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RESEARCH AND INNOVATION AND THEIR ROLE IN ECONOMIC DEVELOPMENT

Petru Roshka,
Doctor habilitat, professor,
ORCID 0009-0000-5300-7394
Free International University of Moldova,
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Abstract. *In the work are studied the main categories of scientific research and innovation. the link of research with other fields. an analysis of the real situation in the given field is made. there are highlighted a series of measures that have led to the improvement of the organizational framework and of the relations of the research-innovation activity, the efficiency of the scientific research results, etc.*

Key words*: research, innovation, innovation potential, evaluation of research and innovation projects, cost reduction and increasing their efficiency, competitiveness of products and services.*

Clasificarea Jel: O1 – Dezvoltarea Economică; O3 – Progres Tehnologic; Cercetare şi Dezvoltare

Introduction

The cardinal acceleration of technical-scientific progress (TSP) is a problem of major importance. Only on its basis can the further launch of the economy be ensured, its efficiency and quality of production can be raised, the needs of the population can be better ensured. The PTS has a positive effect on all elements of production. As confirmed by the calculations of specialists in the field, about 3/4 of the increase in labor productivity is an effect of the introduction of scientific and technical achievements. The technical progress has determined the substantial reduction of costs for material products, people and information, allowing the approximation of economic resources to the sales markets and the creation of information networks between companies located in different geographical areas, thus ensuring a centralized coordination and control of international activities. On the other hand, the increase in R&D costs has had an important impact on the global innovation process, leading to a wide dissemination of its results [3, p.197].

Contained

Scientific research and innovation are essential levers that contribute to raising the economic level of any nation and have a decisive influence on the adaptation of companies in a given country to the general global modalities. The innovation process is a process of permanent introduction of the new into the economic life, of generating and implementing new ideas that materialize in processes, products, works, services for the market, transforming into social economic progress. Figure 1 shows the main types of activities specific to research and innovation.

Research and innovation are complex activities and for this reason they must be analyzed in relation to other fields of activity in the economy, namely: *1) education and the workforce training system; 2) the theoretical bases of discoveries; 3) applied solutions; 4) the material base; 5) qualified personnel; 6) the maturity and casuistry*

basis [10, p.83]. The innovative potential of a country is represented by scientific, design and construction institutions, technological, experimental production organizations, experimental polygons, educational institutions, personnel and technical means of these organizations. In order to properly carry out activities in these areas, there must be an appropriate organizational system that corresponds to the requirements of the economy. In order to improve the organizational framework and the relations of the scientific research activity with other fields, several solutions are proposed [10, p.84]: *ensuring the research potential and establishing optimal dimensions for the research units; approaching and capitalizing on research topics of great importance for the economy; making a more concrete link between the research itself and the capitalization of the results; appropriate stimulation of the research staff. research; stronger collaboration with institutes, academies, companies, etc., in other countries; improvement of the information system; stimulating economic agents to carry out research and innovations*.

