Moya, Bernardo Llamas (Ed.); Storch de Gracia, María Dolores (Ed.); Mazadiego, Luis Felipe (Ed.)

Book

Key issues for management of innovative projects

Chapter 1

Fundamentals of Innovation

Angela Albu

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.69005

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. Evan 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 form 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
• The act of introducing something new. • Something newly introduced	The American Heritage Dictionary [9]
• 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]

Source: 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 leaded 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].

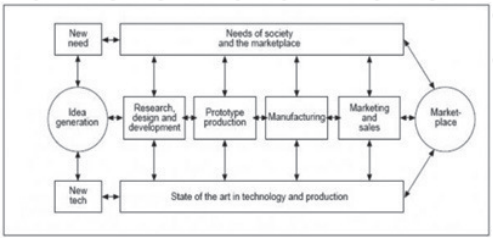

Figure 5. The coupling model of innovation. *Source*: [19].

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,

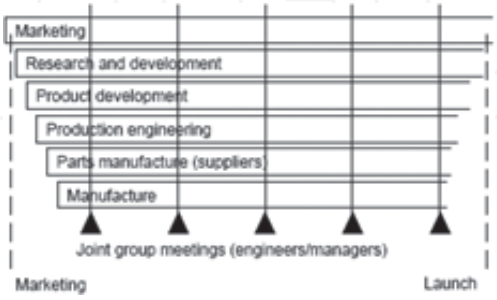

Figure 6. Functional integrated innovation models. *Source*: [20].

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

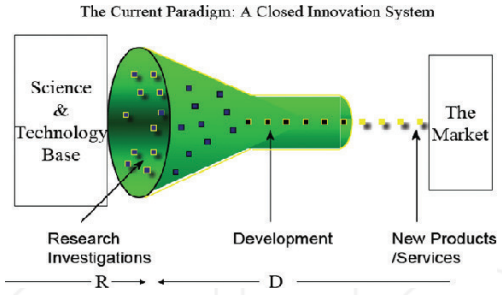

Figure 7. The scheme for closed innovation. *Source*: [28].

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.

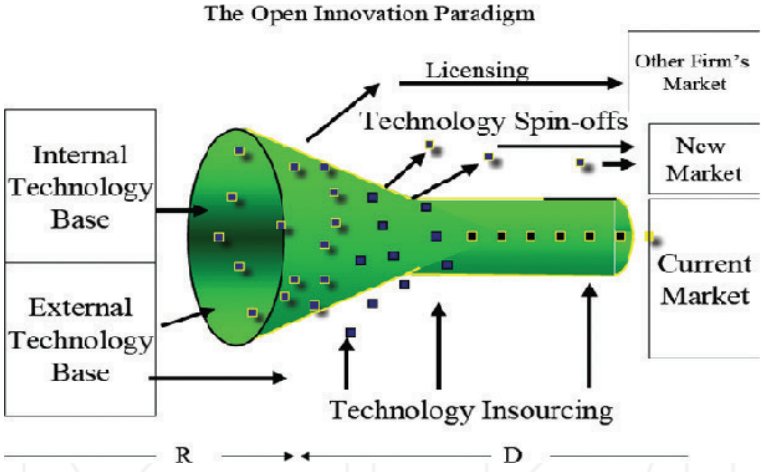

Figure 8. Representation of open innovation concept. *Source*: [27].

5. Conclusions

The subject of innovation is vast and the presentation of the basic concept must synthetize 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.

Author details

Angela Albu

Address all correspondence to: angelaa@seap.usv.ro

"Stefan cel Mare", University of Suceava, Romania

References

[1] Sledzik K. Schumpeter's View on Innovation and Entrepreneurship. https://www.researchgate.net/publication/256060978_Schumpeter's_View_on_Innovation_and_Entrepreneurship [Accessed 1st November 2016]

[2] Croitoru A. Schumpeter, J.A., 1934 (2008), the theory of economic development: An inquiry into profits, capital, credit, interest and the business cycle. A review to a book that is 100 years old. Journal of Comparative Research in Anthropology and Sociology. 2012;3(2):137-148. Available from: http://compaso.eu/wpd/wp-content/uploads/2013/01/Compaso2012-32-Croitoru.pdf [Accessed: 29th October 2016]

[3] Fagerberg J. Innovation: A Guide to the Literature [Internet]. 2003; Available from: http://in3.dem.ist.utl.pt/mscdesign/03ed/files/lec_1_01.pdf [Accessed: 29 October 2016]

[4] Scotchmer S. Standing on shoulder of giants: Cumulative research and the patent law. The Journal of Economic Perspectives. 1991;5(1):29-41. Available from: http://ist-socrates.berkeley.edu/~scotch/giants.pdf [Accessed: 3 November 2016]

[5] Amabile TM. A model of creativity and innovation in organizations. Research in Organizational Behavior. 2010;10:123-167. Available from: http://web.mit.edu/curhan/www/docs/Articles/15341_Readings/Group_Performance/Amabile_A_Model_of_CreativityOrg.Beh_v10_pp123-167.pdf [Accessed: 8 February 2017]

[6] Adams K. The sources of innovation and creativity. National Center on Education and the Economy. 2006. Available from http://www.fpspi.org/pdf/innovcreativity.pdf [Accessed: 31 January 2015]

[7] Schumpeter AJ. Capitalism, Socialism & Democracy. London and New York: Taylor & Francis e-Library; 2003. Available from: http://cnqzu.com/library/Economics/marxian%20economics/Schumpeter,%20Joeseph-Capitalism,%20Socialism%20and%20Democracy.pdf [Accessed: 25 February 2013]

[8] http://innovationzen.com/blog/2006/11/17/the-definition-of-innovation/ [Accessed: 28 October 2016]

[9] The American Heritage Dictionary of the English Language, Fifth Edition. 2016. Available from: http://www.hmhco.com/shop/books/American-Heritage-Dictionary-of-the-English-Language-Fifth-Edition/9780544454453# [Accessed: 28 October 2016]

[10] Websters-online-dictionary. Available from: http://alpha.totodefinition.com/search.php?word=innovation [Accessed: 28 October 2016]

[11] Drucker PF. Remarks on the Peter F. Drucker Award for Nonprofit Innovation. 2105; Available from: http://www.druckerinstitute.com/wp-content/uploads/2015/04/Drucker-on-Innovation-reading.pdf [Accessed: 1 November 2016]

[12] Idea Champions. The Heart of Innovation. 2010; Available from: http://www.ideachampions. com/weblogs/archives/2010/05/change_that_cre.shtml [Accessed: 29 October 2016]

[13] Razeghi A. The Riddle. Vol. 1. San Francisco: Jossey-Bass; 2008. p. 24. Available from: https://www.freshconsulting.com/what-is-innovation/ [Accessed: 6 November 2016]

[14] OECD. OECD Innovation Strategy. Available from: https://www.oecd.org/site/innovationstrategy/defininginnovation.htm [Accessed: 10 November 2016]

[15] Business dictionary. Available from: http://www.businessdictionary.com/definition/innovation.html [Accessed: 10 November 2016]

[16] OECD and Eurostat. Oslo Manual. Guidelines for Collecting and Interpreting Innovation Data. 3rd ed. 2005; Available from: http://www.conicyt.cl/wp-content/uploads/2014/07/Manual-de-Oslo.pdf [Accessed: 10 August 2016]

[17] Baregheh A, Rowley J, Sambrook S. Towards a multidisciplinary definition of innovation. Management Decision. 2009;47(8):1323-1339. DOI: 10.1108/00251740910984578. Available from: https://www.researchgate.net/profile/Sally_Sambrook/publication/41104662_Towards_a_Multidisciplinary_Definition_of_Innovation/links/0c96051e5a3eec5628000000.pdf [Accessed: 1 November 2016]

[18] Kotsemir M, Meissner D. Towards the Fifth-generation Innovation Process. Munich Personal RePEc Archive. 2013. Paper No. 46504. Available from: http://mpra.ub.uni-muenchen.de/46504/ [Accessed: 2 July 2013]

[19] Buyse K. Five Generations of Innovation Models. Available from: http://sis.ashesi.edu.gh/courseware/cms2_9/pluginfile.php/8754/mod_folder/content/0/Reading%201%20Rothwells%20five%20generations%20of%20innovation.pdf?forcedownload=1 [Accessed: 5 December 2016]

[20] Prahalad CK, Rothweel HG. Towards the Fifth-generation Innovation Process. 1994. Available from: http://mba7.tistory.com/attachment/cfile6.uf@135579464D32EB31069E9D.pdf [Accessed: 4 December 2016]

[21] Loebecke C, Van Fenema PC, Powell P. Co-Opetition and knowledge transfer. Database for Advances in Information Systems. 1999;30(2):14-25. Available from: http://ejournal.narotama.ac.id/files/set7.pdf [Accessed: 20 September 2015]

[22] Barbieri JC, Teixeira Álvares AC Sixth generation innovation model: description of a success model. 2016; Revista de Administração e Inovação 13: 116-127. Available from http://ac.els-cdn.com/S1809203916300158/1-s2.0-S1809203916300158-main.pdf?_tid=8918ca70-3b90-11e7-a124-00000aab0f6b&acdnat=1495087942_232abfece812c0d2837136696c112810 [Accessed 31th October 2016]

[23] Utterback J, Abernathy W. A dynamic model of process and product innovation. The International Journal of Management Science. 1975;3(6):639-656. Available from: http://scripts.mit.edu/~varun_ag/readinggroup/images/f/f6/Utterback_Abernathy_-_A_dynamic_model_of_process_and_product_innovation.pdf [Accessed: 1 October 2016]

[24] Van de Ven A. Central Problems in Management of Innovation. The Strategic Management Research Center University of Minnesota; 1984; Available from: http://pubsonline.informs.org/doi/abs/10.1287/mnsc.32.5.590 [Accessed 5 September 2015]

[25] Etzkowitz H, Leydesdorff L. The dynamics of innovation: From National Systems and ''Mode 2'' to a Triple Helix of university–industry–government relations. Research Policy. 2000;29:109-123. Available from: http://paca-online.org/cop/docs/Etzkowitz+Leydesdorf_The_dynamics_of_innovation_-_a_triple_helix.pdf [Accessed: 9 September 2013]

[26] Chesbrough H. Open innovation: A new paradigm for understanding industrial innovation. In: Chesbrough H, Vanhaverbeke W, West J, editors. Open Innovation: Researching a New Paradigm. Oxford: Oxford University Press; 2005. pp. 1-27. Available from: https://www.google.ro/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=0ahUKEwj8kMvYjMrRAhWEAJoKHSjeBN8QFggoMAI&url=https%3A%2F%2Fpdfs.semanticscholar.org%2Fc907%2F23301cc2c1d0040d3f32eec43371ff93e9eb.pdf&usg=AFQjCNEVJow6rb_LJFdLdosGSfIRjUGcTw&sig2=v6jbk5pVtugOJn_tNQqYrg [Accessed: 19th August 2013]

[27] Gassmann O, Enkel E, Chesbrough H. The future of open innovation. R&D Management. 2010; The Authors Journal compilation. Blackwell Publishing Ltd. Available from: https://www.alexandria.unisg.ch/62764/1/future%20of%20OI.pdf [Accessed: 18 August 2013]

[28] https://www.google.ro/search?q=Chapter+1+Open+Innovation%3A+A+New+Paradigm+for+Understanding+Industrial+Innovation+Henry+Chesbrough&oq=Chapter+1+Open+Innovation%3A+A+New+Paradigm+for+Understanding+Industrial+Innovation+Henry+Chesbrough&aqs=chrome..69i57.1288j0j8&sourceid=chrome&ie=UTF-8

Chapter 2

Key Issues to Improve Innovation Project Excellence

Biiljana Stošić and Radul Milutinović

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/67504

Abstract

Nowadays innovation becomes a focal point for corporate success and survival. Thus, in order to be more concurrent and to realize innovation that meets required goals and performance expectations, companies have to achieve excellence in managing the innovation process. Delivering innovations with unique benefits and real value to customers separates winners from losers more often than any other single factor. Therefore, the excellence in innovation projects becomes a necessity, and it implies recognition of all critical success elements that can affect and, in some way, do the harm to the process. There are a lot of factors and issues that can influence innovation project success and excellence. In this paper, we chose some of the critical elements, such as innovation strategy, idea management, innovation portfolio, innovation model, and risk management.

Keywords: innovation, innovation project, innovation strategy, risk management

1. Introduction

Not many words are needed to explain the importance of innovation and, consequently, innovation projects in today's rapidly changing economic environment, where competitive pressures impose companies to continually innovate to sustain profitable growth and business success. In other words, innovation becomes a necessity, not only through new product or service development but also through finding new business models which often implies changing the rules of the game, organizational innovation, through finding a new way to improve the efficiency of production and overall business, process innovation, as well as through implementation of new marketing methods [1].

Studies have shown that those companies who prioritize innovation are also those with the highest increase in turnover. In this regard, the research conducted by European Commission revealed that some 79% of companies that introduced at least one innovation since 2011 experienced increase of their turnover by more than 25% by 2014 [2]. Therefore, innovation gained a status of a key driver and precondition for competitiveness [3, 4], moreover, a key element of modern management and everyday culture.

Having in mind that a huge number of various factors, which potentially influence the innovation project excellence, can be identified in different environments (above all, organizational context and level), this study will be related to those that appear to be the most frequent and the most important. Achieving the project success is always a big challenge, which is even greater in the case of innovation, so the aim will be to overcome the perils and make the success possible. In this paper, we chose some basic elements that have to be included in the innovation process if a company wants to achieve excellence, and that, also, can be recognized in project excellence model presented in Ref. [5]. Those elements are innovation strategy, idea management, innovation portfolio, innovation model, and risk management. Different project excellence models can be found in the literature and practice, and all of them evolve regarding continuous learning and adaptation.

2. The concept of innovation and innovation project

Today, it is commonly accepted concept with a large number of definitions. One of the most cited, giving the widely accepted innovation framework, is presented in *Oslo Manual Guidelines* [1], explaining innovation as an implementation of a new or significantly improved product (good or service), or process, or a new marketing or organizational method. Having this in mind, there are four (conditionally) types of innovation and therefore innovation projects:

1. Product/service innovations.
2. Process innovations.
3. Organizational innovations.
4. Marketing innovations.

Innovation as specific form of change can be defined with respect to various aspects, and the following stand out:

- Drucker defines innovation as the specific tool of entrepreneurship, the means by which they exploit change as an opportunity for different business or a different service.
- Porter observes innovation as a possibility of the company to gain competitive advantage based on innovativeness and ability to realize innovation projects.
- According to Freeman industrial innovation includes technical design, production, management, and commercial activities involved in the marketing of a new (or improved) product or the first commercial use of a new (or improved) process or equipment.

http://dx.doi.org/10.5772/67504

- Rothwell used nature of innovation to define innovation, separating two forms of innovation: radical innovations and incremental innovation. Incremental innovation can be described as series of small improvement to an existing product that usually helps maintain or improve its competitive position over time. On the other side, the result of radical innovation is completely new products/services/processes, and it can be presented as a process in which the direction of the research is known, but the ultimate goal is not.

One innovation is successful if it produces the ability of the company to constantly contribute to the growth, through continuity and adaptation. The essential question is that of the approach to innovation that should be implemented in the firm; organization and its smaller units should be guided through the complex innovation process—from ideas created to sales, revenues, and profits achieved. For instance, a very useful concept is introduced (developed, recognized) by *InnovationLabs* consultants, called Innovation Master Plan, presented in the book with the same name. The *plan* follows the simple structure based on five critically important questions about innovation in the organization [6]:

1. Why innovate—a question about strategic nature of innovation, which explains the linkage between innovation process and intended results based on the innovation.

2. What to innovate—a question about designing and developing innovation portfolio, to prepare many innovation options for a wide range of possible futures.

3. How to innovate—a question about designing the innovation process that is going to identify, create, and develop ideas which are going to become innovations.

4. Who innovates—identifying who is going to participate. It is necessary to identify three roles for achieving broad and consistent innovation results. These roles are (1) innovation leaders, who set policies, expectations, goals, and the tone for the innovation culture; (2) innovation geniuses, who come up with great ideas and insights; and (3) innovation champions, who organize the pursuit of innovation and support those who develop great ideas and turn them into business value.

5. Where to innovate—a question about constitution of infrastructure, support systems, and tools that will be used to enable everyone inside and outside the organization, to participate effectively in the innovation process.

Since innovation means a process from idea to realization, in theory and practice, a growing consensus can be witnessed on innovation being looked at as a project. From the theoretical point of view, both innovation management and project management have evolved over time as two independent disciplines. On the other hand, practice showed just the opposite, namely, the most effective way to manage the lifecycle of innovation process is by using project management. Etymologically, the term project originates from Latin word *projicere* which means to throw something forward. Taking all this into account, the fact that innovations are mainly developed by applying the concept of project management is not surprising at all. Moreover, different authors from the field pointed out that overcoming the difficulties of moving from ideas to value creating can be achieved by using the principles, methods, and techniques of project management. One of the definitions explicating the connection between

innovation and project management identifies innovation projects as the management of a system that transforms inputs into outputs and has a feedback mechanism to ensure that the project output is consistent with its objectives [7].

Therefore, some specific features that distinguish innovation projects compared to conventional ones can be recognized as [8]:

- Conventional projects should have clearly defined objectives. Innovation projects, usually, starts with weakly defined, sometimes ambiguous objectives, which become clearer in the following phases of project. Procedures used are, mostly, experimental or research nature.
- Project teams are comprised of people of different professions (knowledge and skills, etc.), among whom should exist high level of trust.
- Considering the failure as a possible outcome, innovation project teams should with great concern take into consideration risk management.
- The ideas presented in innovation projects should be "sold" to "sponsors."

Bearing in mind the classification of innovation projects based on criteria of nature (intensity), we can talk about incremental and radical ones, as mentioned earlier. Incremental innovations are the most common forms of innovation in many companies, and on average approximately 80% of all investments in innovation in companies refer to them. This classification can be further developed connecting this types (incremental and radical) to key characteristics, such as project goals and objectives, uncertainties, and industrial sector. Additionally, in this classification imitation is also included, representing a creative effort for development of a product or service. Imitation is positioned before the incremental innovation, since it has the lowest innovative intensity. Innovation projects are executed in various industrial sectors (ranging from low- to high-tech). Speaking of high-tech sectors, the imitation projects involve reverse engineering of advanced technological products. Generally, that was a key element of industrialization strategy of many Southeast Asian economies [9].

High performance in projects and excellent project management has become imperative in today's business environment. Hence, resources engaged to projects have to be utilized in an effective and efficient manner with the intention of achieving maximum benefit to the stakeholders involved. Therefore, some authors define project success as the satisfaction of all stakeholders. There are a lot of factors and issues that can influence innovation project success. Some of them are mentioned as features of innovation projects. There cannot be generated a universal checklist suitable for any project, and this, also, works out for innovation. They will differ from project to project depending on a number of issues, for example, size, uniqueness, and complexity. At the company level, successful management of innovation project should include some basic elements [8]:

- Innovation strategy and organization.
- Creativity and idea management.
- Innovation portfolio.

http://dx.doi.org/10.5772/67504

- Innovation models.
- Risk management.

3. Creativity in innovation projects

The most successful companies today are those who are the most creative and innovative. Accordingly, innovation and creativity have become critical skills for achieving success in developed economies. To reach this position, leading companies often tend to distance themselves from the competition rather than compete with them (Apple as an example of the blue ocean strategy). In other words, they are able to leverage their own creativity and their innovation capabilities to attain long-term success. The need for creative problem solving becomes a necessity since more and more management problems require creative insights in order to find suitable solutions. Many examples in the practice have shown that companies increase their productivity by stimulating creativity and exploring completely new and unknown territories (3M Company gives to its researchers time to work on projects that they consider important for the company, and 15% of the weekly working time they can devote to such activities [8]). Encouraging the employees' creative thinking and giving them time and resources to explore new areas for innovative ideas are the key to cost-effective business solutions.

One of the definitions that may be considered as the most comprehensive, designates creativity as the production of novel and useful ideas (some would say ideas that have value). An idea is still novel even if someone else already invented it without your knowing or in a different context. And an idea is still useful for your company even if another company has already applied it [10].

Creativity goes hand in hand with innovation. It can be said that there is no innovation without creativity. While creativity is the ability to produce new and useful ideas, innovation is the implementation of that creativity, in the form of new product, service, process, and business model. In other words, every innovation starts with a creative idea and all together represents a part of fuzzy front end of innovation process [10].

Creativity and innovation are used interchangeably. This is reflected in the commonly accepted definition of innovation equaling creativity plus (successful) implementation. Creativity by itself —coming up with new ideas—is not enough. von Stamm [11] in her work gave some examples of great inventors, who were not able to gain the benefits to their effort—X-ray scanner, invented by Electric and Musical Industries (EMI) but General Electric made a commercial success; VCRs which had been invented by Ampex/Sony but were successfully commercialized by Matsushita; or the vacuum cleaner invented by Mr. Spengler but commercialized by Hoover.

In order to be successful and to achieve implementation, companies need processes, procedures, and structures that allow the timely and effective execution of the projects and that allow for good ideas to come to right place.

Idea management systems offer people a perfect outlet to which they can submit their ideas and, therefore, enable for good ideas to come to right place. For companies, it can be a perfect

way to capture and further develop ideas. They should no longer remain in the drawer. These systems can help to recognize the need for ideas and to generate and evaluate them. Ideas could come from different sources—employees, customers, or suppliers. According to the research conducted by Erasmus University Rotterdam, there are three different types of idea management systems (programs): HR idea management systems, R&D idea management systems, and marketing idea management systems. HR idea management systems are used to collect ideas that improve processes and save money for the company. These systems focus on the employees of the company. The ideas that employees submit are often quite small incremental. One such system engages company DHL. The focus is different concerning R&D idea management systems. These systems care very much about the ideas that people submit. The ideas can come from their own staff or from outside people and organizations. Shell uses one of these systems, named "GameChanger." R&D systems are managed by R&D department and ideas generated are radical. Finally, the focus of marketing idea management systems is on customer. In that way, companies try to engage with customer. Starbucks is using this system. Marketing systems represent very effective marketing and communication tools and result in incremental ideas.

4. The role of innovation strategy

One of the critical points of innovation management excellence refers to the strategic decision-making in the field. These strategic decisions should make balance between companies' ability and opportunities that exist in the environment so as to achieve long-term business objectives. Innovation strategy should support business strategy, acting as a mediator between the company and its environment in the innovation domain. It should be synchronized with other strategies in the organization, such as technological, marketing, manufacturing, and strategy of intellectual property [8].

Innovation strategy is often a crucial step for new company to join the existing market. As well, the existing organizations are using this strategy as an advantage if they have the ability to recognize this advantage. Innovation strategy is grounded on the business model and technology of the companies. Various companies have confirmed in practice that successful implementation of innovation requests a combination of technological change with the change of business model [12].

Generally, there are three key areas in which innovation strategy is associated with the change of business model (**Figure 1**) [12, 13]:

1. Value proposition—**What** is going to be sold and delivered to the market.
2. Supply chain—**How** is it going to be created and delivered to the market.
3. Target customer—**Who** is going to use it.

The process of developing an innovation strategy, similar to the creation of any good strategy, should start with a clear understanding and articulation of specific objectives related to achieving a sustainable competitive advantage. It should answer the following questions [14]:

http://dx.doi.org/10.5772/67504

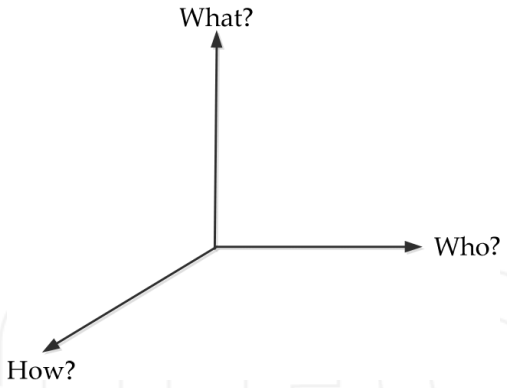

Figure 1. Strategic positioning map [13].

1. How will innovation create value for potential customers?

   Innovation can create value in many ways. After choosing what kind of value the innovation will create, it is important to stick to that, because the capabilities required for each are quite different and take time to accumulate. Apple consistently chose to make its products easier to use than competitors' and to provide a seamless experience across its expanding family of products and services.

2. How will the company capture a share of the value its innovations generate?

   The big problem for innovations is that they attract imitators as quickly as customers. The intellectual property alone is not enough to block these rivals. It is essential for companies to think of complementary assets, capabilities, products, or services that could prevent customers from deserting to rivals and keep their own position in the ecosystem strong. One of the best ways to preserve the position is to continue to invest in innovation.

3. What types of innovations will allow the company to create and capture value, and what resources should each type receive?

   Undoubtedly, technological innovation is a huge creator of economic value and a driver of competitive advantage, but in the past couple of decades, we have witnessed companies like Netflix, Amazon, LinkedIn, and Uber, which power relies on business model innovation. So innovation strategy should specify how the different types of innovation fit into the business strategy and, also, to allocate the resources to each innovation [14].

As already stated, innovation becomes necessity, not only through new product or service development but also through finding new business models which often implies changing the rules of the game [15]. To be successful, a company has to be skillful to break those rules, moreover, to have the ability to strategically redefine its business and play an altogether different game in order to succeed on the long term. Having in mind aforesaid, Markides suggests strategic innovation as a solution for breaking the rules of the game [13]. These new game activities can be performed all over a value chain in one business system [15, 16].

As it can be seen from **Figure 2**, dramatic redesign of the end-to-end value chain architecture can be accomplished improving the efficiency of the end-to-end value chain. For example, IKEA uses standardization by making one type of a product that enables efficient transportation. Dramatic reinvention of the concept of customer value is related to changing the value that customers receive. For example, in addition to selling hardware, IBM moved into supplying total business solutions. Dramatic redefinition of the customer base is related to expanding the size of the market. For example, at a time when computers were used only in corporations and other institutions, Apple made personal computers for individuals.

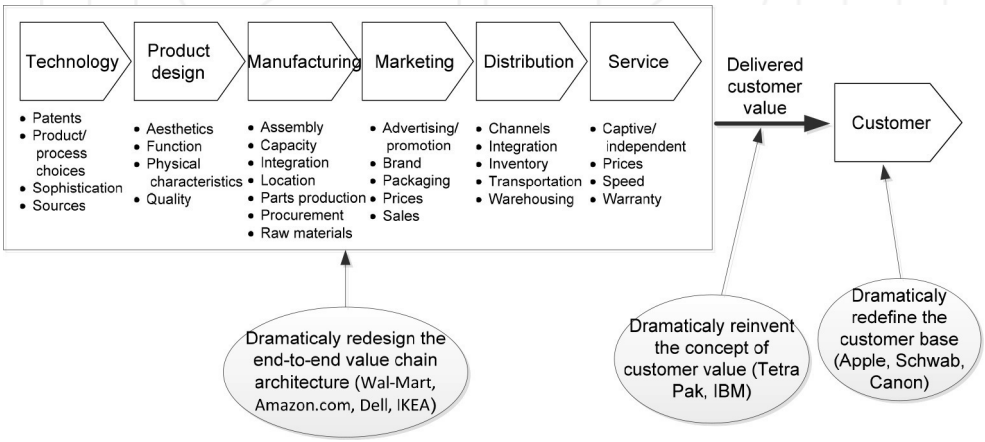

Figure 2. Areas for changing the rules of the game (adapted from Refs. [15, 16]).

Kaplan in his book [17] named the process of changing the game as leapfrogging. In fact, leapfrogging is about creating something completely new or doing something radically different that empowers company to significantly leap forward. If individuals, groups, or organizations prefer to become the new leaders of the future, they have to leapfrog old ways of doing things [17].

Very important factor for defining the innovation strategy for the company is its competence, regarding existing structure and knowledge. Some authors indicate strategy as the architecture that builds competence. The results of empirical research in this area confirmed that the degree and nature of innovativeness are in close relation to the choice of strategy of innovation leader or follower. Companies that choose first strategy mostly develop product innovation, whereas others mostly initiate process innovation [8].

According to innovation matrix presented in Ref. [12], companies focus their resources in selected segments and thus create a portfolio of investments. Depending on the position of investment in the matrix, two types of innovation strategy can be recognized [12]:

- Playing to win (PTW)—strategy of innovation leader. Company invests in new technology or business model in order to be ahead of competitors. The leadership position is achieved on the basis of different types of innovation: incremental, semi-radical, and radical (e.g., Amazon.com, Apple).

- Playing not to lose (PNTL)—strategy typically involves more incremental innovations, aiming to maintain the position of the company in the existing environment by moving slowly and with lower risk (e.g., Johnson & Johnson, Hyundai).

Furthermore, strategy of innovation leader and follower can be perceived as proactive and reactive [18]. Proactive is a strategy of innovation leader. Companies seek to predict and anticipate changes in the environment and, thus, to seize the opportunities. Reactive is a strategy of innovation follower. Companies respond to the customers' demand and needs and to competitors' activity. As a result of previous typologies of innovation strategies, it can be concluded that it is inherent to innovation leaders to engage PTW strategy and proactive strategy while innovation followers engage PNTL strategy and reactive strategy.

5. Innovation project models

Even though the importance of innovation is recognized by most companies and they spend a lot of money on innovation, many of these initiatives do not generate reasonable profit or competitive advantage. Plenty of research on this topic reveals that the main problem does not lie in the invention part or the generation of innovative ideas, but more in the successful management of the innovation process [19]. Successful innovation demands a rigorous and disciplined stage-by-stage approval process combined with regular measurement of every critical factor, ranging from time and money spent to the success of new products in the market.

Speaking of innovation processes from idea to commercialization, literature proposes a lot of different models. Basically, six generations of models can be found, from simple linear to increasingly complex interactive and network ones [20] up to new concept of open innovation (**Table 1**).

Generation	Model	Characteristics
First	Technology push	Simple linear sequential process, emphasis on R&D; market is the recipient of the R&D results
Second	Market pull	Simple linear sequential process, emphasis on marketing; the market is the source of new ideas for R&D; R&D has a reactive role
Third	Coupling model	Recognizing interaction between different elements and feedback loops between them, emphasis on integrating R&D and marketingStage-Gate process
Fourth	Interactive model	Combinations of push and pull models, integration within firm emphasis on external linkages
Fifth	Network model	Emphasis on knowledge accumulation and external linkages, systems integration, and extensive networking
Sixth	Open innovation	Internal and external ideas as well as internal and external paths to market can be combined to advance the development of new technologies

Table 1. Development of innovation models.

Previous table suggests a chronological review of model development, where shifting of models from conventional and unilateral to interactive combination of push and pull models, and contemporary, network models based on knowledge can be clearly noticed.

5.1. Stage-Gate as a linear model

Earlier domination of the linear models is evident, together with evolving of much sophisticated and more realistic models that overcome common weaknesses and limitations of the conventional approach. This can be perceived in development and alignment of the well-known Stage-Gate® model, which, basically, followed a linear template. Stage-Gate models stand for industry standard for excellence in new product/service development. According to several independent research studies, about 80% of leading US companies now use Stage-Gate to drive new products to market. The model enables efficiency improvement and reduction of failure in any case, whether it is launching of new product or technology that could change the competitive image in the market, introduction of new products that could generate additional income for the company, or defense of company's market share by introduction of significantly improved product (**Table 2**). When embraced by organizations, this model generates an organizational culture that includes existence of the new product development process leader, strategic responsibilities definition, high-performance teams, focus on customers and markets, excellent solutions, compliance, discipline, speed, and quality [22].

Benefits [22]	Common errors and fail points [23]
Accelerated speed to market	Gates with no teeth
Increased new product success rates	Hollow decisions at gates
Decreased new product failures	Who are the gatekeepers?
Increased organizational discipline and focus on the right projects	Gatekeepers behaving badly
Fewer errors, waste, and rework within projects	Too much bureaucracy in the idea-to-launch process
Improved alignment across business leaders	Too much reliance on software as a solution
Efficient and effective allocation of scarce resources	Expecting the impossible from a process
Improved visibility of all projects in the pipeline	
Improved cross functional engagement and collaboration	
Improved communication and coordination with external stakeholders	

Table 2. Advantages and disadvantages of Stage-Gate model [21].

The model provides a conceptual and operational roadmap for guiding new product development, from idea to launch. Stage-Gate approach in its core represents a simple model that divides innovation process into distinct stages separated by management decision gates (**Table 3**) [24].

Stages are activities assumed by members of the team in order to collect the information needed for project progress. The stages are cross functional (there is no research and development or marketing stage), and activities are undertaken in parallel to speed up the time to market [24].

http://dx.doi.org/10.5772/67504

Stage	Preliminary investigation	Build business case	Development	Testing and validation	Full production and market launch
Gate	Initial screen	Preliminary approval	Decision on business case (project approval)	Post-development review	Pre-commercialization business analysis

Table 3. Stage-Gate model.

The model is organized so as in front of each stage is a gate. Gates are points where decision is made about whether or not to continue investing in an innovation project. This decision is made by both internal managers and external experts, so-called gatekeepers. The role of the gates is to check whether the project met all the criteria identified in previous gate and to check whether the project meets the criteria for the current phase.

The main elements of every gate are the following [24]:

- Deliverables—results of actions from the previous phase
- Criteria—predefined criteria on which the decision on project are made (what the project is judged against)
- Outputs—results of the decision (go/kill/hold/recycle)

The predefined criteria can be different from qualitative to quantitative, and some of them must meet, while some should meet. Specific criteria are different from gate to gate and become more rigorous with the progress of the project, and some of them can be judged in every gate.

High-level risk taking is one of the innovation project characteristics that have big influence on the innovation process stability. Thus, in order to respond in the right time and manner, it is necessary to carry out risk assessment. So, to achieve stabile innovation process of big importance is to carefully choose the right gatekeepers and criteria within the gates.

5.2. The triple A system: adaptive, agile, and accelerated

The original Stage-Gate model was created in the 1980s, based on a thorough study of successful corporations that successfully launched new products to market. This study primarily, practices and lessons learned, provided the foundation for that early stage and gate model. Since then, Stage-Gate is being evolved and incorporated with many new practices. Some companies have also developed their own versions, adjusting it to their need [25]. Stage-Gate process, generally, has a positive impact on the conception, development, and launch of new products [24, 26, 27], but there are also criticisms; it is accused of being too linear, too rigid, and too planned to handle more dynamic projects [28, 29]. The world has changed a lot since the first Stage-Gate system was implemented; the environment in which the companies are doing their job is now different.

Concerning previous, Cooper suggested next generation of idea to launch system, recognized as "Triple A system." It seems a lot like the traditional process of Stage-Gate, but the details of the process and its function are quite different. There are still stages where work

gets done and gates where decisions are made. Newness is more adaptive and flexible, agile, and accelerated [25].

5.2.1. Adaptive and flexible

For the next-generation model, being adaptive means that it incorporates spiral or iterative development to bring something early to the market through a series of build-test-revise iterations with customers. This upgrading is very good for the process since through these iterations the product evolves by adapting to new information gathered from customers. The system is also flexible to the extent that actions for each stage and the deliverables to each gate are unique to each development project, based on the context of the market and the needs of the development process. Gates are flexible, meaning that there are no standard sets or universal criteria for each gate [25].

5.2.2. Agile

The next-generation system as well incorporates elements of agile development, the rapid development system firstly introduced by the software industry. Introduction of agile development enables usage of short time-boxed increments, in form of sprints and scrums, in which the deliverable is something that can be demonstrated to stakeholders. This is in direct contrast to non-agile approaches, which led to the extensive delays, cost overruns, and sometimes brutally terminal failure [30]. Equally, the agile systems emphasize moving quickly and nimbly from milestone to milestone and rely on a much leaner system with all waste removed; there are no bureaucracy and no unnecessary activities anywhere in the system [25].

5.2.3. Accelerated

The next-generation idea-to-launch system is focused on accelerating the development process. This imposes overlapping of the activities within stages and even stages. The idea of a "stage" is less relevant in this new system. This feature enforces projects in the system to be properly resourced, fully staffed by a dedicated cross functional team for maximum speed to market. Also, fuzzy front end is brought to the forefront, in order to make less fuzzy, so that the project is clearly scoped and key unknowns, risks, and uncertainties identified as early as possible. Here, robust IT support is provided to reduce work, provide better communication, and accelerate the process [25].

5.3. Connecting the open innovation to Stage-Gate

The main question in today's business environment is no longer why innovate, but how to innovate. Consequently, theory and practice recognized that not all good ideas come from inside the firm; neither all good ideas emerged within the particular firm should be commercialized by that same firm [31]. To bridge this gap, open innovation has emerged. Chesbrough coined the term "open innovation" to describe 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 [32]. While some think that "open innovation paradigm" is a new concept, there are some authors such as Trott and Hartmann [33] who

http://dx.doi.org/10.5772/67504

claim that this paradigm represents just an old wine in new bottles. They think that this model has been used over the past 40 years within the theory and practice on innovation management.

For the successful implementation of this model, the organization should define the business in a way to use advantage of both internal and external ideas and to build an adequate business model, which will provide greater value for the organization. Since it is easy to access to a lot of external knowledge, companies which have been using Stage-Gate model for their new product/service development make a great effort to empower their model connecting it with open innovation features [34]. Using the open innovation in new product/service development implies its involvement in all of the stages of innovation process.

5.3.1. Ideation or discovery stage

The first stage of the innovation process/project is always generating ideas—ideation—representing the part of fuzzy front end. In this stage, companies go across of their borders looking for external information (ideas for new product/service development) that could be helpful in satisfying customer's needs [35]. A lot of companies such as Starbucks, P&G, and BMW use open ideation through engagement of co-creation, crowdsourcing, and gamification.

5.3.2. Building the business case

This stage implies detailed business case, that is, defined product, business justification, and a detailed action plan for the next stage [24, 26, 36]. By opening up, this stage considers actions such as identification of missing internal capabilities by seeking for potential partners who will provide technological or marketing capabilities to develop and commercialize new product/service [35].

5.3.3. Development stage

The main purpose of this stage is implementation of the business case and development of the first prototype [24, 36]. As to the open Stage-Gate, companies cooperate with suppliers or partners in order to solve the technology and development problems. Moreover, here companies can out-license or sell their internally developed technologies and intellectual property [35].

5.3.4. Launch or commercialization stage

This stage starts with full production and commercial launching of the product and sales. Monitoring of the innovation project and detecting and correcting mistakes are specific actions of the stage [24, 36]. Opening up this stage, the company can out-license already commercialized products if there is a possibility to gain more value elsewhere or to in-license, purchase, an already commercialized product for achieving new growth for the company [35].

Gates and therefore criteria within the gates must also be modified. If some company does not have all the capabilities needed to develop or execute a project, it does not lead to a "kill," but leads to looking for a partner to handle the missing elements [35].

P&G made an effort to develop and introduce the new version of SIMPL™ [37], the one enforced with open innovation, frequently cited as SIMPL 3.0 [35]. General Electric also engages the open Stage-Gate named "Toll-Gate" for handling an open innovation, both outbound and inbound [35].

6. Risk assessment in innovation projects

Considering the fact that innovation ventures carry considerable risk that cause more than one half of the individual innovation undertakings to fail, companies have to find the way to succeed in commercial success. By itself, risk can appear in any aspect of innovation project and consequently can result in cost overruns, schedule delays, and even poor quality [38]. Therefore, risk management in innovation projects is an important topic for practitioners and academic scholars, and therefore today it is being increasingly incorporated into business models. According to survey conducted by Murray et al. [38], the majority of participants—managers with extensive project management experience—confirmed that they have used some kind of risk management techniques.

The main purpose of risk management is to improve project performance through systematic identification, appraisal, and management of project-related risk [39]. The risk management process can be considered as a very useful to decision-making regarding the possibility of future events and their impact on established objectives. It includes the application of logical and systematic methods for [40]:

- Communicating and consulting throughout this process.
- Establishing the context for identifying, analyzing, evaluating, and treating risk associated with any activity, process, function, or product.
- Monitoring and reviewing risks.
- Reporting and recording the results appropriately.

Risk assessment is a part of risk management which provides a structured process of risk identification, risk analysis, and risk evaluation. The way in which this process is applied depends not only on the context of the risk management process but also on the methods and techniques used to carry out the risk assessment [40]. Various supporting techniques can be used to improve accuracy and completeness in risk identification, risk analysis, and risk evaluation. Numerous techniques and methods for risk assessment divided by the phases of risk assessment are presented in International Standard 31010 [40].

In literature and practice, it can be found a lot of different risk categories that can affect project objectives and that can be observed for various projects. In this paper we presented one risk categorization proposed by Keizer et al. [41], which is very important since it is related to new product development. These categories of risk are recognized as critical success factors in product innovation projects. Three main risk categories, technology risks, organizational risks, and business risks, and 12 subcategories are identified (**Table 4**). *Technology risks* refer to

product design, manufacturing technology, and intellectual property. *Organizational risks* refer to internal project management and external organizational influences. *Business risks* refer to issues such as the impact of a new product on the company's brand positioning, consumer and trade acceptance, commercial viability, and the potential actions of competitors [41].

	Level 1	Level 2
New product development project risk categories	Technology risks	Product technology risks
		Manufacturing technology risks
		Intellectual property risks
	Organizational risks	Supply chain and sourcing risks
		Screening & appraisal
		Organizational and project management risks
	Business risks	Product family and brand positioning risks
		Consumer acceptance risks
		Trade customer risks
		Competitor risks
		Commercial viability risks
		Public acceptance risks

Table 4. NPD risk categories (adapted from Refs. [41, 42]).

This categorization of new product development risk can be found further decomposed on 142 more project issues, which are, also, recognized as critical factors for successful NPD.

7. Conclusion

Generating a continuous stream of innovation successes is an elusive goal. But the quest goes on, because the goal is so important to business success and excellence. This paper has provided an overview of some of the key factors for achieving innovation project excellence and hence insights into how to win in developing and launching new products. The recognized critical elements are innovation strategy, creativity and idea management, innovation portfolio, innovation model, and risk management.

