- 3) **Innovation of marketing:** the implementation of a new and significantly improved marketing method in product design or packaging, the product layout, the promotion of a product or the pricing of a product.
- 4) **Organizational innovation:** it is the implementation of new organizational methods by firms for operational implementation, business implementation or external relations.⁶⁴

Rothwell (1992)⁶⁵ suggests, industrial innovation does not include only major (radical), but also minor (incremental) technological advances. In addition, it implies that the successful commercialization of technology involves considerably more than just technological change activities.

2.3.5. Factors of Technological innovation

Organizations need to provide facilitating conditions, which include the extent and type of support provided to individuals that would influence their use of innovation. Organization will not innovate unless some underlying factors are working correctly, (Mark Sebell & Jay Terwilliger, 2011) think there are some Critical Innovation Success Factors⁶⁶ which are about the compelling case for the innovation, with an inspiring, same vision and a fully aligned strategy of innovation with a clear innovation program that involves the top management by a decision-making that fosters teamwork in support of passionate creators and innovators and creatively resourced by a multi-functional dedicated team work which are open-minded and exploration of the marketplace drivers of innovation, and a willingness to risk taking and value sights in absurdity, to a well-defined and flexible execution of the process.

Souder and Rubenstein (1976)⁶⁷ discussed in detail the innovation decision and its complexity. There are several levels of factors affecting the decision-making process in technological innovations. The categories of factors in their model are⁶⁸:

- 1) Factors related to the enviro-system of which the organization is a part, such as market conditions, economic conditions, legal environment, available technology;
- 2) Factors related to perceived inducements for innovative activities, such as perceived market needs, perceived urgency for a product/process, perceived opportunities for innovations;
- 3) Factors characterizing the firm, such as its technological capabilities, its communication system, its risk propensity, its organizational climate;
- 4) Factors related to the policy subsystem, such as investment policy, project selection criteria, and prior experience with other innovations.

2.3.6. Innovation activities measurement

The use of appropriate methodologies, measurement instruments and tools must lead to a satisfactory analysis. Beside other economic variables such as production, benefit, investment, growth, added value and durable development), the measurement of innovation variables are not easy to deal with. Because the concept and nature of innovation is very complex and complicated to understand, it is nonlinear and heterogenic. Especially the aspects that makes measuring of technology and innovative activities more difficult than other aspects:⁶⁹

- 1) Technological knowledge is in some cases formal and in other a tacit knowledge. Only a small part of Technological knowledge, can be registered by patents and designs, in the major cases this knowledge is tacit, and cannot be measured.
- 2) The Sources of innovative activity can be internal or external to the organization. Generally, the innovations generated by the organization are based on the both types of innovative sources alternatively or combined.
- 3) Some innovative activities are clearly recognized, by its prices or costs, while other technological activities happen outside the formal market place.
- 4) Technological change may be perceptible in economic term through new invention introduced directly to the market, or may be imperceptible like generating new ideas, and innovations.

one problem is that the innovation activities measured indicators are not yet completely capable of describing and predicting the real significant statistics numbers, however, it can be much easier, if appropriate methodologies, measurement instruments and tools are used properly, they may satisfy the study and analysis criteria, to be more tangible and significant, and that contributes in the development of growth. As with many measurements, in quantitative methods like accounting or finance, there is no perfect measurement tool to do so. Then comes Bruce Tether, a Professor of Innovation Management and Strategy at Manchester Business School in the United Kingdom, who suggests that the most widely accepted method to tell if there is a real success of innovation is to consider a new product or services market share across a period of three years from its introduction to the market.

2.4. Interaction between R&D Intensity and Creative Ideas Adoption

Creative Ideas Adoption is also likely to enhance the impact of R&D Intensity on firm's technological innovation and performance. Although the R&D Intensity gives important access to new knowledge and ideas, its effect on firm's technological innovation and performance may depend on how the this organization can adopt such new knowledge and ideas. There is a broad consensus that innovation relies on availability of skills, on a high degree of economic openness, R&D inputs, supportive business environment and policies that nurture creativity (Furman et al., 2002)⁷⁰. New ideas are difficult to adopt by managers because of its complication but it is much easier to accept since it is coming from R&D Researchers whom are directly involved in R & D activities and are known as

“professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and in the management of the projects concerned”⁷¹.

