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Fundamentals of Innovation

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Abstract

To write a book about the Management of innovative projects is a challenge, because innovation goes beyond the usual, normal things, is not a standard behaviour and is difficult to propose techniques and methods to manage the creativity, but, in the same time, represents a very good initiative – to provide a specific guide for a project manager. At the moment, innovation is part of our everyday life and all the projects have innovative elements; these are the “details that make the difference” between a common, mediocre project and a good and efficient one. The management of the innovative projects needs a basic theoretical frame in which to find explanations of all fundamentals concepts. The chapter will present the main fundamentals concepts and prepare the reader for more complex approaches in the field of project management. The chapter will be structured as follows: definitions of innovation; explanation of the differences between innovation and invention; the typology of innovations; factors that influence and drive to innovation; a detailed comment about the models of innovation (five generations of innovation identified by prof. Roy Rothwell); introduction of the concepts of “open innovation” and “closed innovation”, the effects of open innovation on economic growth, business and development.

Keywords: innovation, models of innovation, close innovation, open innovation

1. Introduction

It is impossible to talk about the current level of development of our society without using the concept of innovation. Although the connection between economic growth, progress, development and innovation is a young approach, innovation exists from the beginning of the mankind. We are surrounded everywhere by the results of innovations developed over time, during the whole history of humanity. Thinking different, trying to do things better and looking for

improvements are normal features of human being, with deep roots in its intelligence and creativity. For a very long period, the innovation was used in a simple, primary form, influenced only by the skills and capabilities of each person, but now, the innovation is seen in a broader frame, in which there is the possibility to educate, train and enhance the native innovative talent. Our development is now very strongly connected and dependent on the possibility to promote, sustain and use innovation in all fields of society and this represents the reason to study the innovation, in order to find the appropriate ways to implement and use it currently, for the economic development and well-being of the society.

The systematic study of innovation started after the Austrian economist Joseph A. Schumpeter developed an original approach, focused on the influence of the innovation on the economic development. In his view, innovation is the driven force, which produces the qualitative change in all area of society, based on existing resources, but combined or used in a different way. This “new combination” of the resources will lead to different forms of innovation [1]:

- A new product or an already known product, but with better, improved characteristics.
- A new production method or sale method, not yet used.
- A new market.
- A new source for raw materials or semi-finished goods.
- A new way of business organization.

These five areas defined by J. Schumpeter show us that innovation is not specific only to the industry, but all other sectors of an economy can produce and use innovation. Even his theory has more than 100 years, it still remains very interesting and very actual because it point out that entrepreneurial activities, which are seeking for profit, should have innovation as base for future development. Schumpeter was named “the prophet of innovation” due to this forecast regarding the role and importance of innovation in business and, generally speaking, in economy [2]. To succeed, the entrepreneur must allocate the available resources for new use or in a new combination such that the final product or service is able to:

- be the solution which answer the new requirements;
- be the solution that answer at unsatisfied requirements;
- be the solutions that respond to old customs and market needs, but in a new way.

After a lag period, in the 1960s, we can notice a greater interest for innovation, both in theoretical and practical approaches. In the scientific literature, the number of papers with innovation as subject increased strongly and, also, especially in the industry field, the application of innovation became an usual procedure. According to Fagerberg [3], after 1974, the number of social-sciences publications focusing on innovation has increased much faster than total number of publication in this field. Our knowledge now covers different aspects of innovation, from human creativity to technological application and its impact on economic development. The wide range of areas connected with innovation lead to the transition from a simple approach to an interdisciplinary or cross-disciplinary one. The complex studies about innovation prove the necessity of studying innovation from different perspectives.

Each perspective brings its own knowledge and meanings and together contributes to the construction of the innovation concept. We can conclude that innovation is a cumulative process, in which all the information and knowledge acquired till a certain moment will represent the base for future innovation and improvements; for this process, it uses a very plastic and meaningful expression—“standing on giants’ shoulders” [4]. Nowadays, no innovation appears from nothing, it is the result of a long and complex process of accumulation to which the scientists and inventors contributed over time. For this, now, an innovation uses information and knowledge from different scientific areas and combines it in a new way by the power of intelligence and creativity of human being.

As a matter of fact, innovation is only the material result of creativity; the whole process of thinking and combining different facts/elements in a new form cannot be seen because it takes place inside the human mind. Understanding how it is possible to create new things, ideas, processes, and others, challenged the scientists from different areas and led to a huge volume of knowledge about creativity. For the purpose of this work, we selected some basic information connected direct with the innovation. Teresa Amabile [5] considers that the creative ideas are the bricks from which is built the innovation and notices that almost all the definitions of innovation include implicitly or explicitly the notion of creativity or creative ideas. Regarding the definition of the term *creativity*, in the scientific literature we can find two groups of definitions: first is focused on the person and its capacity to create something new and the second is focused on the result of the process of creativity. From economic point of view, we are interested in the second group of definitions because the results of creativity are, usually, innovation from which is expected a positive impact in terms of development, income or improvement. So, the definition of creativity given by Amabile [5] considers “... *creativity is the production of novel and useful ideas by an individual or a small group of individuals working together.*” For an organization with a precise field of activity, we can talk about organizational creativity, defined as the successful implementation of creativity in the organization. This definition includes both the production of new ideas and the process of transformation of these ideas in useful products, services, processes, methods, procedures, etc. But the definition of creativity is not enough to describe its connections and influence on the innovation; the research must go deeper and investigate the cognitive process behind creativity, the characteristics of a creative person, the evolution of creativity during his/her life span and the factors that create an environment favorable for the creativity. Based on the researches of Amabile, Adams [6] affirms that creativity arises at the confluence of three fluxes: knowledge, creative thinking and motivation.