Innovation strategy is very important for the innovation process and it represents a starting point. The role of the innovation strategy is to make balance between companies' ability and opportunities that exist in the environment so as to achieve long-term business objectives. There are four essential tasks in creating and implementing an innovation strategy. The first is to answer the question "How are we expecting innovation to create value for customers and for our company?" The second is to create a high-level plan for allocating resources to the different kinds of innovation; the third is to manage trade-offs, because every function will naturally want to serve its own interests; only senior leaders can make the choices that are best for the whole company. The final challenge facing senior leadership is recognizing that

innovation strategies must evolve. Like the process of innovation itself, an innovation strategy involves continual experimentation, learning, and adaptation. Without an innovation strategy, different parts of an organization can easily wind up pursuing conflicting priorities—even if there is a clear business strategy [14].

Creativity is also one of the critical factors for companies in achieving long-term success. The need for creative problem solving becomes a necessity since more and more management problems require creative insights in order to find suitable solutions. Stimulating creativity and exploring completely new and unknown territories lead to increasing the productivity of the company. Introduction of idea management systems is closely connected to creativity and consequently ideation. These systems enable an outline for ideas to come to the right place and to be implemented.

One of the most significant factors in achieving innovation project excellence represents implementation of adequate innovation model. Successful innovation project requires a rigorous stage-by-stage process. There are six generations of models that evolve in line with new practices. Today, they are adaptive and flexible, agile, and accelerated and, also, enable the involvement of external knowledge through application of open innovation.

Considering the fact that innovation ventures carry significant risk that causes more than one half of the individual innovation undertakings to fail, companies have to find the way to succeed in commercial success. In order to minimize the risk in innovation projects, companies have to take into account the risk management as one of the most important factors for innovation project success.

Author details

Biiljana Stošić and Radul Milutinović*

*Address all correspondence to: radul.milutinovic@fon.bg.ac.rs

Faculty of Organizational Sciences, University of Belgrade, Belgrade, Serbia

References

[1] OECD & Eurostat. Oslo Manual—Guidelines for Collecting and Interpreting Innovation Data. 3rd ed. Joint Publication, Paris; 2005.

[2] European Commission. Internal Market, Industry, Entrepreneurship and SMEs [Internet]. Available from: http://ec.europa.eu/growth/industry/innovation_en [Accessed: 26/12/2016].

[3] Petrovic, D., Mihic, M., & Stosic, B. Strategic IT portfolio management for development of innovative. In: Handbook on Strategic Information Technology and Portfolio

Management. IGI Publishing, Hershey, PA 17033, USA; 2009. pp. 150–169. DOI: 10.4018/978-1-59904-687-7.

[4] Stosic, B., Milutinovic, R., Zakic, N., & Zivkovic, N. Selected indicators for evaluation of eco-innovation projects. Innovation: The European Journal of Social Science Research. 2016;**29**(2):177–191. DOI: 10.1080/13511610.2016.1157682.

[5] Westerveld, E. The project excellence model®: linking success criteria and critical success factors. International Journal of Project Management. 2003; **21**(6):411–418. DOI: 10.1016/S0263-7863(02)00112-6.

[6] Morris, L. The Innovation Master Plan. Walnut Creek, CA: InnovationLabs; 2011.

[7] Anbari, F. Innovation project management and six sigma method. In: Rahim, M.A. and Golembiewski, R.T., editors. Current Topics in Management. 10th ed. New Brunswick, NJ: Transaction Publishers; 2005. pp. 101–116.

[8] Stosic, B. Innovation Management—Innovation Projects, Models and Methods. Belgrade: Faculty of Organizational; 2013.

[9] Filippov, S., & Mooi, H. Innovation project management: a research agenda. Journal on Innovation and Sustainability. 2010;**1**(1).

[10] Amabile, T.M. Creativity in Context: Update to the Social Psychology of Creativity. Westview Press, New York; 1996.

[11] von Stamm, B. Managing Innovation, Design and Creativity. 2nd ed. John Wiley & Sons, The Atrium, Southern Gate, Chichester, West Sussex, England; 2008.

[12] Davila, T., Epstein, M., & Shelton, R. Making Innovation Work: How to Manage It, Measure It, and Profit from It. Upper Saddle River, New Jersey: Pearson Education, Inc.; 2013.

[13] Markides, C. Strategic innovation. Sloan Management Review. 1997;**38**(3):9–24.

[14] Pisano, G.P. You need an innovation strategy. Harvard Business Review. 2015;**93**(6):44–54.

[15] Afuah, A. Strategic Innovation: New Game Strategies for Competitive Advantage. New York, NY: Routledge; 2009.

[16] Govindarajan, V., & Gupta, A.K. Strategic innovation: a conceptual road map. Business Horizons. 2001;**44**(4):3–12.

[17] Kaplan, S. Leapfrogging: Harness the Power of Surprise for Business Breakthroughs. Berrett-Koehler Publishers, San Francisco; 2012.

[18] Urban, G.L., & Hauser, J.R. Design and Marketing of New Products. Prentice Hall, Upper Saddle River, New Jersey; 1993.

[19] Du Preez, N.D., & Louw, L. A framework for managing the innovation process. In: PICMET'08-2008 Portland International Conference on Management of Engineering & Technology; IEEE; 2008. pp. 546–558. DOI: 10.1109/PICMET.2008.4599663

[20] Rothwell, R. Successful industrial innovation: critical factors for the 1990s. R&D Management. 1992;**22**(3):221–239.

[21] Stosic, B., & Milutinovic, R. Possibilities of Opening up the Stage-Gate Model. Romanian Statistical Review. 2014;**62**(4):41–53.

[22] Stage-Gate® International. Innovation Process: Stage-Gate® Idea-to-Launch Model [Internet]. Available from: http://www.stage-gate.com/resources_stage-gate_full.php [Accessed: 26/12/2016].

[23] Cooper, R.G., & Edgett, S.J. Maximizing productivity in product innovation. Research Technology Management. 2008;**51**(2).

[24] Cooper, R. Winning at New Products: Creating Value through Innovation. 3rd ed. New York: Basic Books; 2011.

[25] Cooper R.G. What's next—after stage-gate?. Research Technology Management. 2014;**57**(1):20–31.

[26] Cooper, R.G. New products: what separates the winners from the losers and what drives success. In: PDMA Handbook of New Product Development. 3rd ed. Hoboken, NJ: John Wiley & Sons; 2013. pp. 3–34.

[27] Cooper, R.G., & Edgett, S.J. Best practices in the idea-to-launch process and its governance. Research-Technology Management. 2012;**55**(2):43–54.

[28] Becker, B. Rethinking the stage-gate process—a reply to the critics. Management Roundtable. 2006;**57**(1):20–31.

[29] Lenfle, S., & Loch, C. Lost roots: how project management came to emphasize control over flexibility and novelty. California Management Review. 2010;**53**(1):32–55.

[30] Morris, L., Ma, M., & Wu, P.C. Agile Innovation: The Revolutionary Approach to Accelerate Success, Inspire Engagement, and Ignite Creativity. John Wiley & Sons, Hoboken, New Jersey; 2014.

[31] Chesbrough, H.W. Open innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business Press, Boston, Massachusetts; 2006.

[32] Chesbrough, H., Vanhaverbeke, W., & West, J. Open Innovation: Researching a New Paradigm. Oxford University Press on Demand, Great Clarendon Street, Oxford; 2006.

[33] Trott, P., & Hartmann, D. Why 'open innovation' is old wine in new bottles. International Journal of Innovation Management. 2009;**13**(4):715–736.

[34] Grolund, J., Ronneberg, D., & Frishammar, J. Open innovation and the stage-gate process: a revised model for new product development. California Management Review. 2010;**5**(3):106–131.

[35] Stage-Gate® International. Open Innovation with Stage-Gate [Internet]. Available from: http://www.stage-gate.com/resources_stage-gate_openinnovation.php [Accessed: 28/12/2016].

http://dx.doi.org/10.5772/67504

[36] Cooper, R.G., & Edgett, S.J. Lean, Rapid, and Profitable New Product Development. Product Development Institute, Canada; 2005.

[37] Cooper, R.G., & Mills, M.S. Succeeding at new product development the P&G way: a key element is using the "innovation diamond". PDMA Visions. 2005;**29**(4):8–13.

[38] Murray, S.L., Grantham, K., & Damle, S.B. Development of a generic risk matrix to manage project risks. Journal of Industrial and Systems Engineering. 2011;**5**(1):35–51.

[39] Chapman, C., & Ward, S. Project Risk Management: Processes, Techniques and Insights. John Wiley & Sons, The Atrium, Southern Gate, Chichester, West Sussex, England; 1996.

[40] IEC/FDIS 31010:2009(E). International Standard: Risk management—Risk Assessment Techniques. Geneva, Switzerland: International Electrotechnical Commission; 2009.

[41] Keizer, J.A., Halman, J.I., & Song, M. From experience: applying the risk diagnosing methodology. Journal of Product Innovation Management. 2002;**19**(3):213–232.

[42] Keizer, J.A., & Halman, J.I. Diagnosing risk in radical innovation projects. Research-Technology Management. 2007;**50**(5):30–36.

INTECH

Chapter 3

Planning and Management Tasks of Innovation Projects in Production and Economic Systems

Leonid A. Mylnikov

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/67260

Abstract

The chapter describes an approach for design and sufficient analysis of management and information models by implementing product innovation projects in production and economic systems (PESs). The obtained model and the set of parameters for project evaluation are unique and depend on the specific features of project, decision-maker preferences, and PES project. This chapter also broadly outlines criteria-based approaches to measure production risks and evaluate risks associated with PES planning. Embodied principles help to design specific simulation models and provide information support for sufficient decision-making in PES that was newly introduced at an enterprise and/or on the basis of available data systems.

Keywords: production planning, risk evaluation, simulation, model, innovation project, production and economic system, management, decision-making, algorithm, analysis

1. Introduction

The development of modern production and economics is generally based on newfound knowledge and scientific achievements that are integrated into technologies and products.

At the same time, companies are very responsive to any fluctuations in the market and consumer preferences. The situation on the market changes very rapidly, and the number of competitive products is vast. The companies have to launch new developments to catch up with modern trends, satisfy consumer preferences, and create new market segments. They should also bear in mind that product life time reduces as a result of increasing modifications and improvements in production and economic systems (PES). So, management sector that

deals with innovation projects, especially in small-scale companies, should always make decisions promptly and ensure high quality in their products. In real project and PES management, we encounter an increasing number of statistical data, lack of universal algorithms, and the sufficient software to operate them, and besides, there are problems for which the current solutions are insufficient. It is difficult to describe the relationship among projects, PES, and the environment; therefore, live data are essential for effective management in the decision-making process.

The problem of management decision-making in PES projects was initially taken up by Albert-Kalmes, as a problem of inventory and statistics in factories and commodity production; later on, Frederick Taylor and Henry Gantt laid the foundations for the methods of planning [1]. Mathematical calculations in this area are connected with system analysis (introduced by J. Von Neiman and L.V. Kantorovich [2]). Economical aspects are considered in this approach in terms of pricing, production planning, sequence scheduling, fixed price and time-and-materials cost, and procurement management. These aspects are dependent on market segmentation and internal structure of PES, well known as Wagner-Whitin algorithm that relates these aspects with market. The idea to integrate market selection and production planning was introduced in Ref. [3] and up till now, this problem has not been solved. It is NP-complete problem that can be solved only if we fix separate factors (in particular, Jean Tirole has successfully solved management task for markets segmentation).

In 1995, Pepall introduced Game theory [4] to describe duplicates and innovations; this theory considers the relationship among projects. Such an approach triggered change management. Today, this idea is used in innovation management in terms of agent simulation and forecasting.

In the 1950s, mathematical and algorithmic calculations helped experts work out methods of planning and management known as Just-in-time; this method still enjoys high popularity. Main achievements in the late 1960s are connected with the works of Oliver White, who suggested that production, supply, and sale departments can be considered altogether in automated industrial enterprises. In his publications and in the periodicals of American Production and Inventory Control Society (APICS), we can find the algorithms of planning, which are known today as MRP. In the 1970s, Eli Goldratt in Israel worked out the method OPT. The modification of the algorithms of planning MRP~II was considered as the final achievement of all these methods till the beginning of the 1980s. The idea of computer-based integrated production CIM appeared in the first part of the 1980s, due to the integration of flexible manufacturing and efficient management. The US Department of Defence introduced, in the 1980s, CALS methods to ensure that all operations with orders, production development and organization, supplies, and operation of military technique were efficiently managed and planned. In beginning of the 20th century, the ideas of intellectual enterprise were introduced [5]; at that time, multiagent systems that were developed to consider such factors as autonomy, external factors' dependency, flexibility, proactivity, social factor, and efficient intellectual management factor were not studied thoroughly enough to use them in complex information systems. In such an approach, it is difficult to ensure effective interaction among the parts of PES at an industrial enterprise. In particular, D.A. Novikov contributed greatly to the development of this area with his theory of active systems. This issue was also addressed by R.K.

http://dx.doi.org/10.5772/67260

Sah and J. Stiglitz who proved the necessity of building complex structures in collective decision-making, for instance in organizational hierarchies.

2. Mathematical formalization of innovation in production and economic systems

The development of conceptual bases in management and simulation plays a significant role in PES and project management as it converts knowledge from object perspective into action [6].

Yu.A. Zelenkov introduced tuple description of goals and current possibilities of PES projects:

$$\Psi\{U, A, R, \Theta, w(\cdot), v(\cdot), I, \Gamma\} \tag{1}$$

where $U = (U_A, U_I)$ —is the managerial vector, that includes institutional and information management; A—multiple actions to achieve goals; R—the set of action results; Θ— nvironmental indicators; $w(\cdot) : A \times \Theta \to R$—the action result dependent on action and environment; $v(\cdot)$—agent preferences assigned by utility function; I—the information possessed by the agent at the time of decision-making; Γ—goals.

Within project approach in PES, it is recommended to use general purpose tuple [7]:

$$\Psi\{U, A, R, \Theta, w(\cdot), v(\cdot), I, \Gamma, \varphi\}, \tag{2}$$

where $U = (U_F, U_B, U_P, U_V, U_C, U_S, U_A, U_I)$ —the managerial vector that incorporates the management of finances, production, products, implementation, sales, R&D, institutional, and information management; where $\varphi = (\varphi_1, \varphi_2, \ldots, \varphi_n)$ is the project vector, where $\varphi_i = \{P, T\}$, consequently, P—the vector of management parameters; T—the set of project resource needs, i—the project number.

Sufficient management [8] requires formalized description of tuple parts (resulting in a lower degree of ambiguity).

In management, we should take into account that project and system develop over time and affect multiple PES. Therefore, it makes sense to consider the models for different points of time, levels, management types, and project stages that lead to necessity to study project identification and define decision points.

Such a task can be illustrated by determining managerial vector parameters U [9], project groups (φ) or one project (φ_i) using indicators or efficiency evaluation indicator (P_{ij}, where j is the number of key project parameter i and management level (see **Figure 1**) depending on the tasks taken into consideration.

By the set of parameters, decision points can be defined by PES data (equipment service intervals and internal technology cycles, etc.), statistical data, or forecasting data that describe a project or projects (the parameters of sales volume and price change, etc., are presented by innovation curves), see **Figure 2**.

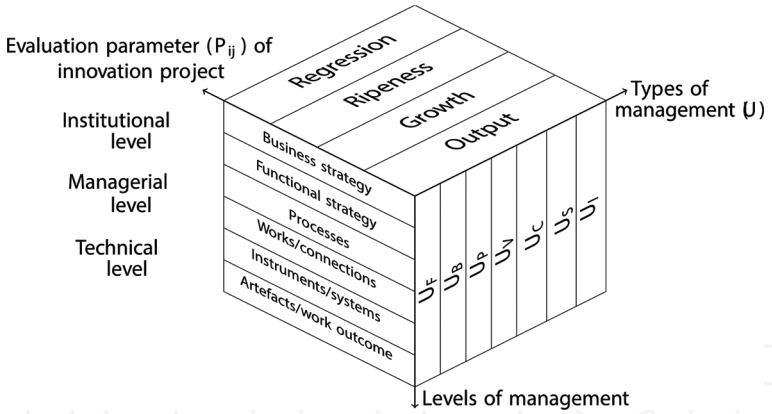

Figure 1. Scheme of current project state based on stages of project indicators, types, and levels of management.

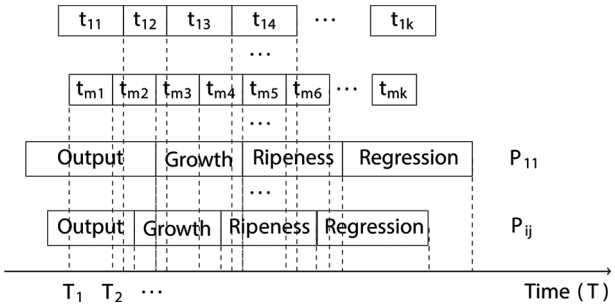

Figure 2. Decision points in PES projects.

As a result, each decision point will be given a model that altogether will form a tuple Ψ ($\psi_k \in \Psi$), where k is the number of decision points for the examined project or PES.

This way to form a tuple, Ψ helps to take into account not only new data that occur in time but also obtain cognitive knowledge, and experience about PES and projects accumulated upon models modification.

Hence, project time management can be reduced to tuples formalization ψ_k in form of models (see the structure of such models in **Figure 3**). Model structure comprises several subtasks to forecast project parameters and formalize optimization task in terms of mathematical programming.

Forecasting tasks and the description of time series are studied by many authors, and there are many methods to solve this problem (mathematical regression model, functional description of parameters by innovation, and S-curves).

For mathematical formalization, we can refer to the scheme illustrated in the **Figure 4**.

http://dx.doi.org/10.5772/67260

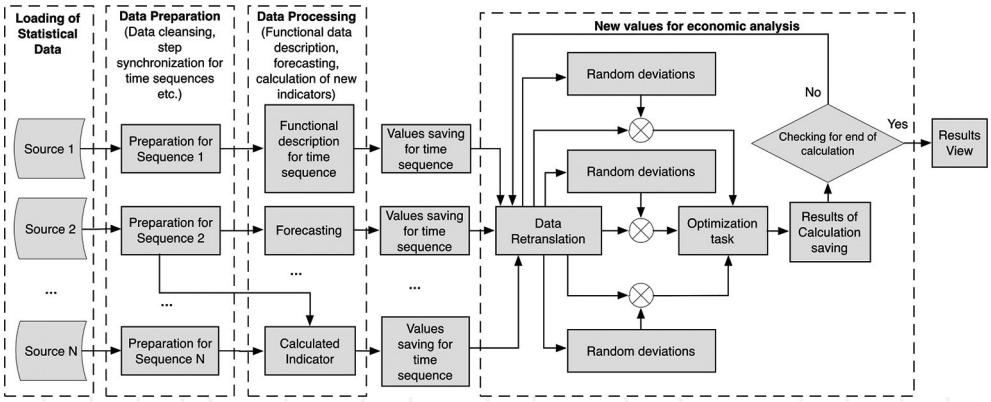

Figure 3. Project management process model at one of PES stages.

Formalization can be presented by selecting most efficient way to developing market segmentation when same project (a development way) can enter different markets (particularly, B2N, and B2C). This task has the following mathematical formula [10]:

$$\max_{1 \le m \le M,\, 1 \le n \le N} D_m(t) C_{nb}(t), \tag{3}$$

where , a—whole numbers, D_m—the market volume m, C_{nb}—the return from project production n in b PES. The market volume $D_m(t)$ is determined as a difference between the asymptote K and the market saturation $N_m(t)$ that is described by S-curve: $D_m(t) = K - m(t)$, and return is described as a difference between the sales price $Q_{nb}(t)$ and the production cost $Z_{nb}(t)$ of goods, n: $C_{nb}(t) = Q_{nb}(t) - Z_{nb}(t)$. Therefore, market segmentation problem will be written as follows:

$$\max_{1 \le m \le M,\, 1 \le n \le N} D_m(t)(Q_{nb}(t) - Z_{nb}(t)). \tag{4}$$

The selection of PES where this project will be implemented is another example (project can be transferred for implementation to existing PES or can be implemented independently by creating new legal entities). Based on PES tasks, we can deal with the task of return maximization from project implementation or handle the task of reducing production time. Therefore, we obtain two models.

First model is built for mitigating the production cost:

$$Z_{nb}(t) = \sum_{g=1}^{l_h} z_{nkg}(t) \to min,\ b = \overline{1, K} \tag{5}$$

where l_h—the number of operations in PES k for manufacturing goods n, z_{ngk}—the operation cost g in PES k by manufacturing goods n.

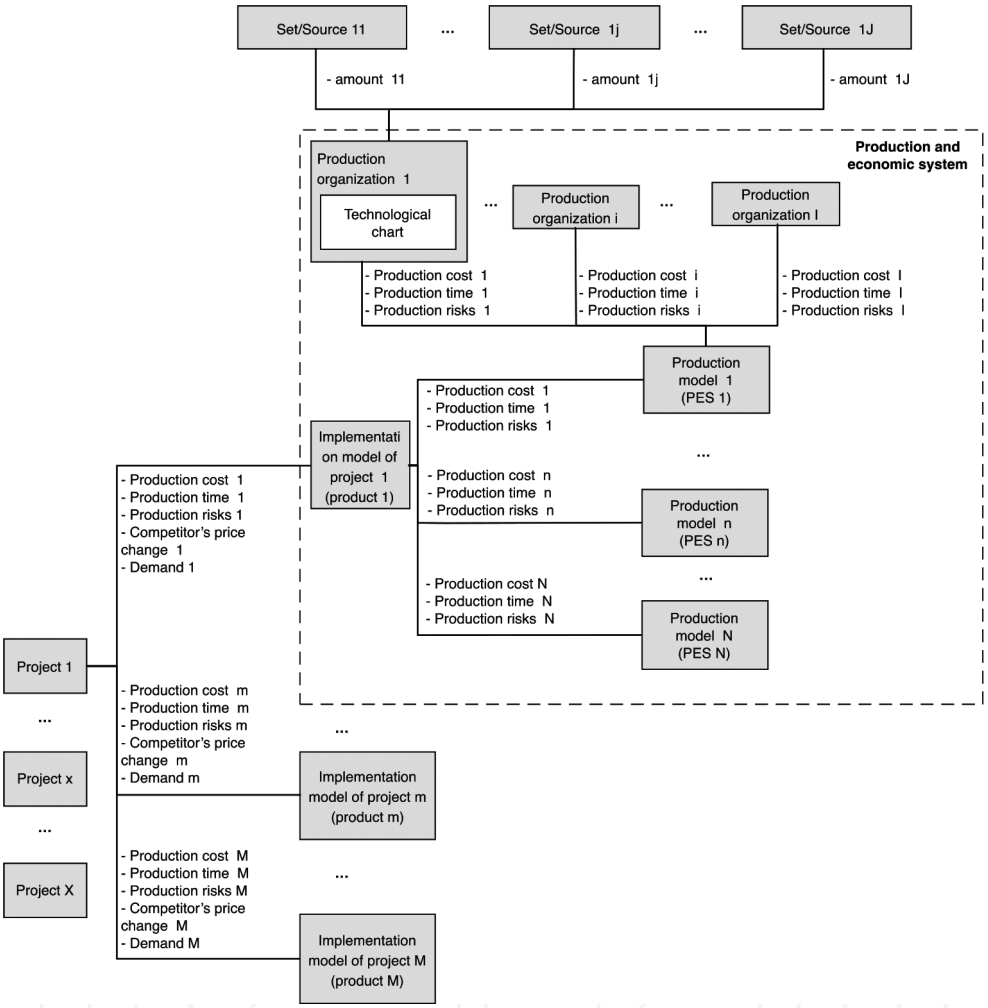

Figure 4. Optimization task structure in production planning.

Second model is designed for mitigating time required. We need to note that certain operations can be performed simultaneously (see **Figure 5**).

The model for mitigating the time required can be given as follows:

$$\sum_{d=1}^{v}\sum_{s=1}^{s_d} max \sum_{f=1}^{w_{de}} T_{z_{nkdef}} \rightarrow min, \tag{6}$$

where d is the number of sequences of performed operations by manufacturing goods n in PES k, s—the number of parallel sequences in the consequence d, w_s—the number of operations in

http://dx.doi.org/10.5772/67260

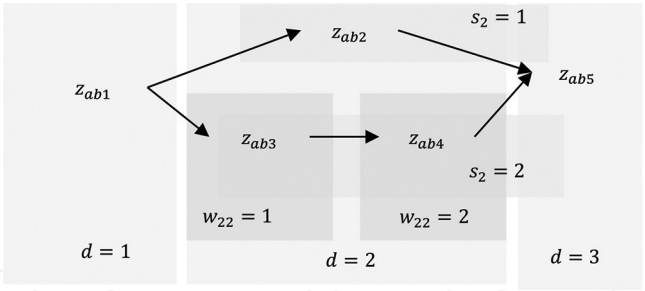

Figure 5. Example of operation sequences by project implementation in PES [10].

consequence, $T_{z_{nkdef}}$—the time required to perform the operation z_{nkdef} in PES k by manufacturing goods n. To use this model, we need to refer to the rendition table between the margins g in Eq. (5) and $d, e,$ and f in Eq. (6).

In PES, project management is aimed at return optimization [11] via portfolio selection for goods. At the same time, not all the economically justified goods can be produced at each technological enterprise.

In order to cover these particular features, we need to give sound suggestions based on the set of criteria. For instance, criteria function and limitations will be given for volume scheduling of production planning as follows:

$$\begin{aligned}
&\sum_i \sum_l K_{il} \sum_t (C_l(t)x_l(t) + C_i(t)x_i(t)) \to \max \\
&\sum_i \sum_t R_{ij}x_i(t) \le P_j(t),\ j = \overline{1,M} \\
&\sum_i \sum_t \mathrm{S_{ki}x_i}(t) \le T_k(t),\ k = \overline{1,K} \\
&\sum_i \sum_t \alpha_i^q x_i(t) \le \mathrm{G^q}(t),\ q = \overline{1,Q} \\
&\sum_l \sum_t R_{lj}x_l(t) \le P_j(t),\ j = \overline{1,M} \\
&\sum_l \sum_t S_{kl}x_l(t) \le T_k(t),\ k = \overline{1,K} \\
&\sum_l \sum_t \alpha_l^q x_l(t) \le G^q(t),\ q = \overline{1,Q}
\end{aligned} \tag{7}$$

where K_{ih}—the ratio of conformity of goods i and h; $x_i,\ i = \overline{1,N}$—the vector of unknowns, each component of which defines the number of released products of type i; $C_i,\ i = \overline{1,N}$—the net income from production of i goods; $R_{ij},\ j = \overline{1,M}, i = \overline{1,N}$—the production technology cycle-based capacity need for each equipment type per unit of final product; $P_j,\ j = \overline{1,M}$—the total

capacity resource for each type of machinery, obtained from data of calculated average productivity of all the equipment of this type; S_{ki}, $k = \overline{1,K}, i = \overline{1,N}$—the product specification-based need in key materials per unit of final product; T_k, $k = \overline{1,K}$—the storage and procurement planning-based volume of available key materials; $\alpha_i^q = \begin{cases} 1 - \text{if product } i \text{ belong to } q \\ 0 - \text{if product } i \text{ does not belong to } q \end{cases}$; G^q, $q = \overline{1,Q}$—market restrictions.

Otherwise, criteria function can be written the following way:

$$\sum_i \sum_l K_{il} \sum_t ((Q_{lb}(t) - Z_{lb}(t))C_l(t)x_l(t) + (Q_{ib}(t) - Z_{ib}(t))C_i(t)x_i(t)) \to \max \quad (8)$$

by $n = h$ and $n = i$ models of market segmentation and portfolio formation can be merged, and we receive the task of optimal project distribution among PES.

$$\sum_i \sum_l K_{il} \sum_t (\left(Q_{lb}(t) - \sum_{g=1}^{l_{h_l}} z_{lbg}(t)\right)C_l(t)x_l(t) + (Q_{ib}(t) - \sum_{g=1}^{l_{h_i}} z_{ibg}(t))C_i(t)x_i(t))) \to \max \quad (9)$$

The amount of costs $Z(t)$ not only demonstrates financial costs but also indicates costs for materials, parts, etc., excluding time required Eq. (6).

If it is necessary to consider these costs and the time required Eq. (6), we can complement the model with respective criteria of type Eq. (5).

The costs are specified by technological charts of product n in PES k. These charts are illustrated in **Table 1**.

Operation number	Operation name	Operation cost	Previous operations	Subsequent operations	Performance time	Need in parts	Need in materials	Need in equipment
⋮								
g	...	z_{vkg}	...	...	$T_{z_{nkdef}}$	...	S_{gv}	R_{gv}
⋮								

R_{gv}—the need in capacity of each type of equipment per unit of final product, S_{gv}—the need in key materials per unit of final product.

Table 1. Structure of technological chart.

Forecast data are used for market conditions. Therefore, value scheduling parameters are C_i and G^q that are determined by forecast data (in particular, curve-based forecasts [12]).

As a result, we receive a portfolio and product release schedule that stipulate the amount of expected return from one product and accumulated effect from a released group of products.

http://dx.doi.org/10.5772/67260

This way of formalization helps distinguish projects in terms of specific features of PES and expected change of market conditions or other critical project parameters that were used in criteria function.

However, we must emphasize that on each stage critical for the task to be tackled (time sequence is restricted by decision points), we might need multiple solution of the problem as a number of parameters is determined by forecast data, and the situation can be changed over the time.

Therefore, the problem can be solved by making a table with time function. Due to lack of analytical methods that can be used nowadays to solve obtained tasks, we suggest use multiple cyclic numerical solution with time period Δt to deal with this problem. This time sequence can be specified based on minimal time required for each enterprise in terms of production cycle or planning time.

Received solutions and time sequence selection can require additional research though, as we can encounter periodical change of production volume that leads to additional expenses for preparation and/or modification of production system.

Despite all the advantages of mathematical programming, in general, it is not easily solved (especially in case of multiple criteria). Such tasks are considered as NP-complete problems (for instance, for market segmentation task [3]). Due to forecast errors, complex tasks obtained by mathematical programming can be solved by approximate methods. That is why it is very important to study sensitivity of gained solutions to the level of market and PES parameters' deviation and take into account production and planning risk evaluation; the stipulated parameters can have Markov property (Markov process) and can be designed by Monte-Carlo method.

Due to considerable restrictions nowadays, we can take advantage of other ways to formalize such groups of tasks. A vast amount of Nobel laureates focus on this problem (L.V. Kantorovich, 1975; R. Solow, 1987; H. Markowitz, 1994; J. Stiglitz, 2001; J. Tirole, 2014). Besides, management and sufficient formalization principles in management and applications greatly contribute to existing approaches and theories.

3. Risk evaluation

The analysis of gained results plays a significant role in managerial decision-making. Many authors make big efforts to tackle tasks with risk analysis of segregate solutions. For example, for project portfolio risk evaluation, we can use capital asset pricing model (CAMP) introduced by Sharpe [13], Lintner [14], and Mossin [15] based on the theory of Markowitz described in Refs. [16, 17]. For risk evaluation, we can also use the approach covered in Ref. [18], when we use function-based parameters obtained by forecast margins.

Over-time consideration of parameters makes it possible to mitigate risks associated with the selection of innovation projects (managerial and organizational), for which membership function may be identified for every moment of time.

In this case, the expected return of product portfolio can be determined as is evident from:

$$E(R_p) = \sum_{v=1}^{u} x_v E(R_v), \tag{10}$$

where R_p—the product portfolio, and x_i—the output volume.

$$VAR(R_p) = \sum_{i=1}^{I}\sum_{j=1}^{J} x_i x_j COV(R_j,\ R_i). \tag{11}$$

Correlation factor can be calculated by the formula:

$$k_{ij} = \frac{COV(R_j, R_i)}{\sigma_i \sigma_j}. \tag{12}$$

Then the risk evaluation for p project portfolio is:

$$\sigma_p = \sqrt{\sum_{i=1}^{I} \sum_{j=1}^{J} x_i x_j k_{ij} \sigma_i \sigma_j} \tag{13}$$

Forecast data can be calculated by the formula [19]:

$$\mu^2 = \int_{-\infty}^{+\infty} x\, f(x)\, dx, \tag{14}$$

and

$$\sigma^2 = \int_{-\infty}^{+\infty} (x-\mu)^2 f(x)\, dx, \tag{15}$$

where x is the production volume at a certain moment of time.

For retrospective data:

$$\sigma^2 = \frac{\sum_{i=1}^{n} (x_i - x_i^*)^2}{n}, \tag{16}$$

where x_i—production volume forecasting at a certain moment of time.

Correlation ration can be defined upon statistical data (**Table 2**) and Slope One algorithm [20].

Period (day, month, quarter, year, …)	Product 1	Product 2	⋯	Product a	⋯	Product n
1	O_{11}	O_{21}	⋯	O_{a1}	⋯	O_{n1}
⋮	⋮	⋮	⋱	⋮	⋱	⋮
N	O_{1N}	O_{2N}	⋯	O_{aN}	⋯	O_{nN}

N—the number of periods, O_{ij}—the sales volume of product i in the time period j.

Table 2. Sales volume matrix.

http://dx.doi.org/10.5772/67260

In this case, the angle cosine between vectors formed by columns of values for each product (item-to-item algorithm) can be used as the correlation factor:

$$S = \cos(T_1, T_2) = \frac{\vec{T_1}\vec{T_2}}{|\vec{T_1}||\vec{T_2}|}, \tag{17}$$

where T—vectors (columns) corresponding to products.

These calculations can be subsequently used to fill in the product correspondence table.

In this case, portfolio will be chosen on the assumption that the expected return can be also determined by the following formula [21]:

$$E(R_p) = R_f + \frac{E(R_m) - R_f}{\sigma_m}\sigma_p, \tag{18}$$

where R_f—the guaranteed risk-free return, $E(R_p)$—the expected return of p portfolio, $E(R_m)$—the expected return of m market portfolio, σ_p—the standard deviation for p portfolio, and σ_m—the standard deviation for m portfolio.

4. Forecasting risks

When we use forecasts in decision making, we face risks on whether the forecasts are reliable and how the result will guarantee the quality of decision-making. Forecasting can be performed only by a certain degree of assurance; however, long-term forecasts produce low degree of accuracy (the intervals of potential deviations will increase). The magnitude of deviations can be calculated for normal distribution parameters based on the maximum margin of error when forecast can be regarded as accurate [18]:

$$F = \sum_{j=1}^{n} E_i^2, \tag{19}$$

where $E_i = (Y_i^T - Y_i^*)$—the margin between forecasting and real values, Y_i^T—forecasting data, Y_i^*—data about parameter margin changes (project experiment data for forecasting).

Let us find $\sigma = \sqrt{\frac{F}{n}}$, where n—the number of experiment points. Due to normal distribution law, the hypothesis proves adequate by reaching the interval $(Y^* - \sigma \le Y^T \le Y^* + \sigma)$—68% experiment data and more, the interval $(Y^* - 2\sigma \le Y^T \le Y^* + 2\sigma)$—not less than 95% experiment data, the interval $(Y^* - 3\sigma \le Y^T \le Y^* + 3\sigma)$—not less than 99% experiment data. Hence, taking into account indistinct forecast given above, lets us introduce forecasting values with fuzzy numbers. Let us assign to each value of forecast curve, a membership function. That is the way to mathematically describe forecast-based risk assets. First of all, let us determine the risk assets.

The fuzzy set A to U is the set of pairs $(u, \mu_A(u))$, where $u \in U$, and $\mu_A(u)$—denotes membership function of fuzzy elements A, $\mu_A : U \to [0,1]$. Here, U is a universal set of elements.

Membership function assigns to each element a membership degree based on formalized fuzzy set. In mathematics, a fuzzy set is defined as follows:

$$A = U\frac{\mu_A}{u}, u \in U. \tag{20}$$

Let us assume that a risk is calculated for a certain set of project parameters taking into account all risk factors, i.e., multivariable risk:

$$r = f(a_1, a_2, \ldots, a_k, \varphi_1, \varphi_2, \ldots, \varphi_m), \tag{21}$$

where let us say, $a_1$is the unit cost, a_2—the unit price, and a_3—the sales volume, etc. In this case, if risk is calculated for the 1st parameter, r_1 can be a function of the following factors: φ_1—the production decline (interruptions in the supply of crude, materials, parts, human faults, machine malfunction, supply of poor quality crude, materials, parts, accidents, natural disasters, strikes, and wars); φ_2—the productivity progress; φ_3—the change of prices for crude, materials, and parts; φ_4—the change in the price of labor; φ_5—the change in the price of outsourcing services for packing, storage, transportation, and sales, etc.; φ_6—tax changes; φ_7—inflation-deflation processes; φ_8—the poor working capital, that leads to taking a loan and paying interests on it; φ_9—the payment of fines, default interests, penalties [18], and so on.

Furthermore, let us suppose that risk is measured over a certain risk set:

$$r = 1 - \frac{a}{a^*}, \tag{22}$$

where a—fixed, planned unit cost value without risk factors; a^*—the defined index of unit cost.

Defined index that is used in this formula should be determined by either expert evaluations or forecast margins generated by diverse methods; all these margins are based on various original data. Hence, we use these data to define margin range of an interested parameter (i.e., risk measured by this method will uniquely be placed in the range, that generates fuzzy set), and membership function is built on Gaussian function (used by the description of normal distribution law).

To define function parameters, let use Gaussian function $(\mu(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\left(\frac{(x-c)^2}{2\sigma^2}\right)}$ and gained margins. c can be assigned, if known, retrospective data or most accurate forecasting data, and arithmetic average of obtained forecasts (same like W.S. Gosset (Student) did with measurement results). To determine the margin σ, let us use the property of full width at half amplitude:

$$\sigma = \frac{c_{max}}{\sqrt{2ln2}}, \tag{23}$$

where $c_{max} = \max_{1 \le j \le n} |c - c_i|$, i—the number of alternative margins for c obtained by forecasts and expert evaluations. The formula of membership function is then as follows (for normal distribution law parameters):

http://dx.doi.org/10.5772/67260

$$\mu(x) = \frac{\sqrt{ln2}}{c_{max}\sqrt{\pi}} e^{-\left(\frac{ln2(x-c)^2}{c_{max}^2}\right)} \tag{24}$$

For the parameters, that do not obey normal distribution law, we can use triangular functions, generic Bell function, and sigmoid function for asymmetric distributions, etc.

Based on membership function and taking into account potential risky events that influence each of the margins, we measure risk evaluation margin [18] for the described parameter value:

$$r = 1 - \frac{\int_{\alpha}^{\beta} \mu_1(x)dx}{\int_{\alpha}^{\beta} \mu_2(x)dx}, \tag{25}$$

where r—the risk evaluation; $\mu_1(x)$ and $\mu_2(x)$—membership functions for different margins of c (for instance, c_1—historical margins and c_2—arithmetic average data); α, β—boundaries of value range.

We should take into consideration that obtained risk evaluations do not consider the risks of previous stages.

Such forecasting risk evaluation can be applied only in the case if we know all the parameter values that we need to assess; that is a disadvantage of this method.

5. Conclusion

A simulated model can help forecast features and behavior of object of inquiry both inside the area, where the model is simulated, and (by proved application) outside this area (forecasting role of a model); manage the object by selecting most efficient model-based impacts (managerial role); recognize the phenomenon or the object that was used for simulating the model (cognitive role of a model); obtain skills to manage the object by using the model as a training simulator or a game (training role); and enhance the object by modifying and testing the model (project role).

In practice, the stipulated task management in PES helps design simulation models for certain tasks avoiding NP-complete problem (for instance, Wagner-Whitin algorithm); furthermore, the use of sequential stage-to-stage transitions of forecast parameters or production cycles as described in Ref. [7] as crucial points in decision-making helps to avoid infinite-horizon problems [22] and exclude innovative regression in PES introduced by the corresponding member of RAS D.A. Novikov [23].

The described approach for management decision-making helps study PES processes at any accuracy degree. At the same time, the model complies with each management algorithm or system behavior and assesses risk margin for decision-making models.

Acknowledgements

The author thanks the Government of Perm Krai for the support of the project for "Development of software and economic and mathematical models for supporting innovation project management processes in production systems", implemented in accordance with decree №166-п of 06.04.2011. The reported study was in part supported by the Government of Perm Krai, research project No. C-26/058.

Author details

Leonid A. Mylnikov

Address all correspondence to: leonid.mylnikov@pstu.ru

Perm National Research Polytechnic University, Perm, Russia

References

[1] Gantt HL, Forrer D. Organizing for work. Florida: Dr. Donald A. Forrer, 2006.

[2] Kantorovich LV. Mathematical methods of organizing of production planning. Leningrad: Leningrad State University, 1939. 67p.

[3] Van den Heuvel W, Kundakcioglu OE, Geunes J, et al. Integrated market selection and production planning: complexity and solution approaches. Mathematical Programming. 2012; 134: 395–424. DOI: 10.1007/s10107-011-0441-7

[4] Peppal L. Imitative competition and product innovation in a duopoly model. Economica. 1995; 64: 265–269. DOI: 10.1111/1468-0335.00077

[5] Tsiganiov VV, Borodin VA, Shishkin GB. Intelligent Enterprise: mastering the mechanisms of capital and the power (the theory and practice of management evolution organization). Moscow: University Book, 2004. 767p.

[6] Riemer K, Scifleet P. Enterprise social networking in knowledge-intensive work practices: a case study in a professional service firm. In: Proceedings of the 23rd Australasian Conference on Information Systems; 03–05 December 2012; Geelong, Victoria: ACIS; 2012; 1–12.