A firm may be able to adopt some new creative ideas and manage new knowledge, but the problem is to know if it will enhance its technological innovation and performance. When a firm does not adopt and manage new knowledge and new ideas. It can not enhance its R&D activities, so it needs more Creative Ideas Adoption to benefit from knowledge. A Firm on a new R&D project can access new knowledge from other companies in the same field of knowledge. and R&D Intensity will have a positive effect on the firm's product innovation and profitability if it has high Creative Ideas Adoption with which to effectively absorb knowledge from other companies. The interaction between R&D expenditure and Creative Ideas Adoption is critical to knowledge transfer.

Without a simultaneous consideration of its R&D Intensity and organizational creativity, a firm is more likely to face a (knowledge transfer problem), this problem means that the transfer of identified knowledge will not be identified in the network search (Hansen, 1999)⁷². The more organizational creativity is adopted in an organizational knowledge process, the broader the knowledge sources accessed by the R&D Researchers at the firm and the higher the Creative Ideas Adoption is necessary to transfer such knowledge.

Hypothesis (3a): Creative Idea Adoption will enhance the relationship between R&D Capabilities and Technological Innovation

Hypothesis (3b): Creative Idea Adoption will enhance the relationship between R&D Capabilities and Firm Performance

3. RESEARCH DESIGN AND METHOD

In the test of the above hypotheses, the technological innovation and Firm performance were the dependent variables. and the degree of R&D capabilities were the independent variables.

3.1. Sample and DataCollection

The data for this study were derived from 17 Algerian firms including 54 units in 5 cities, active in the industrial sector. Each one is specialized in a deferent activity and had a multi-separated unit structures which is responsible for the development, of its own products, and a number of 20 employees or more firms were included in this study. Firms with less number of employees were not included because we consider that some questions about its innovations in the survey will not be applicable to these firms, and were excluded from this study for the same reason the firms of service sector.

In addition, we selected the surveyed firms for many reasons. The main one is that we consider each selected firm as a leader in the market in its activity with some innovations introduced to the market in the past 3 years.

The second reason is the competitiveness of their products and the funding level, which can make the data more accurate for this study. Firms of service sector were also excluded from this study for the same reason.

The confidential survey question about the R&D intensity, creativity, technological innovation and performance in the past 3 years was distributed, only for the top managers of each business unit in

the studied firms and the questionnaire results of 118 respondent data were collected from each Department were analyzed with the help of Statistical Package for the Social Sciences tool.

Of the 118 distributed questionnaires, just 102 were returned and completed, of which only 86 were usable for data collection.

3.2. Independent Variables

In our survey, we used the following independent variables:

R&D intensity : [the total expenditure on R&D of the unit in the past 3 years divided by the Total Sales in the same period] for the R&D Capabilities measurement. In addition, the data collected from the respondents to measure R&D intensity were approximate.

Creative Idea Adoption: to measure organizational creativity level, we asked the survey respondents (managers) some questions related to the creative thinking process adopted by the top management in the business unit even at a low level.

3.3. Control Variables

For the control variables in our survey, we thought that the literature discussed the following:

Size: we controlled our survey according to several studies about Technological Innovation and Firm Performance that linked it strongly with the size of the company beside some other interrelated variables affecting the business unit. Because larger unit is more likely to develop new products and is more profitable because it has more resources allocated, and will have a competitive advantage gained by the interest given to the high yield units. We calculated the size of the units by the average between the employees' number and the total sales in the period of study

Competition: as shown M.Porter that the performance is led by the external forces, the main is the competition, and the innovation also led by the competitiveness in the activity, so we asked in our questionnaire the level or the intensity of competitiveness in a Likert scale of 7 choice answers.

Initial Technological Innovation: as a control variable the history of new product developed by the business units and introduced to the market in a previous period before our period of study, (means before 3 years of our survey), is likely to give prediction to the future development of new products and innovations introduced to the market. We used this control variable as a comparison to the previous innovations

Initial Profit: the accounting history of the company's profitability by the business units a previous period before our period of study is likely to give prediction to the future performance in profitability and total sales in the market. We analyzed it in this study to make a comparison with the previous *performance* and to argue the level achieved by the firm.

3.4. Dependent Variables

There are two dependent variables in the survey: Technological Innovation and Firm Performance measured at the surveyed units. Because there is a difference in the financial level,

activities, strategies, and the competitive priorities of the units in the same company within the deferent industries.