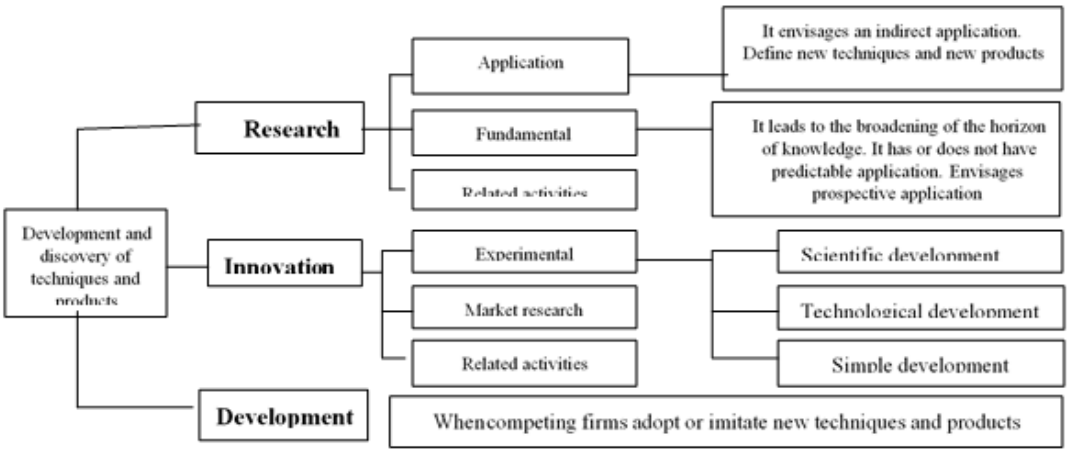

Fig. 1. Main research categories [10, p. 82].

In developed countries, in order to finance new technical-scientific developments, which are sometimes risky projects, innovative funds are created that represent financial resources accumulated based on sponsorship payments to companies or banks. The means of these funds are usually distributed among the applicants who claim to invest, on a competition basis, often in the form of a trend. These and many other measures contribute to the intensification of research and innovation activity, as well as to the more active implementation of research results and their efficiency. The intensive use of natural resources must be oriented towards their minimum consumption. This allows the simultaneous solution of three problems: *reducing the need for natural resources; raising quality; increasing labor productivity*. Technical-scientific progress must be oriented towards the radical improvement of the use of natural resources, raw materials, materials and energy at all stages – starting with the extraction and processing of raw materials and ending with the manufacture of finished production.

Economic growth is the main objective of macroeconomic strategy. It is assessed by the growth rate of GNP (and/or GDP) in percentage reported per capita. Despite the fact that the increase in production covers only a part of the effective

enrichment of the country, economic growth is a major factor in the health of the economy, ensuring new jobs and increasing the standard of living of the population [2, p.12]. A correct management of the research and development activity in collaboration with the research institutions allows the company to develop much more efficient technologies. At the international level, there is a continuous acceleration of technological changes, shortening the life cycle of new products, which implies a high risk of existing technologies and highlights the importance of an efficient management of the technological innovation process. It is intended to enable the company to develop and use new technologies in order to strengthen its position in the market.

In the specialized literature we find frequent statements related to the reduction of the time elapsed from the appearance of a scientific discovery to the fulfillment of some practical applications of these. For example, if in the case of the photograph the time interval was **112 years** (in 1727, the German physicist *J.H. Schulze* discovered the sensitivity of silver nitrate to light, but, conventionally, it is considered that the appearance of the photograph took place in 1839, when the Frenchman *D.F. Arago* presented a communication on successful experiments, by *Nicephore Niepce* and *Louis Jacques Daguerre*, about 2 years earlier); for the transistor, this interval was **5 years** (1948-1953), and for the solar battery, **2 years** (1953-1955). Also, the period of appearance of the telephone lasted **56 years** (1820-1876); of radio - **35 years** (1867-1902); of radar - **15 years** (1920-1935); television - **14 years** (1922-1936); atomic bomb - **6 years** (1939-1945); this interval at the appearance of integrated circuits lasted **3 years** (1958-961) etc. [12, p. 44]. Such events highlight the interest of the society to exploit as quickly as possible the results of new discoveries and the constant orientation of technical research towards the materialization of such trends [9, p.33-41].

Innovation is a specific component of the evolution of human society. In the case of a company, understanding the meaning of the innovation process implies observing quality requirements that are almost continuously changing, knowing the stages that accompany the launch of a new product. In the innovative process, a significant role is played by the engineer, and a good preparation is necessary, in order to cope, in at least acceptable conditions, with the diversity and complexity of the problems that may arise. Any product can be successful if it can withstand competitiveness on the market, which implies *the ability to face competition, therefore to have qualities at least similar to those of the opponents with whom it competes*. So, for the company this means manufacturing a product whose properties correspond to the customer's requirements as much as possible, a product that is agreed by the customers, in the race to gain their trust.

