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Structural Analysis of the Transformation Processes of Scientific and Technical Ideas and Knowledge into Innovations in Technoparks

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Abstract

The paper is devoted to the realization of scientific and technical ideas and knowledge in practice, and to learning and the structural analysis of the content of their transformation processes into innovation in technoparks. We show that the innovation processes are required to be analyzed and classified; their stages, as well as the system of indicators need to be improved. The need for the implementation of scientific and technological ideas is commented and considered as a process of innovation. The structure of the innovation process, its features and stages are explained and classified in technoparks. The factors that affect the innovation processes are investigated; and the processes automation issues are considered, as well. Organizational and economical mechanisms used for the implementation of the innovation processes are analyzed and a number of recommendations are developed to improve the process.

Index Terms: Innovative structure, technoparks**,** innovation processes and stages, scientific and technological ideas and knowledge, research, fundamental and practical research, discovery and invention, technology transfer.

1. Introduction

In modern times, modernization of the economy requires raising of the role of innovative factors in the development of the current economic system. Under such conditions, scientific and technical ideas and knowledge become an important factor in organizing the basis for the modern economic development system, and in determining the competitiveness rate of economic subjects. Therefore, the management of the transformation process of scientific knowledge and ideas into the innovations are considered to be a priority in the economy. Currently, at the background of forming the world economy on the basis of knowledge, technology and innovation, the strengthening of linkages between scientific and educational and production

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areas and the development of appropriate management mechanisms is quite an important task [1, 2].

Formation of an innovative and knowledge-intensive economy, expansion of the production of competitive products will significantly impact on enhancing an export capacity of the country basing on high technology. Therefore, classification, fundamental phases, structural analysis, assessment and management of innovation processes and systems planned to be implemented both on the level of society and the economy, and the fields and enterprises, are extremely urgent. The development of the system of indicators and meters that characterize these processes, assessment of existing and expected economic situation basing on them, as well as an intellectual management of the process is of great importance.

2. Problem Formulation

There is a need for a new management mechanism and a new approach to organization and management of innovative processes and emerging new economic relations peculiar to the information society. Innovation processes need to be analyzed, classified, their stages, as well as indicator system should be determined, existing ones should be improved, and the new ones need to be developed if necessary. The studies show that, the following issues need to be carried out in succession:

- Description and characterization of the socio-economic and scientific-technical substance of innovation processes and stages;
- Determination of technical and economic nature and classification signs, key functions and activities of the main elements of the innovation processes;
- Analysis of the factors that affect innovation process and activity, and learning of existing problems associated with these factors;
- learning of key indicators that characterize innovation processes, basing on foreign experience;
- Development of key indicators groups of various levels of innovation processes;
- Identification of indicators system that characterizes innovation processes;
- Determination of the system of indicators and criteria that enables assessment of innovation processes.

3. The Main Direction of Innovative Structures Technoparks

Technoparks are a necessary infrastructure element of innovative development of economy and are aimed to provide the development of high-technology spheres, creation of scientific basis of production, infrastructure, qualitatively new jobs, involvement of skilled experts, etc.

Technopark represents the separate territory, where real estate and infrastructure venues are located and necessary resources are provided to high-technology companies, which allows to concentrate on its main activity [3]. The main objective of technoparks' building are 1)transformation of knowledge and inventions to technologies; 2)transformation of technologies to commercial product; 3)technology transfer to industry through the science-intensive small entrepreneurship sector; 4)formation and market establishing of science-intensive organisations; 5)support of organisations in science-intensive entrepreneurship sphere.

As economic systems, technoparks have following cooperating elements: 1)government organisations and enterprises; 2)private organisations and enterprises; 3)universities and academic institutions. As a social-economic system it consists of two independent, but interrelated subsystems: managing and managed subsystems. Managing subsystem comprises elements, which provide direct process of creating material and moral welfare or service, managed subsystem includes – elements, which provide management process, e.g. process of goal-oriented impact on people collectives, employed in managed system. The most important element of managing system which supports the interrelation among system elements, is organizational structure of management. Key factors that ICT-technoparks successfully apply Research and Development

designs for Research and Development management process: 1)analyzing product value with deconstruction technology brings up strategies for an enterprise and plans for its internal functional divisions; 2)process of the new product development will bring open innovative operation; 3)responding to the globalized market, ICT-technoparks horizontal integration, strategically aligning crucial cooperative alliance; 4)dynamic environment needs the strategic thinking; 5)in the Research and Development management process, integrating concurrent engineering in order to solve problems for design and manufacturing processes.

4. The need for the Realization of Scientific and Technical Ideas in Technoparks

The share of science, scientific-technical ideas and knowledge in social and socio-economic life of the society is increasing day by day. Nowadays, there is no any field of social life that does not make use of the latest achievements of science. There is a great demand in the society for the development of fundamental and applied science. For the proper use of new technologies and modern technical equipments an infrastructure of science has to be organized efficiently, prior areas determined and developed.

In accordance with modern requirements, the implementation of scientific and technological ideas is one of the most important tasks facing the community. Since the scientific and organizational models differ for various countries, new organizational forms should be determined for the realization of scientific ideas.

In the modern era, science also serves as one of the components of the economy. Thus, achievements obtained through the commercialization of new scientific knowledge and ideas give a great boost to the economy. However, it is possible only if the science is used regularly and efficiently. On the other hand, raising scientific outlook of the population and their skills to adopt application rules of new techniques and technologies results in enlightening the society as a whole, and in an increase in the relative share of science in the structure of the economy.