The knowledge flux includes all the relevant information accumulated by an individual during his/her past studies and experiences and connected with the problem which needs a creative solution. The knowledge contributes to creativity through its two branches—the technical expertise and the ability to combine different elements in a new way. Each of them has the same importance in the development of creativity; the technical expertise is a skill formed by the accumulation of in-depth experience and long-term focus in one specific area and gives the possibility to emit professional ideas, concepts and solutions which fit with the given problems. On the other hand, the ability to combine disparate elements into a new form or in a new way depends upon every person and the work environment. In this context, very often is used the concept “The Medici effect”, which means the innovative product occurred when ideas from different areas come together. For an organization or for the management

of a project, this discussion about the influence of knowledge on the creativity leads to the necessity of an interdisciplinary approach for each problem and for the inclusion in the team work of persons with different backgrounds and different interests.

The second flux which leads to creativity is the creative thinking; it is quite difficult to define the creative thinking due to its very personal and subjective character, but it is agreed by all the scientists that creative thinking is the key aspect in the creative process. This statement is the only one accepted by all the specialists in the field, after that, each of them has different approaches and theories regarding creative thinking and its sources. For example, Amabile suggests that creative thinking is the ability to combine knowledge from disparate fields, to be able to argue with other persons with realistic arguments and to try to find appropriate solutions, to have the ability to persevere for solving complicated problems and to have the capacity to step away when you cannot find a good solution and to return later with a new perspective. In contrast with Amabile, Sternberg launched the “triarchic theory” [6]; he considers that there are three specific forms of intelligence as key factors for creative thinking: synthetic, analytical and practical intelligence. The synthetic intelligence, also called creative intelligence, is the ability to generate new, appropriate and high-quality ideas based on all the knowledge, experience and competences accumulated so far; the analytical intelligence, also called critical intelligence, is the capacity to give a correct judge to own ideas and to the ideas of others, to assess the strong points and the weak ones and to propose improved solutions. The practical intelligence refers to the capacity of using the intellectual skills in everyday context and to sell creative ideas. So, creative thinking results as a combination of these forms of intelligence and involves the abilities described by Amabile.

Finally, motivation is the third pillar of creativity, sometimes being considered the most important one; motivation is like an engine which drives all the efforts of a person to be creative to produce something new with the power of the mind. The scientists highlight that the intrinsic motivation determines, in fact, the creativity because it involves intrinsic interest, curiosity and perseverance, factors which contribute to the self-esteem. For a manager, the knowledge of these three fluxes is fundamental to establish a favorable environment for creativity and innovation.

The notion of innovation was associated by J. Schumpeter with another new concept—creative destruction. In his book *Capitalism, Socialism & Democracy* [7], he connected innovation with change and competition through creative destruction. According to his opinion, the capitalist economy is not static but dynamic and the engine which drives the development is the change. But the change leads to the replacement of old things with new and better ones. In other words, change means innovation; through change/innovation, the economy becomes more competitive, more and better goods and services are offered on the market, new businesses are developed, the needs of consumers are fulfilled and the whole economy progresses. Creative destruction describes the disruptive process of transformation that accompanies the innovation and is seen as a positive process which leads to progress and significant improvements. Also, creative destruction, like innovation, is a continuous process of destroying the old and creating the new. For any type of activity, creative destruction is a milestone and is the border between success and fail; if the economic entity is static, stiff in its old customs, the lack of innovation will disconnect it from the economic reality and the result will fail. But,

if the creative destruction promotes innovation, the changes will allow a better answer of the entity to the market requirements and there will be big chances to have a successful activity.

These direct and non-direct connections between innovation and success and competition call for a detailed analysis of the concept of innovation, in its complexity and in connection with its potential of promoting economic growth and development.

2. Innovation bases: definition and typology

As we mentioned above, innovation is a complex concept, with different faces, according to the field of activity, level of detail and aim it pursues. Consequently, there are several definitions on innovation, all of them trying to explain this term clearly and in detail. From general point of view, if we ask any person what is innovation, we shall receive a simple answer—innovation is something new. This is the core of the concept of innovation and the center of all definitions.

Chronological, we will start with the definition given by J. Schumpeter, as he was the first who launched and explain the concept. He defined innovation through its particular forms in which it is present in industry [1, 8]:

"The introduction of new goods (...), new methods of production (...), the opening of new markets (...), the conquest of new sources of supply (...) and the carrying out of a new organization of any industry"

Later, after his concepts about innovation, entrepreneurship, creative destruction and economic growth have crystallized, Schumpeter gave a new definition of innovation in "Capitalism, Socialism and Democracy" [7, p. 83]:

"... process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one".

This definition shows us that innovation is an internal process, specific to each activity/business/enterprise, which creates values and allows a continuous improvement and development. Together, both the definitions give a complete image of the innovation phenomenon and allow, in an open manner, to include very different activities and actions in an innovation area. For example, if the introduction of new product is obviously focused only on goods, new organization of a sector would have multiple meanings and would involve internal structure, management techniques and methods, financial tools and other. Even the Schumpeter's definitions are very appreciated in the scientific world, in the literature we can find also other definitions of innovation, summarized in **Table 1**. Their existence means that we are innovative and in this context, other scientists proposed new forms for the definition of innovation.

The aforementioned definitions have two core elements:

- Innovation is something new, original or, at least, improved. The level of novelty is the determining factor based on which it is decided if "something new" is or not innovation. There are a lot of new things that are not innovations but are only different "faces";
- Innovation creates value, i.e. is useful and satisfies consumers' needs.