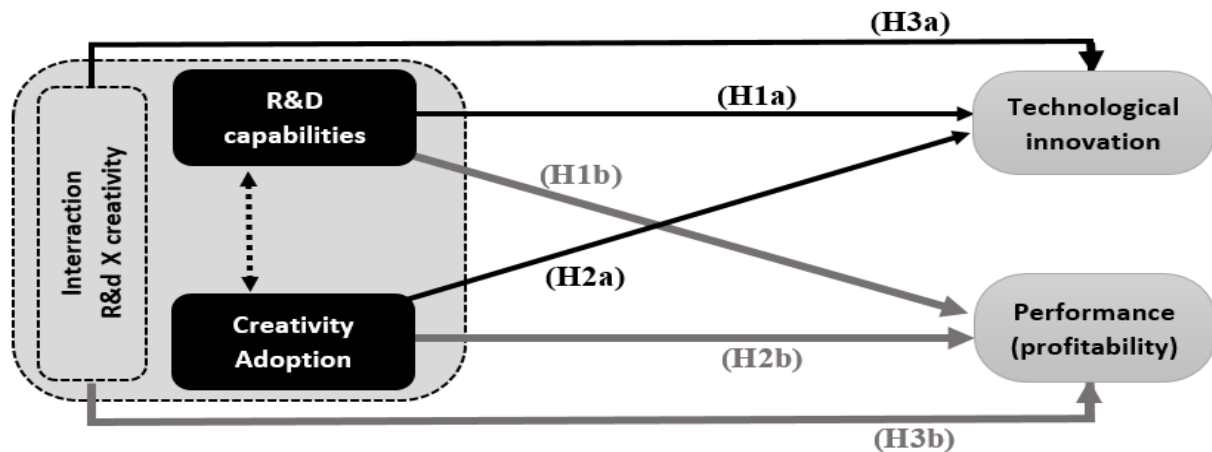
In this study, we used the following dependent variables:

Profitability rate: [ROI the return on investment of the unit in the past 3 years divided by the target ROI in the same period] for the *performance* measurement.

Technological Innovation Achieved Rate: [new products introduced in a unit in the past 3 years divided by the target number in the same period] for the technological innovation measurement.

In technological innovation studies, the measure of technical and innovations is based on a comprehensive list of innovations achieved in a period of 3 years that is why we used this period in our survey as a duration of study.

Fig (1): Research Model Design and Hypotheses illustration



4. RESULTS

The results as shown in Table 1 of Correlation, Standard Deviation and Mean Value for the Firms' business units, we examined our results consistency with the significance levels, and shows that our independent variables. we split the data to two periods and we categorized the two periods then we created interaction for all the variables in this linear model with the F-test Chow, we got the results for the dependent variables as follows:

- Technological Innovation $F_{4, 52}=0.92$, $p=42$
- Firm performance $F_{4, 52}=0.86$ $p=46$

Table (1): Model Means, Standard Deviations, and Correlations

n	Variable	Mean	s.d.	1	2	3	4	5	6	7
1	R&D in	23.53	18.52							
2	Idea adopt	9.14	4.78	0.31						
3	size	6.35	0.45	-0.33	0.22					
4	Compet	3.95	1.70	-0.35	-0.23	0.07				
5	initial innov	93.36	51.19	-0.19	0.31	0.42	0.09			

6	Tech Innov	91.18	49.75	0.41	0.62**	0.39	-0.19	0.47*		
7	initial Profit	108.92	13.87	0.19	-0.32	-0.05	-0.47*	0.10	-0.11	
8	Profit	113.37	24.06	0.29	0.37	-0.35	-0.41	-0.09	0.14	0.17

*p < 0.05

**p < 0.01

The variables were consistent across the studied sample and the results show that the two variables can be represented in a single Linear Regression, so the regression can be pooled for more data analysis.

Variance test of the independent variables is pooled to test the study hypotheses using the control variables (size, compet, initial -innov and initial -perf) as a second step to perform a hierarchical regression analysis. Then in a third step we tested interaction to trace the change in R2 squared correlation coefficient for each step in the models' data analysis.

Table (2) Hierarchical Regression: Effects of R&D Intensity and Creative Idea Adoption

Variable	Technological Innovation			Performance		
	1	2	3	1	2	3
Size	35.36**	29.05**	29.84**	-3.01	-5.97	-4.51
Competitors	0.62	3.15	2.40	-5.72**	-5.03**	-4.69**
Competitiveness	56.40**	50.19**	58.03**	-10.49	-21.12	-15.24
Initial Innov	0.31**	0.15*	0.11*			
Initial Profit				0.21	0.21	0.15
R&D Intensity		0.69**	0.58**	0.35*	0.32	0.37
Creative idea adopt		3.98**	3.92**		1.66	1.71*
(R&D)X(Creativity)			0.20**			0.09*
R ²	0.33	0.59	0.65	0.27	0.41	0.46
ΔR ²		0.27	0.09		0.15	0.06
ΔF		17.07**	10.86**		5.43**	5.01*

* p < .05

**p < .01

Table (2) demonstrates the Hierarchical Regression Analyses results and estimates the impact of the independent variables (R&D intensity and creative idea adoption) on the Technological Innovation in the studied business units. We concluded that:

Hypothesis (1a) which presents that R&D intensity positively influences Technological Innovation and based on the results shown in Table (2) the statistic coefficient of R&D intensity is positive and statistically significant at (p < 0.01), showing that the more expenditure on R&D will hence the business unit's Technological Innovation, and the Hypothesis (1a1) is confirmed by the model.