Researchers and specialists retain the following main directions of action for raising the economic efficiency in perspective, most of them being the direct consequence of the pace of scientific and technical discoveries [8, p. 21-22]: the design of *new technical and technological solutions*, as well as the improvement of the existing ones, capable of ensuring the obtaining of superior products in terms of quality, operating life and safety in operation, but also with a low consumption of raw materials; the creation of *new materials and substitutes* to replace the expensive

and deficient ones in the country's economy; the design of *new techniques and technologies based on new principles* and, implicitly, the modification of industrial production processes.

From many points of view, the production of machines, based on mechanical principles, has exhausted its possibilities, *biotechnologies* proving to be more appropriate to present and future conditions; the organization of new technological flows, characterized by low consumption of raw materials. Most of the opinions converge towards the design, in the sectors where they are suitable, *of active circular processes*; the increase of the role of creativity, respectively the formation of a mass attitude favorable to ensuring the organic link between research-education-production, between research-design-production. Normally, in order to obtain the expected economic and social effects from investments in scientific and technical research, adequate organizational measures are also needed, which contribute to shortening the research-production cycle as much as possible; achieving an *optimal ratio* between short-term and long-term effects in the management and economic-social organization as a whole and assessing the efficiency of activities in particular.

Activities in the field of research and assimilation of new products, technological processes or production processes consume human and material efforts (funds), becoming particularly economically and technically efficient only after application in practice. As such, the time of social actions, especially that of the activity of leadership and organization, is not homogeneous and linear, but has a contradictory character, reflected in the qualitative differences between the "short term" and the "long term" of human activity. Within the short term, a series of disturbances may occur which, if not known and corrected in time, lead to the departure from the proposed objectives.

As a rule, in empirical management, the concern for the current activity (the short term) prevails over the perspective (the long term), the pursuit only of short-term profitability generating losses in a longer perspective. For these reasons, it is possible to achieve real efficiency in the future only if action is taken to increase the productivity of labor and the quality of execution, to extend the service life of the products; improving *the structure* of the economy, in the sense of orienting the industry towards the branches that allow the highest yields: electronics, automation, computer technology, computer science, fine mechanics, fields with positive effects on the increase of labor productivity in agriculture, on social life as a whole.

The impact of the technical-scientific revolution on the economic and social evolution, as well as the orientation of industry towards cutting-edge technologies, have generated some new laws: development and efficient economic growth is a direct function of the efforts made in the field of research; the more diversified an economy is, the more its upward evolution depends on the level of research and development activity. According to specialists in the field [12, p.33], there are three groups of factors that contribute to increasing competitiveness: innovative factors in the narrow sense or *innovation of processes and products*, which hold a share of about 45% of the factors that ensure the performance of competitiveness; innovative factors in the broad sense, which are not directly dependent on technological changes, but are of a managerial organizational nature and have a share of about 29.4%.

These are: a) various innovations at the level of the company; b) some product innovations of a technological nature (for example, building a company's own style); c) innovations in the organization of production, other than those regarding technology); d) innovations in production management methods; *other factors*, not included in the aforementioned groups, which account for about 25.5%. This refers to: the existence of knowledge on the market situation; the availabilities offered by efficient and properly located distribution networks; the existence of human capital; financial capital; the cost of loans; unit labor cost; socio-political context; a growing economy; public policy; tariff regime, etc.

A good example in this context is demonstrated by the European Union. In March 2000, at the Extraordinary European Council in Lisbon, it was set as a fundamental objective for the Union to become the most dynamic and competitive knowledge-based economy in the world by 2010, capable of ensuring sustainable growth and development. In order to achieve this objective, the strategy proposed increasing investments in education and research. In 2002, at the Barcelona European Council, which also aimed to identify progress towards the Lisbon objective, the objective was set to increase investment in research and development from around 1.9% of GDP to 3%, of which 2% should come from the private sector. At the European Council meeting in Brussels in March 2008, a new cycle of the renewed Lisbon Strategy for Growth and Jobs was launched, referring to the importance of investment in knowledge and innovation as a key driver for economic growth [6, p.139-140]. These goals have been priorities in the implementation of the Europe 2020 strategy as well as the Europe 2030 Sustainable Development Strategy.