Definition of innovation	Source
<ul style="list-style-type: none"> • The act of introducing something new. • Something newly introduced 	The American Heritage Dictionary [9]
<ul style="list-style-type: none"> • A creation (a new device or process) resulting from study and experimentation • The creation of something in the mind • The act of starting something for the first time; introducing something new • The act of innovating; introduction of something new in customs, rites, etc. • A change effected by innovation; a change in customs; something new, and contrary to established customs, manners, or rites • A newly formed shoot or the annually produced addition to the stems of many mosses 	Webster's online dictionary [10]
"Innovation is the change that creates a new dimension of performance"	Drucker [11]
The successful exploitation of new ideas	UK Department of Innovation and Skills [12]
"Innovation is not the result of thinking differently. It is the result of thinking deliberately (in specific ways) about existing problems and unmet needs."	Razeghi [13]
Innovation goes far beyond Research and development	OECD [14]
The process of translating an idea or invention into a good or service that creates value or for which customers will pay	Business dictionary [15]
An innovation is the implementation of a new or significantly improved product (goods or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations	Oslo Manual [16]
<i>Source:</i> Own elaboration.	

Table 1. Definitions of innovation.

Both features of innovation have the same importance; an innovation cannot be something old or already known, but, in the same time, must bring an added value. For example, a new color for a product is something new, but it is not an innovation. This change represents only a method for diversification of goods for fulfilling the needs, requirements or customers' desires. **Table 1** presents only some definitions of innovation, there are also other definitions (similar or very close), which reflects the preoccupation about this subject in numerous fields, but, also, their different perspectives. A very interesting study [17] reveals the true dimension of the interest for innovation, generally speaking, and for defining innovation in particular. The authors searched for the definitions on innovation in different fields and found:

- Eighteen definitions in the field of Business and Management from 1966 to 2007
- Nine definitions in Economic fields from 1934 to 2004
- Six definitions in Organization studies from 1953 to 2008
- Nine definitions in Innovation and Entrepreneurship from 1953 to 2007

- Thirteen definitions in Technology, Science and Engineering from 1969 to 2005
- Three definitions in Knowledge Management
- Two definitions in Marketing from 1994 to 2004

In total, there are 60 definitions of innovation proposed during the last 80–85 years, which confirm the development of the concept and the increasing interest for it.

Another conclusion resulted from the definitions above is regarding the area of interest covered by the definition; the goods are the main subject of innovation, but also, the field of innovation is extended at services, marketing, organizational methods or even the way of thinking. This means that innovation is dynamic and widespread and, constantly, new fields or activities are interested to adopt and create innovation.

The definitions of innovation give the possibility to highlight the difference between invention and innovation. Both terms involve a high level of novelty and major improvements, but there are some basic differences regarding the final utility; thus, the innovation is the result of a process formed by several steps: research, funding, production, acceptance by customers, obtaining profit and dissemination of the innovation (**Figure 1**).

It is obvious that innovation is oriented to profit, which means that all innovation must have practical applicability, aim to fulfill some uncovered requirements on the market and represent a source of income for the innovator.

Invention is, also, something new, but has some different characteristics compared with innovation; the invention could be the result of a research process, must have practical applicability, must involve a high level of novelty and represent a progress comparing with known knowledge. If the invention refers to a product, it must be practically achieved or reproduced. We can see some common points between innovation and invention, which are a research process, the high level of novelty and applicability, but some important differences: it does not involve a production process in invention, and neither a feedback from the customers nor a profit is resulted from the use of invention. In order to present an invention better or to apply for a patent, it is possible to make a model or a prototype, but this is not the production step (**Figure 2**).

Although the inventions are not profit-oriented, they represent a very important source for innovation; it is not always possible to identify clearly from the beginning the possibilities for an invention to bring profit, but, in future, these possibilities will have the chance to be exploited.

As the information from this chapter anticipated previously, different forms of innovation are recognized and classified according to different criteria. Based on this information, we can build the following typology for innovation, in which the following criteria are used: the level of novelty, the field and the place where the innovation is implemented.



Figure 1. Innovation chain. *Source:* Own elaboration.



Figure 2. Invention chain. *Source:* Own elaboration.

2.1. Depending on novelty level

Radical innovation—It is also called disruptive or discontinuous innovation, has the highest level of novelty, determines the fundamental changes of products, services, activities and involves new knowledge, processes or a new form of organization. Adopting a radical innovation is a high risk decision because it involves high costs and high uncertainty. On the other hand, if the radical innovation has success, it brings big profits. Radical innovation is a complex process which occurs discontinuously, based on quantitative accumulation of knowledge and experience.

Incremental innovation—It is also called evolutionary, or continuous or step by step innovation and is a significantly improved or updated form of innovation that is applied to an already existing product, service, process or methods. The level of novelty is inferior compared with radical innovation, but meets the requirements for an innovation, involves less risks and less costs for a manager. The incremental innovation is prevalent and represents the basis for the radical innovation. The main goal of incremental innovation is to maintain the edge over competition.