Hypothesis (2a) estimates the positive effect of creative idea adoption on Technological Innovation, and the coefficient for creative idea adoption is positive and statistically significant at (p < 0.01), showing that the business unit which adapts new ideas has more chance to achieve a technological innovation in its products, and the we confirm the Hypothesis (2a).

Hypothesis (3a) predicts that creative idea adoption will enhance the relationship between R&D capabilities and Technological Innovation, and to test the Hypothesis (3a), we did a multiplication between R&D intensity and the creative idea adoption. When entering the multiplicative test section on the regression model (by giving a mean = 0 to the deviation form and test the regression with the model variable), this interaction demonstrated a positive and statistically significant coefficient at (p < 0.01), revealing that the creative idea adoption will enhance the relationship between R&D capabilities and Technological Innovation. Hence, Hypothesis (3a) is confirmed.

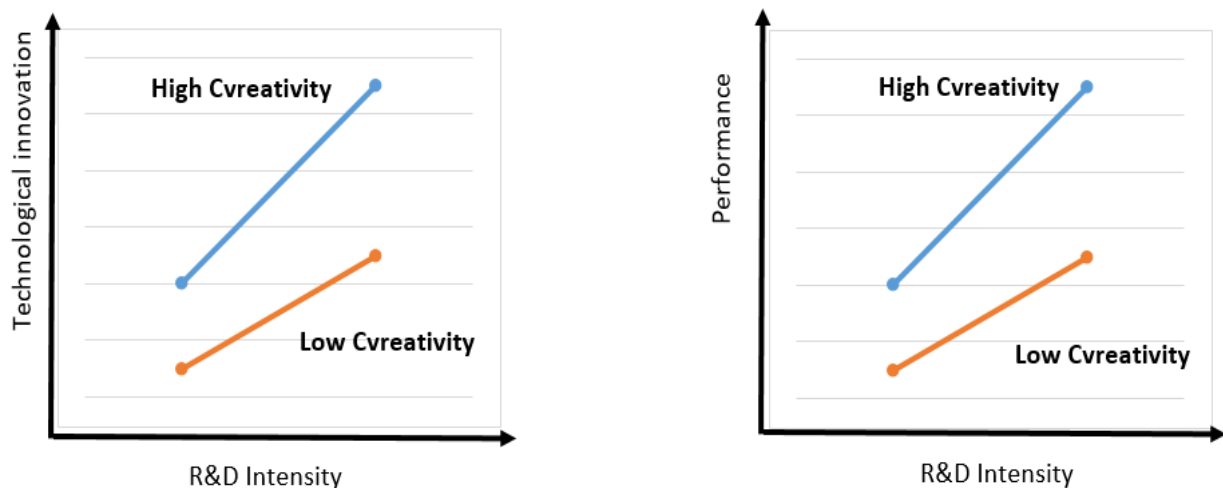
Hypothesis (1b) predicts that R&D intensity positively influences Firm Performance and based on the results shown in Table (2) the statistic coefficient of R&D intensity is positive and statistically significant at ($p < 0.05$), showing that the more expenditure on R&D will promote the business unit's performance, so the Hypothesis (1b) is supported.

Hypothesis (2b) estimates the positive effect of creative idea adoption on Firm Performance, and the coefficient for creative idea adoption is positive and statistically significant at ($p < 0.05$), showing that the business unit which adapts new ideas has more chance to achieve better performance, and then we confirm the Hypothesis (2b).

Hypothesis (3b) predicts that creative idea adoption will enhance the relationship between R&D capabilities and Firm Performance, and to test the Hypothesis (3b), we did a multiplication between R&D intensity and the creative idea adoption. Using the multiplicative test section on the regression, this interaction demonstrated a positive and statistically significant coefficient at ($p < 0.05$), revealing that the creative idea adoption will enhance the relationship between R&D capabilities and Firm Performance. Hence, Hypothesis (3b) is confirmed.