The development of the PTS depends on the financial sources directed to scientific research works and experimental elaborations of constructions, for the training of scientific staff and engineers, the promotion of the state policy in the field of innovation. For example, in 2000 in the USA, Japan, Germany this source constituted 2.7-2.9%, in France and Great Britain – 2.3-2.4% of GDP. The new industrial countries are approaching the level of European countries, and the Republic of Korea – the US indicators. To a large extent, the expenditures for this purpose are borne by entrepreneurial structures (67% in total in developed countries), but the share of expenditures in the budget is also high (in the USA – 33%, in Germany and France – about 40%) [11, p. 30].

For this purpose, some active countries use Euro credits. Although the objective of Euro credits can be different: to finance the balance of payments deficit, to finance significant projects, to financially supplement a credit for international trade. The use of Euro credits as financial credits to complement an export credit aims, concretely, at financing the accounts granted to suppliers by buyers, according to the contract, financing the payment of interest for the period of disbursements or the first installments to be repaid, financing local expenses related to the objective contracted through credits, etc. Apart from these three objectives, Euroloans can be used as collateral for a credit line or for the renegotiation of previous loans. In the first case, they cannot be used, because their only role is to serve as a guarantee (security) for other forms of financing. In the second case, Euroloans are used to renegotiate older debts in the event of the debtor's monetary insolvency or to renegotiate in order for

the debtor to obtain more favorable conditions.

The innovation process, as a rule, is mediated by the analysis of the processes of specialization and concentration, cooperation and integration, by the maximum use of the best scientific consistencies and experimental design works, by the exchange, extension and distribution of knowledge, the degree of centralization of the economic, production and socio-economic functions, etc. In other words, as the basis of the process of integration into the innovation sphere, totally different and qualitatively progressive economic categories and phenomena are accepted. With all the value and depth of the scientific argumentation of such positions, we consider that each of these points of view illustrates the integrity of the phenomenon examined [5, p. 173]. The development of an innovation becomes a complex process, the company collects technical-scientific and market information and must react appropriately, offering products that respond more adequately to customer requests (*Figure 2*).

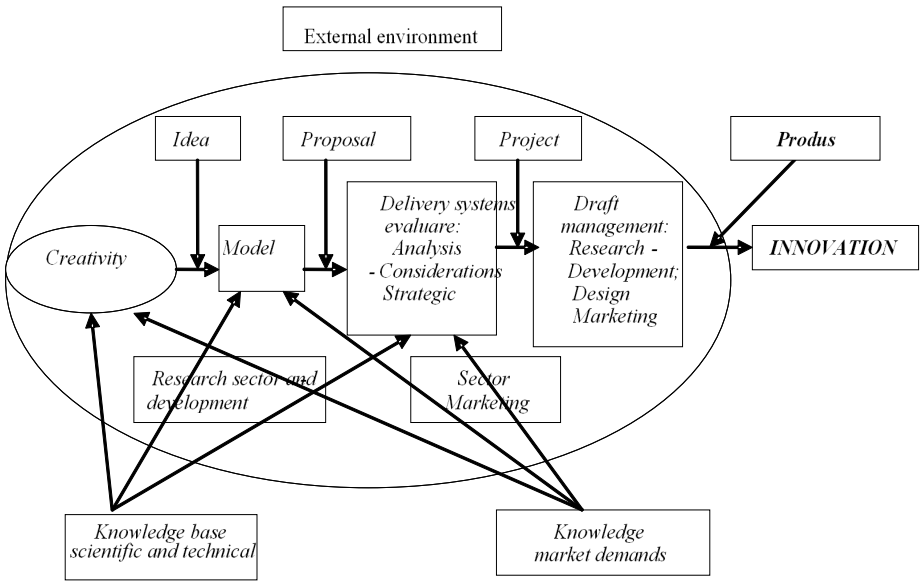

Fig. 2. Developing an innovative action.