[7] Faizrakhmanov RA, Mylnikov LA. The foundations of modeling management processes for innovation projects in production-economics systems. Automatic Documentation and Mathematical Linguistics. 2016; 50: 84–90. DOI: 10.3103/S000510551603002X

[8] Gurevich IM. Informatics rules - the basis of the structure and knowledge of complex systems. Moscow: Torus Press, 2007. 400p.

[9] Mylnikov L. Conceptual Foundations of Modelling of Innovative Production Projects. In: Proceedings of International Conference on Applied Innovations in IT (ICAIIT 2015); 19 March 2015; Koethen: HS Anhalt; 2015. pp. 13–17. DOI: 10.13142/kt10003.03

[10] Mylnikov L. Particularities of solving the problems of support for managerial decision making in production and economic systems using the statistical data. International Journal of Economics and Financial Issues. 2016; S8: 1–11.

[11] Mylnikov LA. A system view of the problem of the modeling and control of production innovations. Scientific and Technical Information Processing. 2012; 39: 93–106. DOI: 10.3103/S0147688212020098

[12] Mylnikov, L., Amberg M. The Forecasting of Innovation Projects Parameters. In: Vision 2020: Innovation, Development Sustainability, and Economic Growth; 27–28 June 2013; Vienna: IBIMA; 2013. pp. 1017–1029.

[13] Sharpe WF. Capital asset prices: a theory of market equilibrium under conditions of risk. The Journal of Finance. 1964; 19: 425. DOI: 10.2307/2977928

[14] Lintner J. The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. The Review of Economics and Statistics. 1965; 47: 13. DOI: 10.2307/1924119

[15] Mossin J. Equilibrium in a capital asset market. Econometrica. 1966; 34: 768. DOI: 10.2307/1910098

[16] Markowitz H. Portfolio selection. The Journal of Finance. 1952; 7: 77. DOI: 10.2307/2975974

[17] Markowitz HM. Portfolio selection: efficient diversification of investments. 2nd printing. New Haven: Yale Univ. Press, 1970. 351 p.

[18] Abdulaev AR, Mylnikov LA, Vasilieva EE. About risks in innovative projects: the causes of, integrated risk assessment of projects subject to risks. The economic analysis the theory and practice. 2012; 245: 41–49.

[19] Mylnikov L. Risk Evaluation in Manufacturing Organization Tasks for Product Technological Projects and Establishment of Project Portfolio for Production Systems. In: Proceedings of the 2016 International Conference on Applied Mathematics, Simulation and Modelling (AMSM2016); 28–29 May 2016; Beijing: Atlantis Press; 2016, pp. 399–402.

[20] Lemire D, Maclachlan A. Slope One Predictors for Online Rating-Based Collaborative Filtering. In: Proceedings of the SIAM Data Mining (SDM'05); 21–23 April 2005; Newport Beach, California: SIAM; 2005.

[21] Vanini U. Risikomanagement: Grundlagen, Instrumente, Unternehmenspraxis. Stuttgart: Schäffer-Poeschel, 2012. 303 p.

[22] Paprotny A, Thess M. Realtime data mining: self-learning techniques for recommendation engines. New York: Springer, 2013. DOI: 10.1007/978-3-319-01321-3

[23] Novikov DA,Tsvetkov AV. Mechanisms of functioning of organizational systems with distributed control. Moscow: IPM RAS, 2001.

INTECH

Chapter 4

Innovations in Research and Development of Scientific Procedures to Reach the Success and the Excellence by Means of Psychology Applied to the High Performance

Amador Cernuda Lago

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.68490

Abstract

In this chapter, the author discusses a new and specialized psychological intervention with scientific procedures in environments of high performance, showing his experience and achievements obtained in the sport and in the high-level art area. The author has intervened as scientist of support in seven Olympian cycles, being the person in charge of the mental training of numerous champions of the World Sport and Olympian of different disciplines and nationalities. These methods, developed during three decades, have been applied to the sports and not Olympian disciplines with optimal results. In 1988, these methods were adapted to the professional world of the art by the collaboration that the author established with the mythical Prima Ballerina Assoluta and choreographer, director of Cuba's National Ballet Company, Ms. Alicia Alonso. They began to work at the mental training of some of the most prestigious international artists at the area of dance and extending the investigations and interventions to other artistic areas, such as theatre, cinema and, especially, music, where the author has been working directly with some of the first world figures of this specialty.

Keywords: peak performance, hypnosis, biofeedback, virtual reality, trait anxiety

1. Introduction

The psychological intervention with scientific procedures in environments of high performance has allowed us to question many principles of the differential aspects in our species. Are we all qualified to come up to the maximum level? What factors contributed to reach the success and the excellence? Are we all born with equal potential?

These aspects have worried me in many years, answers have derived from my processes of intervention and of the scientific procedures of control and potentiation of the performance that I have realized. The experience and the information accumulated during seven Olympian cycles in which I have developed my work have allowed me to detect some key factors to predict and detect the profiles of success. All the world champions and Olympic medal winners with whom I have worked, checking my database, they have some similar factors that have allowed me to select candidates with big possibilities of success and to move this information to other distant environments of the high sport performance as is in the artistic area. One of the most important variables, drawing the most attention, is a variable present in all those have reached the excellence and stay away in everyone physically and technically could have reached it, but they never achieved it. This variable is a psychological factor that is not genetic, it develops in first stages of our life with our parents and adult, which is the anxiety and how can we handle it.

The late Dr. Charles Donald Spielberger was a prestigious and outstanding clinical psychologist world-renowned for his work on personality and health. He was the author of one of the tests most valued and used of measure of the anxiety best known as Spielberger's State-Trait Anxiety Inventory (STAI). Dr. Spielberger [1–3] considered that to define the anxiety of suitable form it is necessary to bear the differentiation in mind between the anxiety as emotional condition and the anxiety as feature of personality and for it, he proposed the theory of anxiety state trait. The state anxiety, according to Spielberger, is a "emotional condition" of the human body, characterized by the subjective and consciously perceived strain and apprehension feelings and by hyperactivity of the autonomic nervous system. On the other hand, the trait anxiety refers to the individual relatively stable differences of anxiety, being these a disposition, trend, or feature. Contrary to the state anxiety, the trait anxiety does not demonstrate directly in the conduct, and it must be inferred for the frequency with which an individual experience increases his condition of anxiety. In this respect, people with high degree of trait anxiety perceive a major range of situations such as threatening, and they are more predisposed to suffer anxiety state more frequently or with major intensity. The high levels of state anxiety are perceived like intensely troublesome; therefore, if a person cannot avoid the stress, it will start the skills of confrontation necessary to face the threatening situation. In the investigations realized in the sport environment of high performance, we have found a relation between a low punctuation in trait anxiety (TA) and capacity of success. Numerous champions of different disciplines have a punctuation low TA, not finding any result of excellence with punctuation high TA, this allows us to indicate that this factor is a predictor of success [4–6].

As we have a high performer with physical and technical potential, it is necessary to train to guarantee his results and to reach the excellence. To achieve this, we have to promote his mental capacity using various ways of science of psychology, in the last decades extended with the development of the new technologies of direct application as, for example, the hypnosis, of which later we will develop its characteristics and possibilities. Other technological innovations developed in the sport environment and pioneer applied them have allowed being a source of realization of their potential: the biofeedback and the neurofeedback, the subliminal stimulation and the virtual reality (VR). Using these technologies, we have helped a numerous gymnasts to be champions of Europa of the World and Olympian Medalists,

http://dx.doi.org/10.5772/intechopen.68490

also, athletes, motorists, and tennis players, and to the champion of the world of chess. This knowledge transferred to the world of the art, we have helped up to reach the maximum professional levels of the art to some of the best dancers and musicians of the world [7–11].

2. Hypnosis/self-hypnosis

The hypnosis is a mental complex phenomenon defined as a condition of high punctual concentration and receptivity to the suggestions that are attracting the attention of the person in a monotonous routine.

The nature contributes two specific moments, between others, that take place spontaneously during the day: the moment of the transitional state from wakefulness to sleep called the hypnagogic state of consciousness; this is one of the perfect moments to program our mind, to suggest modifications in our life, in any process, or to increase our performance. Another moment is to the awakening, the step of the dream to the awakening known as hypnopompic state; it is a lapse of time, in which we can speak directly with our brain to transform conducts and to promote our mind. It is important to avoid, the habit of falling asleep watching the television or listening to the radio because on having done this, we introduce the information that comes to us in our information system and exercises very direct effects on our conduct and thoughts.

During the hypnosis, there takes place a series of phenomena of that they can take advantage directly to optimize the processes of intervention to sports and motor level. For pedagogic reasons, we will consider the following areas to approach the numerous phenomena that the hypnosis carries and that allow to intervene with efficiency in high performance:

- Phenomena associated with alterations in the voluntary muscles.
- Phenomena associated with alterations in the involuntary muscles, organs, and glands.
- Phenomena associated with alterations in the organs of the senses.
- Psychological phenomena associated with the cognitive, emotional activities, and the ideational processes.
- Phenomena associated with the own induction.
- Posthypnotic phenomena.
- Spontaneous phenomena.

2.1. Phenomena associated with the alterations in the voluntary muscles

In hypnosis, the movements of the voluntary muscles can be keep out or excited, it is possible to automate sensations of relaxation, produce paralysis of muscular groups, catalepsy, automatic movements, and increase the muscular performance.

2.1.1. Automation of relaxation

With the process of induction, the members of the body sharply tend to avoid the movement and once reached the hypnotic condition and, as one penetrates into hypnotic condition, the muscular tone diminishes progressively, and of this form, the suggestions of rest and recovery of corporal zones are extremely easy. Thus, it is possible to facilitate the recovery of a sportsman in a small interval of time, making possible muscular rests with effective and great ease measurable psychophysiologically, not as it occurs using basic technologies of relaxation that not be enough guarantee a certain level. It is extremely useful in cases of overloads of physical training, in moments of sport concentration for the preparation of competitive important events, as a facilitator of the recovery of disabled sportsmen, etc.

2.1.2. Paralysis of muscular groups

In actual fact, there does not take place a loss of the motive power, but rather a temporary suspension of the tonicity. The hypnotic paralysis can include small muscular groups such as the eyelids or big groups. There are two types paralysis in nature: flaccid and spastic, depending on the conception that how a paralyzed person behaves. This phenomenon is very useful to learn muscular control for sportsmen with technical purposes.

2.1.3. The catalepsy

It is funny hypnotic phenomenon, some of them are found in the circus spectacles, characterized by an involuntary tonicity of the musculature. The members of the body are kept in any position that one has placed them. There exists a muscular inflexibility, a lack of flexibility. Indirectly, it is the indicative for what the individual is in an average degree of depth. Lamentably, many investigations does not exist in this aspect, since it is not easy to reproduce it in any individual, especially to maximum levels that relate to the effects that the Asian teachers of Chi Kung produce and that seem to us to be so inexplicable. Phenomena of the type that a jeep over the body of an individual and does not produce any hurt to him, or somebody break a block of stone on his body. These skills have not trick and many Chinese teachers reproduce relate to the phenomena of the catalepsy in maximum degree, as the of the circus number of putting a person in cataleptic condition sat between two chairs and eight persons sit down above him and the individual neither doubles, nor notices any discomfort once awake.

Catalepsy is an interesting phenomenon that has limitation, in maximum degrees, not everybody produces it easily, but in sportsmen, who reach it in average degree and this if is easy. It might say that for empirical experience 80% of them obtains it and allows correcting technical elements, to erase bad learning and to optimize complex technologies that could be executed in this condition. It is not the same to reproduce and to work with the hilt of a racket, that with a triple pirouette. It is also an excellent practice to reproduce simultaneously visualizations, technologies of mental test on that hereinafter we will comment.

http://dx.doi.org/10.5772/intechopen.68490

2.1.4. Automatic movements

The automatic movements are movements produced in any muscular group without conscious control. Examples of automatic movements linked with the hypnosis are the hand levitation, which we will penetrate into the technologies of induction. The training in automatic movements is a route adapted to facilitate later phenomena as the writing and the automatic drawing. These phenomena of great usefulness in clinical work are also very useful with sportsmen to level of cognitive recovery of information and of unblocking.

2.1.5. Increase of the muscular performance

In hypnosis, the person can avoid the fatigue and the discomfort posed by certain tasks, and therefore, it can increase his performance, using reservations of power of that in conscious state, the individual does not take advantage. Nevertheless, the individual cannot exceed his physical real capacity; simply he takes more advantage thanks to the hypnosis. The hypnosis brings him over to his maximum limit that normally to ordinary level does not reach. It should be clarified that in this case, we referred to increase of the muscular performance to the hypnotic level. It is only possible possible in some very limited situations, since, in serial movements as that all the performance sports use, the person cannot be in hypnotic condition, because as we have recounted previously, exists a loss of muscular tone. Therefore, the times of reaction are high and with it, we would not do any favor to the sportsman, everything opposite, we would be harming him. This is one of the many reasons by which the hypnosis cannot be considered doping, since theoretically any sportsman can go out to compete in hypnotic condition. Can you imagine a gymnast trying to make his exercises while is half-asleep? What would happen? Would have our dear and big cyclists, Indurain o Contador, won the Tour running half-asleep? It is evident that in hypnotic condition it might not give good results. The increase of the performance we realize it using the hypnosis as a tool in the process interventional of preparation, and during the competition, we can rest on posthypnotic conditions, but not on the hypnotic condition as such.

2.2. Phenomena associated with alterations in the involuntary muscles, organs, and glands

Many of the corporal functions that escape to the voluntary control are regulated by the unconscious mind across the thalamus by the nervous autonomous system. The respiratory, circulatory, and gastrointestinal systems and the endocrine glands are regulated hereby. The unconscious mind has the power to disable or excite the nervous autonomous system, and for it across the hypnosis, all these systems are easily controllable.

2.2.1. The heart

The cardiac rate can be accelerated or can be retarded in hypnotic condition. The experimentation supports this aspect widely and has tremendous implications for the high-level sport, for example, in expert shooters. We know, for the experimental studies, that there is a cardiac ideal rate that allows throwing at the reveille with major precision, by means of this effect of the hypnosis, as it is carried out by the instrumentation of the biofeedback. It is possible

to train to the shooter in order that his cardiac rate fits in competition to the ideal one, and hereby, he has major precision in competition. It is possible to do the same thing with tennis players and other sportsmen, as the football players before throwing a penalty in that the experimental evidence shows an optimization of the performance based on his cardiac rate.

2.2.2. The blood vessels

The hypnotic suggestions can influence on the blood vessels. Many experimental contributions show that the peripheral temperature of the body is possible to increase it in hypnotic condition. The blood pressure and the cardiac rate can also be influenced.

2.2.3. Respiratory system

Numerous experiments and clinical observations indicate that breathing can be influenced and simultaneously influence the hypnotic condition. A very significant experiment realized that an individual in hypnotic condition with rest can increase his pulmonary ventilation up to 50% with simple suggestions of accomplishment of a donkey work [12]. The diaphragmatic breathing associates generally with light conditions of hypnosis, and the abdominal deep and slow breathing associates with deep conditions. The existing interrelationships between breathing and hypnotic state are tremendously useful both for the work of hypnotic induction and for the work with sportsmen to different levels, control of the breathing, control of the emotion, reinforcement of posthypnotic conditionings, works of imagery, etc.

2.2.4. Food system

There exist The present observations show that by using hypnosis, it is possible to increase or decrease the gastric activity by means of suggestions of enjoyment or of displeasure. The peristalsis also can be modified in hypnosis and therefore regulate the functioning of the intestines.

2.2.5. Secretions

All kinds of secretions can be increased by means of hypnosis. There are pieces of evidence to level of secretion of milk in women wet nurse. According to a classic psychological experiment of the onion that suggested in hypnosis can produce watering in the eye and both the salivation and the perspiration they are modifiable. These last two aspects to sport level can be very useful for the relation that they have with phenomena of anxiety and their regulation to competitive level.

2.2.6. Changes in the metabolism

An experiment that we all can realize: a person in the hypnotic state, we suggest him that he is going several days without eating. If in this moment, it was possible to realize an analysis of sugar in blood, it might observe since a decrease takes place in his measure and inversely, if we suggest him that he is eating a few fantastic sweets, there will take place an increase of his rate of sugar in blood.

2.2.7. Anatomical and biochemical changes

Numerous changes can be produced to the organic level across the hypnosis. One of the modifications that can have more interest with feminine sportswomen is the possibility that contributes the hypnosis of influence on the menstruation that can be induced or stop by means of hypnotic suggestions.

2.3. Phenomena associated with alterations in the sensory organs

2.3.1. Hyperesthesia

It refers to an abnormal or pathological increase in sensitivity to sensory stimuli of the sense. In a hypnotic state, variations can be perceived in the texture and the temperature that under no effort are perceived in the ordinary state of conscience. The applications are very useful for sportsmen to level of works of feedback corporal in different procedures of training control.

2.3.2. Hypnoanalgesia

It is the possibility of producing inhibition or absence of the sensibility to the pain. This applicability is of tremendous usefulness in competitive sport, in extreme moments. In fact, I had the occasion to facilitate to gain a final of championship of the world in martial arts to individuals with torn bones.

2.3.3. Hypnoanesthesia

It is the possibility of producing the absence of sensation by means of hypnosis of partial or total form. The usefulness to level of sports injury is obvious. The degree of induced anesthesia depends on the level of hypnotic depth; according to the electromyography study, the pain is in the body and the hypnosis what he avoids is the conscience of the pain. Owing to this situation, nobody might fall down in the mistake of abusing this possibility, the pain it is necessary to treat it since the hypnosis does not treat it, only he avoids this sensation. Equally, the pain is a mechanism that it warns to the body and it marks limits. For it to use this possibility with liberality in combative sports might be dangerous, and this would be one of the few disadvantages that the hypnosis shows, though it would not be due to it but if to a bad utilization and to the ignorance psychophysiological of the hypnotist. For it, the hypnosis only must be used for professionals qualified.

2.3.4. Paresthesia

The paresthesia is the abnormal skin sensations. There are very easy of elicit especially those of the senses of the vision, the taste, and the tact. It is not difficult to give a person, in hypnotic state, a glass of water and to say to him that it is a juice of orange. The person will taste the water as it will be a juice, not because the hypnotist controls the will of the individual but because the person arouses the flavor of the orange and processes this type of taste, not that of the water that really it consumes. It is possible to make the same thing to olfactory level

suggest the smell of a perfume before an onion, etc. The applications of the paresthesia are very useful to train the sportsmen to level of mental test, visualization.

2.3.5. Elicitation of positive hallucinations

The positive hallucination is the sensation of an experience without the royal existence of the sensory corresponding stimulus. The hallucinations can take place in connection with any of five senses. The positive provocation of hallucinations in hypnotic condition has a great usefulness to realize some cognitive trainings with the sportsmen.

2.3.6. Elicitation of negative hallucinations

The negative hallucination is the absence of sensation of an experience before the presence of the sensory royal corresponding stimulus. The problem of the negative hallucinations is that they are possible in general in deep conditions of hypnosis, and therefore, only they are useful with a very minority of population.

2.4. Psychological phenomena associated with the cognitive, emotional activities, and the ideational processes

The psychological phenomena that are given in hypnotic condition are numerous, only we are going to describe some of the most common and useful.

2.4.1. The effects on the memory

All the memories are stored in the brain and the majority of them can be recovered stimulating suitable routes of association. In hypnosis, individual can recover numerous information which they does not have remembrance in ordinary condition.

2.4.2. Hypermnesia

It consists of the recovery of information or increase of the amnesic capacity beyond the ordinary possibilities. Nevertheless, it is necessary to be cautious with the information since they can suffer the distortion of the time if they are distant recollections. Useful for the recovery of cognitive information to level of results to obtain technical details or biomechanics of the occurred process.

2.4.3. Reviviscence, regression, and progression in the time

In the reviviscence, the sportsman can analyze an event spent in equal conditions that when it took place really. All the memories later to the event are annulled. It is a phenomenon similar to the hypnotic regression. A form of psychological activity implies the disorientation of the person and a reorganization of his perceptual balance with specific reference to the perception of the space time. The progression in the time is a strategy of great sports. To lead their imagination to a competitive future moment with apparent reality, it is interesting to develop

http://dx.doi.org/10.5772/intechopen.68490

strategic works, of familiarization, of motivation, of competition simulated for study of specific behaviors, and for the comprehension of how the sportsman will react to potential future situations in that we are interested.

2.4.4. Time distortions

We all have in the brain is a clock that is capable of estimating the passage of time with excellent precision. Many people possess this particular faculty in their ordinary life. In hypnosis, any individual is capable of judging the time with an extraordinary precision, but also there exists the possibility of condensing or expanding the time, this is what is named as time distortion. A minute of subjective time can be compared to 10 minutes of (chronological) real time and 10 minutes of chronological time, they can be condensed in a minute of subjective time. The applications of the effect time in hypnotic condition are very useful in sports where the time of execution is very important; allow a technical very profitable complementation of the training.

2.5. Posthypnotic phenomena

The behaviors or responds persist once removed the effects of the hypnotic condition. Normally, there are answers to specific suggestions realized in hypnotic condition with the premeditation of which they last once finished the experience in hypnotic condition, when the person is to ordinary level of conscience. A major comprehension of this type of phenomenon we can have to pedagogic level using similarly the reflection determined the theory of the learning. The determined reflection and the posthypnotic conditioning are similar phenomena, if we exempt that the posthypnotic conditioning is not fixed by repetition of the stimulus and consistent learning, as he manages in the classic theory of the conditioning. The posthypnotic condition is fixed normally in an alone session of supposed learning, its activity is more prolonged to level of temporary duration and not extinguish so rapidly as a conditioned reflex.

3. Biofeedback

Biofeedback system is a term that is used for naming a set of technologies that aim to provide the information necessary, which allows us to exercise a degree of voluntary control on physiological functions. The devices of biofeedback provide immediate information about the biological situation of the individual: muscular tension, temperature of the skin, conductivity, blood pressure, and activity of the cerebral waves. Using the information that these devices of record supply psychophysiological, we can be trained to modify voluntarily the physiological measured activities. In the case of the brain, the goal of neurofeedback is to encourage us how to control the cerebral waves. The waves of the brain have qualified in four types: wave beta (waking states), alpha (states of relaxation), theta (drowsiness), and delta (deep sleep). This system of a natural way, without external manipulations, helps to control the electrical activity of the brain. When the learning of the wave control has already developed, it is not

necessary to continue using the devices of biofeedback and it is possible to train oneself without external models as an experienced meditator.

The procedures of biofeedback imply a special application of the concept of feedback to monitor and control the physiological processes. It uses the specific instrumental systems that allow to arrange a several type of sign related to some physiological functions, so that the individual could use this reference and learn how to control the function or physiological specific functions. This system allows to show them their aptitude to handle functions that are not subjected to voluntary control, leading them from this form to before unthinkable levels of self-control and control for the own person. On the other hand, the biofeedback allows showing the effects that diverse conducts so many cognitive behaviors have on their physiological responds. Thus, efficiency and facility are possible to help to reorientation with great more inoperative customs and senseless conducts that can affect their performance and that due to the automation on the part of the own person harm his possibilities without conscious awareness of doing so. Finally, the biofeedback facilitates the study of the physiological responds involved in the concrete tasks of every sports or artistic specialty and by means of these programs, training can be designed specific and highly specialized programs of training of self-control of physiological responds involved in the sport that the person practices.

The development and evolution of the biofeedback originated at the beginning of century, in 1901 [13]. Although until the beginning of the decade of the 1917s, the term biofeedback is not generalized, the technologies of biofeedback arise in the 1916s from the paradigms of the learning. The most important precedents that we might indicate are, first, the studies of operating conditioning of the cardiac human beating; second, the study of the resistance of the skin; and in the third place, the animals submitted to it will recover and finally the studies on control, by means of feedback, of the pace alpha of the human electroencephalogram (EEG) [14, 15].

As we have indicated previously, the principal aspect of the biofeedback is to facilitate individuals to learn the control of diverse corporal processes, in which most of the individuals not exercise controls. The investigations with human beings found that it is possible to control the activity of the cerebral rhythm, the galvanic response to the skin, the cardiac rate, the blood pressure, the peripheral traffic, the corporal temperature, the muscular tension, the external sphincters, the rate of the salivation, and the gastric secretion.

To be able to use the procedure of the biofeedback, there are two indispensable elements of great importance: the first term highlights that when any technology of biofeedback applied, it asks the voluntary collaboration of the subject to which it is applied from a sportsman. The technology doesn't work with unmotivated subject since the instrument or machine only provides the information in the case of not available sign. With the help of the psychologist, the individual must develop the control mechanisms. In the second term, for the utilization of these technologies, there is indispensable the availability of a suitable instrumentation, which must fulfill a series of requirements: first, a few conditions guaranteed of validity and reliability required for any device of measure. Second, a few minimal conditions relative to the process of detection of the sign, process that it is necessary to carry out of not invasive form,

http://dx.doi.org/10.5772/intechopen.68490

with a high sampling rate, or in constant detection but so that it does not influence to the own system that tries to measure up. Finally, it is necessary that the own registered sign must be of low latency, so that it reflects linearly the physiological changes.

The biofeedback can be described can be described on basis of phases that constitute the process of control, these phases are the same that has the record psychophysiological, with the difference of which into the last phase, the registered information is simplified and transformed to make them intelligible to the person. Later, we are going to realize an approximation to the principal psychophysiological responds that can be in use in psychology of high performance.

4. EEG: brain recording

The electroencephalogram measures small electrical potential activity of the brain through electrodes placed in the specific points of the head. These potentials were discovered by Hans Berger in 1929, and they have an assessable relevancy since unlike other psychophysiological responds that we will analyze that they reflect the activity of the nervous autonomous system, the EEG is the only direct index of the activity of the nervous central system.

The most commonly used electrode placement system is the international system 10–20. One of the basic parameters of the EEG is the frequency that shows the most relevant information and of more interest for the professional practice. According to the frequency, which different from 0.5 to 60 Hz, the EEG shows different rhythm known as types of waves:

- Delta rhythm: between 0.5 and 4 Hz
- Theta rhythm: between 4 and 8 Hz
- Alpha rhythm: between 8 and 13 Hz
- Beta rhythm 1: between 13 and 20 Hz
- Beta rhythm 2: between 20 and 40 Hz
- Gamma rhythm: frequencies higher than 40 Hz.

The principal areas of study and application of the EEG are the conditions of activation and sleep, the conditions of conscience, the self-control of the rhythm alpha and the evoked potentials. The evoked potentials have enormous applications at sport level to measure times of reaction and speed of transmission of the routes afferent and efferent, very important aspect in the selection of sport talents.

4.1. Electrical activity of the skin

The electrical activity of the skin or electrodermal response is one of the mostly used psychophysiological methods. The resistance of the skin is the impediment that puts the skin to the step of the electrical current, the resistance of the skin depends on the perspiration that covers the zone in which it measures up. Sweat is a saline solution that facilitates the electrical

transmission to more perspiration, minor resistance. We can deduce that the resistance is an inverse measure of activation with major activation, the major quantity of perspiration will reflect a low resistance.

The conductance, it is the inverse measure of the resistance, is a much more comfortable measure which shows a direct relation. The stronger the activation, the stronger the conductance (and weaker the resistance).

The mechanism of the appearance of the response to the skin is based on psychogalvanic in which the stimulus activates to the subject producing a widespread unload of the nice system, with what there is liberated acetylcholine at the postganglionic neurons that innervate the sweat glands. This produces a depolarization and momentary break of the cellular membranes allowing the flow of ions and the consistent decrease of the resistance or increase of the conductance.

The glands of the sweat that are the based on response of electrodermal are the eccrine glands (not the apocrine glands) that are distributed by the whole body, being their major density in the feet and in the palms of the hands. Two routes activate the eccrine glands by psychic stimuli and thermal stimuli. The activation for thermal stimulation is practically despicable in hands and feet, because of it the best place to connect the electrodes is in the palm of the hand.

The most common application of psychophysiological response is to control self-emotional of sportsmen

4.2. Cardiovascular response

The heart is a muscular organ with four chambers and its principal function is to supply blood to all the body parts. The branches of the nervous autonomous systems regulate the activity the heart:

The sympathetic nervous system increases the cardiac rate and the vascular pressure. The parasympathetic nervous system decreases the cardiac rate and the vascular pressure.

There are different types of cardiovascular activity to study the level of cardiac activity; an electrocardiogram (ECG or EKG) is obtained from the electrical sign. To evaluate the level of vascular activity, temperature (to major temperature, major level of blood exists circulating), color (reddish and pale, they allow us to identify major or minor flow of blood, respectively), volume (to major volume, major quantity of blood), and the pressure (to major pressure, major quantity of blood) are used.

The source of the electrocardiogram is the electrical impulses that the heart produces in every beating. When the heart contracts it changes potential the order of few microvolts, which can be detected in the walls of the chest next the heart but which also spreads across arms and legs.

The principal psychophysiological measures that stem from the electrocardiogram are the cardiac rate (a number of pulsations or beatings per minute or unit of time) and the cardiac period (interval of time in seconds between two pulsations). These measures are very useful in sport since they are indexes of the activity of the nervous autonomous system, by means of the EKG, tonic changes can be studied so much as phasic.

http://dx.doi.org/10.5772/intechopen.68490

4.3. Electromyography response

The electromyography response, EMG, is a response of the somatic system that reflects the electrical activity of the muscular fibers.

The electrical changes that take place in this process of depolarization can be detected and provide a measure of the muscular activity which is more relevant than the simple mechanical direct records of the muscular tension.

Overall, the EMG is a technology of measurement of the electrical potentials that are associated with the muscular fibers. The muscular activity can influence emotional and motivational factors, and as such, it is an excellent measure of evaluation of the level of easing and activation of sportsmen, the zone of record normally used with this finality is the frontal muscle.

4.4. Body temperature

The temperature of the skin is regulated fundamentally by the vascular peripheral system to realize biofeedback with this sign. To measure the peripheral thermoregulation of the sportsman, we can use thermometers or, indirectly, transducers, a type of the thermistor, which turn the temperature into electrical sign. The corporal temperature, it also uses in some cases, is an indirect measure of the blood flow.

A methodological requirement to use the thermal feedback is the control of the environmental temperature in the place of capture of information, besides the temperature, before which the subject has been submitted. The temperature during the record should be kept constant (±2 ^{o}C), if this margin excels itself, there would be restricted to the subject the range of elevation of the peripheral temperature.

Another fundamental aspect is the suitable placement of the sensor. The most suitable location is on a zone of great vascularization, trying that the sportsman in this zone could not exercise any type of pressure, otherwise, it might falsify the measure. The corporal temperature is an index witness of activity of great usefulness to verify the effect of mental-specific trainings for the sportsman.

4.5. Respiratory response

It is an important measure of record for the sports biofeedback; it is composed principally by two parameters, the depth of the breathing and the respiratory rate, which they are combined in order to obtain the volume of air inspired per minute. The respiratory function is controlled by the nervous central system across the spinal cord, and the motor nuclei of the brain stem and its psychological importance take root in that it is easily influenced and affected by the emotional conditions. The breathing has two fundamental periods: the inspiration or air capture and the expiration or expulsion of the air.

There exist different methods of measure of the electrical activity; all of them are because of the physical nature of the sign that needs some type of transformation or sign. Another methodology of record used in psychophysiology is the so-called method of displacement of the zones involved in the breathing. The displacement of the thorax measures high as much

as that of the abdomen. The form of measurement is variable. It is possible to realize placing a spring in the thorax and abdomen, which needs the immobility of the person. Also, placing an elastic strap translates the stretching in electricity. A positive aspect of this methodology is that it allows distinguishing the thoracic breathing of the abdominal one. This distinction is important since to major level of anxiety, there is major level of thoracic breathing and contrary to major deactivation level of abdominal breathing.

4.6. Gastrointestinal activity

The gastrointestinal activity is very sensitive to the emotional changes; therefore, its measure is very useful. There exist three principal measures of the gastrointestinal response: the gastric motility, the stomach acidity or level of pH, and the salivation.

The classic technologies of record of information to this level were very invasive; it is enough to remember the gastric pipe introduced to the person to gather inhaling the stomach content or the pipe with an inflatable ball in an end to measure the intragastric pressure. Nowadays, the methods are evolving rapidly, and it is possible that in the future, this type of record is furthermore useful to sports level of field. Recently, they have turned out to be technical more sophisticated as the radio telemetry, which operates across a radiotracer that the person can swallow comfortably, and that by means of the corresponding transducers convert the measure into electrical signs.

The measure of the salivation is interesting because three couples of glands salivate existing (parotid gland, sublingual gland, and sub-maxillary gland) are innervated for the sympathetic and parasympathetic nerve fibers, and therefore, they reflect the activation of the system. The saliva in situations of fear and guilt suppresses its secretion. In stressful situations the assertive individuals increase the level and keep out they diminish it. To level of composition in conditions of anxiety, it is less alkaline.

4.7. Pupillary response

The ocular answers are another type of the psychophysiological record that are very useful, but probably not too widespread motivated by the sophistication and economic cost of the set of instruments used. Fundamentally, we use the ocular movements and pupillary activity. The ocular movements are saccades. The methods used to measure the ocular movements are two types: electrical and nonelectrical types. Between the nonelectrical ones, it is necessary to stand out the ophthalmoscope, which is based on the reflection of the light on the cornea, and the most indicative electrical level is the electrooculogram (EOG).

The pupillometry is the technology of the measurement of the pupil diameter. The pupil is an opening across the iris, the function of the iris is to increase the diameter of the pupil in situations of scanty light and to diminish it in situations of abundance of light. The pupil can contract 1.5 mm and expand 8 mm up to 0.9 mm, these reactions be generated in 0.2 second. The changes in pupil also response to psychological stimuli, to take records the lighting it has to be a constant. The unit of measure is the millimeter and reflects different aspects that are important in the sport. The diameter of pupil is maximum when the sportsman is resting and

diminishes when one is getting tired. As for the task is more complex the diameter of the pupil gets bigger. The expansions of pupils are also an index that reflects the changes in the activation of the nervous system. Though probably these methods seem to the sports technician slightly operative, to level of basic investigation, they represent indexes of great usefulness psychologically sports.

The application of the biofeedback to control and prevent sports stress has been an important evolution of the systems of training. The psychology contributes with the biofeedback an indispensable tool to bring over the sportsman and the artist to their maximum possibilities of performance.

In previous decades of last century, we had the fortune of starting investigating the first applications of the emergent virtual reality at the time to the field of the psychology with applications in the environment of the high-level sport area that, due to the strong social and commercial interest that it supposes was allowing the development of new technologies and applications, because numerous possibilities of financing existed especially before the celebration in 1992 of the Olympian Games in Barcelona. These circumstances allowed us to develop the first applications of the virtual reality in the athletes' training of high performance [16], developing new methods to reduce the anxiety, to facilitate the technologies of mental test and to overcome specific phobias that though they raised the attention of numerous mass media, they supposed skepticism, incredulity, and their funniness [17]. Today, decades later, consolidated the new technologies in our society like something daily and natural and with an abundant scientific international bibliography; it is possible to treat the topic without problem.

The dancers are athletes of high performance who in general do not compete, but they train and have a way of life very similar to the great athletes with the aim to reach the virtuosity in the artistic expression. Unfortunately, the world of the art has neither the technology nor the scientific accompaniment, nor the profit budgets of other activities but provided that the developments are there and are an own property in the investigation that we are developing in the king juan carlos university (KJCU), of applications of the information and communication technology (ICT) in the arts, we have started introducing systems of application of technological innovations of forefront neuroscientist to the area of the dance as the introduction of technologies of psychological training by means of systems of biofeedback and neurofeedback, and as a tool of increase of the artistic performance, we have started using the virtual reality in this area.

A definition of virtual reality is very complex. It is a technology that is in full boiling and exists decades ago, but the large changes that are taking place in the technological evolution and the wide range of designed systems do not allow us to offer a definitive definition. The term had its appearance in the year 1988 attributed to the visual artist and composer of classic music Jaron Lanier [18] founder together with Thomas Zimmerman of the company VPL Research Inc., the first company that sold glasses and gloves of virtual reality at the end of the decade of 1990. Nevertheless, the experts mark its origin in the decade of the 1960s, when Ivan Sutherland developed "a head-mounted three dimensional display" a development that was demonstrating that it was possible to combine three-dimensional graphs generated in a computer with interactive visualizations.

The VR is defined as a method of interaction between the user and the computer, in which user stops being a passive person that receives images and information on the screen and turns into an active being and starts interrelate with a three-dimensional environment. So that the technology VR supposes two new questions between the man and the machine, the possibility of interaction with what there is generated the illusion of being physically inside the virtual space because it interacts real time. This illusion is named as a sense of presence [19] which allows that the user could have reactions and to evoke emotions very similar to those that it has in the appropriate environments, of their stems, efficiency, and big possibilities of utilization in clinical areas, allows to simulate the reality of a convincing way for the brain, beyond the utilization of the imagination that also has its paper of reinforcement in the psychotechnology and is, precisely, what the VR turns into a tool of huge therapeutic potential and with enormous possibilities of being used in the training of artistic capacities. The first works in art we have carried out them with musicians, about a field that presents problematic many since is that of the scenic anxiety. At first, we were thinking that this one was not a problem that was affecting especially the dancers, but the accomplishment of some works of investigation and doctoral theses has showed us a very different situation.

An equipment of VR intervenes different technological components: a computer, a virtual environment, systems of input (to provide information of the actions that the user is going to realize, with sensors of position, systems of eye tracking that register in real time, the ocular movements and the most traditional devices such as the keyboard, the mouse, or a joystick, or the acquaintances and sophisticated gloves of VR), systems of output (those who stimulate the sensory channels of the user, the visual and auditory systems are most developed and are increasing of utilization the olfactory and haptic systems and are starting developing also gustatory system).

In the last years, the VR has started consolidating as a tool of great value for the professionals of the mental and physical health. Beyond continuing extending the range of psychological disorders in which solutions based on the VR will be implemented; one of the large developments will come from the Internet and of the mobile devices (smartphones, tablets, etc.). As a result of these decades of investigation, we already have very optimistic information that show the great clinical efficiency of the VR for the treatment of the most ample range of disorders of anxiety. In general, it is necessary to emphasize that the studies of the analysis of goal [20] indicate that the virtual reality exposure therapy (VRET) is more effective than the exhibition in imagination and, probably the most interesting thing, it is like a minimum as effective as the live exhibition. At present, the most robust information has been principally for the phobia to flying and the acrophobia. During the last decades, some authors have developed experimental procedures capable of producing emotional changes of a controlled way and of inducing states of mind. Based on the needs of the users of the area that we are treating, to assure the sensation of relaxation and to avoid sensations of anxiety, it has been verified that the VR has a high efficiency [21].

The works realized in the Applied Technology for Neuropsychology Laboratory of the Italian Institute for Auxology demonstrate these possibilities. In this institute, there has developed a qualified project "The Dream Island," with the aim to use this technology to confront successfully the stress and the anxiety so much in clinical population, as not clinic. They have developed an environment that is a tropical virtual island, in which the user can train in varied technologies of easing: as Schultz's autogenously training, Jacobson's muscular progressive

http://dx.doi.org/10.5772/intechopen.68490

easing and different exercises of breathing by means of a protocol with two differentiated phases. The first phase is realized in a controlled environment, since it can be the office of the clinical person in charge where the patient is exposed to the virtual island by means of an equipment of VR. In this context, the user with the help of the clinical one tests the technologies of easing learned in the zones that consist the island. In the first zone, the user crosses a bridge that takes him to a beach, where it realizes the first relaxation technique opposite to the ocean. The second area is designed by a waterfall placed in a hill, where the user has the task of imagining that his negative thoughts go away close to the water of the waterfall while he trains in another relaxation technique. In the following space, the user can visit an atoll of the island in which there is a chair when he sits down can observe the tropical environment and the ocean while he practices another technology. Finally, in the last area, he entered a shop of campaign practical, while in another technology, he visualized the movement of the waves of the sea. A characteristic that differs in the VR of the traditional technologies, in which one is employed with the closed eyes, is that the user remains with the opened eyes and listens and sees directly a tropical island, so that the user forgets the space in which he is and has the illusion of being visiting a different space that generates an agreeable sensation of peace. To study the effects of this environment realized, a study with 38 university students assigned to three experimental groups, one work with an equipment of VR, other one with a DVD directed when easing provokes with images and sounds of tropical islands and the third group control the one that did not apply any relaxation technique to himself. The results indicated that the VR can be a very effective technology to diminish the anxiety [22].

Though the VR every time is a more attainable reality, the equipment has started popularizing and degrading drastically; there are companies that already have launched onto the market products of a quality very adapted to attainable prices, the big problem is that the environments, it is necessary to make them in proportion to what he needs. At present, they can find environments as the writing in the text on that we were commenting completely free. The Italian Institute for Auxology, leading by Doctor Giussepe Riva, puts at the disposal of any person who it wishes diverse virtual environments without any cost in his web page (www. neurovr.org). Moreover, it is possible to use the publishers of video games 3D commercial that represent an option with an economic very moderate cost. In our technological projects, it is in production on the part of the University Institute Dance "Alicia Alonso," to put at the disposal of artists virtual environments especially designed for the representation of a ballet or to be a soloist in an important room of concerts or to realize a theatrical representation in an important scene of the maximum level, only we need to provide appropriate environment prototypes that we are generating, and to rely on more funds of investigation that they should allow to make real these projects.

5. Conclusions

The technologies of biofeedback have demonstrated extensively their efficiency for more than 50 years and their therapeutic application to various problems and clinical disorders, but there are still many questions to be answered concerning the efficiency of these technologies per se and, comparatively, with other therapeutic technologies applied to similar clinical problems with who often are combined to assure the best benefit of the patients.

According to a periodic review study in this field conducted by Yucha and Montgomery [23]—one of the principal available sources of information in the matter, supported by the International Association Applied Psychophysiology and Biofeedback—there exists an efficiency confirmed for aspects related to sport and high performance such as anxiety, attention, control of the pain, and regulation of emotions that ensure the utilization and the need of these technologies such as the commented in this writing.