2.2. Depending on the field of action of innovation

These criteria classify the innovations according to the Schumpeter's approach and identify the following types of innovations:

- **Product innovation**—*“is 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”* [16, p. 48]. The definition is valid both for material products and services and involves a broad range of changes with the aim to obtain something new, with new and better characteristics in respect with the old ones. Usually, the new products or services are launched on the market with the aim to cover new needs (brand new products or completely new products/services) or known needs, but insufficiently fulfilled (new products/services). One important trend in product innovation is focused on “environmental friendly” goods or services, i.e. those products with a low environmental impact, both in the production and consumption phases. They represent very good examples of innovative products/services because they have new and better characteristics, very often include new materials or components, and have improved technical specification in order to have as little effect on the environment as possible. The design is fundamental for product innovation. For services, innovation consists in the design of a new service, addition of new function at an existing one or significant improvements in how they are provided. For example, Internet banking is an innovative service resulting from a radical improvement process of the classical banking service.

- Process innovation—*“is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software”* [16, p. 49]. The production processes were always subject of changes and improvements which contributed to the development of humanity. The historical stages of industrial production are examples of process innovation; the mechanization (introduction of the machines into the production process) was a big innovation which reduced the physical effort of workers, improved the quality of products and raised the production volume and the productivity. Similar situations are associated with the introduction of automation, using robots or computer-assisted processes. Process innovation is used for the following purposes: (i) improve the characteristics of a product or produce a new product—in industry, the process innovation is very often combined or implemented together with product innovation; (ii) improve the quality of a product/service—the progress brought by an innovation in a process is reflected in a higher quality for the results of the process. Better quality is obtained through high-performance equipment, the change of the technology or replacement of raw materials. In the case of services, better quality is represented by a new design of the service, using software or different techniques for providing the service, new delivery methods, or reducing the time for providing the service. (iii) Reduce the costs per unit—it is a very important economic goal with influence on the profit and general efficiency of the process. The process innovation is able to reduce the unit costs through a more efficient control of the process, reduction of the losses and emissions, changing the raw material and finding uses for by-products or waste.
- Marketing innovation—*“is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing”* [16, p. 49]. Marketing offers a huge field for innovation; compared with the other two forms presented above, marketing innovation is newer, but with a big impact in business, especially in the relationship between producer/provider and customers. A lot of marketing innovations were initiated with the goal of fulfilling the customers’ needs, while others came to meet these needs. One of the most important initiatives considered innovation in marketing is regarded the design of the product, which includes a new form and appearance, new package, introduction of modulation operation (product is made from several modules which can be assembled in different ways); for the food products, marketing innovation through the design refers to new taste or flavor in order to target a new segment of customers. Another direction where the marketing innovation is active is product placement, which focused on the new methods of presentation of the products to clients and on sales channels. The innovative methods of presentation changed the concept of presentation of the products to customers, usually starting from the idea that the products should be presented in its usable environment (drive tests for the cars, showrooms for the furniture, wearing clothes test method). Regarding the sales channels, marketing innovation introduced new methods of selling, different from classical ones, like licensing or franchising system. Very often, the innovative sale channels are combined with new ways of promotion which intend to give a new image to the product or to obtain a better placement on the market. Here, an important role had the initiative to personalize customer relations with the aim of fulfilling in a better way the specific needs of individual clients. The last, but not the least, is the marketing innovation focused on the price of the product/service; these innovations

refer to the first use of a pricing method according to different factors on the market and can be combined with other forms of marketing innovation.

- Organizational innovation—*“is the implementation of a new organizational method in the firm’s business practices, workplace organization or external relations”* [16, p. 51]. Like marketing innovation, organizational innovation is a new form of innovation, introduced out of necessity of modernization of organization and its adaptation to a dynamic economy. The core of organizational innovation is the implementation of an organizational method that has not been used before in firm. Changing the organizational approaches is, usually, a strategic decision and is made with very clear purposes. First group of goals regards internal improvements and the second one, the external relations of the firm. From the first group, we can highlight the innovations in business practices, which involve new method of organization or new procedures for business administration. In this direction, a very good example of organizational innovation was implementation of quality management systems or, generally speaking, the management systems (for quality, environment, food safety, integrated systems), which innovated the general approach of conducting the business with specific goals in a specific field. Another organizational innovation which falls in the first group is innovation in workplace organization; here, the innovations can be structural (new concepts for structuring the activities) or innovation regarding human resources management. There are a lot of examples of innovation in this field which led to very good results for the business, but also, for the internal environment of the organization and for the culture of the organization. Empowerment is an innovative organizational method, which gives higher level of autonomy to the employees, members of the empowerment group, but, in the same time, asks for a very good efficiency of their job. The second group of organizational innovation focused on the external relation of the firm. Here there is, also, a big area for expressing the innovative concepts; on the first place are new relationships with other business organization and public institutions, then new methods for outsourcing or subcontracting, adding new ancillary services, participating in integrated chains or networks. According to the Strategy Europe 2020, the firms have the possibility to introduce organizational innovations participating in clusters or enhancing and extending the relationships with universities and research institutions.

After the presentation of the main types of innovations, some final remarks are necessary; analyzing the innovations, it is possible to notice that, for some of them it is very difficult to fit into a certain group because they have characteristics belonging to several types. Thus, we can find: (i) innovations with both product and process innovation features; (ii) innovations with product and marketing characteristics; (iii) innovations with process and marketing-specific; and (iv) innovations with process and organizational features. These combinations are normal in a dynamic economy, where an innovation can pursue several goals. From economic point of view, the statistics show that the firms which innovate have a bigger profit, a good image on the market and good relationships with customers, business partners and authorities. Product and process innovations are also called technological innovations, whereas marketing innovation and organizational innovations are called non-technological innovations.

Producing and implementing innovation is a difficult and complex process, which calls for a big effort from all the employees of an organization. For this reason, the innovation is not always a continuous process, but it occurs at different period of time and focuses different problems or needs of the firm. The most important thing for an organization is to be open to innovation and change and to have an innovative manner of decision-making process.