Source: elaborated by the author after Bellandi G. L innovazione tecnologica e la gestione della quqlita.

On the fly. Innovazione tehnologica e impresa. Napoli: CUEN, 1993, p. 123-128.

The process of evolution of a technological innovation in the enterprise, in the opinion of *Emilio Esposito* [4, p.77-78], is characterized by the crossing of six stages (phases) with the respective connections that are shown in *figure 5,* namely: *1) recognition of an opportunity; 2) the formulation of an idea (the constitution of a concept); 3) solving technical and market problems; 4) making the prototype; 5) commercial development; 6) homologation and/or generalization of technology*.

The analysis of the innovative activity at the enterprise requires taking into account a multitude of factors on which the level of technological innovation of a product depends and which, at the same time, determine the efficiency of the enterprise. These factors can be grouped as follows [12, p.89]: *factors intrinsically related to the enterprise* (acceptance of innovative manifestations, marketing

capacity, manufacturing conditions, internal financial availability, strategic objectives, flexibility of the organizational structure, technological design capacity, concrete objectives that the manager or team of managers proposes, etc.); *factors related to industrial policy* (the existence of labour factors with adequate qualifications, financial availability outside the enterprise, public demand, the existence of regulations and/or norms in the field, the extent to which the research and development sector is supported, etc.); factors *that define the market and environmental conditions* (the existence of competition, market demands, suppliers, relations with other enterprises, the existence of a favorable climate for the innovation process). Depending on the presence of the aforementioned factors, four categories of enterprises can be determined: *conservative enterprises; stabilized enterprises; open enterprises and overly innovative enterprises*. Some characteristics of these categories of enterprises can be seen in table 1.

Table 1. Characteristics of enterprises in terms of attitude adopted against an innovative process

Feature	Type of enterprise			
	Conservative	**Stabilized**	**Open**	**Exaggeratedly innovative**
Structure	*Bureaucratic*	*Partly bureaucratic*	*Partly bureaucratic*	*De tip colegial*
Driving mode	*Closed for news*	*Lacking enthusiasm for novelties*	*Accepting the news*	*Support for the introduction of novelties*
Efficiency	*Reduced*	*Medium*	*High*	*Medium or low*
General behavior	*Hostile to novelty, slow innovation*	*Easily adapts to new developments leading to safe effects, medium-paced innovation*	*Acceptance of novelties, innovation at a medium pace*	*Risk-free adoption of novelties, intense innovation*
Source: elaborated by the author after: Baloiu l.M. Managementul inovaţiei. Bucureşti: Ed. Eficient, 1995.				

The experience of American and Japanese companies regarding the ways to obtain low costs in the process of innovating a product that can be briefly characterized on the basis of certain data as such is of interest. In the American example, *the interests of customers ("our customer – our master"*) are mainly taken into account, and in Japan the focus is primarily on *the manufacturer's requirements.* If in the USA innovation is preferentially aimed at products and reducing costs, in Japan the degree of available employment is not neglected, the latter problem being considered as an aspect of national importance. In the USA, the management conditions of companies – existing in the conditions of a diffuse shareholding – have as their main objective the obtaining of profit in the shortest possible time and the increase, as such, of the value of the shares; in Japan such a concern is considered secondary. In the promotion of new products, a prior evaluation of the quality level can prove its effectiveness, knowing that *a customer is willing to buy a product when the quality/price ratio falls within certain limits*, which implicitly implies the acceptance of the product, a certain reliability [12, p.137-138].

Before moving on to the materialization of an innovation, especially when it has a certain scope, it is necessary to evaluate the consequences it will generate. In the

literature, it is recommended to apply the following criteria for evaluating technological progress: *the time in which the extension of a new technology occurs in a certain industrial sector*; *the replacement period*, i.e. the time interval in which the replacement of a product or process with a new one is practically recorded. Conventionally, the replacement time corresponds to the time interval in which a technology or a product register, in a certain field, an increase in the market from a share of 10% to 90%. For example, the duration of replacing natural rubber with synthetic rubber was **58** years, while for electronic computers or for some software products this duration reached **1,5 ... 3** years, etc. [7, p.19-207; 10, p. 82-90].