It is necessary to continue research and improve the methodologies, but the basis is there, a present that consolidates these processes and a very promising future. The same thing occurs with other methodologies suggested in the writing as the hypnosis and the virtual reality, they have very promising applications, being necessary to increase the investigation to consolidate and to generalize their applications.

Author details

Amador Cernuda Lago

Address all correspondence to: amador.cernuda@gmail.com

King Juan Carlos University, Madrid, Spain

References

[1] Spielberger CD. Theory and research on anxiety. In: Spielberger CD, editor. Anxiety and Behavior. New York: Academic Press; 1966. pp. 3-22

[2] Spielberger CD. Anxiety as an emotional state. In: Spielberger CD, editor. Anxiety Behavior. New York: Academic Press; 1972. pp. 23-49

[3] Spielberger CD. Anxiety in Sports: An International Perspective. New York: Hemisphere Publishing Corporation; 1989

[4] Cernuda A. La Importancia del Factor Ansiedad Rasgo en la Selección Psicológica de Talentos Deportivos para el Alto Rendimiento. Actas XII Congreso Nacional de Psicología de la Actividad Física y el Deporte y I Jornadas Internacionales de la AMPD en la Universidad Autónoma de Madrid; 2010

[5] Cernuda, A. La importancia del factor ansiedad rasgo en la selección de talentos artísticos de alto nivel. Actas XXVII Congreso Mundial de Investigación de la Danza de la UNESCO. Córdoba; 2010

[6] Cernuda A. La ansiedad rasgo como predictor de éxito. Libro de resúmenes del IX Congreso Internacional de la Sociedad Española para el Estudio de la Ansiedad y el Estrés, Valencia; 2012. pp. 50

[7] Cernuda, A. Hipnosis y Rendimiento. Congreso Iberoamericano de Psicología. Colegio Oficial de Psicólogos y Sociedad Interamericana de Psicología; 1992

[8] Cernuda A. Flotation rest and subliminal stimulation in the improvement of concentration. In: Lidor R, Bar-Eli M, editors. Innovations in Sport Psychology: Linking Theory and Practice. Proceedings IX World Congress of Sport Psychology. Israel. Vol. I, pp. 188-191. Wingate, Israel. International Society of Sport Psychology. 1997

[9] Cernuda A. Biofeedback, hypnosis and subliminal stimulation in the improvement of concentration of elite athletes. In: Proceedings X World Congress of Sport Psychology. Skiathos, Grecia. Vol. II; pp. 101-104. Thessaloniki. Christodoulidi Publications. 2001

[10] Cernuda A. I Seminario Internacional de Tecnologías Aplicadas al Deporte de Alto Rendimiento, TADAR organizado por las Universidades Carlos III y Politécnica de Madrid y la Universidad de las Palmas de Gran Canaria. Celebrado en la Facultad de Ciencias de la Educación Física y el Deporte de Madrid; 2006

[11] Cernuda A. Hipnosis, Deporte y Alto Rendimiento. Hipnológica. 2009;**1**:17-25

[12] Hartland J. Medical and Dental Hypnosis and its Clinical Applications. London: Bailliere, Tindall & Cassell; 1966

[13] Bair JH. Development of voluntary control. Psychological Review. 1901;**8**:474-510

[14] Basmajian JV. Control of individual motor units. American Journal Physical Medicine. 1967;**46**:480-486

[15] Kamiya J. Conscious control of brain waves. Psychology Today. 1968;**1**:57-60

[16] Cernuda A, Ramírez J. Virtual reality and sport psychology. In: Book of Abstracts 23rd International Congress of Applied Psychology; pp.17-22; Madrid: The International Association of Applied Psychology (IAAP). 1994

[17] García A. Entrenamiento en los Límites de la Ficción y la Realidad Virtual. Entrevista al Dr. Amador Cernuda. Diario Médico. 26 Julio 1994. p. 14

[18] Lanier J. A Vintage Virtual Reality Interview. Disponible en [Internet] 1988. Available from: http://www.jaronlanier.com/vrint.html. Descargado el 15 de julio de 2007

[19] Steuer JS. Defining virtual reality: Dimensions determining telepresence. Journal of Communication. 1992;**42**(4):73-93

[20] Meyerbröker K, Emmelkamp P. Virtual reality exposure therapy in anxiety disorders: A systematic review of process-and-outcome studies. Depression and Anxiety. 2010;**27**(10):933-944

[21] Westermann R, Spies K, Stahl G, Hesse FW. Relative effectiveness and validity of mood induction procedures: A meta-analysis. European Journal of Social Psychology. 1996;**26**(4):557-580

[22] Villani D, Riva G. Virtual reality to reduce Anxiety in healthy population: The dream Island. In: Wiederhold B, Riva G, Bullinger MD, editors. Cybertherapy. San Diego: Interactive Media Institute; 2005

[23] Yucha C. Montgomery D. Evidence-Based Practice in Biofeedback and Neurofeedback. Wheat Ridge, CO: Association for Applied Psychophysiology & Biofeedback; 2008

INTECH

Chapter 5

Risk Mitigation Strategies in Innovative Projects

Riaz Ahmed

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.69004

Abstract

This chapter discusses the challenge imposed by the dispersed innovation that shifts toward replicating the positive traits of co-location and coupling it with the unique advantages of the global initiative. Key concepts in this chapter include project risk, risk pertinent to the innovative projects, importance of risk mitigation in innovative projects, different risk categorization involved in mitigating risk in innovative projects, risk mitigation planning, risk mitigation strategies in innovative projects, and risk evaluation and mitigation strategies (REMS) in various types of innovative projects including the lesson learnt from the innovative projects to handle project risk by adopting risk mitigation strategies.

Keywords: strategies, risk evaluation, risk mitigation, innovative projects

1. Risk and innovative projects

In the current context of market globalization, where the world is emerging with new and more advanced technologies and increasing their competitiveness, companies are trying to offer more and more innovative products. New projects or new ideas always give birth to new challenges, new risks which come across during the development and execution of a project. Different mitigation strategies exist to handle new risks. Moreover, increasing companies are now drifting toward project management tools and techniques to manage innovations, to ensure a better product quality, to meet deadlines, and to reduce the cost. Thus, decision makers along with academicians are trying to minimize risk by applying project management methods.

A risk is "an uncertain event or condition that, if it occurs, it has a positive or negative effect on at least one of the project objectives." A risk is an uncertain event that if it happens, adversely impacts on the project objectives such as scope, schedule, cost, or quality. Project managers should identify risks using different project management approaches that can impede the project's success. Risk identification is carried out through various processes depending

upon the nature of the organization and projects which can be related to operations, technology, organizational procedures, etc. Once risks get identified, then techniques, strategies are observed, and contingency planning is done to lower the impact [1]. According to the ISO 31000:2009, risk analysis is a critical exercise for any project regardless of its size to manage risk. A risk analysis becomes an imperative element in the planning phase of the business development.

The risk, defined as the likelihood of occurrence of a condition or event, may have a positive or adverse effect on project objectives. In projects, there are three categories of risks: (a) project risks; (b) product risks; and (c) business risks. Every organization or project must learn to adapt against the emergence of risk, business changes, and investments in anticipation of its likely futuristic occurrence. However, risk significance is even more important for organizations working on innovative projects because the management must adopt strategies to overcome and mitigate the potential effects of risk which may be negative and alongside its related opportunity. Innovation brings itself with the prospects together with many types of risks such as strategic, technical, delivery, and enterprise [2]. Innovative products are usually ahead of time, strategic risks relate to the lack of investment, different business process understanding, and limited support from management [3].

Innovation is a key to organizational rejuvenation and success. Novelty is central to innovation, but this inevitably implies risk. The risks are inevitable in all projects but are especially important in innovation for which a high failure rate is typical [4]. In some industrialized countries, the success rate of new products is 15%, and for underdeveloped countries like Hong Kong; it is just 2% [5]. It is desirous from innovative management to identify the unacceptable risks as early as possible that often become apparent only in the later stages, at a greater expense. However, a fear of failure would be detrimental to innovation; indeed, accepting the possibility of failure as an everyday reality is one of the defining characteristics of the innovation project. Any model for the process novelty needs to incorporate failure as a likely outcome. In many other projects abandoning the venture is general but remote option, whereas in the innovative project, it is integral for good management. Risk management can help managers in making the critical decision to abandon a project, providing an active sieve of the good and poor prospects and helping direct the continuing research that is fundamental in innovation projects. The risk is central to innovation, but it is often not managed explicitly [6].

Projects regardless of their type and size face risks. Project's characteristics such as innovation level, constraints, a joint venture by multinational and political stakeholders, changing the environment, and such similar traits can increase the project risk level. Hence, the project manager must find a win-win solution to lessen risks besides ensuring that the novelty rate is achievable, and the available resources are adequate to meet the expectations. The risk mitigation strategy plays a vital role to keep the project on track for which identification of potential risks is a must. There are calls for correct risk evaluation and appropriate remedial strategies to gain a realistic and accurate estimation of the project's cost and duration.

Modern innovation requires quality global resources at a rapid pace for which outsourcing—a concept very popular to bring about efficiency, seems a realistic option especially in the context

of risk mitigation. Outsourcing extends the proficiencies to take on complex and pioneering projects, and over the period has proved to be an excellent risk mitigation strategy. However, despite it being the best resource across the globe, outsourcing also has presented with the challenges of managing the means in new turbulent economic scenarios. In recent times, a detailed scrutiny has been carried out to seek the portfolio of the outsourced IT companies [7]. Some of the studies have focused on the level of complexity and cost and time overrun, and the primary emphasis of which has remained on developing a model that can establish a relationship between the complexity, the related risks, and its implication on overall objectives. Its foundation stands not only in identifying risks at commencement but also the mitigation strategies alongside by allowing for the interaction of the three and all that in the framework of Expected Utility Theory [8].

A similar concept is also given due consideration in the context of the impact of innovation on the environment in the long-term sustainability of nanotechnology argues in the risk governance approaches to mitigation of risks with clear and well-structured risk assessment and management criteria to risk governance [9]. For undergoing any innovative project, as for instance the development of London Heathrow Terminal 5, a lot boils down to the dynamic capabilities of the firms or the organization under consideration to take on the innovative projects. Pioneering projects are often strategic in nature and often made complex owing to the number of stakeholders involved in the project. It therefore requires the whole project to be broken down into phases for better contemplation of fragility of the innovative projects and the list of stakeholders involved in strategic management, ultimately balancing out demands on both ends [10].

Project complexity has direct linkage with the innovative nature of the project. Hence, it is important to assess the prospective level of difficulties that may arise due to the very character of the project. As a result, this could save the delays in project completion and keep in check with the budgets besides keeping repute in a cut-throat competition as in the case of Boeing Dreamliner [11]. Sometimes it comes to sourcing alternative ways of energy from the traditional fossil fuel where the idea itself is innovative and has strong linkages in diversifying the risk regarding risk expansion and decreasing dependencies. Identifying alternative sources of energy is a risk mitigation process other than insurances are very complex and requires work at multidimensional levels of complexity. However, for investment in renewable sources, a major hindrance other than the execution of the project itself is the regulatory requirements prevailing in a given country along with the country's long-term strategic goals which can limit alternative risk mitigation strategies [12].

2. Significance of risk mitigation

Risk management can aid good managers in making the critical choice of abandoning a project. It provides an efficient filter of good and poor prospects and helps in continuation of research that is essential for innovative projects. The risk is not often managed explicitly but is crucial to innovation. Encouragement of people in generating ideas is a difficult task, and excessive

use of risk management may discourage radical suggestions and stifle this critical stage. While defining the suitable and profitable method of risk management, every project has to consider the data available, costs and management worth of the outputs of the additional analysis. Likewise, innovative project has to balance the likely effect on creativity. Risk management is inherent in the innovation process, but there may always be significant in making it more unambiguous by incorporating models of innovation and project risk management [6].

The usage of newly acquired information, data, or knowledge for the development of a fresh product of service is referred as innovation [6]. Novelty is vital for innovation but unavoidably involves risk. Risk can occur in any project, but it plays a great role in innovation, and failure rate in such projects is common. Proficient innovation management should be able to ascertain excessive risks as early as possible but time and again risks only become evident in later stages, at a significant cost. Nevertheless, fear of failure can be damaging to innovation; in fact, tolerance to the possibility of failing as reality is one of the essential characteristics of innovation projects. Incorporation of failure, as a likely consequence, is often required in a model designed for change.

Contingency theory in the context of innovative projects is of the view that a project can trail different number and as it is about the state-of-the-art projects, it may not be following the seasoned phases from the generation of an idea to launch. So the biggest challenge lies in identifying a particular configuration that can get employed and resource allocation as per the setup and the reasoning behind it in ensuring the overall success of the pioneering project [13]. In the public sector, the stake is the public, and the success of social sector projects is the resultant outcome regarding its implication on the life of an ordinary man. Social sector projects, in general, do not face funding challenges, while risk mitigation often is assessed on equalities impact assessment (EIA). Added innovative decision-making process of social risk impact assessment (SRIA) must have a preference over EIA which does not take due account of a sector that could face adverse impact due to service cuts [14].

Innovation has a lot to do with the risk management. Exploration of the relationship between the two done with a notion that the whole process of risk management splits into stages with a strong emphasis on when to perform laborious risk management processes and when to go with simpler methods to optimize effectiveness [6]. While considering the risk mitigation policies, the biggest challenge is identifying the root cause of such projects. In this scenario, any system that may get formulated must not only be focusing on the production side of things but must also take into consideration the co-benefits [15]. It is hard to deny the prospective impact of the innovative projects on the intangibles. For example, it is apparent in the case of health, environment safety, and overall sustainability. It is also opined by many that the creators and inventors of technology, more often than not, do not have the skill set and capability to foresee the risks that may get associated with the development of new technologies, especially the impacts on the intangibles. Furthermore, it can be stipulated that incorporating the risk mitigation strategies beforehand and before the launch of new innovative technologies in the market can bring about the much desired competitive advantage to such corporations [16].

Risk management strategies are critical as they contribute to the success of the projects in following ways:

- Indent and priority of risks enable the project managers and staff to focus on the most essential aspects which have the most impact on the project.
- Risk mitigation actions reduce overall project risk thus accelerating project completion.
- Due to an earlier completion of projects, the projects cost less, besides the risk reduction actions may further reduce project costs.
- Projects which enforce risk mitigation strategies have more predictable completion schedules and experiences few surprises.
- The risk extenuation strategy helps PM set contingency budgets and thus review the adequacy of the budget as the delivery progresses.
- Risk identification allows all personnel to record their perception of what could go wrong and offer ideas on how to avoid or reduce the impact of such problems.
- It provides an audit record of risk handling effort in a project.
- Risk mitigation also helps in achieving business objects and maximizing shareholder value.
- It promotes job and financial security.

3. Risk categorizations and mitigation

Risk mitigation strategies are the conceptualized action plans, and it is the process of developing options to enhance opportunities. It performs a thorough evaluation to reduce the likely threats, vulnerabilities, or impairments that can distress a business operation, a project, or any form of the undertaking. A suitable response to each risk should be specified and recorded in a risk register. Studies have indicated several project risk management actions identified, and these may be summarized into categories reflecting the particular characteristics of innovative projects [17, 18]. Risk management is a major component in project success. It is an important activity that should get applied to all projects as fundamental part of every facet of managing the project, in every phase as well as a process group.

3.1. Increase responsiveness

Another strategy of mitigating the risk in projects is the increasing responsiveness related to faster deliveries, which accounts for a 20% increase in production rates. The faster one gets the item into consumers' hands the better. Fast-track project implementation can also help mitigate three significant threats to risks associated with costs, scheduling, and safety and quality renewable energy parks.

3.2. Reducing cost risks

Some of the most common cost risks that are faced when needing to expedite a project include the accuracy of cost estimates, delayed or miss appropriate funding, complications from schedule compression, and the dearth of vendor competition. Through the fast-track project delivery, risks in cost estimates get minimized through adequate preliminary engineering and scheduling. When the team can identify budget issues early in the design process, cost estimates are more thorough, eliminating threats from potential, costly surprises.

3.3. Mitigating schedule risks

When modularizing equipment, it is vigorous for the project team to involve merchants early and to launch an equipment expediting plan to avoid potential scheduling barricades caused by equipment deliveries or damage during transportation.

3.4. Mitigating safety and quality risks

Fast-track projects also alleviate issues caused by work area congestion by developing an hour-by-hour roster that ascertains areas of trade overlap and enables the project team to make alternate plans to eliminate this overlap.

3.5. Rapid prototyping and test feedback

Rapid prototyping is an essential part since suitable comparisons might not be available in the market or within the organization. However, it can be a part of the quality assurance process of the organization/project. The feedback from the prototyping/experimentation should be thoroughly analyzed and tested, and suitable recommendations for changes adhered to throughout the project duration. The risk like grid connection, delays in start-up, or maintenance issues can be sorted out after critical analysis of these prototypes.

3.6. Political, policy, and regulatory risks

Relevant political, policy, and regulatory risks for wind parks include:

- The risk of ex-post facto adjustment of support.
- Continuous inconclusiveness on prospective policy support or regulatory requirements concerning solvency capital requirements.
- The risk of expropriation or war like developing countries. Risk management instruments or mitigation strategies for political, strategic, and regulatory risks are:
- Due persistent practices including an assessment of potential future changes in the legislation such as by identifying political risk indicators.
- Geographical and regulatory diversification is a primary risk mitigation tool. Divergence appears to be a single risk management tool for policy and regulatory risks in general.

3.7. Efficient communication

Effective and efficient communication among all key stakeholders throughout the project lifetime is the lifeblood of a project. Without effective and efficient communication mechanism across the channel, no project is bound to be successful. Its importance intensifies even more in such like innovative projects because the lack of proper and timely communication between the project team and all the stakeholders (in this case it is public) can create confusions/conflicts which can act as benchmarks for serious setbacks to the project.

3.8. Staff training

This strategy includes developing and supporting organization-wide edification and drill for soft skills in communication, partnership, enablement, servant leadership, critical thinking techniques, and strategic thinking as well as technical expertise. Proper training of staff is of fundamental importance once the team hired might not have experience working in the particular environment and handling the specific equipment/machinery. Training employees can lead to fewer costly mistakes which mean there are less recalls less rework and reduced chances of failure. Therefore, it is essential to devise a suitable comprehensive training program for the project team members to develop proficiency in specific areas of the project.

3.9. Relying on proven technologies

Innovation always scatters around uncertainty. In an innovative project like this, there is a need to build on the already proven technologies/strategies for building/manufacturing the products to control the uncertainty factor. Moreover, proven techniques/strategies are more likely to have been tested and verified already and information regarding their effectiveness/efficiency might be available in the market. It would naturally reduce the uncertainty factor of the overall project to some extent.

3.10. Multiple sourcing

Multiple source approach relies on the options such as never to keep all of the eggs in the same basket. A good project manager should always have multiple concurrent options available at any point of reference. A single option can quickly turn into chaos due to any unforeseen circumstances. The importance of various sources becomes even more important in this innovative project due to the unpredictable/uncertain availability of resources/parts which require replacement. The idea of multiple source strategy can be extended to various disciplines, for instance, technological options, HR options, vendor/seller options, etc. However, holding various resources can get very costly. The reason is simple: Because cost holdings incurred continually, the optional resources would be used only in the rare event of a disruption. As a consequence, the company pays (and continues to pay) for reserves that may never get tapped.

3.11. What-if scenario

It is imperative to understand the complexity and nature of issues/problems that could arise throughout the project life. The reason is that there might not be sufficient time or resources

to act on the time when the issue occurs. Therefore, all the issues need to pre-assessed and analyzed in advance. Relevant what-if scenarios require formulation, and contingency plans should be proposed accordingly in advance to avoid the future disturbance or failure due to damage to physical assets or non-availability of certain items.

3.12. Counterparty risk

The supplier or contractor's financial stability of operation and maintenance (O&M) services is critical. The counterparty risk of major suppliers or contractors considerable issue for offshore wind parks, where financial strength concerns contract fulfillment, as well as guarantees or warranties. All parties see skilled developers and reputable contractors with current credit evaluation and performance track record, particularly pertinent for offshore wind parks, as well as long-term contracting.

4. Planning risk mitigation

The risk mitigation step involves the development of mitigation plans designed to manage, eliminate, or reduce risk to an acceptable level. Once implemented that plan is continually monitored to assess its efficacy with the intent of revising the course-of-action if needed. The risk reduction plan includes evolving options and actions to enhance opportunities and reduce threats to project objectives. Reducing risks is the process of executing risk mitigation actions. Risk mitigation progress monitoring includes tracking identified risks, identifying new risks, and evaluating risk process effectiveness throughout the project. Risk mitigation handling options is (a) assume/accept—acknowledge the existence of a particular risk and make a deliberate decision to take it without engaging in extraordinary labors to control it. However, approval of a project or program leaders is a priori in such cases; (b) avoid—adjust project necessities or constraints to eliminate or reduce the risk. This adjustment could be to accommodate a change in capital, technical requirements, or timetable; (c) control—compliance with planned actions to minimize the effect or probability of the risk occurrence; (d) transfer—making others responsible for causing or handling risks; (e) watch/monitor—monitor an event for a change that may yield an effect on nature and the impact of the risk.

Best management practices require that the known and perceived risks need to be analyzed on merit based on the gradation and probability of the anticipated adverse results. After that, all such risks examined gets preserved according to their priority levels in accordance with the risk mitigation plan followed by the development and integration of the corresponding risk reduction strategies and get referenced in the previously qualified risk management plan. A risk mitigation plan shall serve as the checklist of the anticipated risks, explaining by the degree of probability, like high, medium, or low. Some project managers, however, deem it more appropriate to categorize the risks as most likely, likely, or unlikely. The project manager must take complete authority of reducing the probability of occurrence of risks while executing a project.

5. Risk mitigations strategies in innovative projects

Risk mitigation in innovative projects means taking steps to reduce adverse effects or a systematic reduction in the extent of exposure to a risk and the likelihood of its occurrence. The risk response must revolve around following response strategies to ensure minimization of the paraphernalia of uncertain events. Doing this will facilitate innovative project continuity and ensure disaster recovery. These risk responses include:

5.1. Attending to the uncertainty level

If a project is destined to have a small degree of risk, then the optimal policy is to proceed expediently to upsurge the present-day value of the project by finishing it as soon as possible and thereby earning its benefits faster. Fixed-price contracts, conceivably with schedule enactment incentives, are suitable for this type of project. The whole enchilada otherwise being similar, projects that take longer generally cost more and deliver less value to the owner. However, when a project has some ambiguity, a full-speed-ahead approach may not be optimal. In such projects, scope changes and iterative recycling of the design are the norms not the exception. For projects with an extraordinary degree of uncertainty, fixed-price contracts may be inappropriate, but performance-based incentive contracts appear convincing.

5.2. Risk transfer and contracting

There is a common perception about risk management, namely that the owner should allocate risks to the parties best able to manage them. Even if this sounds right, it is far as easy to say in place of performing. It is hard, for example, to allocate risks when there is no quantitative extent of them. Risk apportionment without quantitative risk assessment can lead to attempts by all project participants to shift the responsibility for risks on others, instead of searching for an optimal allocation based on mutually recognized risks. Contractors in general agree to take risks only in exchange for adequate rewards. It is necessary to quantify the risks so as to come to an understanding in a fair and just price that the owner should pay a contractor to accept the risks associated with particular uncertainties. Risk transferal can be entirely appropriate when both sides fully understand the risks compared to the rewards. This strategy seems applicable to contractors, indemnities, or indemnification firms. The party that assumes the risk does so because it has an acquaintance, expertise, or other characteristics that will lessen the risk. It then is justifiable and economically proficient to hand over the risks, as each party considers itself to be better off after the altercation than earlier and the net project value increases with risk transference.

5.3. Risk hedging

Risk hedging (or risk buffering) is to keep some reserve that can engross the effects of several risks without endangering the project. A contingency is an example of a buffer where a

large exigence decreases the risk of the project running out of money before its completion. Buffering can also include the allocation of additional time or other resources used by the project. It can mean increasing supplies to cater for the uncertainties in futuristic requirements. Risk buffering is often applied by project contractors as well as by owners. Misjudging the number of hours worked, or other costs such as buffering used by project contributors. If jobs get awarded by lump-sum, fixed-price bids, then too much budget cushioning can be detrimental to contractors' competing abilities. Contractors and sub-contractors may succeed in winning compensation by overestimating project or activity durations. Schedule buffers allow contractors to adjust their workforce and resource allocations within projects and across multiple projects.

5.4. Risk evasion

Risk avoidance is the exclusion or evasion of the class of risks or by altering the bounds of the project. It strives for reconfiguring the project such that the risk in question disappears or gets abridged to some bearable value. The flora of the solution may be engineering, technical, financial, political, or whatever else addresses the cause of the risk. However, care is needed so that circumventing one known risk does not lead to taking on unknown risks of even greater significance. Risk averting is perhaps underutilized as a stratagem for risk extenuation, whereas risk transference is overused. It is because those owners are likely to first think of how to transfer risk to someone else rather than restructuring the project to avoid the danger. Risk averting is a plan that the stakeholders can turn to their benefit.

5.5. Risk controlling

Risk control prohibits the unlikely events from occurring in a project. It minimizes risks by barring their freely spread in the project through planned mitigation. Risk control can employ data gathering for analysis purposes or an advanced cushioning system that is capable of providing accurate and on time information about a risk. Managing risk is expensive. For example, in the case of a new product development (NPD) where competition may cause risks, then one of the solutions is to accelerate the proceedings even at a substantial cost, to come out as a leader. This technique is a standard norm in high-tech industries. The associated risk, however, is that the scientific development as promised may not occur and may require abandoning of the project.

5.6. Risk acceptance

Accepting risk is the last resort in developing a risk encountering strategy. It means that if a risk remains unavoidable, cannot be controlled, indemnified, eradicated, transferred, or mitigated; then it must just be accepted so as to continue with the project. Ostensibly, this implies that the risks associated with going ahead are less than, or more acceptable than, the risks of not going forward.

6. Risk evaluation and mitigation strategies (REMS) in innovative projects

The purpose and importance of risk evaluation mitigation strategies (REMS) are to lessen or reduce if not eliminated but at least are being reduced to some lower level that the adverse impacts of the known or perceived risks are inherited in a particular undertaking or even before any damage or disaster takes place. The quicker the risks get identified and avoided, the smaller the chances of having to face that particular risk's consequence. Known risks must get analyzed according to their anticipated impact. All the risks should be first prioritized and then documented.

6.1. Research and development (R&D) projects

The risks and uncertainties are mostly high in research and development projects, especially new product development projects. To handle such challenges one of the most shared and efficient risk mitigation strategy used in R&D projects is FMEA model, that is, failure mode and effect analysis. The extended version of this model is a project risk failure mode, and impact analysis abbreviated as RFMEA which is now evolving as an emerging technique rigorously used in R&D and new product development (NPD) projects efficiently. RFMEA model can benefit the project managers to classify operational contingency plans for effectively mitigating high-priority risks in R&D projects. While FMEA reduces the risks linked with the project's technical facets such as design and planning progressions of the product development, RFMEA is used to quantify and analyze risks, specifically in the project environment.

The five risk prioritization parameters of RFMEA technique depend on: (1) the likelihood that a risk will occur; (2) the severity of the effect on the project should it occur; (3) the risk score (RS) for a risk (RS = likelihood × severity); (4) the risk detection factor, that is, the ability to foresee its occurrence; and (5) the risk priority number (RPN) for a risk (RPN = RS × detection factor). This technique not only helps to prioritize risks and mitigate them accordingly but also to reduce the risk management efforts exercised on the projects. The efforts become streamlined as there are fewer risks to focus on, and hence the ability of the team to work on the project efficiently, by focusing on other areas, significantly increases which in turn results in higher productivity [19].

6.2. Operational hedging in innovative technological projects

Every technologically savvy project is exposed to uncertainties some of which are technology specific whereas others are organization specific. Organizations going through the deployment of highly innovative technologies have to tolerate significant operational and financial risks. Invariably it becomes tough to assess the risk profiles. Investigation of the operation management literature shows that organizations can, in fact, manage and mitigate risks using services, that is, through operational hedging.

In literature, operational hedging appears as "the ability of an organization to anticipate and respond to uncertainty and change in development and market conditions flexibly

using structuring of resources and processes with the product, production and supply chain options". The operational activities include activities like flexibility, postponement, capacity, which is akin to real options like "prospects to delay and adjust investments and operating decisions over time in response to a resolution of uncertainty" and are termed "operational hedging mechanisms".

Operations design is integral to operational hedging by adding to the evaluation of the project risk profile through the structuring of operational activities. The operation design brings about tradeoffs linked to structural investments and infrastructural decisions to mitigate risks and value degradation due to uncertainties. Its basic aim is to maximize net organizational value by acquiring resources and configuring processes. For example, with smart structural and production volume decisions, an institution lacking in financial resources can effectively manage supply uncertainties for better future growth. Hence, the project managers involved in highly innovative and risky projects can use such operation design to improve the project valuation and efficiently manage risks by engaging risk mitigation levers.

6.3. Drug manufacturing projects

Risk evaluation and mitigation strategies are conceived as essential in drugs manufacturing projects for protecting public health by ensuring the safety of drug use. In new drug development projects, there are a lot of questions hindering the success factor in such projects. For instance, the efficacious of the drug or the disease/syndrome/symptom it is intended to treat? Is the drug safe for use in the intended patient population? Do the benefits of the product outweigh the risks? [20].

REMS has emerged as one such technique to tackle such uncertainties. REMS approach is being used to manage and mitigate risks effectively. Not all drugs require REMS; this method is being used for those drugs that are of high-risk bearing associated with the treatment of fatal diseases. REMS apply to any new drug application. Therefore, this risk management approach has raised the thoroughness that the manufacturers must meet [20]. Depending on the magnitude of the risk to be mitigated, risk evaluation and mitigation strategies differ in scope and complexity. Standard REMS elements are Medication Guides (MedGuides), Communication Plans, and Elements to Assure Safe Use (ETASU). The REMS is here to mitigate risk to its full potential to get the full benefit from the drug. The primary stakeholders are very much required to be involved in the developing and implementation of a REMS program to enhance the benefits to the public.

6.4. Global software development projects

Global software development projects encounter a lot of risks having different dimensions. One of the most common risks in such projects is language and cultural barrier problems between client and the vendor. This risk usually occurs because of the different foreign languages. In global projects, people from ethnically diverse backgrounds group together to work resulting in high risks of failure in coordination and collaboration. Product failure occurs because of lack of common language and mode of communication as a result of which the product requirements and specifications fail to get comprehended.

To mitigate these types of risks, strategies are formulated such as selecting a vendor who has the knowledge of the client's language and culture. Merit should get ahead of any other selection criteria while choosing a supplier. For example, a vendor should have a reliable supply and delivery record for a large number of projects. The vendor should possess a know-how of the client's language and culture which should act as an enabler for understanding the product requirements and for the customer to give away full specifications and information resulting in a successful project with minimal risk impacts.

6.5. New IT software projects

Software projects are always prone to high-level risks especially the innovative IT projects. When working on an innovative software development project, one of the major hurdles which come across is the incorrect specifications or requirements of a software project. This, however, is tough to manage in innovative projects as no previous data can be used or consulted in that matter. One has to be very vigilant in gathering requirements of the customers and end users.

6.6. Clear scope specifications

To mitigate such risk effectively, the scope of the project and the specification of the product should be clearly defined and sign off. Moreover, to mitigate such risks, stakeholder involvement is of paramount importance. Stakeholders should be involved in the whole process so as to clear the requirements and specifications of the product or software. Stakeholder engagement is a sure way to a successful project and mitigates most of the risks. This strategy not only helps to eliminate the risks but also to control any future uncertainties as well. The functional people in the client's organization should actively participate to gather complete requirements and precise specification for a particular scope. If the end user of the product is an organization, then functional people are important to be engaged in the process as they are the ones who would be using the product and their satisfaction is necessary, and only they can help in mitigating the risk of incomplete requirements and specifications.

6.7. Effective communication plan

While undergoing innovative software projects, one of the biggest challenges that come across is to communicate the scope of the project and the progress to its stakeholders and team members. This risk can create havoc if not treated properly at every level of the course of the project. If the pertinent information fails to get conveyed to the team member and the principal stakeholders, the project can lead to failure. Hence, it follows that mitigation of this risk is essential for developing an effective communication plan and implementing it. Effective and efficient communication strategy is imperative for delivering the right kind of information at the right time to the right audience through right kind of channel. Ease of access and availability of information to the general public can reduce many of the uncertainties and ambiguities surrounding the project. The strategy should also include face-to-face meetings and social events

to enhance communication and collaboration. Improved communication and cooperation increase trust and mutual understanding which is of utmost importance in innovative projects.

This risk can majorly arise in software projects where teams are located at different geographical area and cannot communicate face to face. Visits and exchanges between sites are a must to overcome the communication gap and interaction limitations. A delegation of responsibilities among team members and relocation of team members to support each other can also be the risk mitigation actions in this strategy [21]. There must be infrastructure compatibility among geographic locations to remove any confusion and frustration causing hurdles [22].

6.8. Resource planning

In innovative projects, one risk that came across to be very evident was the improper project plan. As innovation comes with no prior experience, hence, it usually faces planning failures such as an inadequate resource allocation. Risk planning strategies are preferred means to mitigate risks. Planning is the backbone of any project and its successful completion. Therefore, project execution requires adequate time and effort in the devising a plan. The mitigation actions include clear roles and responsibilities of the team members so that they know their job and how to make them active. The project manager can play a significant role in such case. The project manager should explicitly relate the purpose of the project to organization's overall strategy, mission, and vision to communicate the purpose of the task. The project manager should establish and compel the members to a shared project goal to cultivate a collective identity [22].

Clearly planned and communicated project's mission and scope statement are important to plan resources accordingly. During innovative projects, resource constraints occur at the crucial point of the project which has a very negative impact on the project. This risk, however, should be mitigated by proper planning of resources and taking members on board by making them aware of all aspects of the project.

6.9. Autonomous vehicles (AVs) technological innovation projects

Today development of autonomous vehicles (AVs) is under way. There are various uncertainties and risks exists while utilization of this AV technology which varies from the danger of technological failure to uncertainty concerning the impact of AVs on society, etc. However, these risks and developer's understanding of them will change and evolve as the technology and its implementation progress.

6.10. Liability attribution

The existing system of attributing vehicular accident liability is well established however with the development of AVs will threaten to disrupt standard conventions. For example, individuals while operating vehicles assume the responsibility for accidents since they voluntarily take control of their vehicles and the responsibilities associated with such control (personal/tort/criminal liability). This risk exists both for the user and manufacturers. To mitigate this

risk, manufacturers need to come up with vehicles that meet given standards and performance expectations. Thus, they can be liable for accidents in case a defect or failure in their manufactured vehicle contributes to an accident (product liability).

Formulations of strict liability seem reasonable for accidents occurring under fully driverless conditions, the situation becomes less clear when considering accident scenarios involving vehicles using semi-autonomous technology. Any mode that is not driverless necessarily infers some degree of human control and interaction which introduces the possibility of human error and consequentially liability. Therefore, precise rules/regulation regarding the liabilities of AVs with fully automated and semi-automated needs to be developed and finalized prior to formal utilization of AVs at the government level.

6.11. Check and balance

While "to err is human," machines are not excluded from the capacity to err as well. Sensor suites and algorithmic capabilities of AV are not immune to failure, creating the potential for significant known and unknown safety risks. Risks identified to affect AVs include environmental factors such as snow and heavy rain, potentially hindering the ability of AVs to perceive their environment accurately. Even detecting primary obstacles, for example, potholes and uncovered utility holes, and differentiating between individual objects, like a rock and a potholed piece of paper, proves to be challenging for AV technology. Furthermore, while detecting a pedestrian is possible, however, it can become a problem in winter, or when the person is moving or quickly emerging from behind an object. Employing reliable technology and more learning from tests and pilot studies can alleviate these challenges/risks. However, the improvements may not be immediate or linear.

The mitigation of risks is crucial if companies producing AVs want to remain in business. Almost every vehicle production company installs automation technology in vehicles. Some use series of sensors and cameras to make sure that car drives smoothly with the help of automation technology, adaptive cruise control or simple cruise control, lane departure warning and front collision assist are a very typical example of this system in which automation system works with the support of human driver. Tesla on the other side has taken automation to a new level and built the full automatic self-driven vehicle. Here, the risks above are very likely to happen. However, they also have come up with a new strategy in which headquarter of Tesla always remains in touch with the onboard car computer. Every moment of a vehicle gets recorded even in different conditions such as weather, road condition wise, and also, the self-driving feature's ability to drive in rush hours. Through such techniques, Tesla, improve the software of the car and give software updates regularly and Tesla's study shows that their self-driving cars got a less ratio of accidents on human being driving. At the start, Tesla was only using sensors, but now with the improved technology, they are putting cameras, in car side pillars to avoid different risks. This, obviously, is to ensure that automated systems will solve many risks on its own, which a man never think off during driving because they are getting data, from across the world and from that they are improving technology so that AVs can work anywhere without any hazards. Therefore, by Tesla's example, making improvements in technology, these risks will never get solved companies must keep a check on their vehicles like the Tesla and keep on improving the software and hardware as well.

6.12. One step at a time

The main risk involved in AVs technology to develop is investment risks as the technology may not work out as hoped, resulting in a loss of profit. Conversely, failure to invest in new and potentially transformative technology can make businesses irrelevant, or at best, set them behind their competitors. The uncertainty surrounding AV technology and its applications requires businesses within the automotive industry to take risks that align with their best predictions of how the technology will develop and used. However, this risk is manageable by employing features of autonomous driving commercially attractive and viable, as these AVs can be accepted quickly and easily considering inherent advantages. Additionally, for an industry that typically operates from traditional car ownership-based models, the new capabilities promised by AV suggest a gradual shift to a more service-centric business models. Also to mitigate the risks of going out of business because of lack of interest of people can be overcome by different ways but one step at a time can be a good strategy to solve such issue. The automotive company must not offer the full AV vehicle at once, they must offer some automatic feature at the start and get feedback from the customer about the mechanical features installed in the vehicle. Results based on those surveys will suggest whether launching a fully automated vehicle is a good idea or not. The step-by-step policy will also show that which areas of the world or country are suitable for AVs and when will be the appropriate time to launch such vehicle and slowly company transfers their vehicles to AVs. Through this, company's chances of going out of business will be less. Also, this transaction is anticipated as well received by the market.

7. Conclusion

Projects are used as a mean of innovation in organizations. Uncertainty is the foremost impediment in developing innovative merchandise in today's exceedingly vibrant business and technologies which lead to a high degree of risks resulting in significant project failures. Hence, it is imperative to manage risks through all stages of product development to improve project success rates. This chapter proposes a framework to manage risk throughout the product and project management phases and its alignment with business strategy and performance, gauging system to increase project success rates and to attain business strategic goals. Quality function enticement transforms business measures into project enactment measures and an organized procedure helps to identify risks, its assessment, mitigation planning, and control. The risk mitigation strategies discussed in this chapter enable the projects to remain focused on accomplishing the business goals and objectives while delivering in a more effective way to detect, gauge, scrutinize, and perceive risks across the project phases.

Today, it is domineering to develop knowledge and technology based innovation to drive the economy for establishing strong collaborations within the business community. Innovation for technological development requires an entwined system of business interactions with public and private sector alike. Such interactions increase the likelihood of

innovative development within the innovation systems framework. Adhering to strategies is of paramount importance and a significant necessity in industries such as autonomous vehicles (AVs) with its intricate physiognomies, inflated, and laborious procedures. Embracing innovative stratagems and plan for technology development requires a clear understanding of the business environment and subsequent identification of the success factors. This chapter aimed to highlight critical success factors in high-tech innovative development of autonomous vehicle (AV) industry. Liability, check and balance, and one step at a time are the techniques emphasized in this chapter as the most prominent and effective methods for such innovative programs.