3. Models of innovation

As we mentioned previously, the concept of innovation involves a new, different way of thinking with the aim of finding new technological, economic or managerial solutions to the current problems. All scientists/scholars who have dealt with this issue agree that the process of innovation goes through three distinct phases: the emergence of new ideas, its development (or production phase) and diffusion or marketing. However, this description is too simple to be an accurate picture of the innovation process and does not show the factors which influence it. On the other hand, since the second half of the twentieth century it became increasingly clear that innovation is a necessary component of the process of economic growth, a very effective tool for the business management and for the market competition. In order to understand better the innovation process and how to manage it successfully inside an organization, there a lot of studies were developed that focused on logical sequence of steps needed to initiate and develop innovation at firm level. Also, these studies were extended to the investigation of regional and national innovation, differences between countries, success and risk factors which can drive or hinder innovation. The studies revealed the fact that it is possible to identify patterns in the process of innovation, called models of innovation. Most of them are conceptual models which express the vision of specialists at different points in time over the place and role of innovation in the complex process of development.

English sociologist Roy Rothwell, Professor at the University of Sussex, had a major contribution to the understanding of the innovation process (especially developed in industry—industrial innovation) and provided an overview of industrial innovation management; he systematized information occurred from 1950 till 1992–1993 and formulated a classification of the models of innovation, published in his paper “Towards the Fifth-generation Innovation Process” in 1994 [18]. In his classification, Rothwell identified five generations of innovation models, emphasizing that each generation has emerged in response to the significant changes occurred in the market after the Second World War: economic growth, expansion of industry competition as more intense, inflation, stagnation, unemployment, constraints on the use and access to resources.

Rothwell’s models are descriptive models showing how innovation takes place in organizations (especially those with production profile) and how it has evolved over time. **Table 2** presents the classification of the models of innovation, as it was proposed by Rothwell.

Evolution of the models of innovation shows both the importance of technology and technological progress in implementation of innovation, but, also, a better understanding of the complex mechanism of relationships between business and different stakeholders. The conceptual

Generation	Period	Name of the model
First generation (1G)	1950s—first half of 1960-s	Technology-push models
Second generation (2G)	Second half of 1960s—early 1970s	Market-pull models
Third generation (3G)	Early 1970s—early 1980s	Coupling model
Fourth generation (4G)	Early 1980s—early 1990s	Functional integrated innovation models
Fifth generation models (5G)	Since early 1990s	Integrated, interconnected, parallel and flexible innovation process models

Source: Own elaboration with information from Ref. [18].

Table 2. Five generations of innovation models.

approach proposed by Rothwell is appreciated very much in the scientific world and still represents the basis of many works regarding evolution of innovation. In parallel, other scientists developed the innovation model, but many of them accepted the classification proposed by Rothwell. Also, we can find different approaches, where the innovation models are classified in six or seven generations, or there are no classifications, only a description of the historical evolution of the concept (single models, without integration in a structured classification).

First generation of models, named Technology-push models are related with a period of intense economic development after the Second World War. Companies understood that the scientific research gives the possibility to produce new products to improve the efficiency of the technological equipment to sell more on the market (the approach “more R&D in, more new products out” [19]). It was a linear model, in which the steps are organized sequentially, with the flux of materials and information in one direction (**Figure 3**).

The research is seen as the engine of the innovation process, while the market is only the place which receives the results without any possibility to influence the previous stages. This lack of correlation between research and customers’ needs has led to useless innovation for them, which is the main critic for the Technology-push model. The innovations promoted during this period, according to the 1G model, were merely technological innovations asked by the industry that focused on the technical devices, tools, technology, apparatus and not on the market.

Second generation of innovation models is formed from linear models, too, like the first one. Due to the critics of the Technology-push models, in the second generation of models, the center of gravity was changed from the scientific research to the market. They were called Market-pull models to highlight that the innovations were driven by the market needs. The economic context was quite different; the industrial production had an ascendant trend, based on the developments



Figure 3. Technology-push model of innovation. Source: Own elaboration with information from Ref. [19].

and innovations implemented in the previous stage, but the number of employees remained constant or decreased. The service sector started to develop and attracted the workforce not occupied in the industry. The incomes of the persons were bigger and, as a result, the demand on the market rose. The sequence of steps characteristic to Market-pull model is represented in **Figure 4**.

This generation of models reflects better the real connection between sectors in an economy, but in a very simplistic manner, which hinder the possibility to identify the main factors and the ancillary ones which influence the relation between market needs and research and innovation activities. The main preoccupation of the companies was to offer products and services asked by the market at competitive prices. In this context, the research was oriented to innovation which improved the existing products and not to develop new ones. An important tool used in this period was cost-benefit analysis, for a better allocation of the resources and the implementation of the best solution according to the market needs. The innovations according to the Market-pull model led to shortening of the time between new idea emission and its materialization in a new product or service and to a better satisfaction of the market needs. The main critic of the Market-pull model refers to excessive focalization on the market, which led to a dissipation of the scientific research in minor activities geared toward the improvement of existing products and technologies.

First two generation of innovation models supported many entitled critics due to their linear structure; in reality, the innovation is not a linear process, with loops and feedback circuits of information, which influence the decisions and activities. The following three generations of models tried to overcome these critics.

Third generation of innovation models, called coupling model, combined the first two models by introducing a loop between research and sales steps and other bidirectional channels of communication between the needs of market and society, on one hand, and all other steps of the innovation model in 2G form (**Figure 5**). The main reason of adoption of another innovation



Figure 4. Market-pull model of innovation. *Source:* Own elaboration with information from Ref. [20].