Frequency of introduction of technological innovations (e.g. number of innovative actions completed within one year); *the time interval elapsed between the moment of the appearance of an investment and that of the commercialization of a product based on that invention.* It is well known that not every patented or patentable invention is a generator of commercial success. Specialists admit that only 5–10% of registered inventions actually lead to the emergence of successful products or technologies; *imitation time,* i.e. the time interval in which, after the appearance of a new product, products with similar characteristics appear on the market. Taking into account *the development of adoption*, entrepreneurs can be classified into 5 groups: the group of innovators, the group of first followers, the group of the majority in anticipation, the group of the majority in delay, the group of entrepreneurs who are late in adopting a technological novelty.

Technological innovation is oriented towards the discovery of products that will successfully enter commercial competition, so that the enterprise maintains or improves its position on the market. The design of such processes is characterized by a high degree of uncertainty and implicitly a higher or lower risk. That is why project selection is one of the most difficult decisions involved in R&D management. The criteria to be taken into account must allow the detection of those qualities of information on the basis of which the decision to choose the most viable projects can be made, because the abandonment of a certain project must also be decided on the basis of almost identical factors. The following criteria can be used in the evaluation of innovation projects by entering them in the so-called *weighted checklists* [7].

In order to assess the efficiency of technological projects with a high degree of probability, all aspects necessary to be able to form a clear vision of the real possibilities of the enterprise to successfully carry out the technological innovation project must be taken into account. That is why the block of analysis criteria contains aspects related to technical possibilities, commercial possibilities, financial capacity, production capacity, research structure and institutional aspects, such as the tradition of the enterprise and its attitude in developing new products and, of course, the risks it is willing to assume.

The use of qualitative analysis (*very good, good, satisfactory, poor and very poor*) may be sufficient to define the correspondence of projects from the point of view of one criterion or another, without the need to resort to complicated quantitative methods that do not allow the determination of weaknesses and the actions to be taken to eliminate them. The method is based on establishing a numerical correspondence of qualitative criteria. As in the technique of imposed

decision, the criteria must be ordered in order of their importance. A first way of ordering the criteria is the overall assessment, giving each criterion scores on a scale from 0 to ten (*0* being awarded for the criterion that is considered to have no influence on the development of the project, and *10* is awarded to the project that has a very special relevance on the project in question). The second method, more rigorous, and therefore more precise, consists in determining the coefficients of importance: the criteria are compared with each other, two by two, obtaining a D number of decisions. Thus, a score of "1" (one) and "0" (zero) is awarded respectively, if one criterion is considered more important than the other, and a score of "0.5" is given to both criteria, if they are of equal importance. The methodology for calculating the various decisions on the innovative project is exposed in the literature [7, p.199-207; 12, p. 149-156].

In carrying out the innovative activity, it is necessary to know the factors that can increase efficiency or, on the contrary, lead to a reduction in profitability, by taking various organizational, technological, economic-financial or other measures in time. In the opinion of specialists in the field [7], these factors can be included in one of the following two groups: *internal or endogenous factors*, intrinsically linked to the innovative person (this group includes *biological factors* – genetic potential, memory capacity, age, health status, etc., *predominantly psychological factors* – imaginative qualities, aptitudes, temperamental traits, volitional qualities, motivation, curiosity, level of involvement in innovative activities, etc., *factors of a cognitive-intellectual nature* – specialized intellectual qualities, level of education, gnoseological factors, spirit of observation, discernment, etc.); *individual external factors (exogenous),* among which we will mention *the socio-economic factors* – school, material condition, technical and informational endowment of the workplace, the climate within the micro group, the existence of a technical creation group, the socio-economic requirement, the stage of development of technology, the social climate, etc. (There are enough cases in which chance was at the origin of the revelation of unexpected solutions, of some quite remarkable discoveries) etc.