Moreover, for more explanation about the effect of our independent variables on the dependent variables and the interactions demonstrated in Table (2) about the Hierarchical Regression Analysis, the interaction effect is shown in the following Figure (2), based on the Max and Min standard deviation with regard to the mean, to track down min and max organizational creativity within the Firm.

Fig (2): Interaction effect on Creativity levels



5. Evaluation of Effectiveness of R&D Capabilities and Organizational Creativity as Factors to Technological Innovation and firm Performance Success

The literature discussing success in creativity, innovation and R&D is vast. Success of a firm is 'any sign of economic profitability, like growth, increasing productivity and profits'⁷³. The results of empirical studies shows that Creativity fosters both product and process innovation and increase of productivity. Therefore, the role of creativity for innovation and success increases during the firm's life cycle (J. Heunks, 1989)⁷⁴.

As globalization and technology continue to evolve it is likely that Spending on R&D will increase. Because it is widely viewed as a form of investment in intangible assets, with predictably positive effects on future cash flow, and as such, it is a way to create growth options and success (Gartrell, 1990; Chauvin and Hirschey, 1993; Martinez and Burguet, 2000)⁷⁵.

Studies and researches about the innovation performance are generally associated with the measurement of the results and outcomes of the innovative activities. Generation of ideas as patents are results of the new product development process and are consequently indicative of R&D intensity, expenditures, efforts and effectiveness. However, patent criterion reduces the evaluation of innovation because only the tangible technological outcomes are patented. Economic studies give all the importance to patent citations as an indicator of the innovation performance of organizations, beside journal-based innovation (Jensen & Webster, 2004) and some financial indicators such as the increase in sales volume related to the development and introduction of a new product to the market.⁷⁶

Unfortunately, firms' success cannot be related only to a single activity such as R&D or innovation⁷⁷. "The path of innovation is always thorny; there are no short cuts to success, no infallible formulae." (Jewkes, Sawers, & Stillerman, 1969)⁷⁸. Many other qualitative variables must be considered in such analysis of organizations' success or failure as concluded most researches and case studies in the field. In addition, only measuring innovation and technological capabilities cannot explain the success or failure of the organization.

6. Implications and Conclusion

In this paper, we have tried to highlight the role of creativity and research and development, in the enhancement of innovation and performance, as we do believe that much more attention should be paid to the selection of effective organizational creativity and R&D as real Factors of success to Technological Innovation and Organizational Performance.

How can a firm gain effectiveness from its R&D capabilities and Creativity to enhance its Technological Innovation and Performance? This research suggests that a firm's organizational creativity and R&D capabilities are essential to answering this question. A Firm's organizational creativity is characterized by its degree of adoption of the new ideas of researchers and the high intensity of its R&D. By spending more on R&D, a Firm is likely to try and adopt new ideas and access new knowledge from surrounding environment. The result of this study shows that a firm's technological Innovation capability and profitability is significantly increased by its Research Factors and input such as creativity and research & development.

Towards the end of the last Millennium, there was an intensified interest in R&D, creativity and technological innovation triggered by developments. Considered as a mean by which innovative firms can improve their product and process innovation leading to better productivity levels and overall performances to overpass their competitors and provide much more value to the firms' stakeholders. Organization success is a vector that includes quantifiable and no-quantifiable inputs such as organizational creativity and intensity of R&D, and output such as process and product innovation, which reflects the quality and the correlation between outputs and the global organizational strategies and objectives. In economic term, organizational success refers to effectiveness and degree of productivity over a period of time, which is generally measured in a period of three years

Furthermore, looking across innovative firms, there has been a strategic move towards science outputs from basic to applied researches, in order to gain more market share by generating more ideas and developing more new products or services. Success and performance of organization can be determined by the success of its technological innovation which is determined by a number of different factors, determinants and criteria, linked together to formulate knowledge base to better understand the economic phenomenon. In the innovation case, these determinants can be represented by the quantity of output such as the numbers of: reports, publications, new products, patents obtained, major innovations developed for commercialization return on R&D investment. Alternatively, by other criteria such as the quality of the work, increases in the size.

To innovate requires both creative thinking and intense research & development capabilities; this led to give more importance to technology research units in term of investment. The shift in investment towards R&D has also led to build more research cooperatives and strategic research alliances to face the changing business world. Because “Not only the technological change is too fast, but the process of the commercialization of technological change - the industrial innovation process - is changing also” (Rothwell, 1992)⁷⁹. Despite the emerging benefits of R&D capabilities, some firms have seen only one option, which is increasing in its R&D dependence, by evaluating its position and becomes a success criterion. For evaluating the success of an R&D organization should be the record of its success or failure in meeting its objectives.

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