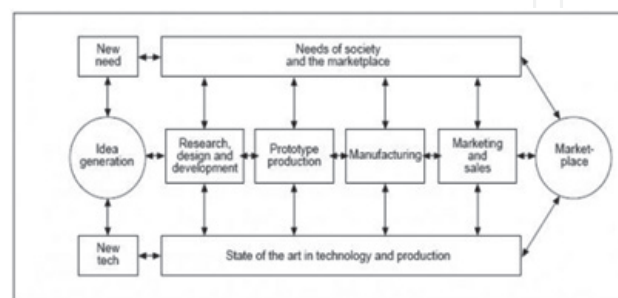


Figure 5. The coupling model of innovation. *Source:* [19].

model was the economic and social environment, specific to the period 1970–1980. This was characterized by inflation and stagflation, context in which the companies tried to consolidate their results and to reduce operational costs.

In this model, the innovation process is viewed like a combination between market needs and technological opportunities. The Coupling model used only product and process innovations and practically neglected the nontechnological types of innovation.

The fourth generation of innovation models (Integrated innovation process models) appeared in early 1980s, when companies began to use integrated concepts or “total concepts.” In this frame, innovation also is seen as an integrated process, with functional units, integrated in a whole system within the company and integrated beyond the organization borders, with suppliers and customers (**Figure 6**). The models reveal iterative processes, feedback loops and bidirectional relations between marketing, research, manufacturing and sales phases.

Due to the integration beyond the company’s borders, the 4G models also involved the possible collaborations with other organizations, including the competitors. At the same time, with the development of the 4G models, the co-opetition concept was launched [21].

The fifth generation of innovation models represents a superior level of 4G models; the integration processes continue together with the networking with stakeholders outside the company (are called integrated, interconnected, parallel and flexible innovation process models or network models). The main constraints which organizations must face are the limited resources and the speed of adopting the novelties. Regarding the first constraint, the companies’ answer was the implementation of electronic tools, modeling and simulation techniques, computer data basis, the use of computer software for process monitoring, expert system for design and production, and others. All these tools led to the digitalization of innovation process. To face the second constraint, the companies used the innovation to shorter the period from the new idea emission till its implementation in production or in service delivering processes; concretely, they focused on the sectors where the product cycle are short and rate of technological change is high. The innovation is seen as a succession of iterative cycles, much of them developed simultaneously. There are used all types of innovations,

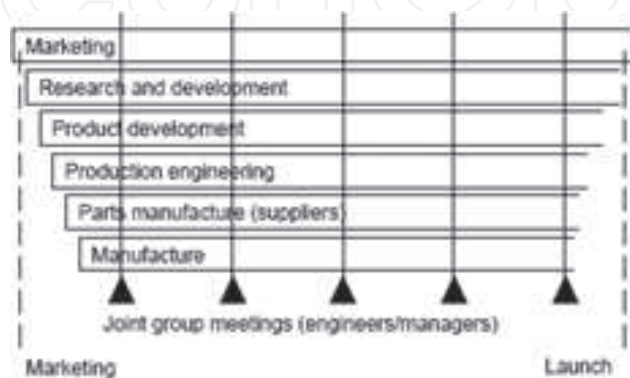


Figure 6. Functional integrated innovation models. *Source:* [20].

both technological and non-technological ones. The fifth generation of innovation models is adapted at the high risks associated to innovation and, also, to the dynamic and unpredictable markets.

According to Kotsemir and Meissner [18], the classification proposed by Rothwell is fundamental for understanding the mechanism of innovation developed in a company. They affirm that Rothwell's analysis and classification are not regarding the models of innovation themselves, but the strategies in innovation area developed by the organizations under different economic and, sometimes, political circumstances. Nevertheless, the classification of the innovation models in five groups represents a qualitative synthesis of very high level, which made a systematization of the knowledge in the field and contributed to the development of new concepts and works.

Another serious and comprehensive analysis and classification of innovation models were proposed by Marinova and Phillimore [22], who identified six generations of innovation models; they analyzed the models themselves, as theoretical and conceptual constructs, this representing the main difference from the Rothwell approach. Some steps from the classification proposed by Marinova and Phillimore are overlapping with the Rothwell's classification and together form a complete overview of the innovation, both on micro-level (the company) and macro-level (the economy). **Table 3** shows the classification proposed by Marinova and Phillimore and the correlation with Rothwell' classification.

In addition to the classifications presented above, the scientific literature also presents other innovation models, not included in a certain structured classification, developed for a specific type of innovation (such as Abernathy-Utterback model, proposed for product and process innovation) [23], for a general description of the innovation process (Van de Ven model) [24] or for specific sectors of economy (Triple helix model) [25].

Both the innovation models included in the classification and the models developed separately confirm the characteristics of the innovation process: it is a dynamic, complex and

Classification of innovation models according to Marinova and Phillimore	Correlation with Rothwell classification
First generation—the black box model	-
Second generation—linear models	Technology-push model, market-pull model
Third generation—interactive models	Including coupling model and integrated innovation process models
Fourth generation—system models	Including network models and national innovation systems
Fifth generation—evolutionary models	-
Sixth generation—innovation milieu model	-

Source: Own elaboration with information from Refs. [18, 22].

Table 3. Correlations between classifications of innovation models.

progressive process. Accordingly, there were identified some trends in the process of development of the innovation models [18]:

- Formation of an innovation system extended at national level, like cluster model.
- The development of eco-innovation—is the innovation which aims to fulfill economic and ecological goals in the same time.
- Innovation systems adapted to local dimension or local problems.
- New models of innovation, without relations with the previous ones.