Any company will not be willing to concern itself with research and innovation, if certain privileges are not ensured that would allow the exploitation and obtaining benefits compared to the investments allocated and the risk it assumed when it initiated the innovation activity. *The identification and use of techniques and methods capable of stimulating the innovation process has been an object of careful concern for researchers and for those interested in exploiting the effects of innovation. Currently, there is a certain amount of knowledge regarding how the identification of new constructive, technological and organizational solutions can be stimulated.*

In the opinion of specialists in the field [12, p.110-111], *the following could contribute to favoring the development of innovation processes*: *the existence of forecast studies*, which would provide the management team with pertinent information on the directions of evolution of the market requirements; the manifestation *of favorable situations at the market level*, noticed, for example, as a result of close ties with the company's customers; *an attitude favorable to innovative processes*, manifested by the company's management team, materialized, for example, in the acceptance of solutions or proposals that come from outside

specialized services or that have the ability to make decisions in relation to innovative processes; *a rational policy of the enterprise,* of concentration and distribution of the forces at its disposal on the directions of innovation of maximum intensity and maximum efficiency; the existence *of specialists* who have the knowledge and motivations necessary to promote innovative processes; the possibilities to better satisfy *the specific requirements of the national market*; the *reduction of the competitiveness of older products*, due, for example, to the increase in the value of the wage component of costs; the possibilities of *imitating innovative processes* already manifested in other countries.

In the process of innovation at the level of a country, there are some *obstacles of an external nature* (barriers created or favored by those structures whose position could be threatened by the initiation of a possible innovative process, the difficulties derived from the protection of advanced technological elements by patents or secrets, etc.) or *of an internal nature*. Among the obstacles likely to be included in the latter group, the following can be mentioned: high absolute costs and pronounced risks; lack of financing possibilities from own sources or high credit costs; the manifestation of effects corresponding to periods of economic depression (limitation of funds oriented towards innovative processes, reduction of demand, increase of risks, etc.); the exaggerated orientation towards perfecting only the processes already in production and which enjoy a certain commercial success; the tendency of the company's management not to assume the risks involved in an innovative process; inadequate policy at national level, in relation to the support of the research and development departments. Along with the above, a special role is played by the motivation (material and moral co-interest) of the persons involved in the research-innovation-development process and many other organizational, technological, economic-social factors, etc.

Conclusions.

In order to accelerate the technical-scientific progress and increase the effectiveness of the realization of innovations in the branches of the national economy of the republic, we consider it necessary**:**

- improvement of the legislative framework in the technical-scientific field that would correspond to the requirements of the market economy and entrepreneurial development;
- creation of technology parks as a new form of territorial integration of science, education and production in the form of associations of scientific institutions, design and construction offices, educational institutions, enterprises, companies;
- the establishment of innovation centers and technopoles;
- reforming the country's scientific-technological system and raising the level of coordination of research in the country's scientific institutions;
- the formation of a system of financial insurance for science, which would include the multiple channels and sources of financing of technical-scientific, design and construction works, financial support from the state for technical-scientific priorities;
- definition of priority directions and allocation of financial means based on free competition;

- harmonization of academic science with branch and university science;
- internationalization of research and development with participation in international programs and grants;
- establishment of mechanisms for technology transfer, extension of knowledge and commercialization of the results of scientific and technological activities;
- creation of the system of selection by competition of state technical-scientific programs, fundamental scientific research programs and applied elaborations;
- focusing the attention of ministries and departments, scientific and design institutions of the republic on solving the problems of applying innovations and their economic effect in production, increasing the technical level of production;
- improvement of the process of training of engineers and economists in the field of forecasting the development of science and technology, appreciating the economic and social effect of the realization of innovations;
- ensuring the obtaining of the most extensive statistical information regarding the development of the technical-scientific progress and obtaining the economic-social effect in the branches of the national economy as a result of the application of new techniques and technologies in production.

The implementation of these and other measures will contribute to accelerating the technical-scientific progress and increasing the effectiveness in the development of the national economy.

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