Author details

Riaz Ahmed

Address all correspondence to: riazutm@gmail.com

Department of Management Sciences, Bahria University, Islamabad, Pakistan

References

[1] Luppino R, Hosseini MR, Rameezdeen R. Risk Management in Research and Development (R&D) Projects: The Case of South Australia. Doctoral dissertation. Asian Academy of Management; 2014

[2] ChePa N, Jnr BA, Nor RNH, Murad MAA. A review on risk mitigation of IT governance. Information Technology Journal. 2015;**14**(1):1-9

[3] Kumsuprom S, Corbitt B, Pittayachawan S. ICT risk management in organizations: Case studies in Thai business. ACIS 2008 Proceedings. 2008. pp. 98-106

[4] Simon R. New product development and forecasting challenges. The Journal of Business Forecasting. 2009;**28**(4):19

[5] Ozer M. New product development in Asia: An introduction to the special issue. Industrial Marketing Management. 2006;**35**(3):252-261

[6] Bowers J, Khorakian A. Integrating risk management in the innovation projects. European Journal of Innovation Management. 2014;**17**:25-40

[7] Su N, Levina N, Ross JW. The long-tail strategy of IT outsourcing. MIT Sloan Management Review. 2016;**57**(2):81-87

[8] Qazi A, Quigley J, Dickson A, Kirytopoulos K. Project Complexity and Risk Management (ProCRiM): Towards modelling project complexity driven risk paths in construction projects. International Journal of Project Management. 2016;**34**(7):1183-1198

[9] Subramanian V, Semenzin E, Hristozov D, Zabeo A, Malsch I, McAlea E, Murphy F, Mullins M, van Harmelen T, Ligthart T, Linkov I, Marcomini A. Sustainable nanotechnology decision support system: Bridging risk management, sustainable innovation and risk governance. Journal of Nanoparticle Research. 2016;**18**(4):1-13

[10] Davies A, Dodgson M, Gann D. Dynamic capabilities in complex projects: the case of London Heathrow Terminal 5. Project Management Journal 2016;**47**(2):26-46

[11] Shenhar Shenhar AJ, Holzmann V, Melamed B, Zhao Y. The challenge of innovation in highly complex projects: What can we learn from Boeing's dreamliner experience?. Project Management Journal. 2016;**47**(2):62-78

[12] Gatzert N, Kosub T. Risks and risk management of renewable energy projects: The case of onshore and offshore wind parks. Renewable and Sustainable Energy Reviews. 2016;**60**:982-998

[13] Salerno MS, de Vasconcelos Gomes LA, da Silva DO, Bagno RB, Freitas, SLTU. Innovation processes: Which process for which project?. Technovation. 2015;**35**:59-70

[14] Asenova D, Bailey S, McCann C. Managing municipal austerity: mitigation of social Risks. Local Government Studies. 2015;**41**:1-19

[15] Wang C, Cai W, Liao H, Lin J. China' s carbon mitigation strategies: Enough?. Energy Policy 2014;**73**:47-56

[16] Köhler AR, Som C. Risk preventative innovation strategies for emerging technologies the cases of nano-textiles and smart textiles. Technovation. 2014;**34**(8):420-430

[17] Pyra J, Trask J. Risk management post analysis: Gauging the success of a simple strategy in a complex project. Project Management Journal. 2002;**33**(2):41-48

[18] Smith Smith NJ, Merna T, Jobling P. Managing Risk: In Construction Projects. John Wiley & Sons; 2002

[19] Luppino R, Hosseini M, Rameezdeen R. 'Risk Management in Research and Development (R&D) Projects: The case of South Australia. Asian Academy of Management Journal. 2014;**19**(2):67-85

[20] Brooks MJ. Mitigating the safety risks of drugs with a focus on opioids: Are risk evaluation and mitigation strategies the answer?. Mayo Foundation for Medical Education and Research. 2014;**89**(12):1673-1684

[21] Ghobadi S, Mathiassen L. A model for assessing and mitigating knowledge sharing risks in agile software development. Journal of Info Systems. 2016

[22] Verner JM, Brereton OP, Kitchenham BA, Turner M, Niazi M. 'Risks and risk mitigation in global software development: A tertiary study'. Information and Software Technology. 2014;**56**(1):54-78

Chapter 6

Risk Management in the Decisional Process

Florin Boghean and Carmen Boghean

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/67873

Abstract

The achievements of individuals have generated an attitude change toward risk, and the passion for gambling and bets has channeled itself toward economic growth, enhancing the life quality and technological progress. The capacity of defining something that will happen in the future and to choose between more than one alternative represents a central principle of today's society. Managing risk helps us to orient in a large spectrum of decisional processes, ranging from investing capital to making a family, from insurance premiums market to whether wear a seatbelt. Long time ago, means of production, business administration, and communication were simple. Failures were often, but they could be solved without calling on a computer technician, accountant of investment adviser. Presently, the means we use are much more complex and failures can be catastrophic, with a devastating impact. We must constantly be aware of the failures' probability and errors.

Keywords: corporate governance, responsibility, decisional process, risk management, support systems for decisions, accounting

1. Introduction: theoretical background of the current research

The modern idea of risk has its origin in the Indo-Arab numerical system that came in West some 700 or 800 years ago. However, a more careful study of risk has begun in Renaissance times, when people have freed themselves from the constraints of the past and have doubted the deep-seated ideas and believes. It was then when vast territories were discovered and when the planet's resources were about to be explored. There were times marked by religious disagreements, early stages of capitalism, and a courageous approach toward science and future.

All the instruments we use today in risk management and in analyzing decisions and choices, from the strict concept of game theory to the challenges of chaos theory, they all have their origin in the discoveries between 1654 and 1760, with two exceptions:

- In 1875, Francis Galton, an amateur mathematician (cousin with Charles Darwin), has discovered the linear regression, thus explaining why arrogance predicts collapse and why there cannot be evil without good. When we make a decision based on the idea that things will go back to normal, we apply the notion of linear regression. Regression, he writes, is "the tendency of that ideal mean type to depart from the parent type, 'reverting' towards what may be roughly and perhaps fairly described as the average ancestral type."
- In 1952, winner of the Nobel Prize for economics, Harry Markowitz (then a young doctoral candidate at Chicago University) mathematically proved why choosing to bet all on one card is a highly risky strategy and why the diversification is one of the most popular instruments which one investors have.

Many times tens discussions appear between those who consider that be best decisions are taken based on numerical calculations, on some templates of past events and those who base their decisions on more subjective degrees of confidence related to the unsure future. This controversy has not yet found its solution. The issue comes down to each person's vision on how the past conditions the future. The future cannot be quantified, because it is an unknown [1]. The individual has always wanted to project the future based on the present or based on the past experiences. Any decision related to risk results in two distinct elements and at the same time, indissolubly linked: the objective reality and the subjective vision about the value of what can be gained or lost, as a consequence of that decision. Objective calculations, as well as the degree of confidence, are essential elements; none of them are adequate without the other. "The value of our expectation always signifies something in the middle between the best we can hope for and the worst we can fear" [2]. "The Risk of losing any sum is the reverse of Expectation; and the true measure of it is, the product of the Sum adventured multiplied by the Probability of the Loss" [3].

In an economy-based market, information represents a force that gives powers of decision to those who have it, ever if it does not represent the absolute truth. One of the most respected mentors in business, Warren Buffett said: "It takes 20 years to build a reputation and five minutes to ruin it. If you think about that, you'll do things differently", and it seems that it is true. In the current economy, in a world developed from an information technological point of view, you are a click away of success or failure. If we were to think about what Buffet said, the most important asset of an organization is its reputation and among the elements that influence this reputation we find the quality of products (40%), business grounds (34%), and social responsibility (56%).

Organizations should transform their organizational culture from one based solely on risk control, in one that allows a better acknowledgement of risks. In the chapter "Black swans turn grey. The transformation of risk", it is reconfirmed the fact that, in the current context defined by high uncertainty, we cannot anticipate future events and the effect they have if

http://dx.doi.org/10.5772/67873

we use only the retrospective analysis of existing data (forecasting) [4]. Based on this, we have highlighted in the present research the way the entities integrate risk management in their business strategy. To this scope, we will prove that for many categories of decisions, risk represents, alongside efficiency, a major evaluation criterion of decisional versions. The descriptive approaches from the theory of decisions have revealed some particularities of the way managers act in uncertain conditions. When facing risks, they do not only asset them, but also apply active actions in order to diminish the potential losses [5].

In uncertain situations, the decisional process is based on rationality, as well as calculations. Rational persons conduct an objective analysis of the information: the errors they might make when forecasting are completely random and cannot be blamed on some subjective factors like the optimism or pessimism of the decision makers. They react to new information based on a set of well-established priorities or preferences. They know exactly what they want and used the new information in such a way that they can satisfy those priorities. We can do the puzzle of, more or less, fragmented information that we have, but we may never have all of the data. We will never know how representative the chosen sample is. This uncertainty is the very one that complicates our decision making, and it enhances our fear to act. When we lack information, we need to resort to inductive reasoning and try and guess the probabilities. Keynes and his followers have concentrated on money and contracts in order to prove that uncertainty is the dominant principle of the real world and not mathematical probabilities. The prevalence of uncertainty in the decisional process is highlighted by our desire to own liquidity and to consolidate our future agreements through enforceable contracts. We are no longer inclined to orient ourselves by the mathematical frequency of past events.

Man has always endeavored to ease his existence, assets, and thus to be able to adapt as well as possible to the needs of day-to-day life. All of the above have been made more consistent and more rigorous, along with the usage of the scientific method in conducting various researches. Thus, an essential role lies upon the research that can be understood as a search within a methodical process, intended to improve our own knowledge, as well of other people, through the discovery of facts and visions.

From the perspective of game theory, almost every decision that we make is the result of some negotiations through which we try to diminish the uncertainty, responding to the needs of other in order to obtain something we want. Like the game of chess, real life is a strategic game, combined with contracts and handshakes to protect ourselves from cheaters. Choosing the alternative that we consider to be the most profitable means, in many cases, the most risky decision, because it may raise the most powerful defensive reaction from the players that will have the most to lose if we achieve what we want. So, we usually make do with a compromise, trying, in this way, to gain the most from a not so profitable transaction; these kinds of decisions are described in the game theory with terms like “maximin”, or “minimax” [6].

From an increasingly larger number of desk research of relevant literature, it is shown that, while making a decision, people may be tempted to satisfy different vanities or may have a narrow or deformed vision about things. These disruptive factors do not seem to count very much when the stake is winning in gambling or the big lotto price. But, it has been proven

that these weaknesses become even more visible in fields in which consequences may be much serious. We would be exaggerating if we were to call this behavior "irrational", because irrationality means madness, and the majority of people are not insane. Richard Thaler, an economics professor at Chicago University, has observed that people are neither "down right stupid" nor "highly rational robots". However, Thaler's revolutionary studies about the way people make decisions in day-to-day life show great irregularities from the decisional models in which Bernoulli or Markowitz believed [7].

Investors need to sometimes expect also failures as a consequence of the risk that they take. The expectations of rational investors need to be impartial, a rational investor will sometimes exaggerate and some other times will minimize, but he will not show one of these tendencies all the time and not even most of the time. Rational investors are not among the people who always see the half full of the glass or the half empty of the glass.

No one really believes that reality is one and the same with the investor's sketch description that always negotiates risks and efficiency in a rational way. The uncertainty is frightening. No matter how rational we may try to act, emotions make us often avoid unpleasant surprises. Daniel Kahneman considers that "the imperfection of the rational model does not consist in its logical structure, but the human intelligence that they postulate. Who would conceive a mind capable to act the way this model says?" [8]. If investors have the tendency to defy the rational model, maybe this model does not offer a very real description of the way the capital markets act. In this case, there are new methods of calculus for investment risk.

Capital markets have always been volatile because they only trade some bets for events that will happen in the future, and this time dimension is full of surprises. Buying a pack of stocks that do not have a final maturity date is a pretty risky business. The only way the investors can liquidate their participations is to sell to other investors—absolute every one depends on the expectations and the purchasing power of others. The same principals apply in the case of bonds that will returned to their owners the sum of money invested in cash but at a later time.

This kind of environment is a perfect one for unsound events: uncertainty is frightening. If unsound players from this arena overwhelm the rational ones, by number as well as fortune, the assets' prices may start from values that are far from the equilibrium level and might maintain themselves for a long period of time. These periods of time are often pretty long and may test the patience even of the most rational investors.

Despite the many bibliographic references, I have studied in the attempt to unravel this mystery, many things have been left unclear. The discontinuities, irregularities, and fluctuations seem to multiply instead of disappearing. In the finance world, newer and newer instruments appear in an overwhelming rhythm, new markets develop much faster than traditional ones and the global interdependency increases the complexity of risk management. The economic uncertainty, especially employment, is greatly published. Environment, health, and personal security are being attacked by enemies never seen before.

In this kind of world, does probability, linear regression, or diversification even matter? Is it even possible to adapt these strong instruments that help us to interpret the nature changes in order to search the source of these misstatements? Will we always be haunted by disorder?

http://dx.doi.org/10.5772/67873

Rarely, the experiences of the past may give us a hint about the moment when disorder will be unleashed. Wars, crises, capital market's ups and downs, and inter-ethnical massacres will come and go, but their appearance always takes us by surprise, so powerful that it is difficult to imagine how the victims of these incidents did not realize what was about to happen to them. The surprise is more present in the finance world. We cannot include in the calculus information about the future, because we do not have them. So, we feed them with data from the past to power decisional mechanisms created by our models, either linear or nonlinear. The similarity to the truth is not the same thing as the truth.

2. The objectives and methodology of the research

The research fits into a positivist scientific approach, not being deprived of some critical and interpretative approaches, which aim to clarify various concepts and to highlight possible solutions to the issues identified. To examine scientific issue and to achieve the objectives and goals of the research, we will use the following methods:

- *the analytical method* will be used to perform analysis of the theoretical approach of decisions, risks, and their role in making decisions process;
- *the qualitative and quantitative research method* will be applied though the data collection using a survey, conducted national wide, of public and private decision-makers;
- *the method of induction and deduction*.

Research carried out in this paper has a part of empirical testing of some hypothesis about the impact of the risk management assuming in decision-making processes in the context of effective corporate governance.

3. The concept of mathematical derived risk

Risk can be encountered day by day and is associated most of the times with insecurity. Risk is inherent to every process, existing in the essence of all things, and the term "risk" is used in the most varied fields: from the financial to the political, from the medical to the military. A fair amount of the traditional concepts of risk have used mathematical formulas. Economical representations of risk have been based on the estimated value theory. According to this definition, risk is characterized though the distribution of probability of different results. When confronted with the possibility of choosing between two situations with same estimated values, the risk averse decision maker would always choose the situation that offers a safe result over the situation which offers a diversity of results over and under the expected value. A person with a risk appetite would have its preferences exactly the opposite, and a neutral-to-risk person would be indifferent to both situations because the estimated values are the same. Over time, the behavior of each and every one of these tip of decision makers/agents has been studied. Among the risk averse agents, there are certain categories, which prefer a smaller estimated value than a higher

value in the context of assuming a bigger risk. Although, these agents can choose those risk situations when there is a provision of a sufficient raise of the estimated value. The degree of risk aversion of the decision maker determines the requirements that need to be fulfilled in order to choose a risk situation.

Other mathematical correlations of risk have been offered by the business literature, especially the finance one. These definitions have state that risk is the meaning of mathematical variation of possible outcomes [9, 10]. For example, risk has played an important role in finance developing the modern portfolio theory defines risk as being the income variation and provides a method for the return of this variation through investments in assets that are not perfect correlated with one another [11–13]. Thus, the method to manage risks is to diversify the assets portfolio. By choosing a sufficient number of assets and holding a small share of the whole portfolio of the investment in a certain asset, risk is thus alleged to be reduced to a minimum.

Notable of this approach of defining risk is that potential of the positive evolution contributes to the whole value of risk. This is contrary to many traditional notions, irregular to risk, in which only negative surprises are truly considered risks. Considering positive evolutions as being risky, the outcomes are some counterintuitive situations [11]. For example, a person finding a stalk of unclaimed lottery tickets will immediately see the risk level associated with the rising of his net value, despite the lack of a negative result associated with the tickets. In a similar way, Kaplan and Garrick, consider an heir, of whose benefactor has passed away [14]. The assets of the benefactor need to be evaluated, but it is estimated that they will be about 1 or 2 million dollars. The authors mention that, while the heir is confronted with considerable uncertainties, it will be unlikely that it will be about a situation that has a risk. Thus, managers that want to reduce the advantages as well as the disadvantages of risk are advised to avoid similar risk examples, which may be produced in a corporative context, even if the real preferences of a manager are typical asymmetrical when it comes to every kind of risk (**Figure 1**).

These kinds of approaches of risk management in the managing of financial risk were not always well received or well implemented. The hedge fund *Capital management on the long run*

Figure 1. Result-time correlation in risk management. *Source*: Own processing.

http://dx.doi.org/10.5772/67873

has included two Nobel laureates, which, after the stockpile of large amount of capital have continued by losing more than 4 billion dollars over several months, as a result of a Russian financial crises in 1998 [15]. The fund has determined the intervention of Federal Reserve to avoid a colossal financial collapse. The excessive and abusive use of some of these practices has been one of the triggers of the global financial crises of 2008, but also of other crises that have left a print on economic history [16, 17]. Actually, some speculative hedge funds have won great amounts of money by exploring these systemic dysfunctionalities. In comments about the financial crises of 2008, Lewis explains that the hypothesis of the uncorrelated prices of houses at a national level has allowed the different combinations of individual mortgages, which permitted the selling of low-quality houses at a higher value and the diversification between more than one mortgage [18].

March and Shapira extend traditional notions about risk that have been used by the academia [19]. Compelling evidence is assured by the conclusions of MacCrimmon and Wehrung, which have noticed that, when executive directors are tasked with ordering a list of portfolio investments, the estimated value theory was only followed by only 11% [20]. March and Shapira's review has observed that the majority of the managers have considered that the risk could not be quantified that risks could be directly compared one with another, and a vice-president of finance says that "no one is interested in obtaining quantifiable measures", another manager asserts "you do not quantify risk, you just need to feel it". It would be useless to state that it is difficult to design models based on "the feel" of the risk, so traditional definitions, quantifiable of risk, remain mostly in the literature [19].

Reviewing the traditional risk notions, Kaplan and Garrick discover that risk includes both uncertainty notions, as well as the ill ones. The later discovery is the distinction between risk and hazard. A hazard refers to a source of damage. Nevertheless, a pre-eminent danger and a potential lethal danger (for example, a nuclear plant), however, may be accompanied by small risk using pro-eminent guaranties. Kaplan and Garrick note that "the danger cannot be associated with zero risk, and the risk will be smaller when the guaranties overcome the danger" [14].

They note an important epistemological fact about risk: risk is inherent perceptual. The perceptual nature of risk transpires from the contribution of uncertainty of risk. Uncertainty (besides the invented games and quantic events) comes from a lack of knowledge from the one who evaluates the situation. Thus, a reference to "the perceived risk" is redundant. Usually, when one refers to a perceived risk, one pursues the comparison to perceived risk by another group of experts—mentioned as "absolute risk". In their evaluations, the group of experts often can rest upon previous experiences and on the damages made by some risks. Still, these expertises are sensitive to more precise evaluations that the ones offered by managers.

4. Intuition versus rational analysis in making decisions

Intuition is an immediate process and as such is not perceived as a conscious process of reflexive thought. Is wrongful identified with processes, which are even from the subconscious. In order to understand the intuition concept, we can try to consider the combination between its opposite meaning reasoning. More and more often, literature refers to the process of decision

making as a combination of the two types of thinking and perception: rational thinking and intuition. Intuition is seen as a rapid and high-capacity process, which needs relatively low work; reasoning, on the other hand, is a time-consuming process, reflective, goal oriented. By applying intuition, managers may manipulate a large amount of information and processes at the same time. Even if they are not aware of the way the process works, this does not mean that it appears only outside the conscious. Researchers link rational thinking and perception to the so-called work memory, which measures through the pieces of transitory information that are saved in time that operates a cognitive task. In contrast with reasoning, it is assumed that using intuition does not need work memory in order for it to be busy; as a result, intuitive knowledge is fast and high capacity and is less linked to consciousness.

Quasi-reasoning offers a compromise between competing opinions of the individual members of the decision making team as highlighted in **Figure 2**.

There are two types of human thinking: rational and irrational. Thinking and behavior are considered to be rational when it is taken into account the accumulated social values (social level rationalizing). On the other hand, rationality is defined as a set of aptitudes (abilities) though which a chain of action can be identified and which allows us to set an objective. Irrational thinking can be understood as being a prolonging of rational thinking, meaning the

Figure 2. The respondents share in the sample's structure according to the consent linked to the assessed affirmation. *Note*: 1 = in total disagreement, 2 = disagreement, 3 = neutral (neither agreement, or disagreement), 4 = agreement, 5 = total agreement. *Source*: Own processing.

http://dx.doi.org/10.5772/67873

ability to blend thinking in patterns of the logical structures, with the end purpose of obtaining an objective. Irrational thinking and actions do not mean that logical thinking is applied. This means that thinking is based on principles that deviate from the classical reasoning, the rational.

Intuition, imagination, and managing emotions are based on the experience one has. Experience, in turn, is a combination of explicit and implicit (or tacit) knowledge accumulated by a person. It is defined as a set of competences and abilities, which an individual gains while he/his is learning formal and informal through practice and observation.

Some authors believe intuition is a form of rationality, rather than the opposite. This reflects the person's capacity to identify a derived solution from the unique experience of the decision maker and a blend of explicit and tacit knowledge of a person. First of all, intuition is used in making strategic decisions. Rather than being an irrational process, it is based on the profound understanding of a problem situation. Intuition is a complex phenomenon based on experience and knowledge, which are first deep rooted in subconscious [21].

Knowledge can be divided in two categories: *explicit and tacit. Explicit knowledge* is kept in the conscious and is the result of studying. The buildup of explicit knowledge leads to the so-called mediate experience. Explicit knowledge can be formed as books, encyclopedias, databases, and innovations, at a logical-social level as well as technical one. Explicit knowledge cannot be monopolized: it spreads fast in the organizations and continuously evolves with experience accumulated by the members of the organization. *Tacit knowledge*, on the other hand, directly derives from the experience of a certain person and is stored first of all in the subconscious.

In trying to locate irrational thinking, as part of the conscious and subconscious, authors have placed it on the border between the two moods. Especially, irrational thinking is linked exclusively to the qualitative mood (nonlinear, flexible, and very hard to quantify).

Literature on this theme makes a distinction between rational thinking and applying intuition. As for the decision making process, the distinction cannot be made with preciseness, because in a large part, reasoning is based on the decision maker's experience and knowledge and, in the involved mental processes, it refers to emotions, intuition, and imagination.

Therefore, it can be said that the logical-rational structure of any effective process of decision making is enhanced by a blend of experience, imagination, intuition, and emotion (all of them being components of the irrational thinking). It is believed that rational and irrational proportions from this blend depend on the decision maker's personality and the kind of problem and situation at hand. Accordingly, it may be assumed that the manager can use different kind of combinations of rational and irrational thinking when he is dealing with different decisional situations.

Literature offers a few orientations for efficient decision making [22]:

- Making decisions based on group heightens the efficiency of the whole process;
- Decisions should come from the contradictory opinions of the members of the team and not from consensus;

- Efficient decisions need nontraditional approaches to be used, unorthodox questions to be asked and solutions to be accepted because they are not always logical.

When some guidelines are being analyzed, the first observation would be that the efficient decisional process reduces the adding of irrational thinking components (like intuition, emotions, and imagination), in a rational way of knowledge. The rational way of making decisions conjectures stages that, more than others, need the irrational thinking to be enforced. These are identifying a decision issue and choosing a decision from a large number of alternative solutions. In order to correctly continue these stages, all the available information sources should be exploited through imagination and emotions, including intuition.

To sum up, manager who tries to ensure a more efficient decisional process should add the irrational element to the rational thinking, to lean on consciousness and unconsciousness and to look at explicit and tacit knowledge. Now, returning to the limited rationality notions and "double" limited, we will observe that:

- *Limited rationality* is, in the first place, the result of some organization norms, insufficient resources, time pressure, and lack of necessary information;
- *"double" limited rationality* is the result of some thought mechanisms of managers (blend between rational and irrational in their thought).

Making decisions that combine the rational analysis with intuition is, also postulated by J. Woiceshyn, the author of a model ethical decision making in which the interaction between intuition and analysis is facilitated by some moral principles, which are stated, summoned, and applied in order to reach success on the long term [23]. Ethical decisions in business imply many transactions and relationships with shareholders, employees, suppliers, and clients. A model of ethical decision was created based on an empirical study in which the accent was placed on strategic decision making by efficient directors. They applied the so-called double process, which implies reasoning and intuition. The essential elements of the process include "integration through essential" and lead to morals being applied in decision making, as well as the spiral decisional process as shown in **Figure 3**.

As I mentioned, the decisional process, in which the intuition and rational analysis are combined, is formed by two processes. The first was discussed above and involves the integration of essential elements; the other is called in spiral. The spiral notion takes its name from the fact that the process includes an iterative action model (looping). Three stages can be observed:

- *The first stage:* the decision maker does a quick analysis of the decisional context, and then he focuses his attention on essential elements and facts; as a result, they are selected feasible solutions and the ones that are not considered realistic eliminated. As part of this stage, the information resulted from the observations is integrated in intuition, that are based on knowledge from past experience;
- *The second stage:* available decisional options are evaluated according to the adopted principles so it may lead to an initial decision;
- *The third stage:* the initial decision is compared and tested by analyzing more than one alternative. This is done with the main goal of learning which of the alternatives fulfill

http://dx.doi.org/10.5772/67873

the requirements and principles for improving decisions. The results of this stage are new knowledge, which results from the integration of essential elements and facts.

The spiral process ends with the selection of one or a combination of logical decisions. The three stage process is not a rigid sequence of actions. Empirical research shows that managers are the actual decisional factors which pass from a stage to another, but many times they return to past sequences, with the aim of improving decisions. Even if they concentrate their attention on solutions that are initially identified as possible, managers do not completely give up other decisional alternatives. Decision makers try to explain why they choose to give up and select others in turn.

Intuition is often understood as the effect of the subconscious processing, the one that flows from integration of present observations and confronting them with past experience. Empirical research shows that using intuition is linked to subconscious processing. To action in fully conscience manner need a large amount of knowledge. It is impossible to possess this knowledge all the time in focal conscience, so it can be used freely. As a result, some knowledge is stored in the subconscious. The use of intuition is reduced to the separating of knowledge that has occurred in the subconscious and remembering it in a specific situation. The kind of knowledge we store in the subconscious is altered by the past experience; for this reason, managers with experience use intuition more effectively. This is not only an experience, but the way knowledge is separated in the subconscious and how often is recovered from there has an impact on the way intuition is used and thus the quality and quickness of decisions. If the new knowledge is not separated and linked to past knowledge, probably it could not be used in a proper way in the future. The way conscious mind integrates new

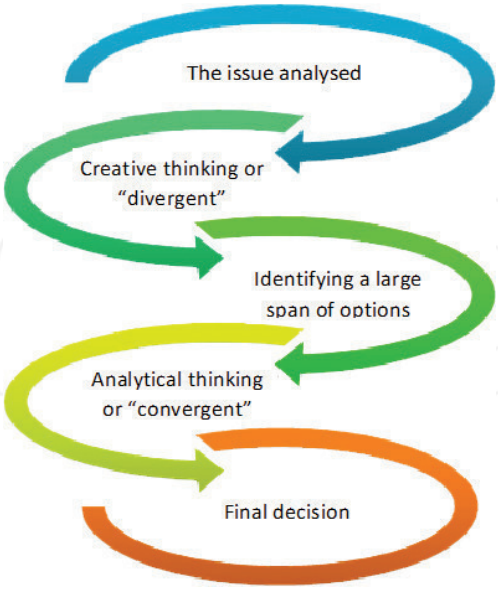

Figure 3. Rational and non-rational in the decisional process. *Source*: Own processing.

knowledge, depends on the subconscious a great deal, and there is not a universal method of integrating knowledge we can count on. The knowledge of objects, phenomena, or processes should be completed in groups, classes, or specific categories. Then, it is easier to remember how to use them in practice. Efficient managers incorporate essential elements, meaning that they firstly identify the essence of an object, phenomena, or process which they are trying to analyze. This thing enables the recovery of similar knowledge stored in the subconscious. In the next stage, the knowledge of essential elements is incorporated in larger concepts, and then, the principles are formed on these concepts. Incorporating the recovered information though the identification of the essence of every given phenomena does not only facilitate but also speed up the recovery of information from the subconscious. The principles are created as a result of the integration of a larger part of knowledge; they are based on the essence of phenomena, processes, or objects and casual relationships undiscovered between themselves, which are suited for specific situations. The principles are a kind of generalization that is designed from observations or past experience. They guide the decision makers in their decisional processes. Decision makers need principles because our capacity to store knowledge is limited; at the same time, information needs to be qualitative, if we want them to make a good decision. Principles allow us to condense extended knowledge from statements that are easy to remember and absorb when making a decision. Onward, we will enunciate a few principles that are most often cited in decision making [24]:

1. Rationality—this principle implies systemic observation and logical analysis of facts and information, thus:

- Decisions should be based on facts, rather than emotions;
- Efforts need to be done for a larger objectivity though the search of external expert's opinions and using counseling teams whose members are competent in several fields or specialities;
- Haste must be avoided when making decisions;
- The quality of information needs to be verified.

2. Productivity—this principle has concentrated on building added value:

- The risk should be reduced because it threatens the building of value;
- The enfaces should be placed on competitive advantage (what we can do better than our competitors);
- Resources and competences should be aligned with the strategy.

3. Innovation—this principle recommends to turn to one's own judgment:

- Decisions must be made by consulting third parties, but made on their own;
- There should be trust in the capacity of resolving issues of the decision maker.

4. Objectivity—this principle is about the objective evaluation and handling through other people, among others:

http://dx.doi.org/10.5772/67873

- Honest criticism;
- Equal treatment of subordinates and associates;
- Laying of the people that prove low commitment.

5. Honesty—this principle implies the correct evaluation of reality, not distorting facts or conditions, with the goal of not creating false values.

When they make decisions, managers identify and use not only these principles which refer to strategy but also implement ethical principles in a spiral-like iterative process which combines conscious and subconscious. The results of our research also show that managers use the same decisional process when talking about ethical aspects, the same as when making business decisions on the long run. The main principles of this theory are the following:

- Own interest (every person should see one's self as the most important value and be the beneficiary of his own actions);
- Human life as imperative value (choices and actions should have an impact over the human survival and prosperity);
- Rationality (recognizing rationality as the only save source of knowledge);
- Productivity (process of creating material values);
- Honesty (reality cannot be falsified);
- Justice (the action needs to be objective, the reward should be appropriate);
- Independence (reality orientation);
- Integrity (loyalty toward rational principles);
- Pride (the commitment to achieve moral perfection).

In **Figure 4**, there is a model of ethical decision making. In the center of the model, there are two levels of information processing and the interaction between the two of them (integration through essential elements) [23]. Interaction implies the design of a spiral between the conscious and subconscious level. The first step in the ethical decisional process is to identify a moral issue. Later, a decision maker identifies the moral principles that can be applied, which can be done at a rational processing level. In this stage, the conscious mind of the decision maker is based on the subconscious in order to find the necessary information to solve the issue. If the manager has integrated his knowledge of essential elements, the necessary information would come to his conscious mind.

The next stage is to apply the identified principles (that are suitable in certain situations) to the issue, in thought and in action. Though the using of relevant principles, the issue is solved and the solution its self should, through in the integration of essential elements, lead to new principles to be formed that end the decision making process. The principles J. Woicieshyn identified in his empirical study are, a great deal, in agreement with the characteristics and principles of the rational egoism theory.

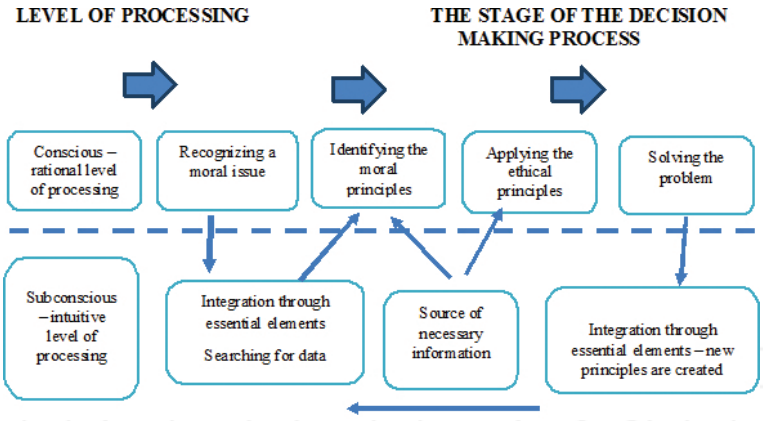

Figure 4. Double model for ethical decision making. *Source*: Woicieshyn (2011).

Risk management is an important concern for entities. Consistent to this, **Figure 5** presents some ways for handling the risk. We can see that risk management is still in a beginning faze in most entities even if managing risks are underlain to try and diminish the negative effects implied by its manifestation.

The key to success of an entity is its capacity to identify (provision) the source of added value and to explore them accordingly and to identify the factors which positively influence the decision making process presented in **Figure 6**. The value is judged from the prospect of goods, as well as from the prospect of the organization as a whole.

Analyzing **Figure 7**, we can identify some important measures that may improve the decisional process. Thus using interactively the accounting management system is appreciated by

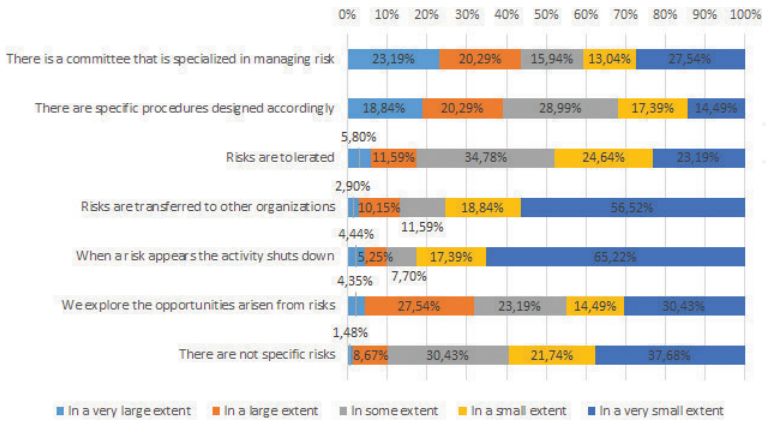

Figure 5. Ways of handling risk. *Source*: Own processing.

http://dx.doi.org/10.5772/67873

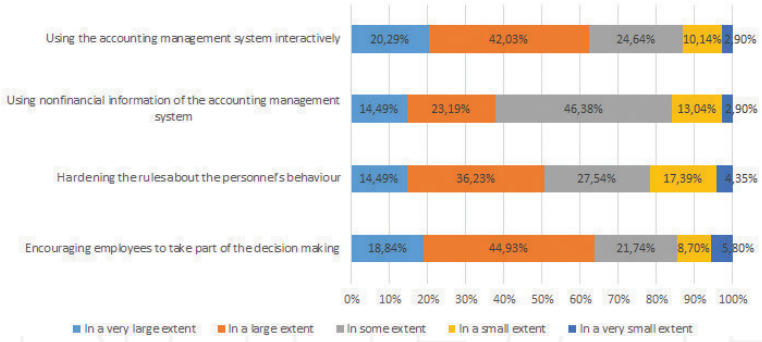

Figure 6. Factors that positively influence the decision making process. *Source*: Own processing.

42.03% of the decision makers in great extent; the encouraging of employees to participate in decision making is appreciated in a very great extent by 18.84%; using nonfinancial information and hardening the rules about the personnel's behavior 14.49%.

The only inexhaustible resource, the information has become today an authentic power factor, a good social that influences directly the wealth of a people. The most profound change that Romanian economical entities go through is the one linked to the generating, selecting, elaborating, and spreading the information. Organizations cannot exist outside communication that they generate and intermediate. Most of the respondents have agreed upon opinions which say that accounting has the purpose of supplying information that can represent with accuracy the financial position, the performances and the changes in the financial position (39.13%), in a shape and form that is most useful to those who use accounting information in order to fundament their decisions. Accounting information plays a decisive role in the testing of the decision factors with essential elements of security of a judicious economical mechanism that may favorite, on the medium and long run, the profitable integration of economic entities in the competitive market environment.

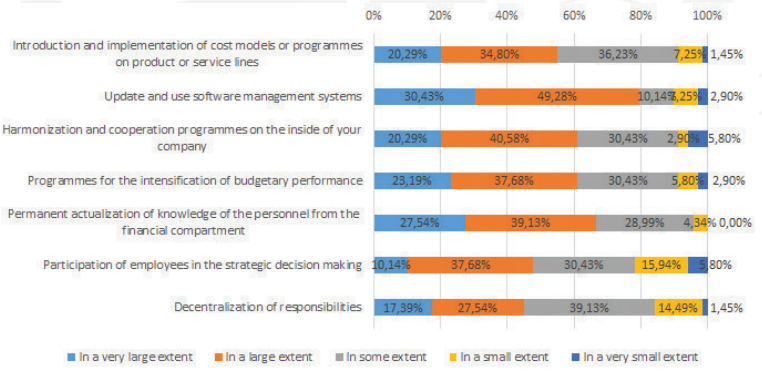

Figure 7. Measures that may improve the decisional process. *Source*: Own processing.

5. Conclusions and proposals

The results target especially the behavior issue of management decision making in the context of implementation of corporate governance principles. Similar past studies include observation and empirical studies of the management decision making behavior, experiments based on observing in order to highlight some particularities of management decision making behavior. Other researchers have also analyzed factors used by managers in making their decisions when projects are terminated [25]. Many times decision makers can use rational models that do not fit analytical recommendations. Normative papers in these fields insist upon the way decisions should be made, pointing out that often situational and personal factors may intercede with the managers when applying without changing the standard methods. This is a less researched area of risk management although with the developing of risk management techniques, scientists admit that existing techniques are insufficient. As a result, the results of this research paper may be used when speaking about some of these specific techniques.

We have chosen to use a qualitative, a direct, a selective, and base on questioners research in order to find out the opinion of decision maker on corporate governance—risk management—decisions, in the organizations they are part of. In this chapter, managers answered the questioner. The questioner was composed of a series of questions, 24 items, questions with free and closed responses, with the goal of identifying the large range of particularities of the studied field. The purpose of using this research instrument was to tackle different aspects of the decisional models and decisional process, like the rational model, incremental, hands-on, information sources that are used by different actors in making decisions, actors that take part of the decision making, what are the characteristics of a decision and the style of leaders when they make a decision.

The results of the study offer stakeholders a model that tries to encourage the risk managing practices in their investment. First of all, they should try and rethink the easiness with which issues can be solved after they have occurred, because, they resort to risk management when they perceive the solving of the issue with a minimal effort. A way to do this could be to look at real effort cost of issue solving from typical scenarios with which the entity is confronting with.

Moreover, top managers should try to implement the risk management policies in their companies. These policies should be oriented toward current practice of risk management. Therefore, policies should be more concentrated on the process rather than results. Managers should not be allowed to resort to hazard but should be rewarded for the rigorous performance in risk management, no matter if the effort of risk managing is eventually necessary.

When auditing the practices of risk management in an organization, top managers should show a great deal of attention to ambiguous situations, because they are the ones managers are usually tempted to give up in risk management. All of this makes the monitoring of the risk management process an important one.

The research also offers perspectives for the individual players, when they are sensitive and are tempted to avoid risk management. Another implication of this study is that the benefits,

http://dx.doi.org/10.5772/67873

of the risk management proactive practices, are tangible. Although the benefits of practices are not always easy to identify, there is a significant improvement of risk management efficiency and of entity performance. This means that the organizations can justify the time and effort assignment for the encouraging and performing of risk management practices.

Organizations should transform their organizational culture from one that is based only on risk control in one that allows a better understanding of risks. In his research, Nassim N. Taleb confirms again that, in the current context defined by high uncertainty, we cannot anticipate future events and their effect if we only use hindsight analysis of past data (forecasting) [26]. Having this in mind, we highlighted in this research paper the way entities integrate risk management strategies in their business. For more decision categories risk is, alongside efficiency, a major evaluation criterion for the decisional variables. The descriptive approaches from the decision theory have shown some particularities of the way managers act in uncertainty situation. Confronted with risk, they do not limited themselves to assess them, but also apply active measure of decreasing potential loses [4].

A final managerial implication refers to management performance. The research suggests specific techniques that a stakeholder can use. This may include supplying data with the help of which he may make risk management decisions and can communicate issues that may appear and the way they need to be approached. For example, this may include a list of common issues with which other investors may have confronted. This would offer an historical set of data that can be used in risk management. Though the assisting in identifying of known risks, this reduces the unforeseen role of risk in the discouragement of risk management. Moreover, by classifying risk by their gravity and frequency, stakeholders can be guided when it comes to situation they need to be careful about.

McGrath writes about the limitations of different methods of research: field studies, field experiments, experimental simulations, laboratory experiments, thinking tasks, sample surveys, formal theory, computer simulations, etc. They vary according to level of implication of the participant (and therefore, the risk that the researcher may change the behavior of subject that needs to be studied) and his concern for the universal behavior versus specific behavior. Among these methods of research, the sample survey is the most often used instrument in the research of universal behavior, rather than in special behavior research (which is in general is better done through technics like field studies). The survey is also discreet enough for the participant, compared to extremely invasive research methods, like the laboratory experiments [27].

The limitations of the current study are related to the existence of difficulties in the choosing of the indicators for every class of determinants, conditioned by the necessity to similar highlight of them and the magnitude of the sample from the qualitative analysis. We express our belief that the current paper answers to some challenges associated to scientific endeavors shown in the field, which remains in the difficulty of understanding and assuring the comparability at a global level.

I believe that the present paper brings a series of contributions to the research evolution in the risk management field associated with decisional processes, in the context of respecting

the principles of corporate governance, build on a series of novelties and originality elements. The extent to which companies respect the principles of corporate governance becomes a more and more important factor in the decisional process. The relationship between the corporate governance practices and the more international character of investments gains a greater relevance in the context of listed companies, well managed, with strong structures in corporate governance, with adequate social and environment programs, have a superior marker performance, rather than others.

Author details

Florin Boghean* and Carmen Boghean

*Address all correspondence to: florinb@seap.usv.ro

Faculty of Economic Science and Public Administration, Ștefan cel Mare University, Suceava, Romania

References

[1] Bernstein P. Against the Gods: The Remarcable Story of Risk. John Wiley&Sons Inc; New York, 1996.

[2] Hacking I. The Emergence of Probability. Cambridge University Press; New York and London, 1975. p. 144.

[3] Hald A, McClintock B. "A. De Moivre: 'De Mensura Sortis' or 'On the Measurement of Chance'". International Statistical Review Vol.52, no. 3; 1984. pp. 229-62. doi: 10.2307/1403045

[4] Mohammed A, Sykes R. Black Swans Turn Grey. The Transformation of Risk. PricewaterhouseCoopers International Limited (PwCIL); January 2012.

[5] Nocco BW, Stulz, RM. Enterprise Risk Management: Theory and Practice. National Bureau of Economic Research (NBER); European Corporate Governance Institute; July 2006.

[6] Neumann JV, Morgenstern O. Theory of Games and Economic Behavior. Princeton, NJ: Princeton University Press; March, 2007. pp. 1903-1957.

[7] Thaler RH. Behavioral Economics, NBER Report. National Bureau of Economic Research; 1995. pp. 9-13.

[8] Kaherman D, Tversky, A. Choices, values and frames. American Psychologist, vol. 39, no. 4; 1984. pp. 342-347.