4. From closed to open innovation

The conceptualization of the innovation phenomenon and its description starts from the assumption that all the phases and activities involved in innovation process are developed inside the company, using its assets, human capital, and financial resources. The results of innovations are materialized in new products, services, processes, packaging, management systems and other which company itself sells on the market or uses inside the organization. This is the picture of a theoretical and ideal situation in which all the results of a company in the field of innovation are fully exploited on the market. In reality, the situation is different, i.e. very often, the companies are not able to fully use the results of innovation from objective reasons and a lot of efforts, work, commitment and money are lost. This situation was called “closed innovation” by the Henry Chesbrough, Executive Director at the Center for Open Innovation from the University of California, Berkeley. In a closed model of innovation, innovative ideas from a company are studied inside, in the research step; if they are considered valuable, they are transformed in products, processes and services, which are launched on the market. It means that not all the innovations arrived on the market; some of them are stopped for different reasons. There is only one direction for the innovation process, from the idea, research phase, and development to the final result and then to the market (**Figure 7**).

When the companies began to preoccupy for creating and implementing innovation, the universities and research institutions were not involved in the process of innovation; they were focused on the fundamental research. Some companies created their own research units for their internal purposes of development and innovation and managed all the activities inside the organization. From the basic research to the marketing and product sale, everything took place inside the boundary of the company. This is the classical example of closed innovation. The preoccupation of the organizations to keep everything inside led to suspicion and secrecy. The patents were hidden very well and even the company was not able to implement them into its production system.

But business has developed and it was obvious that the boundaries of a company must be more flexible, to be able to assure the integration of the organization in the economic environment. This has influenced, also, the innovation process within a company; a lot of good ideas that could not be incorporated for development due to the lack of money, time, appropriate qualification for the human resources, technical endowments or simply because the management

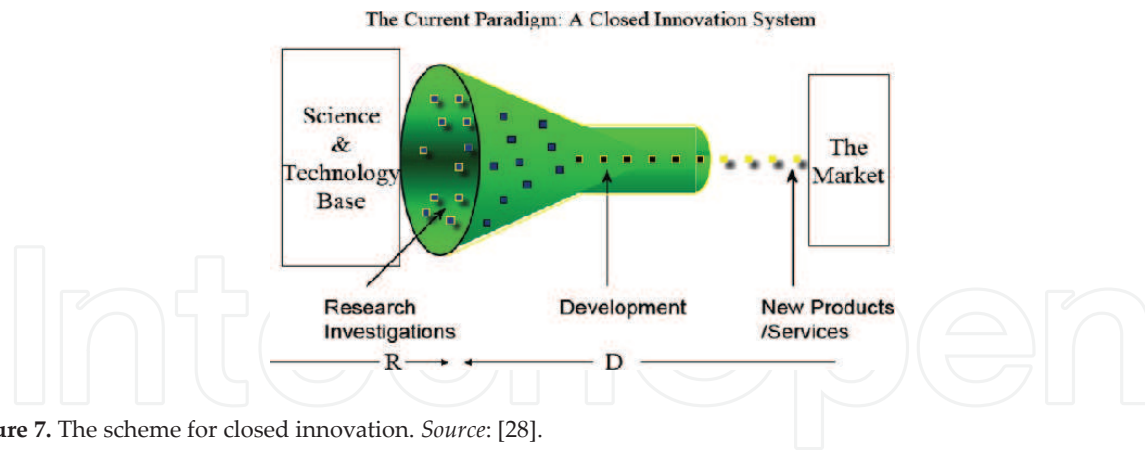


Figure 7. The scheme for closed innovation. Source: [28].

did not want to share them, could be developed by other companies, with mutual benefits. On the other hand, problems to which the company could not find solutions had the possibility to be solved in collaboration with external partners.

For the first time the concept of “open innovation” by Henry Chesbrough was launched, in contrast with “closed innovation”. According to his definition,

“Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology”. [26]

Open innovation is not based only on internal capacity to initiate and produce innovation, but also, on a business model developed by the companies. In a business model, a firm is not alone; it has multiple connections, collaborations, interactions with different stakeholders, is part of networks, clusters or other collaborative systems, situation that influence in positive or even in negative way its activity, including the innovation aspects. This opening of the organization to the external environment has developed as an answer to the complex and difficult problems of current society, where economic issues are intertwined with the environmental, political, and social ones. The solutions to these types of problems must be innovative and should result from an innovative process developed by all the stakeholders.

Chesbrough identified several characteristics of the open innovation concept [26]:

- Open innovation uses internal and external ideas to develop innovative solutions to its problems, requirements and goals.
- The research and development steps from the innovation chain are considered open systems.
- In open innovation, the useful knowledge is widely distributed in the economic environment to be accessible for all stakeholders.
- Open innovation is a valuable tool for dissemination of the information for innovation diffusion.
- Open innovation gives a new value to the intellectual property; in closed innovation, intellectual property is a secret that must be hidden very well and no one outside the company

has access to it. Open innovation considers intellectual property, a new class of assets of the company which can bring revenues and offer the possibility to participate in new business.

- Through open innovation, there are more possibilities to access funding, to penetrate new markets, and to extend or improve own activities.

Chesbrough propose a representation of open innovation (**Figure 8**), according to its definition and properties:

According to Chesbrough's representation, there is a continuous flux of information between the internal environment of the company and the external one, both in the phase of research and development. The concept of Open innovation has a big impact on the business model; the opening of the company to the external business space enhances the opportunities of organization to develop or to diversify its activities. Methods like licensing, strategic alliances, joint ventures, patenting and patent selling and buying, joint projects are only some of the channels promoted by the open innovation for a fully valorization of internal and external innovative ideas or even innovations themselves.