[9] Pratt JW. Risk aversion in the small and in the large enterprises. Journal of the Econometric Society, vol. 32, no. 1/2; 1964. pp. 122-136.

[10] Arrow K. Extended sympathy and the possibility of social choice. American Economic Review, American Economic Association, vol. 67, no. 1; 1977. pp. 219-25.

[11] Markowitz HM. Portfolio selection. Journal of Finance, vol. 7, no. 1; 1952. pp. 77-91.

[12] Markowitz HM. Portfolio Selection: Efficient Diversification of Investments. Wiley & Sons, Inc. London, 1959.

[13] Sharpe WF. Capital asset prices: A theory of market equilibrium under conditions of risk. The Journal of Finance, vol. 19, no. 3; 1964. pp. 425-442.

[14] Stanley K, Garrick BJ. On the quantitative definition of risk. Risk Analysis, vol. 1, no. 1; 1981. pp. 11-27.

[15] Lowenstein R. When Genius Failed: The Rise and Fall of Long-Term, Capital Management. Random House; New York, 2000.

[16] Patterson S. The Quants: How a New Breed of Math Whizzes Conquered. Wall Street and Nearly Destroyed It. New York: Crown Business; 2010.

[17] Cooper C. The Blackwell Encyclopedia of Management, 2nd ed, vol. IX. Blackwell Publishing Ltd; Oxford, UK, 2005.

[18] Lewis M. The Big Short: Inside the Doomsday Machine. Norton & Company, Inc.; New York, 2010.

[19] March, JG, Shapira Z. Managerial perspectives on risk and risk taking. Management Science, vol. 33 no. 11; 1987. pp. 1404-1418.

[20] Maccrimmon KR, Wehrung D. Taking Risks: The Management of Uncertainty. New York: Free Press; 1986.

[21] Khatri N, Alvin NG. The role of intuition in strategic decision making. Human Relation, vol. 53, no. 1; 2000, p.57-86.

[22] Drucker P. Managing for Results. New York: HarperCollins; 1993.

[23] Woicieshyn J. A model for ethical decision making in business reasoning, intuition and rational moral principles. Journal of Business Ethics, vol. 104; 2011, p.311-323.

[24] Woiceshyn J. Lessons from "Good Minds": How CEOs use intuition. Analysis and guiding principles to make strategic decisions. Long Range Planning, Vol. 42, no. 42; 2009, p. 298-319.

[25] Dilts DM, Pence KR Impact of role in the decision to fail: an exploratory study of terminated projects. Journal of Operations Management, vol. 24, no. 4; 2006. pp. 378-396.

[26] Taleb NN. The Black Swan: The Impact of the Highly Improbable. Random House; New York, 2007.

[27] McGrath JE. Dilemmatics: the study of research choices and dilemmas. American Behavioral Scientist; 1981. p. 179.

INTECH

Chapter 7

Financing Innovation

Carolina Rodríguez Rodríguez

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.69632

Abstract

Financing innovation is the mechanism that allows public support for public or private innovation to compensate the inherent market failure of innovation activities. An insight of the main drivers and mechanisms of implementation at European level is provided.

Keywords: financing, innovation, market failure, public support, innovation policy

1. Introduction

Throughout history, innovations have been taken place with or without financial support from external sources, under the umbrella of specific research and innovation programmes or "out of the box". Socio-political and economic conditions have contributed to challenge innovation conditions to penetrate markets [1, 2].

This chapter is focused on financing innovation (non-technical military ones) in the European context, as the mechanism that allows public support for public or private innovation to compensate the inherent market failure of innovation activities. An insight about the current state of play of mechanisms to support systemic[1] and technological innovation is summarized through strategy, policy and implementation approaches to deal with the "funding gap" for investment [3, 4].

There is a large number of available mechanisms to promote public and private investment in research and innovation (from lower Technology Readiness Levels[2] to higher ones) to increase competitiveness at global scale [5, 6].

[1]Systemic innovation means completely redesigning the way a system works (for example, the health service), and achieving innovation across every part of it.

[2]Technology Readiness Levels (TRLs) are indicators of the maturity level (TRL 1 being the lowest and TRL 9 the highest) that provide a common understanding of technology status and address the entire innovation chain.

Public-Private Partnerships (PPPs), Joint Technology Initiatives, Public-Public Partnerships, Knowledge Innovation Communities, and InnovFin [7] (as access to risk finance) are some examples of innovation supporting schemes. Furthermore, collaborative research, innovation, coordination, and support actions promote cooperation not only between different kinds of entities (enterprises, universities, research centres, etc.), but also among countries and regions, with a view to approaching internationalization, globalization and competitiveness challenges [8].

2. Open Innovation

There are several challenges and needs at socio-economic level that may be tackled through innovation, on the basis of a collaborative and open approach [9, 10].

Regarding Europe's competitiveness, lower growth than its main competitors seems to be due to a productivity gap caused by lower levels of investment, and barriers to implement some kinds of innovation at practical level in all segments of society.

Concerning education, some 25% of European school children have poor reading skills, under a third of Europeans aged 25–34 have a university degree (40% in the US, over 50% in Japan), and European universities rank poorly in global terms—only 2 are in the world top 20. Therefore, the European institutions stand for a better knowledge economy with more opportunities to help people work longer and relieve the strain.

The five policy targets for the European Union (EU) in 2020 can be summarized as follows:

1. Employment: 75% of the 20–64 year olds to be employed.
2. Research and innovation: 3% of the EU's gross domestic product (GDP) investment.
3. Climate change and energy sustainability: greenhouse gas emissions 20% (or even 30%, if the conditions are right) lower than 1990, 20% of energy from renewables, and 20% increase in energy efficiency.
4. Education: reducing the rates of early school leaving below 10%, at least 40% of 30–34-year olds completing third level education.
5. Fighting poverty and social exclusion: at least 20 million fewer people in or at risk of poverty and social exclusion.

Coherently, challenges for smart growth include the combination of public and private investment levels (to reach 3% of EU's GDP, specifically) as well as better conditions for innovation. Digital agenda for Europe to create a digital market, Innovation Union refocusing on research and development, and youth on the move to help students for the future job market are the current main flagships.

Cooperation within regions, European Member States and Associated Countries, and other countries in a global context is a pillar of enhancing current capacities towards better results. The conceptual insights behind *Open Innovation*, *Open Science*, and *Open to the World* highlight

http://dx.doi.org/10.5772/intechopen.69632

actions to strengthen every link in the innovation chain. Reforming the regulatory environment (through Scientific Advice Mechanism, InnovRefit, Innovation Deals (IDs), and Policy Support Facility), boosting private investments in research and innovation, and maximizing impacts (through the seal of excellence for projects, simplification, etc.) are the three pillars of the strategy to foster Open Innovation (**Figure 1**).

From a historical perspective at European scope, common research and innovation has been done since the Iron and Steel Community; from 1984, FP1 legitimized the expansion of research and innovation programmes beyond energy and information technologies becoming the Commission's industrial policy. Until FP6, just about cross-border research and development actions by the Commission were justified as having European Added Value. The Commission

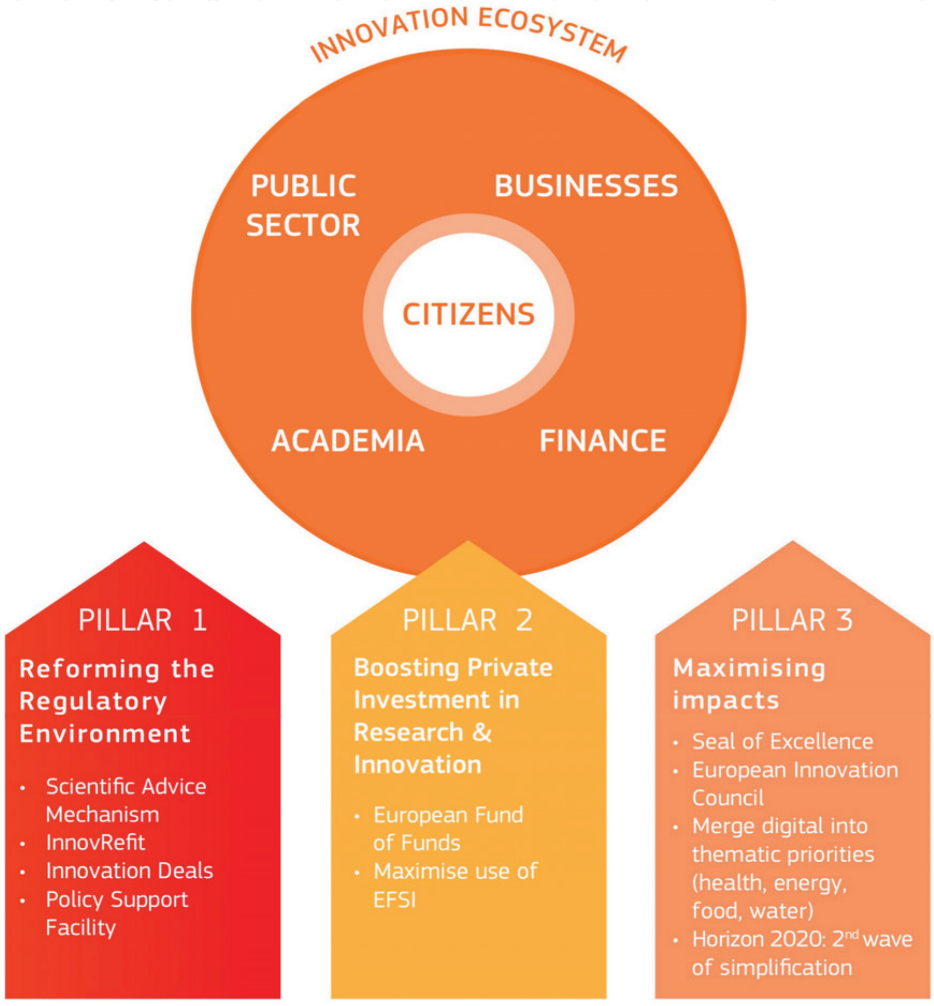

Figure 1. The European Commission's pillars to foster Open Innovation.

respected the subsidiarity principle and kept out of national research and innovation policy, however, the budgets kept increasing. From FP7, the agenda-setting function has become more explicit moving the focus of the FP from solving problems to seizing opportunities using this idea to tackle societal 'Grand Challenges' such as environment, ageing, and health.

Some authors identify different generation approaches linked to societal challenges:

- *First generation*: basic research; a policy for science. The linear model implies there is little need for coordination.
- *Second generation*: 'science policy' but actually the birth of innovation policy, more demand-led, industry-focused. Eventually, an understanding of the need for 'holistic' research and innovation policies and therefore a need for cross-sectorial coordination.
- *Third generation*: societal rather than industrial demands made of science. It requires large transitions and shifts in socio-technical systems. Coordination needed not only across sectors in research and innovation but among wider policies.

3. Mechanism of implementation

3.1. Horizon 2020: an overview

Apart from the national and regional, bilateral and transnational instruments for cooperation, the practical implementation measures to approach challenges at European level have a common main framework: Horizon 2020—the Framework Programme for Research and Innovation (2014–2020).[3]

The legal basis of different mechanism of implementation and instruments are described in the Treaty of the Functioning of the European Union (TFEU) and the Rules for Participation of Horizon 2020 and its three pillars (Excellence Science, Industrial Leadership, and Societal Challenges), which stand for a rather high degree of variability (in terms of target entities/institutions, degree of collaboration, timeframe of the actions, etc.) (**Figure 2**).

Among all, mechanisms of implementation can be divided into grants/subsidies, and loans, even if other schemes, as public procurement are also implemented. Collaborative projects (e.g. Research and Innovation Actions, and Coordination and Support Actions), Small and Medium Enterprise (SME) Instrument, Fast Track to Innovation, European Research Council grants (e.g. Proof of Concept), Marie Sklodowska-Curie Actions (to foster research career, with a number of typologies to create links to the innovation environment, like the Innovative Training Networks, or the international and inter-sectorial cooperation through the Research and Innovation Staff Exchanges) are some examples of the abovementioned variability.

The management of those schemes is a competence of the public administration itself, together with delegated *ad-hoc* institutions in some special cases.

[3]Horizon 2020 is the biggest EU Research and Innovation programme with nearly €80 billion of funding available over 7 years (2014–2020).

http://dx.doi.org/10.5772/intechopen.69632

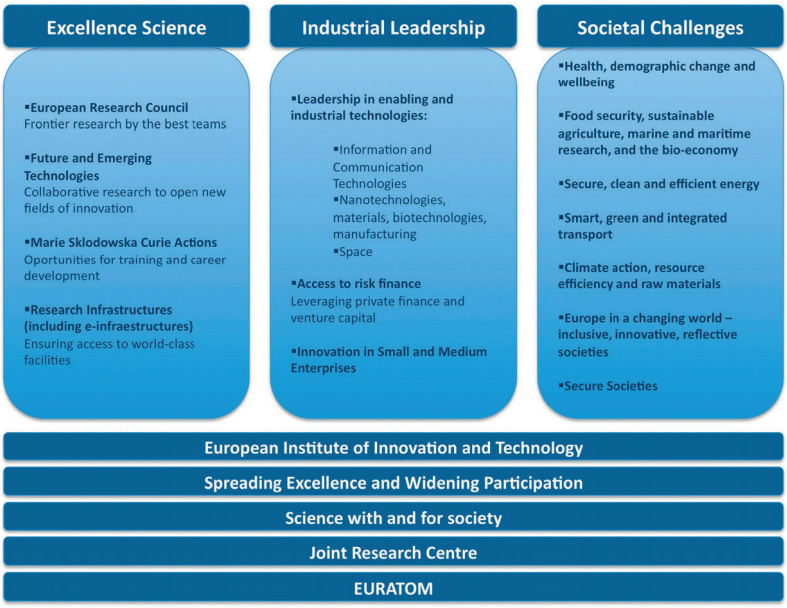

Figure 2. Horizon 2020 (2014–2020) main structure.

The TFEU also foresees the launching of new initiatives at any moment, after a positive assessment following the Better Regulation principles (e.g. new Art. 187 TFEU, namely Joint Technology Initiatives, or Art. 185 TFEU, as long-term Public-Public Partnerships for the execution of new integrated programmes).

3.2. Public-Private Partnerships

Contractual Public-Private Partnerships (PPPs) of strategic importance for the European industry were launched to leverage investments to be allocated through open calls for proposals, managed by the public administration itself. Their conceptual approaches are industry-driven to enable a long-term, strategic approach to research and innovation and reduce uncertainties by allowing for long-term commitments. Some of them are inspired by the Key Enabling Technologies, identified in 2009 to tackle societal challenges from a multiple industries' approach (on micro and nanoelectronics, nanotechnology, industrial biotechnology, advanced materials, photonics, and advanced manufacturing technologies) to bridge the well-known "Valley of Death" (from knowledge to market, and from science to production) (**Figure 3**).

Some thematic examples of PPPs are outlined below:

- Factories of the future towards high added value manufacturing technologies (clean, highly performing, environmentally friendly).
- Energy-efficient buildings towards a high-tech building industry to develop affordable breakthrough solutions at building and district scale.

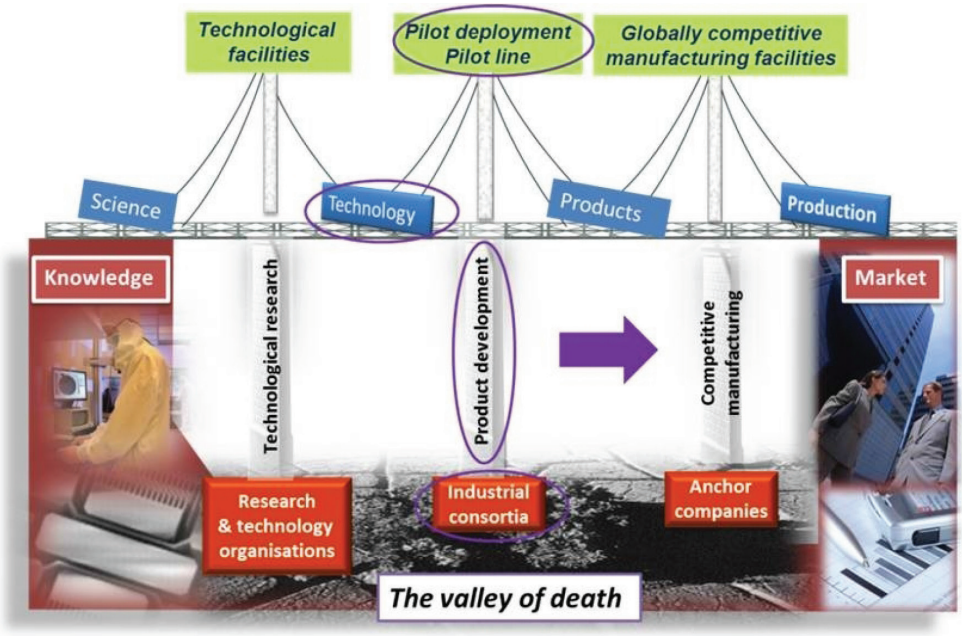

Figure 3. Valley of Death.

- Green vehicles to deliver green vehicles and mobility systems.
- Sustainable process industry to innovate in resource and energy efficiency enabled by the process industries.
- Photonics, bringing together all players from the European photonics sector and related activities including end-user industries and professionals.
- Robotics, teaming up of the robotics industry, research and academia.
- High performance computing.
- Advanced 5G networks for the future Internet.
- Cybersecurity to access innovative and trustworthy European solutions (information and communication technology products, services and software).

Joint Technology Initiatives aim at implementing Public-Private Partnerships in technological fields. The legal entities to implement them, Joint Undertakings, are industry-driven, as well as the calls for proposals. Meaningful examples are the following:

- Innovative Medicines 2 (IMI2) developing next generation medicines and treatments.
- Fuel Cells and Hydrogen 2 (FCH2) accelerating clean and efficient technologies in energy and transport.

- Clean Sky 2 (CS2) developing quieter aircraft with less CO_2 emissions.
- Bio-based Industries (BBI) fostering greener everyday products and renewable natural resources.
- Electronic Components and Systems for European Leadership (ECSEL) boosting Europe's electronics manufacturing capabilities.
- Shift2Rail developing better trains and railway infrastructure that will drastically reduce costs and improve capacity, reliability and punctuality.
- Single European Sky ATM Research (SESAR) 2020 standing for a European Air Traffic Management system that will enhance the performance of air transport.

3.3. Public-Public Partnerships

Public-Public Partnerships allow European Member States and Associated Countries to draw up joint research and innovation programmes [11–13]. They target the highest level of integration of national programmes at scientific, management, and financial levels through long-term commitments [14, 15]. Dedicated Implementation Structures manage their calls for proposals for 7–10 years, in general. The Public-Public Partnerships launched under Horizon 2020[4] are the following:

- European and Developing Countries Clinical Trials Partnership 2 (EDCTP2) dealing with treatments for diseases within poverty environments.
- The European Metrology Programme for Research and Innovation (EMPIR) focussing on technologies to measure.
- Eurostars 2 provides support for high-tech SMEs.
- Active and Assisted Living Research and Development Programme (AAL) empowering the elderly and disabled to live safely in their own homes.
- Partnership for Research and Innovation in the Mediterranean Area (PRIMA) [16] on water and agro-food systems, with an important approach to equal footing in neighbourhood countries in the Mediterranean region in the future.

European Joint Programmes (EJP) and Joint Programming Initiatives (JPI) through ERA-Nets (COFUND) target alignment of national programmes within a timeframe of 1–5 years.

3.4. Knowledge Innovation Communities

The Knowledge and Innovation Communities (KICs) are partnerships that bring together businesses, research centres, and universities. They allow new companies to be started and a new generation of entrepreneurs to be trained [17].

KICs are inspired in "knowledge triangle integration", as a coordinated process in which the diverse skills and competences are empowered to deliver new products, services and

[4]Under the FP7, BONUS was launched to tackle the key challenges of the Baltic Sea Region.

business models; equip students with the skills to become entrepreneurs; and create start-ups and accelerate the scaling-up of ventures. The current KICs are the following:

- Climate-KIC about climate change mitigation and adaptation.
- EIT Digital aiming at generating world-class Information and Communication Technologies.
- KIC InnoEnergy addressing sustainable energy.
- EIT Health focused on healthy living and active ageing.
- EIT Raw Materials towards sustainable exploration, extraction, processing, recycling and substitution.

The funding model stands for a public financial contribution to a maximum of 25% of a KIC's overall resources over the KIC's lifetime. The public administration financial contribution to the KIC is provided in the form of a grant for action, where the funding rate for the specific grant may be up to 100% of the total eligible costs of KIC added-value activities.

Each of the KICs operates in innovations hubs called 'Co-location Centres' across Europe to catalyse impacts within regions.

3.5. InnovFin (access to risk finance)

"InnovFin—EU Finance for Innovators" consists of integrated financing tools and advisory services to support investments from through a wide range of loans and guarantees. Financing is either provided directly or via a financial intermediary, most usually a bank. InnovFin has been developed in such a way to provide a series of integrated and complementary financing tools [7] (**Figure 4**).

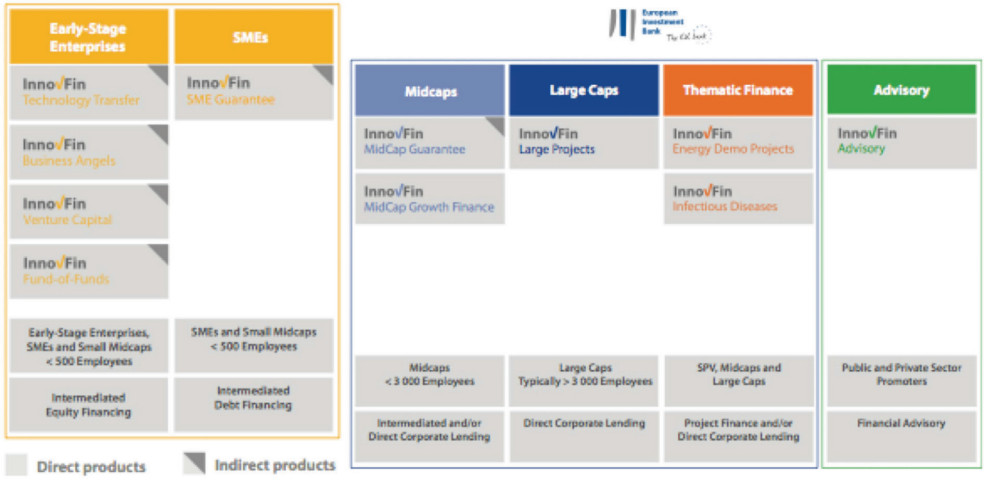

Figure 4. InnovFin product table.

http://dx.doi.org/10.5772/intechopen.69632

InnovFin builds on the success of the former Risk-Sharing Finance Facility developed under the seventh EU framework programme for research and technological development 7th Framework Programme (2007–2013) (FP7).

3.6. European Innovation Partnerships

European Innovation Partnerships (EIPs) are challenge-driven, focusing on societal benefits and a rapid modernisation of the associated sectors and markets. There is no budgetary provision for the outcome of their activities; however, their governance, with a high level group including public and private sector, the elaboration of the Strategic Innovation Agendas, and the calls for commitments has influenced the design of call for proposals and financial instruments (**Figure 5**).

3.7. Innovation Deals

One meaningful example to support innovation without financial support is the Innovation Deals (IDs). They aim at overcoming the regulatory environment, as already mentioned to swiftly address legislative obstacles, shortening the time between moment of inspiration and market uptake. If a rule or regulation is confirmed as an obstacle to innovations that could bring wider societal benefits, the deal will make it visible and feed into possible further action [18].

The IDs are inspired by the "Green Deal" Programme of the Government of the Netherlands, where a large number of Green Deals are proving to be successful in supporting the national Green Growth policy by providing regulatory clarity for innovative solutions. IDs take the form of voluntary cooperation between the European Union, innovators, and national, regional and local authorities.

One of the most relevant communications is "Closing the loop—an EU action plan for the circular economy". It explains the concept of Innovation Deals as "a pilot approach to help innovators facing regulatory obstacles (e.g. ambiguous legal provisions), by setting up agreements with stakeholders and public authorities".

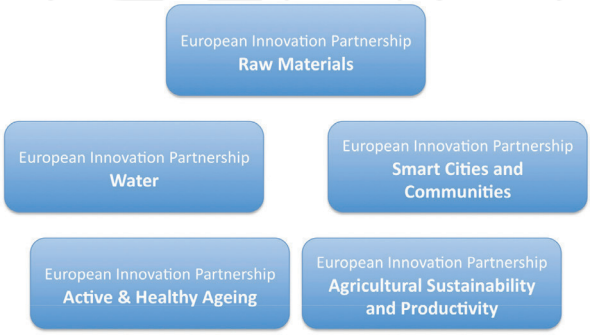

Figure 5. European Innovation Partnerships.

4. Impacts

Important impact mechanisms may operate over extended time periods at policy/governance level. Both sorts of research and innovation are at various times needed [19].

Different mechanisms of implementation may lead to different types of impacts, from scientific/technological to economic impacts that can denote changes at the organizational and also national budgetary levels, and or cultural and societal impacts reflecting changes to mind-sets or behaviours.

The alignment of programmes through the creation of networks called "process impacts" can range from:

- policy-related or conceptual impacts when participation (e.g. in a Public-Public Partnership) changes the way a certain research area is perceived at policy level;
- connectivity impacts reflecting the collaboration of funding agencies or programme managers that can have a long-lasting effect;
- capacity building impacts in organizational and personal skills in international programme management for instance;
- attitudinal/cultural impacts reflecting a more positive or negative attitude towards transnational collaboration; and
- structural impacts relating to changes in institutions and structures in the national or European research landscape.

When analysing different programmes, those impacts are usually examined at project level. So, a common practice in the evaluation of research and innovation programmes reflects the notion that the impact of the whole programme is the aggregate impact of the component projects.

For example, in 2015, around 4500 transnational projects had been funded by the Public-Public Partnerships representing a combined investment of some €5 billion. Most of the networks, and the national funding organizations, have some forms of monitoring system for the projects that are spawned from Joint Calls but assessment of their economic, societal and/or environmental impacts is less common [20, 21]. Impacts by beneficiary (research organization, industrial organization, public administration, societal organization, and environmental organization) could be summarized as shown in **Figure 6**.

Type of Beneficiary	Outcomes	Intermediate Impacts	Global Impacts
Research organisation	new technology, new data/method, formal publications, patents	additional research income, commercial income, increased research capacity, spin-off businesses, enhanced reputation	new research trajectories, new solutions for socio-environmental challenges, economic spill-overs to industry
Industrial organisation	new product/service, new technical process, new organisational process, patent, improved capacities	increased turnover/profit, new jobs, protection of existing jobs, increased market share, geographic expansion	economic spill-overs to other businesses, new solutions for socio-economic challenges
Public service organisation	new methods/services, new organisational process	improved service quality, reduced cost of service delivery	improved health, safety, security and/or quality of life for citizens
Public administration	improved scientific evidence, new organisational process	improved governance, reduced administration costs, evidence-based policy making	improved economic, social and/or environmental impacts
Societal organisation	improved scientific evidence, improved services, improved capacities	increased influence	improved standards/regulations, improved quality of life
Environmental organisation	improved scientific evidence, improved services, improved capacities	Increased influence	improved standards/regulations, reduced environmental impacts

Figure 6. Outcomes, intermediate impacts, and global impacts by beneficiary.

The literature says research and innovation-society links focuses on direct effects as increasing in the stock of useful knowledge, supplying of skilled graduates and researchers, developing new instrumentation and methodologies, creating of networks and stimulation of social interaction. The solving capability is based on "spin-off" companies and the provision of social knowledge [22, 23].

A review from the Organisation for Economic Co-operation and Development (OECD) suggests there seem to be six kinds of impact mechanism to consider:

- Human capital development—which is not orthogonal to the other categories but tends to feed into them.
- Research-influenced changes in policy, agenda-setting.
- Industrial innovation (including innovation in services as well as products and processes).
- The improved exercise of professional skill, for example, in research-based improvements in medical practice.
- Tackling "grand" or societal challenges, that impede social and economic development or provide existential threats (e.g. climate change).
- The provision of improved public goods (and potentially the provision of associated state services).

At European level, there is an evolution of instruments and on-going exercises to deep on impacts [24, 25].

Author details

Carolina Rodríguez Rodríguez

Address all correspondence to: carolinardrd@gmail.com

European Commission – Directorate General for Research and Innovation, Brussels, Belgium

References

[1] http://ec.europa.eu/eurostat/web/microdata/community-innovation-survey

[2] https://www.elsevier.com/solutions/scopus

[3] SPRU, editor. The Benefits from Publicly Funded Research, Paper No. 161; Ben R. Martin & Puay Tang. 2007. https://www.sussex.ac.uk/webteam/gateway/file.php?name=sewp161.pdf&site=25

[4] Arnold E, Barker KE. Assessing the impact of state interventions in research—techniques, issues, solutions. In: IMPAR Conference 2015, Paris. 2015

[5] http://www.nesta.org.uk/sites/default/files/systemic_innovation.pdf

[6] https://ec.europa.eu/research/participants/portal/desktop/en/support/faqs/faq-2890.html

[7] http://www.eib.org/products/blending/innovfin/

[8] http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/priorities/smart-growth/index_en.htm

[9] http://www.oecd.org/about/publishing/

[10] https://ec.europa.eu/digital-single-market/en/news/open-innovation-open-science-open-world-vision-europe

[11] https://www.era-learn.eu/events/annual-joint-programming-conference-2016/session-2-impacts-at-project-level/Angusintro.pdf

[12] https://www.era-learn.eu/publications/other-publications

[13] http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=eip

[14] https://www.era-learn.eu/events/annual-joint-programming-conference-2016/

[15] http://ec.europa.eu/programmes/horizon2020/en/official-documents

[16] https://ec.europa.eu/research/environment/index.cfm?pg=prima

[17] https://eit.europa.eu/activities/innovation-communities/what-makes-kic-kic

[18] https://ec.europa.eu/research/innovation-deals/index.cfm?pg=about

[19] http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/targets/index_en.htm

[20] http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573899/EPRS_BRI(2016)573899_EN.pdf

[21] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A12012E%2FTXT

[22] http://ec.europa.eu/smart-regulation/guidelines/toc_guide_en.htm

[23] http://ec.europa.eu/programmes/horizon2020/en/official-documents

[24] https://ec.europa.eu/growth/industry/key-enabling-technologies_en

[25] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52009DC0512

Chapter 8

Leadership and Teamwork in Innovation Ecosystems

José Miguel Muñoz Pérez and Manuel Irún Molina

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.69006

Abstract

As experts acknowledge innovation is rarely driven by individuals acting in an isolated capacity, it is generally a social and collaborative element that triggers the concepts of organizational behavior. The question is then how to create environments in projects and in organizations where individual's creativity and contribution fosters pollination to drive innovation. Studies confirm that the key impacting element in this area is teamwork quality, rather than team composition. Thus, organizations need to create teams with key traits that drive positive collaborations such as communication, coordination, balance of member contributions, mutual support, effort, and cohesion. These traits will allow a social group to deal with the inevitable creative tension needed for innovation ecosystems to flourish. Since human behavior is not mathematical, the only way to do this is creating the conditions for these traits to appear. In this context, leaders as social architects become very important, setting the tone of the organization, clearly defining the mission, identifying and living shared values, setting example, and understanding how organizations and social groups behave. When they are able to build high quality and performing environments, they become innovation brokers generating models that are scalable to be able to impact communities.

Keywords: innovation ecosystems, leadership, teamwork, trust, collaboration, communities, innovation brokers, social architects

1. Introduction

Since prehistoric times, people have gathered together in tribes to seek safety in an environment plenty of uncertainty, life threats, and challenges. Those tribes were not isolated, but they had both conflicting and amiable relations with other tribes. The socialization, organization, and governance within these communities were far from being a haven of peace, as

inevitable tension between the individual and the group arose. Since Ancient Greece, this balance between the individual and the group has been a major field of study as it is the basis for the social interaction and management.

However, it was in this environment where human beings started innovating with things like the wheel, weapons, construction, or transportation, propelled by the need for survival. This kind of innovation would have not been possible by isolated individuals, hence, it is relevant to acknowledge that innovation is not about sole genius but about collaborative genius as [1] have demonstrated. The question then is: how we can create environments where innovation flourishes and nurtures? How organizations can balance the individual creativity and contribution, with the group innovation and performance? Provided that human behavior is not mathematical, can organizations and societies develop a framework to foster innovation?

For centuries, human kind has been acknowledging and rewarding creative individuals, but the truth is that innovation rarely happens without cooperation and collaboration. Therefore, it seems straightforward to understand what the key elements of collaboration are. Looking back again to our ancestors, give us the opportunity to understand that trust is the basis for that collaboration. As mentioned earlier, when the hominids got together, they did it seeking safety for the numerous dangers that they were facing. In order to do that, they needed to build trust between themselves, so they took calculated risks and, therefore, meanwhile some of them were taking care of the babies, some others were hunting, others looking and building shelter, etc. This would not be possible without trust, because when people have to focus on dangers from inside the group, they are less able to handle the dangers from the outside [2]. Therefore, when a group of people feel safe and feel that their objectives and hopes are going to be met, they trust each other and start working together to get things done, share ideas, and collaborate to make them happen. Trust is not only firm belief in the reliability, truth, or ability of something, some person, or some group within the rules, but it is also to know when to follow the rules and when to break the rules. Rules and processes are set for standard operations to make sure that we are able to achieve the objectives and avoid issues, but when there are special situations or there are no written rules, we "trust" in the expertise of people to look for solutions. Knowing when to break the rules is a key challenge in organizations [2]. Therefore, it is then key to create organizations where internal stability, safety, and trust in order for people to focus on external issues, threats, or challenges that ultimately ignite innovation and performance.

The problem happens when there is a general confusion about creating an internal safe, stable, and trustable environment, with the lack of some creative tension, constructive conflict, healthy debate, and positive controversy coming from diversity, ambition, and pursue of excellence. These are different elements but not exclusive between them, as cooperation and collaboration does not mean agreement, it means working together advancing toward a common purpose. The question is how those two elements can co-exist in an effective manner, so that high performance and innovation can happen. As Dyer et al. [3] put it, "one's ability to generate innovative ideas is not merely a function of the mind, but also a function of behaviors," meaning that when working in teams they need to generate the behaviors to be able to generate innovation.

In this context, leadership allows of creating groups where internal trust happens and where focus is on external factors that help people develop from individual performance to team performance, to organizational performance, and finally to community performance. As Sinek remind us "the responsibility of leaders is to teach their people the rules, train them to gain competency, and build their confidence. At that point, leadership must step back and trust their people know what they are doing and will do what needs to be done" [2].

2. Team composition and diversity

The key element to consider when working in social environments (groups, teams, organizations, communities, or networks) is, as reflected by Collins research [4], to have the right people in the organization. His studies conclude that instead of first setting up the mission, objectives, and processes, it works the other way around, hiring first the right people and then figuring out the next steps. Main reasons are that in a rapid changing world, adaptation is better as direction has not been set yet, motivation issues largely go away, as people motivations are self-driven and trying to implement a vision with the wrong people has many chances of failure. Catmull [5] from Pixar coincides with this approach when he says "My conviction that smart people are more important than good ideas probably isn't surprising. I've had the good fortune to work alongside amazing people in places that pioneered computer graphics."

The right people for the organization should be considered based on character traits, soft skills, and core values rather on knowledge, background, or skills. Bennis and Thomas [6] identify that key elements for outstanding managers are adaptive capacity through resilience openness, creativity and observational skills, clear ethical framework, and deep sense of purpose and self-awareness with comfort of dissent. Thomas [7] will later propose that another key skill is the learning capacity from experiences focused more on soft skills, values, and evolving as a person.

One very important question that has been discussed in the academic and scientific literature is diversity, propelled by the fact that missions and tasks faced by teams are becoming more and more complex involving different technologies, fields of knowledge, and processes. Paulus et al. [8] reviewing the studies available mention that they are not fully conclusive as some are positive, some are negative and say that there is no impact. As these authors suggest, the main reason for this lack of comprehensive results is that it depends on the type of diversity. The authors suggest, after reviewing previous research, that background diversity has a negative impact in innovation, whereas job diversity has a positive impact.

However, in this context, Kurtzberg [9], starting from previous studies, concluded that heterogeneous teams outperformed homogeneous teams despite the perception of creativity of those diverse teams was not consistent with reality (quantitative and qualitative). This means that the perception of the ability to generate creativity and innovation might be more important than ability itself. In our opinion, this research demonstrated the intuitive approach that diversity has a positive impact in innovation, provided that there are not prejudices and preconceived ideas that preempt the team to perform. The self-fulfilling prophecy seems to have a very important impact again in human behavior.

Hoegl and Parboteeah [10] demonstrate that high teamwork quality (measured in several factors as communication, coordination, balance of member contributions, mutual support, effort, and cohesion) has a positive impact in innovation, whereas they are less dependent on domain relevant skills, creative-thinking skills, or team efficiency (as adherence to schedule and budget). These conclusions are in line with literature that suggest, that to be effective, teams need to have effective cognitive processes, be cohesive, have a sense of efficacy, coordinate their activities, have effective task structure, have goals and feedback, be trained, and have appropriate leadership [11, 12]. These could also help understand why some of the research about innovation and creativity in teams is not conclusive about its impact in performance, as the key factor is quality of teamwork rather than the diversity itself. In short, how to manage a group or community is the key relevant factor to performance and innovation. For us then, it is relevant to focus on how to create a culture that generates the conditions for high performance organizations where creativity and innovation can flourish, rather than the creative process itself.

3. High-quality teamwork and stages of group development

In order to reach a high teamwork quality, we need to understand how a group evolves from a sum of individuals to a high performing team. Tuckman [13] defined in 1965 the four different stages of group development which have been widely used, and despite other authors have different number of stages, all of them seem to be quite similar [14]. These stages are as follows:

- Norming: This is an existential phase where people are cautiously exploring the situation and the relationship. Members are trying to understand who are they as a group, what will be the individual roles, and how they are going to operate.
- Storming: People start working together but diverse perceptions about mission, vision, objectives, and roles emerge. Disagreement and conflict turns up creating tension in the organization. If the conflict is constructive and if the group is able to manage the conflict appropriately, clarification will start happening and then the group is able to mature and go to the next stage.
- Norming: The team works together toward the agreed objectives in a cohesive and collaborative manner. Members develop their tasks and they start getting results.
- Performing: In this phase, performance reaches the maximum, exchange of ideas, successful implementation of new concepts and shared leadership appear in the team.

Later on Tuckman and Jensen [14] added one final stage called adjourning to reflect the final disband of the group.

Not all the groups make it to stage 4 because, although they can reach to stage 3 and start providing results, they do not necessarily maximize their synergistic performance. In this context, a group that has already moved out from the storming phase will become a team, instead a mere group, and it will be more able to build and nurture trust between the different members and commitment with the mission. However, if the team is able to start delivering

results in the norming stage, then it will be more capable to move to the next stage to handle creative tension, diversity, and conflict, which are key conditions to innovation behaviors to emerge (associating, questioning, observing, networking, and experimenting), producing a synergistic team value called innovation premium [3]. That is the reason that high performing teams (stage 4) are generally associated with creativity, innovation, and shared leadership as described in the research [14, 15].

Therefore, leader's role is to create the conditions to enable teams to become high performing groups, where there are three key elements for success: Collaboration, discovery-driven learning, and integrative decision making. To make sure this happens, leaders need to be able to balance the paradoxes of innovation [1], meaning that they need to make sure there is appropriate balance between individual and collective value, support on the ideas and constructive confrontation, learning and performance, structure and improvisation, and patience and urgency.

Additional to this, the roles of senior leadership in developing disruptive innovation according to Christensen and Raynor [16] include:

- Bridging the interface between disruptive growth and mainstream business.
- Designating the appropriate resources and processes for the innovation process; creating and mentoring a disruptive growth engine that starts early, providing oversight, and engaging an expert team of well-trained movers and shakers; and sensing when the context is changing and training others to recognize the signals.

4. Innovative leaders as social architects

So how can leaders create those organizations? In order to answer that question, we need to understand how effective leaders behave. In a study of more than 10 years, 24,000 people and two dozen corporations, Logan et al. [17] reached to the conclusions that human behavior in the corporate world is not very different to the aforementioned of our prehistoric ancestors. People gather together in groups (namely, tribes) of 20–150 people as that is exactly the Dunbar number [18], which is the suggested cognitive limit to the number of people with whom one can maintain social relationships. Each of these tribes has a particular culture that is set by tribal leaders, and those tribes can be defined in a scale from 1 to 5.

- Stage 1: People in this group are alienated. Motivation is power and survival. Trust only happens for safety reasons. They perceive that "life sucks."
- Stage 2: People in this group are passive, reactive, and noncollaborative. They rarely cluster together and it is usually temporary. It represents 25% of the population. Their perception of the situation is "my life sucks."
- Stage 3: Forty-nine percent of people are in this stage. Relationships are dual (1-to-1) with increased egocentric and competitive approach. These people feel "I am great" and there is an implicit thinking of "and you are not."

- Stage 4: Relationships at this stage move to triads, in which the group is preeminent versus the individual. Competitiveness happens only at group, team, or organization level, but not between members. Full collaboration at organizational level happens. The perception of these people is that "we are great" with the inner thinking of "and they are not."
- Stage 5: People at this level are not competitive, but fully collaborative. They do not see the boundaries in the organization as long as they share values and mission. The perception here is that "life is great." They do not see the traditional hurdles of other stages set as "I can't, I don't want, or I don't know" and they focus on making things happen.

This classification seems very relevant to innovation for us as these authors set up different grades of collaboration according to the stage of the tribe. **Table 1** shows their adapted proposal.

Therefore, in this case, stages 1 and 2 represent a situation with no teamwork and collaboration. Stage 3 shows a typical organization where there is very limited teamwork and management approach is command and control. Stage 4 is a stage where teamwork happens and high-performing teams can definitely be represented here. Stage 5 for us represents collaboration communities where different nodes connect each other to work together. In this context, innovation happens within organization in a very limited amount in stage 3 (i.e., military environment); however, within organizations, innovation is strongly happening in stage 4 (i.e., 3M, Google, Microsoft, etc.). Maximization of innovation can only happen in stage 5 where collaborative economy, exchange of ideas, shared trust, open frameworks, and creative environments are the norm (i.e., Silicon Valley).

This type of leaders is also mentioned by Collins [4] where he identified organization with higher performance than similar companies during 15 years in a row. These companies were led by 41 CEOs labeled by their employees as quiet, humble, modest, reserved, shy, gracious,

Tribal Stage	*Collaboration*	*Communication*	*Structure*
5	Community	"Life is great"	
4	Team	"We're great"	
3	Personal	"I'm great"	
2	Separate	"My life sucks"	
1	Alienated	"Life sucks"	

Table 1. Collaboration stages and structures.

mild-mannered, self-effacing, understated, did not believe his own clippings, and so on. He mentions that these successful leaders put their ego away, focusing in the "we" more than in the "I."

Basically, leaders in stages 4 and 5 set up a tone in the organization where purpose, shared values, and rules allow to create the conditions for the right behaviors and thinking process to emerge. Those leaders are masters managing the inevitable tensions that arise between the individual and the group, and they do it by clearly setting purpose, defining clear values, setting example, and being able to manage the group behavior and psychology. Because of these leaders' life attitude, they are able to instill and motivate the group and take the performance of those groups or communities to the next level.

Amabile and Khaile [19] expand on the behaviors that innovative leaders reflect values of humility, openness, and pragmatism and are result driven. The behaviors are as follows:

- Tap ideas from everyone in the organization regardless of level and function, motivating, avoiding punishment for failure, valuing contributions, and providing recognition.
- Open the organization to diverse perspectives. Making sure that there is enough diversity and people are not afraid to show that diversity.
- Avoid bureaucracy and resistance to change by eliminating obstacles and clearing paths.
- Identify when to set up controls and when to avoid them. Understand if the group is in a confusing discovery phase and allow to nurture the ideas on that stage.
- Set up the right controls in the commercialization phase. This is a critical moment. Having teams from diverse disciplines and in separate spin off entities will help test and gauge the ideas.

In this context, the importance of leadership in innovation cannot be minimized since they set the tone and the attitude of the organizations as research concluded. Leaders must be able to understand the maturity of the group or the community, be able to pulse the emotional tone of the team and channel those emotions to energize the innovation effort. People are placed at the first line of the innovation process, and it explored the individual role, the capacity of teams, and the scalability of the model in the community of practice to accelerate the process. As mentioned before, the leader and the organization must manage the inevitable tensions of the paradoxes, constantly looking for a balance between conflict, improvisation, and chaos, and structure, performance, and direction.

So leadership is a personal growth journey that goes through the mentioned stages to reach a point where shared leadership allows positive interaction. Leaders here are social architects where often take an advisory role connecting "dots," communities, and ideas. They can create a vision and therefore set direction in a participatory way. These leaders also usually take the role of innovation brokers helping to consolidate the integration of knowledge and ideas in order to create synergetic value. They act as facilitators or systemic intermediaries of cooperation in innovation systems, and their activities usually cover different parts of the process taking even some years.

5. Scaling up the teamwork: the role of innovation brokers

When creating innovation communities, there is also the need of trust between different organizations and, therefore, from the different stakeholders' perspective, the neutrality and ethical approach of the brokers is a key factor, as it will determine the trust and credibility to develop their job. In this context, their reputation and a high degree of independency from the major stakeholders in the process and the innovation system have to be clearly identified. This is very sensitive, because if there is a conflict of interest due to stakeholders' pressure to position their particular interests, this does not help to build productive innovation networks [20].

Once the initial network consolidates and starts interacting, it is relevant to identify participatory needs and assess opportunities, reorganizing the network if necessary. Following steps in the innovation broker functions are to plan the actions, to facilitate or coordinate the network, to be prepare for problem solving and conflict resolution, and to have an exit strategy [21].

For all this, it is suggested from experts a fourth strand in the Triple Helix: the broker [20]. In this context, the innovation brokers, individuals, or entities (i.e., accelerators, knowledge transfer organizations, or economic development agencies) are key in an innovation economy due to the capacity to connect strengths and values from the regional ecosystem to facilitate the creation of new businesses, jobs, and wealth [22, 23]. These brokers are able to manage the mentioned tensions and paradoxes at community level between the different stakeholders, such as structure and improvisation, learning and performance, or conflict and support [24].

In this sense, it is worth highlighting that the innovation economy is not only limited to the creation or the support of start-ups. In addition, it covers the existing entities (i.e., SMEs), which can become more competitive thanks to the activity of the innovation broker [20]. Another element is that existing entities (i.e., Small Medium Enterprises, corporations) that started small and innovative often lose their ability to innovate as they focus on growth and not existence [2], and also focusing on performance rather than learning [1]. This also directly links with the key role of the innovation brokers for the successful commercialization of innovations [25] and their role in the regional innovation [26, 27] which is depicted in **Figure 1**.

Therefore, this role is key because if an existing organization cannot develop a successful innovation strategy relative to its core capabilities, other smaller entities will disrupt the market. These assets and capabilities required to the innovation brokers are shown in **Figure 2**.

Innovation brokers are crucial to be identified or to be trained (i.e., thanks to regional investments) and to be involved in the different stakeholder management levels to assure the efficient triangulation between all players in the open innovation system as depicted in **Figure 3** [27].

However, the emergence of these innovation brokers is not easy. It is usually a consequence of specific needs of an innovation network (i.e., physical distance among network members, lack of trust, or different objectives [28]). They can be formally or informally assigned. In any

http://dx.doi.org/10.5772/intechopen.69006

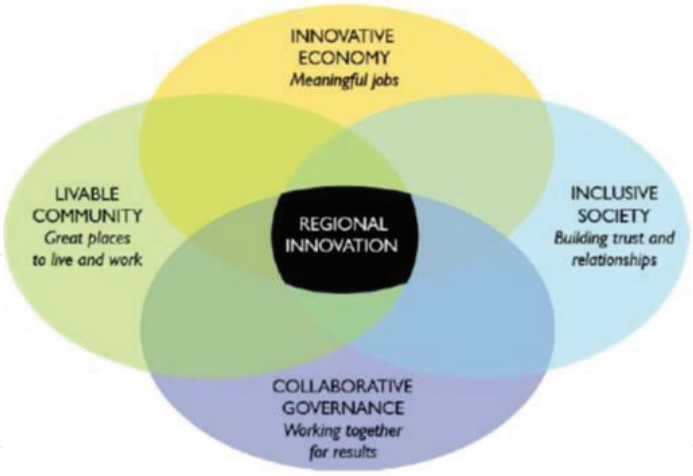

Figure 1. Regional innovation landscape. Source: Collaborative Economics [27].

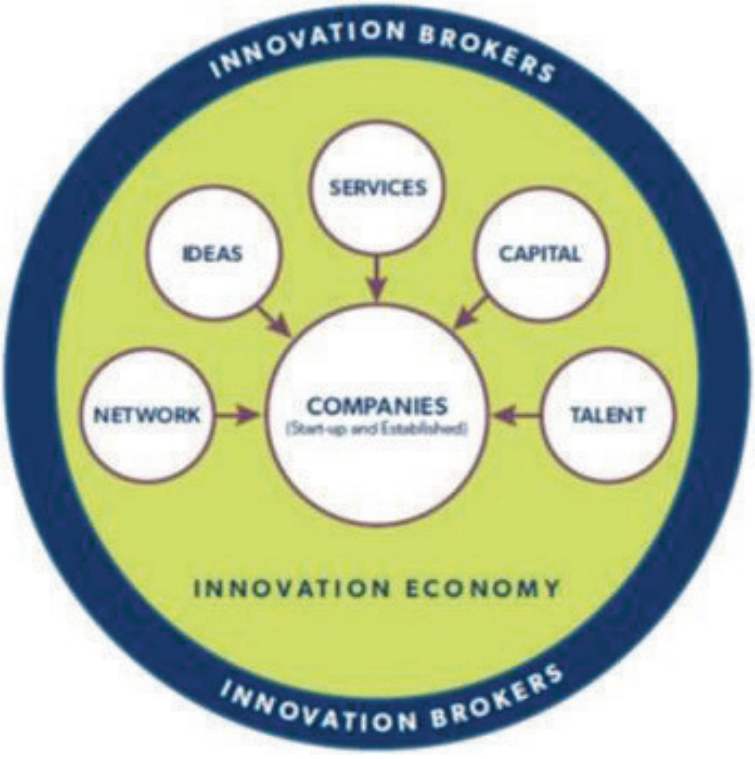

Figure 2. Brokers as the centripetal force that directs regional resources toward business. Source: Henton and Oettinger [20].

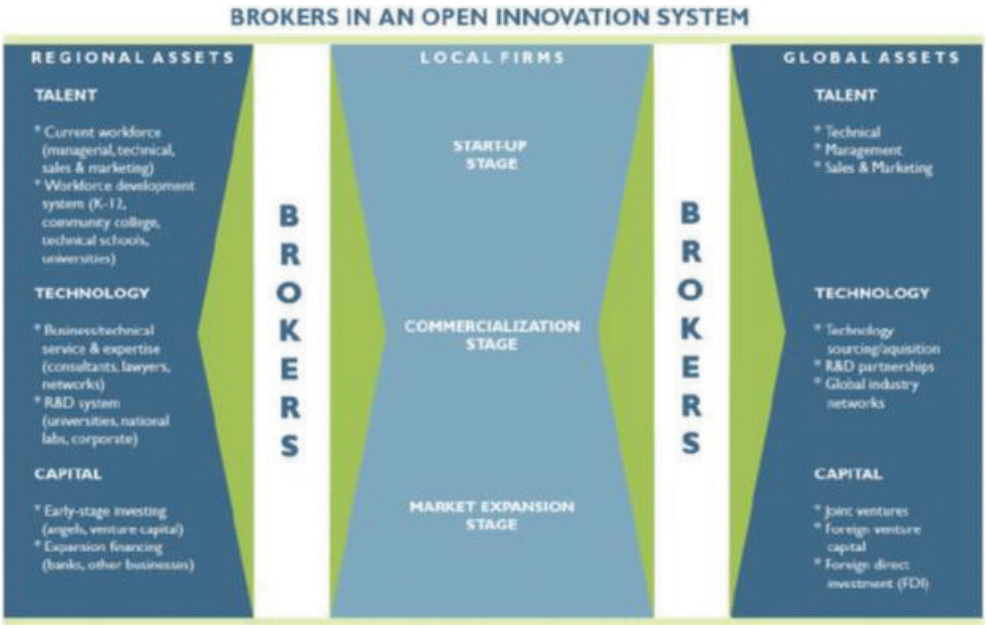

Figure 3. Brokers in an open innovation system. Source: Collaborative Economics [27].

case, innovation brokers are successfully identified in an innovation network based on bridging people and knowledge, personal reputation, and influence within the network and their relationships with other individuals in different levels of interaction.

Considering all this, one of the best broker profiles is that of a person from the business sector, with access to investors and the possibility to influence stock and capital owners to invest on the innovation network, start-ups, products, or services developed. This is why it is so important that the business schools and other education networks start educating the next generation of leaders but also the next generation of innovation brokers that are able to deal with the challenges of the innovation economy [29].

In any case, the brokers need to be internally legitimized, what will allow them to successfully perform their role [30]. Precisely, the Global Innovation Index 2014 focused that year's report on the "Human Factor in Innovation" [31]. The analysis of the human contribution to innovation is a complex challenge. It is relevant to place the people at the first line of the innovation process and explore the individual role and the capacity of teams to accelerate the process.

Only with practical analysis of strategic management in a particular innovation network or project with the recognition to the key role of individual innovation brokers, it is possible to learn more about what happens at the intersection of people, technology, services, business models, financing, policy, and institutions to design a strategic framework to scale up to the top stage of the collaboration structure [32].

6. Conclusion

In summary, research concludes that most innovative organizations and projects are those that are able to create a high-quality teamwork ability, fostering collaboration, discovery-driven learning, and integrative decision making. This is only possible with the appropriate leadership based on personal development process that allows to developing a positive attitude with very strong human values such as humility, solidarity, and generosity. Research shows not only that these types of leaders are far more innovative, but also that their sense of purpose, their share values, their ability to manage organizational psychology, and their example are key to manage the inevitable tensions of the group. Leading innovative organizations have behaviors and thinking processes funded in balancing key paradoxes and tensions like individual and collective, support of ideas and constructive confrontation, learning and performance, structure and improvisation, and patience and urgency. Leaders have to act as brokers in these organizations to ensure balance between these elements, but they have to do it during all lifecycle since inception and group gathering, to team, to organization, to finally scale up their roles to the community level to maximize impact in innovation ecosystems. In addition, since innovation happens when high-quality interaction arises, communities need to proactively appoint innovation brokers to be able to ensure that high quality interaction that balances the aforementioned tensions to successfully drive innovation and performance to our society. This is a far less intuitive role in our current ecosystems, although the rewards of such structure are very significant. The selection process of these roles should be extremely careful to be able to meet all the requirements mentioned in this chapter. The key conclusion is that innovation always depends on the human factor and the quality of the interaction between people and, therefore, human values are key for the successful implementation of innovation social architectures at project, organization, and network levels.

Author details

José Miguel Muñoz Pérez[1]* and Manuel Irún Molina[2]

*Address all correspondence to: jmmunoz.mba2000@alumni.ie.edu

1 People & Organization Development, Dubai, United Arab Emirates

2 Personal capacities, Budapest, Hungary

References

[1] Hill LA, Bandeau G, Truelove E, Lineback K. Collective Genius. The Art and Practice of Leading Innovation. Boston: Harvard Business Review Press; 2014

[2] Sinek S. Leaders Eat Last. USA: Penguin LCC US; 2013

[3] Dyer JH, Gregersen H, Christensen CM. The Innovator´s DNA: Mastering the Five Skills of Disruptive Innovators. Boston: Harvard Business Review Press; 2009

[4] Collins JC. Good to Great. United Kingdom: Harper Business; 2001

[5] Catmull E. How Pixar Fosters Collective Creativity. Boston: Harvard Business Review; 2008

[6] Bennis W, Thomas RJ. Crucibles of Leadership. Boston: Harvard Business Review; 2002

[7] Thomas RJ. Crucibles of Leadership: How to Learn from Experience to Become a Great Leader. Boston: Harvard Business Review; 2008

[8] Paulus PB, Dzindolet M, Kohn NW. Collaborative Creativity-Group Creativity and Team Innovation. Handbook of Organizational Creativity. Associated Press; 2012. Available from: https://www.researchgate.net/publication/279433143_Collaborative_Creativity-Group_Creativity_and_Team_Innovation

[9] Kurtzberg TR. Feeling creative, being creative: An empirical study of diversity and creativity in teams. Creativity Research Journal. 2005;**17**(1):51-65

[10] Hoegl M, Parboteeah KP. Creativity in innovative projects: How teamwork matters. Journal of Engineering and Technology Management. 2007. DOI: 10.1016/j.jengtecman.2007.01.008

[11] Salas E, Rosen MA, Burke CS, Goodwin GF. The wisdom of collectives in organizations: An update of the teamwork competencies. In: Salas E, Goodwin GF, Burke CS, editors. Team Effectiveness in Complex Organizations: Cross-disciplinary Perspectives and Approaches. New York, NY: Routledge/Taylor & Francis Group; 2009. pp. 39-79

[12] Tasa K, Taggar S, Seijts GH. The development of collective efficacy in teams: A multilevel and longitudinal perspective. Journal of Applied Psychology. 2007;**92**:17-27

[13] Tuckman BW. Developmental sequence in small groups. Psychological Bulletin. 1965; **63**(6). American Psychological Association

[14] Tuckman BW, Jensen MA. Stages in small group development revisited. Group and Organisation Studies 1977;**2**:419-427

[15] Miller DL. The stages of group development: A restrospective study of dynamic team processes. Canadian Journal of Administrative Sciences. 2003;**20**(2):121-124

[16] Christensen C, Raynor M. The Innovator's Solution: Creating and Sustaining Successful Growth. Boston: Harvard Business School Press; 2003

[17] Logan C, King J, Fischer-Wright H. Tribal Leadership. Leveraging Natural Groups to Build a Thriving Organization. United States: Harper Business; 2008

[18] Dunbar RIM. Neocortex size as a constraint on group size in primates. Journal of Human Evolution. 1992;**22**(6):469-493

[19] Amabile TM, Khaire M. Creativity and the Role of the Leader. Boston: Harvard Business Review; 2008

[20] Henton D, Oettinger J. The Role of Innovation Brokers in a Knowledge Economy: The Fourth Strand to Triple Helix [Internet]. 2013. Available from: http://www.biginnovationcentre.com/Assets/Docs/Triple%20Helix/Papers/Theme%201/Henton.pdf

[21] Klerkx L, Gildemacher P. The Role of Innovation Brokers in Agricultural Innovation Systems [Internet]. 2012. Available from: http://www.keepeek.com/Digital-Asset-Management/oecd/agriculture-and-food/improving-agricultural-knowledge-and-innovation-systems/the-role-of-innovation-brokers-in-the-agricultural-innovation-system_9

[22] Ranga M, Etzkowitz H. A trans-Keynesian vision of innovation for the contemporary economic crisis: 'picking winners' revisited. Science and Public Policy. 2009;**36**(10):799-808

[23] Ranga M, Etzkowitz H. Great expectations: An innovation solution to the contemporary economic crisis. European Planning Studies. 2012;**20**(9):1429-1438

[24] Klerkx L, Hall A, Leeuwis C. Strengthening Agricultural Innovation Capacity: Are Innovation Brokers the Answer? [Internet]. 2009. Available from: http://www.merit.unu.edu/publications/wppdf/2009/wp2009-019.pdf

[25] Aarikka-Stenroos L, Sandberg B, Lehtimäki T. Networks for the commercialization of innovations: A review of how divergent network actors contribute. Industrial Marketing Management, Special Issue on Innovation in Networks. 2014;**43**(3):365-381

[26] European Commission, DG Regional and Urban Policy. European Structural & Investment Funds [Internet]. 2014. Available from: http://ec.europa.eu/contracts_grants/funds_en.htm

[27] Collaborative Economics. Innovation Driven Economic Development Model. A Practical Guide for the Regional Innovation Broker [Internet]. 2008. Available from: http://www.bayareaeconomy.org/media/files/pdf/InnovationDrivenEconomicDevelopmentModelfinal.pdf

[28] Moreira Ottani S, Bou E. Connecting worlds: The role of innovation brokers in the context of innovation networks. In: 1st ESADE-HEC Symposium on Transversal Topics. Ecole des Haute Etudes Commerciales (HEC), Sant Cugat del Vallès; 2009. Available from: http://www.esade.edu/itemsweb/wi/Prensa/ResearchBulletin_19_2009.pdf

[29] Mohamed E. The future is green for business schools. Financial Times [Internet]. 2014. Available from: http://www.ft.com/intl/cms/s/2/c01a951c-166d-11e4-8210-00144feabdc0.html#axzz3KRJJMO00

[30] Moreira Ottani S, Bou Alameda E. Bridging old worlds and building new ones: The challenge of integrating knowledge in innovation networks. In: ESADE 25th EGOS Colloquium European Group for Organizational Studies (EGOS), Barcelona; 2009. Available from: http://www.esadeknowledge.com/view/connecting-worlds-the-role-of-innovation-brokers-in-the-context-of-innovation-networks-154126

[31] Cornell University, INSEAD, and WIPO. The Global Innovation Index 2014: The Human Factor In innovation [Internet]. 2014. Available from: https://www.globalinnovationindex.org/userfiles/file/reportpdf/GII-2014-v5.pdf

[32] Bou E, Sanz-Carranza A, Collet F, Moreira Ottani S. SUCCESS Report. Model Design: Creating a new Collaboration Model [Internet]. 2009. Available from: http://www.knowledgetriangle.eu/

Chapter 9

Evaluation of the Project Management Team Members by Using the MCDM

Blanka Bazsova

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.69229

Abstract

Modern trends in human resources show the necessity to quantitatively express employees' evaluation and their complex assessment. The competency models are more and more involved in the evaluation process. They can significantly contribute to the objectification of the rewarding system. The evaluation process was introduced to the project team members from one of the high-tech companies. The company's primary focus is on a creation of the web sites and e-commerce. The competency models were tested for various positions, such as a project manager, graphic designer, web developer and tester, with an application of the multi-criteria decision-making methods (MCDMs). Using Saaty's method based on expert evaluation, groups of competencies were evaluated.

Keywords: competences, evaluation, MCDM, project management, Saaty's matrix

1. Introduction

Evaluation of the work is an integral part of human resource management in the organization. According to Duchon and Safrankova [1], the most common forms of evaluation include evaluation by direct supervisor, evaluation by staff and self-assessment. The best known forms of evaluation include verbal description or questionnaire, comparison with the objectives set, comparison with other workers and an assessment based on critical cases, as stated by Duchoň and Šafránková [1]. Evaluation by the supervisor and self-assessment can cause distorted or subjective picture of the work done and the qualities of the worker, while the evaluation by other workers appears to be more objective. For all the above methods of the work evaluation and especially when compared to actually performed work with the stated objectives, it is useful to create a system of assumptions—competences—which serve to measure the quantity and the quality of the work. An important issue for all project managers is whether they are

competent to manage large and complex projects. Competence expresses qualification or ability to perform a specific job, namely to hold the position. This is an evaluation of behaviour of the employee to perform job duties. Hronik [2] understands competence as the qualification for a particular performance. The aim of the evaluation by competences is to determine whether the organization is poised to implement its outlined strategy. Evaluation by competencies reflects comparison of expectations of the manager with the actual behaviour of the employees. Based on the comparison of assumptions for the work performance and the actual achieved behaviour, there is a differentiation in remuneration. According to Kleibl et al. [3], analysis of the work focused on the task doesn't say about skills and personal characteristics of the ideal worker. As asserted by Hronik [2], the performance of the company depends on the processes and people in the organization. The proper competency model should recognize the level of knowledge and skills of the employees; the time needed for training and education of employees should be provided, the model should match the goals of the organization and focus on the performance of the organization as such Redmondova [4]. In the literature, there is no uniform classification of competencies. Generally, competences can be divided into general, expertise and specific. To hold a certain position, it is important to have a choice from these three categories. The unique combination of these sub-competencies creates the so-called competency model. Competency model for a specific position should be described in a written form. Developing of the employees' competences also becomes an opportunity for the personal and professional growth and development of the employee. Wagnerova [5] provides the skills, knowledge, experience and motivation as the so-called 'personal determinants of performance'. The unique combination of competencies forms the culture of an organization that promotes learning and education seemed as an important business process by the top-level and line managers that are committed to it and that are permanently engaged in it, as stated by Armstrong [6].

2. Assessment of the competences

The Project Management Institute (PMI) was founded in the 1970s to cover project management and standardization of procedures and project management methodologies. The PM institute defines the project management as project management is the application of knowledge, skills, tools and techniques to project activities (as stated by Caupin et al. [7]). According to Rehacek [8], human resources are one of the areas, which the project management is aimed at. Human resources describe the processes for the efficient use of labour (organizational planning, personnel and project teams) to meet the project requirements. IPMA (International Project Management Associations) defines three groups of competences—contextual, technical and behavioural. The contextual competences group includes project, programme and portfolio orientation, also knowledge of finances, laws, knowledge of project, implementation, a programme and a portfolio, and so on. The technical competences group includes the ability of the success of the portfolio, project organization scope and deliverables, time and project phases, resources, start-up, close-out and communication. Behavioural competencies include leadership, self-control, assertiveness, openness, creativity, results orientation, reliability, efficiency and so on (according to Caupin et al. [7]).

Project managers are responsible for a wide range of processes, from planning the work (selection of potential spectrum of suppliers, management of contractual relations, determination, risk valuation, risk response creation) through the implementation process (the implementation of the project plan, spreading of information, acquisition of bids and team development), control and management processes and ultimately closing processes (termination of contractual relations and archiving of project documentation) [9]. Project manager competency model will be designed in accordance with CSN ISO 21500 and PM Book (Project Management Book) (as stated by Rehacek [10]).

In practice, a series of competency models were created. Most of them are based on three pillars—focus on the product, customer and service and system. Krenar and Taraba [11] deal with the assessment of holistic competencies in the management of multinational corporations. They argue that the holistic competencies can increase the efficiency of functioning of the international management teams. A crisis manager competency model evaluating especially managerial competencies was created [12].

3. Multi-criteria decision-making

The present complexity of problems requires analysing and taking into consideration not only one but several important aspects (points of view), according to which we evaluate a certain problem. Whereas the decision-making problem is such a problem, in which we are making a decision between at least two versions [13]. One of the most used groups of methods for solving problems of multi-criteria decision making are the methods that are based on calculation of the rate of benefit. The higher benefit from the given version we have, the more suitable this version for solving the problem is.

The number of authors quote the classification of multiple-criteria decision methods (MCDMs), for example, Brozova et al. [13] and Zonkova [14]. They are subdivided according to different points of view. The TOPSIS method is ranked among the methods based on minimization of the distance from the ideal version. Further, we differentiate methods based on the evaluation of the preferential relation (Electre and Promethee), methods based on the threshold rate of substitution, methods that require an aspirating level of criteria (conjunctive method, disjunctive method and PRIAM method) and methods that require ordinal information (lexographical method, permutation method and ORESTE method).

To evaluate competences of the project team members, we are going to use one of the multiple-criteria methods—Saaty method. Saaty's matrix is useful method for evaluation of the criteria, which are difficult to express quantitatively. Saaty's matrix evaluates manager's preferences among criteria. Bazsova [15] states that the criteria reflect the way, how to solve problems which means the way of goal achievement. The criteria can be expressed qualitatively and quantitatively [16]. We compare preferences of criteria with each other. We can obtain information about preferences and criteria's weight.

Saaty´s matrix is the quadrat matrix, $S = \{s_{ij}\}$, where $i, j = 1, 2, \ldots, n$, of size $c_n x c_n$, where $c_1, \ldots c_n$ are the individual criteria [17, 18, 19, 20].

$$\begin{array}{c} \\ c_1 \\ c_2 \\ c_3 \\ c_n \end{array} \begin{array}{c} \begin{array}{cccc} c_1 & c_2 & c_3 & c_n \end{array} \\ \begin{pmatrix} 1 & s_{12} & s_{13} & s_{1n} \\ 1/s_{12} & 1 & s_{23} & s_{2n} \\ 1/s_{13} & 1/s_{23} & 1 & s_{3n} \\ 1/s_{1n} & 1/s_{2n} & 1/s_{3n} & 1 \end{pmatrix} \end{array} \tag{1}$$

We compare each criterion and determine the preferences [15]. The element of the matrix s_{ij} expresses the weights of ith and jth criterion. On the diagonal are displayed notes 1

$$s_{ij} \approx \frac{w_i}{w_j} \tag{2}$$

where w_i is the weight of ith criterion and w_j is the weight of jth criterion.

Saaty uses the nine-escalate scale of the criteria evaluation, where value 1 means that criteria are equally significant, value 3 means that the first criteria are slightly more important than second criteria, value 5 means that the first criteria are strongly more important than the second criteria, value 7 means that the first criteria are of much greater importance than the second criteria and value 9 means that the extreme importance of the first criteria than the second criteria [18]. We determine the weight of each criterion according to the geometric mean

$$w_i = \frac{\left(\prod_{j=1}^{n} s_{ij}\right)^{1/n}}{\sum_{j=1}^{n}\left(s_{ij}\right)^{1/n}} \tag{3}$$

The final rating is then expressed in the following relationship:

$$U_i = \sum_{j=1}^{k} u_{ij} \times w_j \tag{4}$$

where U_i represents the overall significance of the variant with respect to the objective of the decision-making process, u_{ij} expressed the significances of the variants for the individual criteria, and w_j expresses the significance j of that criterion.

On the basis of an expert assessment of the superior manager, the significance for each group of competencies, and also within each group, is determined. Further, by means of Saaty's matrix, the significance calculation and evaluation of three project managers in the Czech IT company engaged in designing websites is performed. Its organizational structure is formed by the project teams managed by three project managers and graphic designers, web developers and testers (see **Figure 1**). Every team works on many projects.

Table 1 shows the professional duties of the work of project team members. In the project team, there are project managers, graphic designers, web developers and testers.

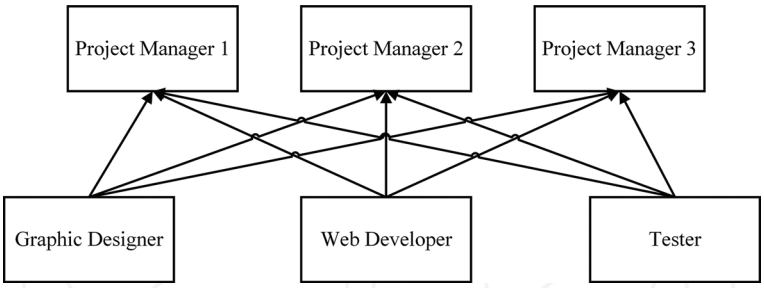

Figure 1. Organizational structure of the project team in IT company.

	Project manager	Graphic designer	Web developer	Tester
Web pages graphic proposal		x		x
Web pages content	x	x		x
HTML, CSS and JS coding			x	x
Change management	x			
Modules and functionality development		x	x	
Scripts development			x	
Functionality testing				x
Fixing the bugs		x	x	
Implementation and consultation	x			
User documentation	x	x	x	
Contract with costumer	x			
Handling with extern users	x			
Revision list management	x			

Table 1. Requirements for expertise in the project team of IT firms.

4. Case study

Now, we create and evaluate the competency model of each team member using multi-criteria decision-making method, concrete Saaty's method by evaluation of the criteria.

4.1. Project manager competency model

Each manager is assigned to one or more projects. According to the qualification standard, the following expert knowledge is important for the project manager:

1. Orientation in related terminology,
2. Definition of reasons of the project creation, targets and benefits of a particular project, understanding the differences between the target and the benefit of the project,
3. Applications of the triple imperative of the project,
4. Practical knowledge (application) of the project cycle,
5. Applications of the logical framework of the project,
6. Application of the management of the interested parties (stakeholders),
7. Application of the project plan,
8. Application of the principles of the formation of the organizational structure of the project.

In addition to these basic skills, the project manager must be able to coach the time frame of the project, the quality of the project, risks, the project scope, the project changes, resources, and also to be able to process the information and documentation in the project.

Based on the above skills, five groups of competences were created—professional, managerial, general, computer and language (see **Figure 2**). For the project manager, the professional competencies are important, that is, competencies relating to the application of knowledge of the project management. For this purpose, the so-called competency model serves. The level of importance is adapted to the needs and requirements of each organization. The competency model should be simple, not too long, meaningful and understandable.

In the proposed competency model (see **Figure 2**), five groups of competences were created, and individual partial competences that should be possessed by the project manager to handle the complex project management and effectively manage the projects of the highest quality were formulated within these groups. The results verified the suitability of Saaty's matrix for the project manager position.

The professional competences 3.1–3.5 (knowledge of project management principals, application of project life cycles, knowledge of ISO standards (Internal Organization for

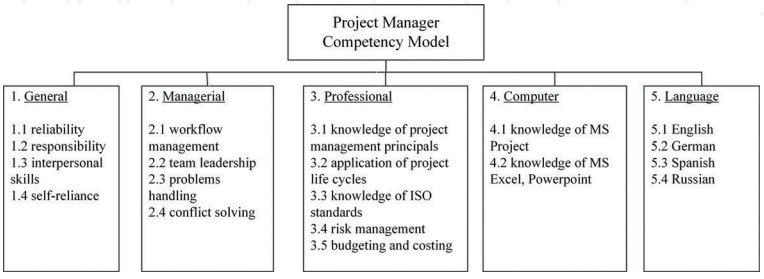

Figure 2. Project manager competences structure.

Standardisation), risk management, budgeting and costing) have been evaluated with the same weight value 0.2.

Results show that the most important for the project manager are the general competences (weight 0.5232) and the managerial competences (weight 0.2777) (see **Table 2**).

The evaluation of the competences has been done inside of each group (see **Tables 3–6**). Inside the group of general competences (see **Table 3**) are the most important interpersonal skills (weight 0.3676) and responsibility (weight 0.2974).

For the group of managerial competences, the most important competences are team leadership (weight 0.5857) and workflow management (0.2214; see **Table 4**). The group of the professional competences has not been proved by using Saaty's matrix because the superior marked the same weight inside the group (weight, 0.2). The most important competence inside the group computer competences is knowledge of software MS Project with weight 0.8333 (see **Table 5**). The most important competence inside the group language competences is English, weight is 0.63 (see **Table 6**).

The superior performed the evaluation of three project managers. As we can see, the best evaluation is project manager No. 3. (see **Table 7**).

4.2. Graphic designer competency model

The other member of the project team is the graphic designer, whose competences are to be evaluated. On defining the competence groups, we go from these groups: general, managerial, professional and language ones. Among the general competences, we consider reliability, work under pressure, responsibility and interpersonal skills. Among the managerial competences, we consider workflow management, cooperation in team, problems handling and conflict solving. As for the professional and computer ones, we consider, mainly, knowledge of Adobe Photoshop, knowledge of Adobe Fireworks and knowledge of GIMP (General Image Manipulation Program). Among the language competences, we involve English and German (see **Figure 3** and **Tables 8–12**).

The most important group of competences are the professional competences, weight 0.5755 (see **Table 8**). Inside the group of professional competences is the most important knowledge of Adobe Photoshop, weight 0.6370 (see **Table 11**).

	1.	2.	3.	4.	Geomean	Weight
1.	1	3	3	7	2.81731325	**0.5232**
2.	1/3	1	3	5	1.49534878	0.2777
3.	1/3	1/3	1	3	0.75983569	0.1411
4.	1/7	1/5	1/3	1	0.31239399	0.0580

Table 2. Criteria evaluation of the main groups project managers'competences (own calculation).

1.	1.1	1.2	1.3	1.4	Geomean	Weight
1.1	1	3	1/5	7	1.43156912	0.2847
1.2	1/3	1	3	5	1.49534878	0.2974
1.3	5	1/3	1	7	1.84814779	**0.3676**
1.4	1/7	1/5	1/7	1	0.25276008	0.0503

Table 3. Evaluation of the general competences (own calculation).

2.	2.1	2.2	2.3	2.4	Geomean	Weight
2.1	1	1/7	3	5	1.2099	0.2214
2.2	7	1	5	3	3.2011	**0.5857**
2.3	1/3	1/5	1	3	0.6687	0.1223
2.4	1/5	1/3	1/3	1	0.3861	0.0706

Table 4. Evaluation of the managerial competences (own calculation).

4.	4.1	4.2	Geomean	Weight
4.1	1	5	2.2361	**0.8333**
4.2	1/5	1	0.4472	0.1667

Table 5. Evaluation of the computer competences (own calculation).

5.	5.1	5.2	5.3	5.4	Geomean	Weight
5.1	1	7	5	3	3.2711	**0.6300**
5.2	1/7	1	5	3	0.8939	0.1722
5.3	1/5	1/5	1	3	0.5886	0.1134
5.4	1/3	1/3	1/3	1	0.4387	0.0845

Table 6. Evaluation of the language competences (own calculation).

4.3. Web developer competency model

For a web developer, we evaluate general, managerial, professional and language competences. The professional competences include computer knowledge of languages of Java Script, CSS, knowledge of HTML (Hypertext Markup Language), knowledge of PHP (Hypertext Preprocessor—one of the script languages), knowledge of JQuery and knowledge of databases (My SQL) (see **Figure 4**). Evaluation of the competences is calculated in **Tables 13–17**.

The most important are groups of professional competences, with weight 0.5809 (see **Table 13**). In the group of professional competences is the most important knowledge of HTML, weight 0.4071 (see **Table 16**).

1.	Weight	Manager 1	Manager 2	Manager 3	MAX
1	0.1377	4.12982781	4.12982781	5.50643708	5.50643708
2	0.2621	6.55146915	7.86176298	11.79264446	11.7926445
3	0.4504	11.2604813	15.7646738	18.01677001	18.01677
4	0.0516	1.54833593	1.80639191	1.806391913	1.80639191
5	0.09825	3.92999438	3.43874508	2.456246486	3.92999438
Total		27.4201085	33.0014015	39.57848995	41.0522378
Percentage		66.79%	80.39%	**96.41%**	

Table 7. Evaluation of the project managers by using main groups of competences (own calculation).

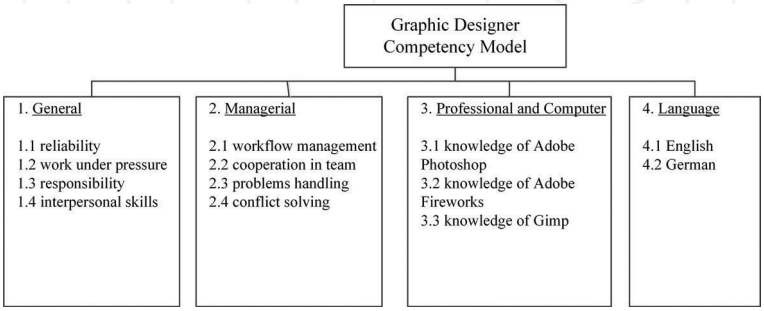

Figure 3. Graphic designer competences structure.

	1.	2.	3.	4.	Geomean	Weight
1.	1	3	1/5	7	1.43156912	0.2464
2.	1/3	1	1/5	5	0.75983569	0.1308
3.	5	5	1	5	3.34370152	**0.5755**
4.	1/7	1/5	1/5	1	0.27494162	0.0473

Table 8. Evaluation of the main competences (own calculation).

1.	1.1	1.2	1.3	1.4	Geomean	Weight
1.1	1	3	1/5	7	1.431569123	0.2847
1.2	1/3	1	3	5	1.495348781	0.2974
1.3	5	1/3	1	7	1.84814779	0.3676
1.4	1/7	1/5	1/7	1	0.252760077	0.0503

Table 9. Evaluation of the general competences (own calculation).

2.	2.1	2.2	2.3	2.4	Geomean	Weight
2.1	1	1/7	3	5	1.2099	0.2214
2.2	7	1	5	3	3.2011	0.5857
2.3	1/3	1/5	1	3	0.6687	0.1223
2.4	1/5	1/3	1/3	1	0.3861	0.0706

Table 10. Evaluation of the managerial competences (own calculation).

3.	3.1	3.2	3.3	Geomean	Weight
3.1	1	5	3	2.4662	**0.6370**
3.2	1/5	1	1/3	0.4055	0.1047
3.3	1/3	3	1	1.0000	0.2583

Table 11. Evaluation of the professional competences (own calculation).

4.	4.1	4.2	Geomean	Weight
4.1	1	5	2.2361	0.8333
4.2	1/5	1	0.4472	0.1667

Table 12. Evaluation of the language competences (own calculation).

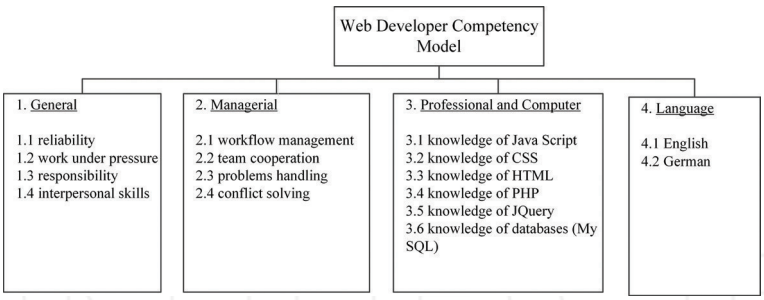

Figure 4. Web developer competences structure.

	1.	2.	3.	4.	Geomean	Weight
1.	1	3	1/5	1/3	0.6687403	0.1162
2.	1/3	1	1/5	1/7	0.31239399	0.0543
3.	5	5	1	5	3.34370152	**0.5809**
4.	3	7	1/5	1	1.43156912	0.2487

Table 13. Evaluation of the main groups of competences (own calculation).

1.	1.1	1.2	1.3	1.4	Geomean	Weight
1.1	1	3	1/5	5	1.31607401	0.2532
1.2	1/3	1	1/5	3	1.49534878	0.2877
1.3	5	5	1	3	1.62657656	0.3129
1.4	1/5	1/3	1/3	1	0.75983569	0.1462

Table 14. Evaluation of the general competences (own calculation).

2.	2.1	2.2	2.3	2.4	Geomean	Weight
2.1	1	1/3	1/7	1/5	0.3124	0.074483178
2.2	1/3	1	3	5	1.4953	0.356531595
2.3	7	1/3	1	3	1.6266	0.387819848
2.4	5	1/5	1/3	1	0.7598	0.181165379

Table 15. Evaluation of the managerial competences (own calculation).

3.	3.1	3.2	3.3	3.4	3.5	3.6	Geomean	Weight
3.1	1	1/3	1/3	5	3	1	1.088867	0.1415
3.2	3	1	1/3	5	3	1	1.570418	0.2041
3.3	3	3	1	5	7	3	3.132603	**0.4071**
3.4	1/5	1/5	1/5	1	5	3	0.702312	0.0913
3.5	1/3	1/3	1/7	1/5	1	1/5	0.29317	0.0381
3.6	1	1	1/3	1/3	5	1	0.906681	0.1178

Table 16. Evaluation of the professional competences (own calculation).

4.	4.1	4.2	Geomean	Weight
4.1	1	5	2.2361	0.8333
4.2	1/5	1	0.4472	0.1667

Table 17. Evaluation of the language competences (own calculation).

4.4. Tester competency model

For a tester, there are also important general, managerial, professional and language competences. The professional competences include knowledge of testing tools (Sabi, Silenium or EggPlant) and knowledge of methodics of the test types (see **Figure 5**). We evaluate competences and groups of competences again (see **Tables 18–22**).