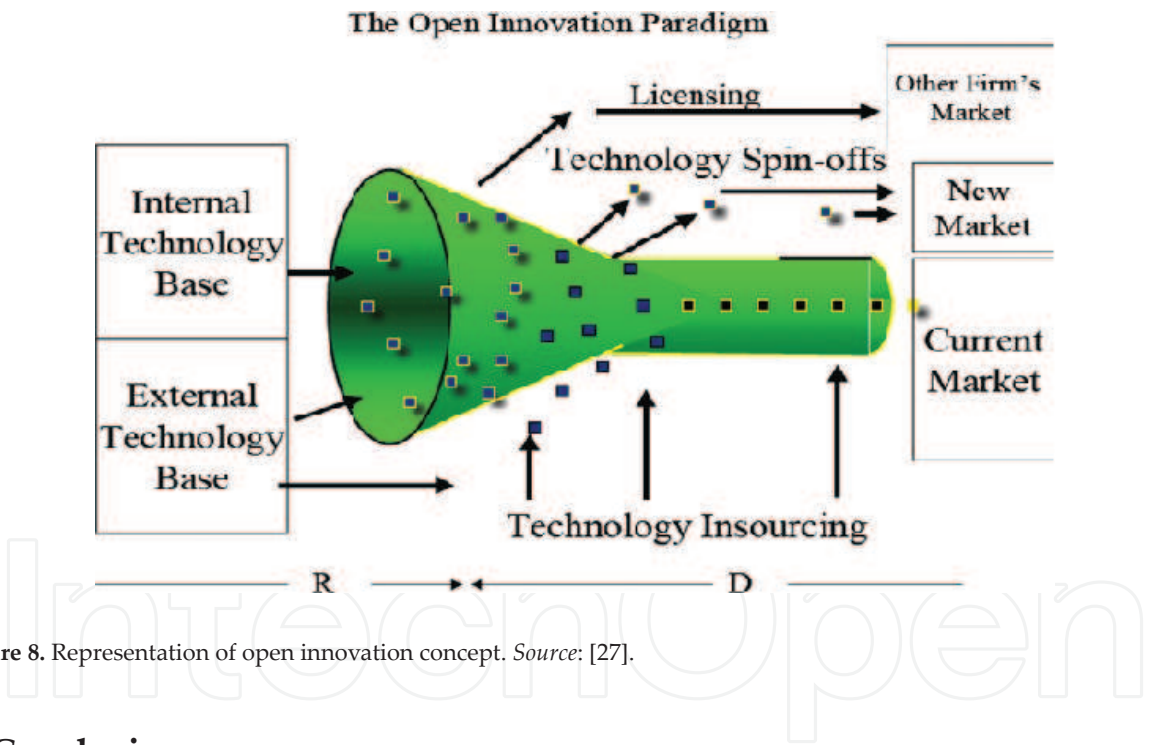


Figure 8. Representation of open innovation concept. Source: [27].

5. Conclusions

The subject of innovation is vast and the presentation of the basic concept must synthesize a big volume of information, in order to extract the essence of knowledge; the chapter highlighted the main elements necessary to understand and to use the concept in practice, especially in business sector. The innovative projects are a very useful tool for solving problems, improving activities, development and growth and their management is also a creative work. In this context, we can affirm that has begun a new era—the era of open innovation in all fields, including the project management.

Open innovation is not a singular trend; we can talk now about open research and development or open business models. All these new approaches represent innovative concepts adapted at the complex system of relations that characterized the global and globalized economy. The development of communication channels, the huge volume of information and its high speed of spreading allowed an intensive process of diffusion of innovations. The diffusion phase is placed at the end of the innovation process, after the penetration on the market. Over time, more and more individuals (or organizations) adopt the innovation and it becomes a routine, an usual product or service. The diffusion of innovation is as important as the innovation itself. The project management gives the possibility to diffuse innovations, to share information, competencies, experiences and best practices between the team members and to use innovative techniques or ideas for solving the problem and assuring an appropriate management during the entire period of the project.

For the future, there were identified several trends in innovation, namely in open innovation, regarding the perspectives of development and increase the efficiency [24]:

- The spatial trend—reflects the process of globalization; in a globalized world, the research expand its borders, the networks are common systems of collaboration, the co-opetition reshape the relations between organizations, with implication on the innovation process, which becomes more open and more focused on the specific problems;
- The trend related with the users—more often, the users are integrated into the innovation process. Their requirements and needs are the starting points for new innovations and, also, they contribute to the diffusion of innovations;
- The institutional trend—refers to the collaboration between public bodies and private companies in the field of innovation. Thus, the two types of organizations are now deeply involved together in the innovation process with mutual advantages. The Triple helix model of innovation, which presents the collaboration between universities, authorities and business sector depicts very accurate this trend; concepts as “entrepreneurial university” show that it is possible to assume the tasks from one to another, based on an innovative system of relations;
- The cultural trend—innovation, but especially open innovation is a mental process. The disappearance of barriers, specific to open innovation allows the process of creating of a new culture in the field of innovation and research. The syndrome “Not invented here,” specific to closed innovation, is overcome and the new culture of dissemination of knowledge, competencies and best practices represents a condition for the development of open innovation.

We can conclude that adopting innovation is now a condition for survival on the market and open innovation is a strategic decision for the future development of the business sector in any country.

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