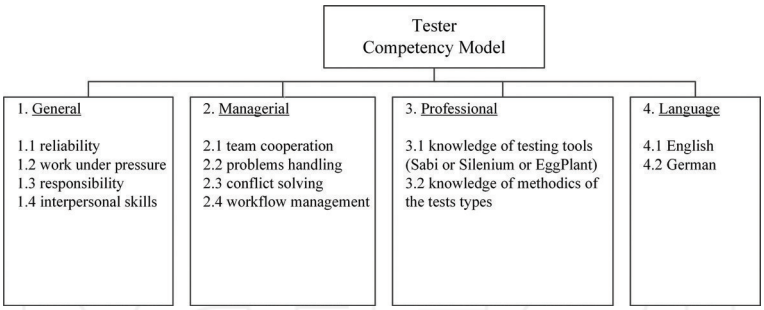

Figure 5. Tester competences structure.

	1.	2.	3.	4.	Geomean	Weight
1.	1	3	1/5	7	1.43156912	0.2510
2.	1/3	1	1/5	1/3	0.3860974	0.0677
3.	5	5	1	5	3.34370152	**0.5864**
4.	1/7	1/5	3	1	0.54108227	0.0949

Table 18. Evaluation of the main groups of competences (own calculation).

1.	1.1	1.2	1.3	1.4	Geomean	Weight
1.1	1	3	1/5	7	1.43156912	0.2847
1.2	1/3	1	3	5	1.49534878	0.2974
1.3	5	1/3	1	7	1.84814779	0.3676
1.4	1/7	1/5	1/7	1	0.25276008	0.0503

Table 19. Evaluation of the general competences (own calculation).

2.	2.1	2.2	2.3	2.4	Geomean	Weight
2.1	1	1/7	3	5	1.2099	0.2214
2.2	7	1	5	3	3.2011	0.5857
2.3	1/3	1/5	1	3	0.6687	0.1223
2.4	1/5	1/3	1/3	1	0.3861	0.0706

Table 20. Evaluation of the managerial competences (own calculation).

3.	3.1	3.2	Geomean	Weight
3.1	1	1/3	0.57735	0.2500
3.2	3	1	1.732051	**0.7500**

Table 21. Evaluation of the professional competences (own calculation).

4.	4.1	4.2	Geomean	Weight
4.1	1	5	2.2361	0.8333
4.2	1/5	1	0.4472	0.1667

Table 22. Evaluation of the language competences (own calculation).

The most important are the professional groups of competences, weight 0.5864 (see **Table 18**). Inside the group of professional competences is most important knowledge of methodics of the tests types, weight 0.75 (see **Table 21**).

5. Results

In this research, a mathematical approach for evaluating of the competences was considered. This approach compares each competency with each other and each group of competences with other groups of competences. By applying this approach, we can determine the importance of the competences and groups of competences at the superior. This means that we transform and evaluate qualitative criteria into the quantitative ones. This study enables to evaluate competences of all the team members. Evaluation of the competences can be involved in the complex employee evaluation. Contemporary assessments require not only performance evaluation but also the competence evaluation in the companies. Modern trends in the measurement of organizations targets are currently based on a performance assessment of employees based on and assessment of employees' competence. Organization that wants to achieve a success must know the requirements on the competences on each work position and must develop them by the employees.

The companies primarily focused on the creation of the websites and e-commerce. According to the results, we can say that the professional competences are the most important for job positions of graphic designer, web developer and tester. For the position, project managers are the most important general competences with weight 0.5232 (see **Table 2**), especially interpersonal skills. For the work position, graphic designers are the most important professional competences with weight 0.5755 (see **Table 8**), especially knowledge of Adobe Photoshop. For the position, web developers are the most important professional competences with weight 0.5809 (see **Table 13**), especially knowledge of HTML. For the position, testers are the most important professional competences with the weight 0.5864 (see **Table 18**), especially knowledge of methodics of the tests types. Current company management needs workers, not only professionally equipped but also self-capable of solving the assignments on time, reliable and team-oriented employees who can resist stress situations and problems that require quick and professional solution.

The multiple-criteria evaluation methods were applied for the solution of complicated decision-making problem in the small IT company. If we compare the evaluation of the project managers, we can reveal very significant impact in the language competences. The high demands on project managers in general competences, managerial competences and language competences are recognized. It is learnt that organization is focused on the international project, international customers and handling with them.

If we compare the competency models of the subordinates—graphic designer, web developer and tester—the professional competences are the most important for these positions. This fact is very significant. If we reveal the background, it is clear that the next step of the superior will be to conduct training courses for the reinforcing professional competences.

6. Conclusion

Any such organizational structure is based on direct responsibility for results. The project manager is responsible for the whole IT contract. He/she is responsible for a set of goals for all aspects of the work, as well as changes that were previously discussed with the customer. Project manager delegates tasks, which emerge within the project cycle. Created competency models can be an integral part of the modern complex system of evaluation. On the basis of application of the manager's multiple-criteria decision-making methods, we particularly used Saaty's method for criteria evaluation, as well as the benefit maximization method. To illustrate it, we performed a selection between three candidates for the job position of a project manager. It may be helpful not only for organizations implementing project management within the existing organizational structure but in particular also for organizations focused on management by projects to improve the quality of projects and the project team performance.

Acknowledgements

This chapter was supported within Operational Programme Education for Competitiveness—Project No. CZ. 1.07/2.3.00/20.0296.

Author details

Blanka Bazsova

Address all correspondence to: blanka.bazsova@vsb.cz

Faculty of Economics, VŠB-Technical University of Ostrava, Ostrava, Czech Republic

References

[1] Duchon B, Safrankova J. Management. Integrace tvrdých a měkkých prvku řízení. Praha, Czech Republic: C. H. Beck; 2008. p. 378

[2] Hroník F. Hodnocení pracovníku. Praha, Czech Republic: Grada Publishing; 2006. p. 126

[3] Kleibl J, Dvorakova Z, Subrt B. Řízení lidských zdroju. Praha, Czech Republic: C. H. Beck; 2001. p. 264

[4] Redmondova E. Competency models at work: The value of perceived relevance and fair rewards for employee outcomes. Human Resource Management. 2013;**52**(5):771-792. DOI: 10.1002/hrm.21560

[5] Wagnerova I. Hodnocení a řízení výkonnosti. Praha, Czech Republic: Grada Publishing; 2008. p. 117

[6] Armstrong M. Odměňování pracovníku. Praha: Grada Publishing; 2009. p. 442

[7] Caupin G, Knöpfel H, Pannenbächer K, Pérez-Polo F, Seabury CH, editors. ICB-IPMA Competence Baseline Version 3.0. 3rd ed. IPMA International Project Management Association; 2006. p. 200 [Online]. Available: http://www.ipma.world/assets/ICB3.pdf. [Accessed: 3 March 2017]

[8] Rehacek P. Usage of the standards for project management in the Czech Republic and their comparison. Scientia et Societas. 2016;**4**(12):174-186

[9] Rehacek P. Risk management and FMEA. In: Kaluza J, editor. Proceedings of the 9th International Conference on Strategic Management and its Support by Information Systems (SMSIS2011); 5-7 September 2011; Čeladná, Czech Republic. Ostrava: VŠB-Technical University of Ostrava; 2011. pp. 154-158

[10] Rehacek P. Standard ISO 21500 for Project Management. In: Nemec R, Zapletal F, editors. Proceedings of the 10th International Conference on Strategic Management and its Support by Information Systems (SMSIS2013); 29-30 August 2013; Valašské Meziříčí, Czech Republic. Ostrava: VSB-Technical University of Ostrava; 2013. pp. 195-205

[11] Krenar P, Taraba P. The holistic competence of multicultural team member in the Czech. In: Soliman KS, editor. Knowledge Management and Innovation: A Business Competitive Edge Perspective; 06-07 November 2010; Cairo, Egypt. New York: International Business Information Management Association; 2010. p. 51-58

[12] Mikusova M, Copikova A. Competency model of crisis manager. In: Nemec R, Zapletal F, editors. Proceedings of the 11th International Conference on Strategic Management and its Support by Information Systems (SMSIS2015); 21-22 May 2015; Uherské Hradiště, Czech Republic. Ostrava: VSB-Technical University of Ostrava; 2015. pp. 83-91

[13] Brozova H, Houska M, Subrt T. Modely pro vícekriteriální rozhodování. Praha: Česká zemědělská univerzita, Provozně ekonomická faulta; 2014. p. 172

[14] Zonkova Z. Rozhodování managera. Ostrava, Czech Republic: VSB-Technická univerzita Ostrava; 1995. p. 93

[15] Bazsova B. Use of Saaty's matrix by performance employee measuring at the university department. In: Nemec R, Zapletal F, editors. Proceedings of the 11th International Conference on Strategic Management and its Support by Information Systems (SMSIS2015); 21-22 Mai 2015; Uherské Hradiště, Czech Republic. Ostrava: VSB-Technical University of Ostrava; 2015. pp. 25-35

[16] Fiala P, Jablonský J, Manas M. Vícekriteriální rozhodování. Praha, Czech Republic: Vysoká škola ekonomická v Praze; 1994. p. 316

[17] Saaty TL. The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation. London: McGraw-Hill International Book Co; 1980. p. 287

[18] Saaty TL, Vargas LG. Models, Methods, Concepts and Applications of the Analytic Hierarchy Process. 2nd ed. New York, NY: Kluwer Academic Publishers; 2012. p. 326. DOI: 10.007/978-1-4614-3597-6

[19] Saaty, TL. Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process. Analytic Hierarchy Process Series, Vol. 6. Pittsburgh: RWS Publications; 1994. p. 477

[20] Bartuskova T. Use of AHP Method for the Synthesis of External Strategic Analysis Results. In: Nemec R, Zapletal F, editors. Proceedings of the 11th International Conference on Strategic Management and its Support by Information Systems (SMSIS2015); 21-22 Mai 2015; Uherske Hradiste, Czech Republic. Ostrava: VSB-Technical University of Ostrava; 2015. p. 14-24

Chapter 10

Handling Innovative People

M. Dolores Storch de Gracia, Luis Mazadiego and Bernardo Llamas

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.69851

If you want to go fast, go alone. If you want to go far, go together

African Proverb

Abstract

In innovative environments or departments, where employees must be motivated to produce new ideas, products or processes, is critical to consider not only technical skills but soft skills such as communication, leadership, responsibility and teamworking. The result of an innovation team goes beyond the optimum performance that is asked of a standard team, since they usually set ambitious goals that allow to go beyond the current state of the art and this makes the operation of these teams especially delicate. As a result, general considerations about work teams are considered, focusing on the model of Tuckman's team development sequence and Belbin Theory. Last but no least, a section is dedicated to "what to pay attention to in groups" as a key issue. As a conclusion, the working group can be an effective management tool for companies to solve difficult and complex problems. In the case of innovative profiles, special attention must be paid to the motivations of these people, who are often different from others. The authors have identified all these aspects as key issues to research and they will dedicate the following academic courses to study in detail some specific roles and their implication in successful innovative projects.

Keywords: innovation skills, work teams, innovative people

1. Introduction

In innovative environments or departments, where employees must be motivated to produce new ideas, products or processes, it is critical to consider not only technical skills but also soft skills that create the difference between adequate candidates and ideal candidates. Moreover, these soft competences have increased their interest as the current markets are global and fast-changing: the difference between similar products depends on the creativity and innovation [1].

One of the most considered soft skills is teamwork, and it involves a combination of other soft skills (communication, leadership, responsibility, among others). In an increasingly complex and information-rich world, the value of collaboration is growing in importance. Work is increasingly being organized in teams rather than individuals [2]. Teamwork enables:

- Recognition of each person's unique contribution to the team.
- More effective "data collection" in rapidly changing situations.
- Commitment and satisfaction that responds to the social needs of individuals and groups.
- Improved interpersonal communications that allow more energy to be directed toward the task.
- Efficient assignment of work based on the strengths and experience of each member.
- Quality in decision-making through the wisdom of team members.

But this implies:

- It is important to have the right people at the right time.
- It is crucial to assign specific roles to each team member.
- A communication system is needed among project members.

In the case of innovation working groups, the reason for creating a team responds to the need to respond to a specific need (project, work group, etc.) and in many cases are temporary teams formed by people belonging to other departments and should contribute in a timely manner to the team [3].

Whether members of innovation teams belong exclusively to an Innovation Department or whether they come from other departments, the main characteristic that defines them is the degree of excellence that is expected of their performance.

The result of an innovation team goes beyond the optimum performance that is asked of a standard team since they usually set ambitious goals that allow to go beyond the current state of the art (in many cases patent objectives or new discoveries are established) and this makes the operation of these teams especially delicate.

2. Work teams: general considerations

Building and managing teams is difficult, and even the best managers are sometimes wrong. For people, to find a reason to work as a member of a team, it needs a common goal and a sense of identity [4].

There is technique in team building, and it can be done well or bad. When done well, an effective team can exceed all reasonable expectations given to its individual members, that is, a team has a synergistic effect ($1 + 1 > 2$).

This is especially true when the perspectives, skills, and experiences of the members are diverse but complementary. Diversity allows you to respond to each challenge in your

own way and as a team you increase productivity, foster commitment, and stimulate innovation.

However, if done wrong, teams can become catalysts for communication failures, unclear role limits, misallocation of jobs, roles, etc., all this hinders the success of all involved (individual/team/organization).

To be considered:

Team work: Tuckman theory and Belbin theory (roles of people in a team).

What to pay attention to in groups?: Factors that could affect your ability to perform.

2.1. The model of Tuckman's team development sequence

It identifies the phases of the development through which the team passes and rectifies its equipment management style [5, 6]. This theory puts the emphasis on the actions that have to be undertaken to transform a group of individuals into a great team [7]. In the following **Figure 1** you can see the diferent phases in a team.

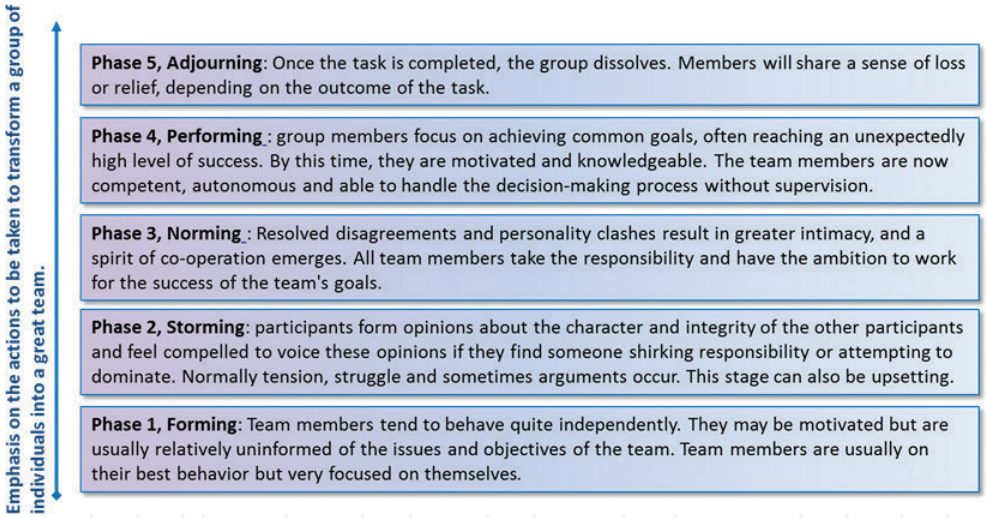

Figure 1. Different phases in a team (Tuckman theory).

The most important aspects to consider in each phase are:

(1) Orientation at the time of forming the team:

- Explain the raison d'être of the team, its goals, and its objectives.
- Negotiate and establish the rules of the game.
- Listen to concerns raised by team members and address them accordingly.

(2) In the storming phase:

- The manager and/or coordinator should be prepared to handle any challenges to their authority and internal conflicts.
- The way to deal with it will establish the tone of the behavior that you can expect members to display throughout the team's operational life.
- It is possible that acting passively or aggressively is not the best when thinking about the interests of the team.
- Whenever possible look for a win-win solution; point in common (Covey's Seven Habits of Highly Effective People®).

(3) In the norming stage:

- The manager's role becomes supportive.
- Team members solve their own problems.

(4) In the performing phase:

- Adopt an observer position.
- The group takes the initiative.

(5) In the phase of adjourning:

- Celebrate the success of the team and to recognize the contribution of all its members.

2.2. Work teams: Belbin theory

Teams are widely recognized as the basic building blocks of current industries and companies [8]. However, team composition should be balanced and with different roles, considering knowledge, skills, abilities, and other characteristic which provide an optimal combination of members. A role is generally defined as a cluster of related and goal-directed behaviors taken on by a person within a specific situation [9]. There are two different branches in the team role literature: (i) role as position and (ii) role as person [10].

Dr Meredith Belbin of the University of Industrial Training Research, obtained a convincing and widely documented answer that helped crucially to understand the functioning of groups and how to make them work better [11].

Belbin's fundamental discovery is that all members of a management team have a double role [12]. The first role, the functional role, is obvious (production engineer, accountant, marketing executive, etc.). Nevertheless, the second role he calls the "team role" is much less evident and yet we are all a little aware of. For example, we all know that Mary has great ideas, John wants to make decisions and assign tasks and Paul throws away the proposals of others but we also know that Mary, John, and Paul exhibit these characteristics in any team.

2.2.1. Why Belbin?

Previously, we explained that when setting up a computer you may use techniques and therefore get it done right or wrong. If we are going to build teams, we must configure them well

http://dx.doi.org/10.5772/intechopen.69851

and this is where Belbin's theory can help us. Moreover, a balanced team will increase and accelerate innovation process [13].

Belbin proposes that the result of teamwork is effective when its members work as "team players"—where each player understands how important it is for everyone to cooperate and work toward a common goal. When everyone does their job well, this increases the goals the team can achieve. It is of key importance that each person knows what brings to the team (from a functional and behavioral point of view).

Belbin suggests that each person has a double role: functional and team roles (**Figure 2**).

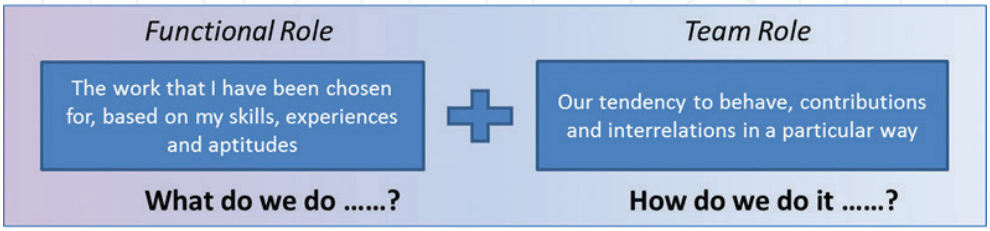

Figure 2. Roles suggested by Belbin theory.

The conclusion is that, without ignoring or neglecting the individual, we should pay much more attention to the teams: to their selection, development, and training but above all to their psychology, motivation, composition, and behavior … but how?

The first problem we face is that psychology has traditionally been oriented toward individuals and knowledge of successful teams is very scarce.

3. Belbin: no one is perfect (but a team can be!)

The producer of ideas, the child genius, the constant worker, the slave loyal to the company on other, are people we know or have worked with. Individually, they can drive us crazy, but if we give them a role in a team, they can eat the opposition.

Many companies look for the right person to develop good management and care about the qualities, experiences, and achievements of people. However, we all know that the ideal person does not exist.

In enumerating the qualities of the good manager, we see that many qualities are exclusive: he must be energetic but sensitive to people, dynamic but patient, communicate well but listen carefully, make decisions but reflect. Not everything at once is possible and even if it were, even if we found this wonderful person he or she could go one day.

However, a team can meet these qualities and do not usually go all at once and for this reason, the success of management is mainly due to the team. A team can hoard the necessary qualities, can be renewed by recruiting new people and accumulate lots of shared experience and can be in 10 places at a time. We have all seen a successful person in a team not perform at that same standard when

changing teams we have seen effective teams that are destroyed by the rise of individuals without considering the rest of the team. We have also seen teams that produced quality and amount of work much larger than the sum of the work that individuals could have produced individually.

The main conclusion of Belbin was that there is no person who meets all the qualities of the good manager and therefore the key to success in management resides in teams. When?

Choosing team members, it is not only essential to have people with the skills identified by Belbin theory, but also people who are able to complement their strengths and compensate for their weaknesses [14].

This theory identified team roles by observing teams for 7 years and achieved most perfect prediction level.

Belbin sought to identify four factors in his tests:

- Intelligence
- Domain
- Introversion/extroversion
- Stability/anxiety

The Belbin model is based on the following three premises:

a. If you form a team with individuals with the knowledge of where each profile fits you can let the energy of the team focus on the task when it was formed instead of consuming time in knowing what each one of them expects from the other.

b. We all have behavior patterns in groups or team situations (known as team roles).

c. The team can be greater than the sum of the parts by the synergy that is produced by the diversity of roles.

In a balanced team, a set of roles fulfilled is as follows:

(i) Useful people in a team are those who possess strengths or characteristics that serve to satisfy a need without duplicating those that already exist.

(ii) Teams are a matter of balance.

(iii) You need people who balance each other in their team roles.

(iv) One or two team roles can be observed in a person (if two are observed, one of them will be dominant and the other secondary).

Various investigations have led to the identification of nine team roles that team members often adopt:

1. Director/coordinator

2. Impeller/motor

3. Brain/creative/plant

http://dx.doi.org/10.5772/intechopen.69851

4. Monitor/evaluator
5. Implementer
6. Resource investigator
7. Co-worker/team worker
8. Finisher
9. Specialist

The following figure (**Figure 3**) shows the diferent roles and their main focus associated.

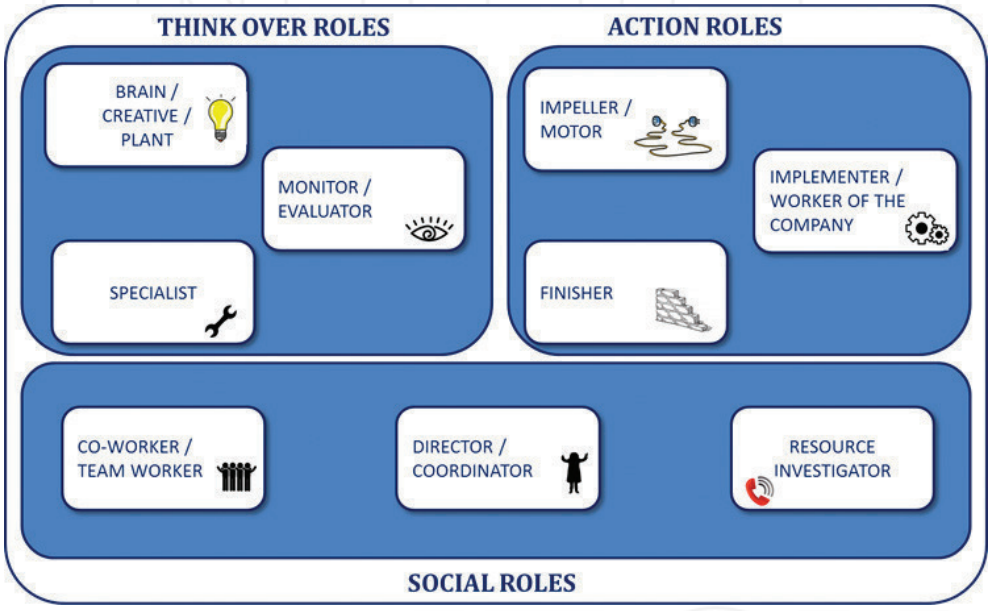

Figure 3. Belbin roles.

1. Director/coordinator: Is responsible for coordinating efforts to reach the objectives. Sets the agenda, is calm, confident, and responsible for maintaining the balance of the team. He is the social leader (stable, dominant, and extrovert).
2. Impeller/motor: Is the task entrepreneur and influences the decisions of the team; he is willing to be unpopular if the job demands it. He is the task leader (anxious, dominant, and extrovert).
3. Brain/creative/plant: Generates ideas and develops innovative ways to solve problems; highly creative and good problem-solver in an unconventional way (very intelligent, dominant, and introvert).
4. Monitor/evaluator: Is the analyst dispassionate, analytical, and objective; can annoy his teammates with his criticism but is almost never wrong (very intelligent, stable, and introvert).

5. Implementer/worker of the company: Is the practical organizer. He works hard to turn ideas into facts, can annoy his teammates because he is reluctant to compromise; needs stability (stable, controlled).
6. Resource investigator: Often astute and enthusiastic, is the most relaxed; finds the necessary resources and immediately blocks any opposition (stable, dominant, and outgoing).
7. Co-worker/team worker: Is the most active internal communicator; is the support of the social group; unites the team and helps to resolve any interpersonal and professional conflicts that occur within the team (stable, outgoing, not very dominant).
8. Finisher/retailer: Worries about what can fail. The main concern is the order, the dates, and commitments. Determined and committed, although he may be considered interested in completing the work at all costs (anxious, introvert).
9. Specialist: Provides technical expertise in key areas; can annoy others by focusing solely and exclusively on their area of expertise.

According to these roles, Belbin theory defines different weakness and strength of each role [15]. It is convenient to identify the role of each member of the team, and lead them considering their contribution, working together to avoid non-allowed weakness (**Table 1**).

	CONTRIBUTION / STRENGTH	WEAKNESSES PERMITTED	WEAKNESSES NOT ALLOWED
	**Director / Coordinator** Takes advantage of group skills	Manipulator Lazy if he finds someone to do his homework	Assumes all credit for team effort
	**Impeller / Motor** Energetic and challenging	Aggressive / Provocative Prone to frustration	Inability to readdress negative situations
	**Brain / Creative / Plant** Creative, solves difficult problems	Ignores the reality of everyday life	Little cooperation with others. High sense of ownership of an idea
	**Monitor/ Evaluator** Insightful and objective	Skeptical	Cynicism without logic
	**Implementer** Organized, efficient, practical	Slow in perceiving new possibilities Inflexible at times	Obstructing change
	**Resource investigator** Entrepreneur, seeks new opportunities	Not good for finishing tasks Too optimistic	To defraud the trust of the team for neglecting the follow-up of the agreements
	**Co-worker / team worker** Cooperator, avoid clashes	Undecided Influential	Avoid situations of pressure
	**Finisher** Careful, thorough	Reluctant to delegate Perfectionism	Obsessive Behavior
	**Specialist** Delivered to his profession	Limited Interests	Ignores factors outside your own area of competence

Table 1. Belbin's role and its strength and weakness.

Belbin's main conclusions are as follows:

1. The absence of a role weakens the team but also if there are too many with the same role.

http://dx.doi.org/10.5772/intechopen.69851

2. A team role shows our "tendency to behave, contribute, and interrelate in a particular way".
3. If there are fewer than nine people, each member takes several roles (main and secondary) while in large teams, subgroups are usually formed where these roles appear in each of them.
4. The knowledge of the roles in established teams helps less than in the new teams where the combination of roles has been very effective.
5. The construction of equipment through the balance of papers is more important in areas of work under pressure or fast action as well as in environments where creativity is needed (R&D, innovative projects, and others).
6. Teams made up of a majority of very smart people usually fail.
7. In recruiting people in the workforce, in addition to Belbin's skills, people should be selected to complement strengths and compensate for weaknesses.
8. Set SMART goals: Specific, measurable, attainable, realistic, and timely. Recent studies include two more characteristic to be smarter goals which add two new characteristic: evaluable and relevant (smarter).
9. Evaluate the environment (internal and external).
10. It is necessary to adapt the style of leadership (situational leadership theory).
11. While all teams are made up of groups of individuals, not all groups of individuals form a team.

3.1. Ecorun project as a case of study

Nowadays, there is increasing interest in the development of teamwork skills in the educational context as one of the soft skills: competences in higher education include, among others, this skill.

Master degree of the mining engineering at Universidad Politécnica de Madrid is one of the university program which is recognized by ABET institution—one of the most renowned audit institution worldwide [16].

According to the master degree program, the students should achieve teamwork and communication skills. For this reason, project evaluation and risk management subject includes an innovative methodology to evaluate such competences [17]. Students should collaborate in small groups, developing innovative projects. At the end of the course, they should explain their project to a panel of experts on different fields (civil works, energy, mining, water, and others) and, as a result, the experts should evaluate their project and different skills: creativity and communication.

One of the most promising projects—Ecorun project[1]—failed in its objective to achieve the investment needed to develop the project. But why?

[1]EcoRun Systems Project. Students proposed a system of energy recovery through the footsteps, as a strategy toward smart cities. The technical principle was based on tracks of any size formed by piezoelectric materials to transform mechanical energy into electricity energy. Electricity would be used in public lighting near the track and/or sports area within the city, in order to achieve both, an environmental benefit and a reduction in the cost of electricity consumption. Execution Term: 21 months, budget: 338.000 €.

Considering the Junk analysis (**Figure 4b**) the team showed a balanced team to work and collaborate for a goal—present a nice project proposal. However, every project needs to be financed and that is the point where resource investigator role defined in Belbin's Roles (**Figure 4a**) is critical for the success in the project phase approval.

In this case, none of the six students had this role, and they did not communicate properly the advantages of this project (**Figure 5**); a balanced team (**Figure 4a**) demonstrates which roles are necessary in innovative projects (plant/creative and resource investigator)—where external and internal support is critical. Unluckily the project was not financed in this simulation where the rest of the project (balanced teams) got the required investment.

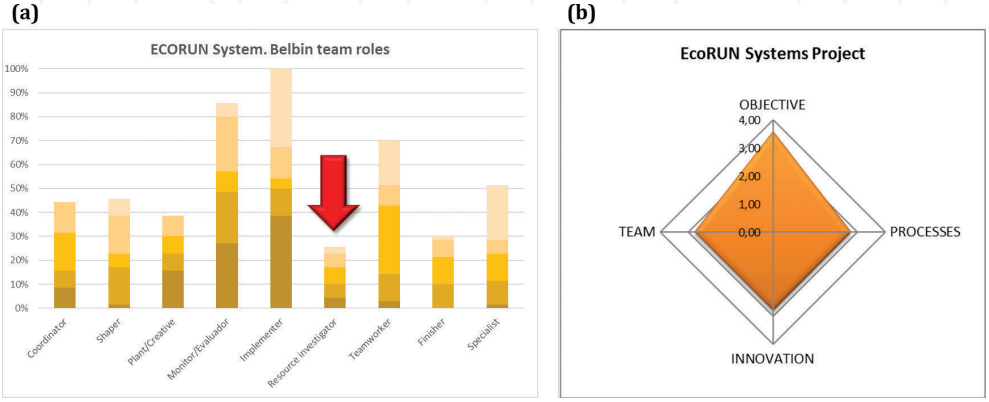

Figure 4. Ecorun systems as a case of study: Belbin roles (a) and junk behaviors (b).

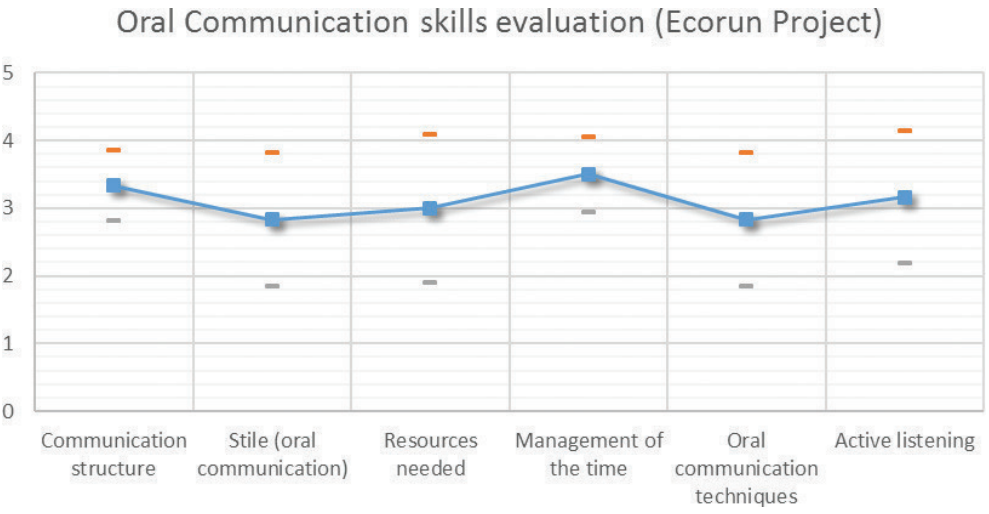

Figure 5. Oral communication skills (five-point Likert scale). Values based on the evaluation of six professionals—public and private sectors.

http://dx.doi.org/10.5772/intechopen.69851

4. Work teams: what to pay attention to in groups

In all human interactions, two ingredients are necessary to consider: (i) the content: subject or work on which you work and (ii) the process: refers to what happens between and among members of the group while working. In the process, we deal with topics such as morals, feelings, atmosphere, influence, participation, styles of influence, competitiveness and cooperation, among others.

In many interactions, little attention is given to the process even though it is the major cause of inefficiency of group action. Knowledge of these processes will allow participants to be more effective.

The following subsections are the issues that help the group behavior analysis.

4.1. Participation

An indication of commitment is verbal participation. Observing the differences in membership will give us a lot of information.

For considering this aspect, we should pay attention to who is participating more or less, if there are any changes in participation (the more participants are silenced, the less talkative) and if we see any reason for this in group interactions.

Other aspects to be considered are how the silence of people is treated, how it is interpreted (consent, disagreement, disinterest, fear), who speaks to whom or who takes the leading role.

4.2. Influence: styles of influence

Influence and participation are not the same. Some people may talk little but get the attention of the whole group while another speaks a lot but they are not heard by the members.

In order to get information about influence in the team, we should detect which members have the highest influence (when they speak they are heard), which members are of low influence (do not listen or follow), if you see rivalry in the group, there is conflict to lead and what effect does it have on other members of the group.

The influence can be positive or negative. The following tips suggest four behaviors that frequently emerge in groups:

1. Autocritic: If anyone tries to impose their will or values on other members or tries to push them to support their decisions, evaluates or judges other members of the group, a member blocks the action when it does not move in the direction you want or is trying to keep the group organized.
2. Pacifier: You can suspect this behavior when someone supports the decisions of the group, anyone is trying to avoid conflict or there is a member who tries to avoid negative feedbacks.

3. Laisser-faire or leave to do: If any member draws your attention for his/her apparent lack of commitment to the group, any member follows the group's decisions without seeming to affect them, someone appears as reserved and little involved or there is a member who do not start activities and only answers questions from other members.
4. Democratic: When someone tries to include everyone in a group decision or discussion, expresses their feelings and opinions openly and directly without evaluating or judging others, is open to feedback and criticism from others or there are members which try to improve conflict by finding compromising situations.

4.3. Decision-making process

Many decisions are made in groups without taking into account the effects of them on other members. Some try to impose their own decisions on the group while others try to involve or share the decisions that are made with the rest.

The following aspects of this process should be considered:

1. If anyone makes decisions and carry them forward without reviewing them with the rest of the group and what effect it has on other members.
2. If the group fluctuate from topic to topic (Who skips the subject?) and if you see any reason for it.
3. Who supports the suggestions of others.
4. If there is a majority trying to push decisions about objections from member bulls or if there is a vote.
5. If there are attempts to reach consensus among all members and what effect it produces.
6. If there is anyone who suggests without finding an answer and what effect it has.

4.4. Functions of task

These functions illustrate the behavior of the person who structures the work that the group has before.

Try to investigate if there is any member who suggests the most appropriate way to proceed when facing a problem, if anyone tries to summarize what has already happened or what has happened in the group, if there are any questions about facts, ideas, opinions, feelings, or research alternatives.

Who leads the group toward the goal or who prevents from jumping from one topic to another or going off on tangent?

4.5. Maintenance functions

These functions are important to the morale of the group. They maintain good and harmonious working relationships between members and create an atmosphere in the group that

allows each member to participate to the fullest. Ensure peace of mind and effective work in the group.

Observe who helps the other participants in the discussions, who cuts others off or interrupts them, how members get their ideas out, if there are some members concerned and not listening, if there are attempts by some members to help others sort their ideas or how ideas are rejected and how people react when their ideas are not accepted.

4.6. Group staff

The way the group works generates an atmosphere. People, moreover, often differ on the type of atmosphere they like in the group. You can find people that prefer a friendly atmosphere if there are attempts to suppress unpleasant conflicts or feelings.

On the other hand, people that prefer an atmosphere of conflict and disagreement can be detected if you find some members teasing others.

As a general rule, try to observe if people seem interested and how is the atmosphere.

4.7. Members

One of the important points is the degree of acceptance or inclusion in the group. It is crucial to observe if there are any subgroups or some members consistently support or oppose others, if some seem to be out of the group or look like this "in or how outsiders are treated."

Finally, if some move outside and within the group and under what conditions they move.

4.8. Feelings

During group discussion, feelings are generated by interactions between members. Of these feelings that are rarely spoken observers should make assumptions based on tone of voice, facial expression, gestures, and other forms of non-verbal language [18].

The feelings that are observed in the members of the group are anger, irritation, affection, excitement, boredom, defensive attitude, competitiveness, and others. We should take into consideration if there are attempts to block expressions of feeling, particularly negatives, how it is done or if anyone consistently does it.

4.9. Norms

Standard or basic rules can be developed in a group to control the behavior of its members. Standards generally express the beliefs and desires of most members about what behaviors should or should not take place in the group.

These rules may be clear to all members (explicit) or well known or felt by a few (implicit). Some rules facilitate progress in the group and some make it difficult.

Observe if there are certain avoided areas in the group (religion, feelings,), there are members of the group extremely polite or gentle among them, only positive feelings expressed or you

can see rules about participation or about the kinds of issues that are allowed or members feel free to demonstrate their feelings.

5. Conclusion

The working group can be an effective management tool for companies to solve the difficult and complex problems. In the case of innovative profiles, special attention must be paid to the motivations of these people, who are often different from others.

In the innovative profile, in our opinion, it is very important to satisfy the need to perform and supervise the correct role assigned to bring results that come from basic competences such as creativity, innovation or communication. On the other hand, in general, factors that contribute to the effectiveness of the groups' performance would be observed to be met:

- The group concentrates well on the task, either because it has been formed to solve a specific problem or to achieve a defined result (when the problem is solved or the task is finished, the group dissolves).
- If the group brings together people from different functional areas affected by the problem to be solved or task to be undertaken, it will possess a diversity of knowledge and skills that in principle must produce high quality solutions.

The results of our approach allow us to identify as points to work in the future, the functionalities, and resolution of engineering problems taking into consideration economic and beneficial aspects for several stakeholders or society in general. Another aspect to work on the creativity concept will be the impact, looking for engineering solutions that allow a greater replicability.

The authors have identified all these aspects as key issues to research and they will dedicate the following academic courses to study in detail some specific roles and their implication in successful innovative projects.

Author details

M. Dolores Storch de Gracia*, Luis Mazadiego and Bernardo Llamas

*Address all correspondence to: lola.storch@.alumnos.upm.es

ETS, Ingenieros de Minas y Energía, Universidad Politécnica de Madrid, Ríos Rosas, Madrid, Spain

References

[1] Muzio E, Fisher D, Thomas ER, Peters V. Soft skills quantification (SSQ) for project manager competencies. Project Management Journal. 2007;38(2):30-38

[2] http://www.highperformanceteams.org/ [Accessed: December 21, 2016]

[3] https://www.mindtools.com/pages/main/newMN_TMM.htm [Accessed: December 21, 2016]

[4] Turner JR, Muller R. The project manager's leadership style as a success factor on projects: A literature review. Project Management Journal. 2005;36(2):49-61

[5] Tuckman B. Developmental sequence in small groups. Psychological Bulletin. 1965;63:384

[6] Tuckman B, Jensen MA. Stages in small group development revisited. Group and Organisation Studies. 1977;2:419-427

[7] http://www.businessballs.com/tuckman forming storming norming performing.htm [Accessed: December 20, 2016]

[8] Mathieu JE, Maynard MT, Rapp T, Gilson L. Team effectiveness 1997-2007: A review of recent advancements and a glimpse into the future. Journal of Management. 2008; 34:410-476

[9] Mathieu JE, Tannenbaum SI, Kukenberger MR, Donsbach JS, Alliger GM. Team role experience and orientation: A measure and test of construct validity. Group & Organization Management. 2015;40(I):6-34

[10] Aritzeta A, Ayestaran S. Applicability of Belbin's team roles theory: A longitudinal and comparative study with work teams. General and Applied Psychology. 2003;56:61-75

[11] http://www.belbin.com/ [Accessed: December 20, 2016]

[12] Belbin RM. Management Teams: Why They Succeed or Fail. 3rd ed. Oxford, United Kingdom: Elsevier; 2010

[13] Mostert NM. Belbin - the way forward for innovation teams. Journal of Creativity and Business Innovation. 2015;**1**:35-48

[14] McGrath J, Bates B. The Little Book of Big Management Theories: …And How to Use Them. Pearson; New Jersey, United States. 2013

[15] Bernardo Llamas M. Dolores Storch de Gracia. Evaluación de proyectos y gestión del riesgo. De una idea a un proyecto. Fundación Gómez-Pardo. 2017. ISBN: 978-84-617-7988-8

[16] http://www.abet.org/wp-content/uploads/2015/05/E001-15-16-EAC-Criteria-03-10-15.pdf [Accessed: March 13, 2017]

[17] Llamas B, Dolores Storch de Gracia M, Mazadiego LF, Pous J, Alonso J. Assessing creativity as a critical competence in engineering. Case of study in mines engineering degree. Thinking Skills and Creativity. 2017. Forthcoming

[18] Llamas B, Pous J, Dolores Storch de Gracia M. Principios de la Ingeniería de Proyectos. Fundación Gomez-Pardo. ISBN: 978-84-608-8312-8

INTECH