Of course, every nation has the intellectual resources to some extent. However, its realization requires a very large capital investment, long-term social organization. At the moment, Azerbaijan does not lag behind other developed countries for its individual intellectual level. Since the country has enough financial resources, it is very important where and how these resources will be directed. Now the main issue is the correct assessment of the current situation, efficient economic and scientific-technical policy, the management of innovative processes by scientific principles. The scientific basis of the application of scientific and technological ideas enables the concentration of intellectual resources of society, and its optimal orientation. For the application of science sustainable economic system with high-level scientific and technical capacity, as well as specialized manufacturing network are required. Nevertheless, the need of the economy for science does not always occur. Low-level institutions get ready the means of production facilities from other countries which have knowledge-based economy. Investing in major innovative programs and projects without a strong economic base in any country is not right. Science develops only in terms of proper economic foundation and production system; and scientific and technical ideas transform into innovations only through practical realization [4].

5. Characterizing the Innovation as a Process in Technoparks

Innovation and innovation processes as economic terms have different meanings. An innovation process is a sequence of stages and transition of any idea from its formation and production to its sale, diffusion, and transfer. An innovation process is a part of innovation performance of any entity. An innovation process is the transformation process of scientific knowledge or idea into a product or service. Unlike the scientific and technical progress an innovation process is not limited to mere application. This process continues even after the application stage, and this innovation is improved as it spreads, gaining more efficient shape and new consumer qualities. This creates new application areas, new markets and consumers for this process, who perceive these products and technologies new for themselves.

Thus, this process is focused on the creation of the product technology and service that the market requires,

and it is realized through the interact ion with that environment.
An innovation process covers the whole transformation process of scientific knowledge and scientific ideas, discoveries and inventions into products, in other words into innovation in technoparks. Innovation process innovation is the implementation of a certain economy of any entity. In other words, it is a collection of sequential stages, which includes obtaining innovative products from completed research, and their sale.

Innovation process is the process of presenting scientific and technical achievements in the form of new or improved products to the market, and reflecting additional research and developments related to the application of new or improved technological processes, which are used in practice. Essentially, innovation process is the chain of purposeful activity of developing and implementing new products and operations, and its subsequent diffusion [5].

6. The Structure, Stages and Characteristics of the Innovation Process in Technoparks

Creation of an innovation needs to be managed as a complex process. On the one hand, it should be regarded as the sequential-parallel processes of research, scientific-technical, manufacturing and marketing activities, on the other hand, as the ordination of life cycle stages of novelty from its creation until its development and dissemination within the time framework. Furthermore, this process can be regarded as the process of financing the development and distribution of a new product or service. In this case, the innovation process is managed as an investment project management. Generally, innovation process is the process of obtaining and commercializing the results of administrative, financial, manufacturing solution of any discovery, new product, technology, service, or another intellectual activity.

Characterizing an innovation as a process structurally shows that it may result in as follows [5]: 1)the product range renewed, competitiveness improved, the needs of the population satisfied; 2)the production efficiency improved, limited resources used efficiently, production costs reduced, profits increased; 3)innovations characterized by social consequences, and so on. Innovation development should be managed as a process. On the one hand, it is required to be formalized as a research, design work, on the other hand, as a scientific-technical production, marketing and trade innovation. In general, it's a process of commercialization of new discovery and innovation, technology, products and services, intellectual activity. Therefore, the structure of the innovation process includes as many stages as: 1)basic research, 2)research, 3)development, 4)projecting, 5)development of new information or technology, 6)acquisition of new tested information, 7)marketing, i.e. launching a new product at the market and delivering to the recipients, 8)sales and after sales service, and etc. [6]. The stages of the innovation process implements the followings: 1)systematization of received ideas; 2)development of selected and new product ideas from revealed ones; 3)analysis of the economical efficiency of the new product, the development of a marketing program; 4)conducting market testing; 5)decision making on introducing a new product into production, and so on. This allows the classification of the stages of innovation processes in following directions [5]: 1)performance of research of search nature; 2)performance of research of applied nature; 3)performance of experimental project design; 4)acquisition of mass production of new innovative products, and commercialization of innovations.

After all, the sale of innovations and innovative products, in other words, presenting a small amount of innovation to market, its promotion, economic efficiency and diffusion process are realized. The characteristics of the stages of the innovation process can be as follows (Table 1).

Table 1. Characteristics of the Stages of the Innovation Process in Technoparks

Stages	*Features*
Idea	Forming interest and requests for the objects and processes promising economic benefits and achievements
Discovery	Determining previously unknown phenomena, materials, dependence, relationships and so on
Research	Theoretical rationale and experimental verification of discovery or observation
Developments	Transforming the studies and results of observations into design, experimental samples and schemes
Invention	Patents, or determining innovation features and characteristics appropriate for publishing
Application	Promoting new product or service in the market, as well as promotion of the technology in production
Realization	Performing serial production, sales network, crowding out the types of products available in the market

The movement of innovations includes numerous measures aimed at their realization. This also includes the processes of providing information about the innovation, advertising, organization of trade processes, and so on. The results of innovation realization and the expenses spent for its promotion are analyzed statistically, and economic efficiency of innovation is calculated. Innovation processes ends up with diffusion of innovation. Innovation diffusion is a distribution of the formed innovation in new regions, new markets and new economic and financial conditions. Diffusion may be associated with the acquisition of new markets through making changes in the characteristics of financial innovation, and its movement.

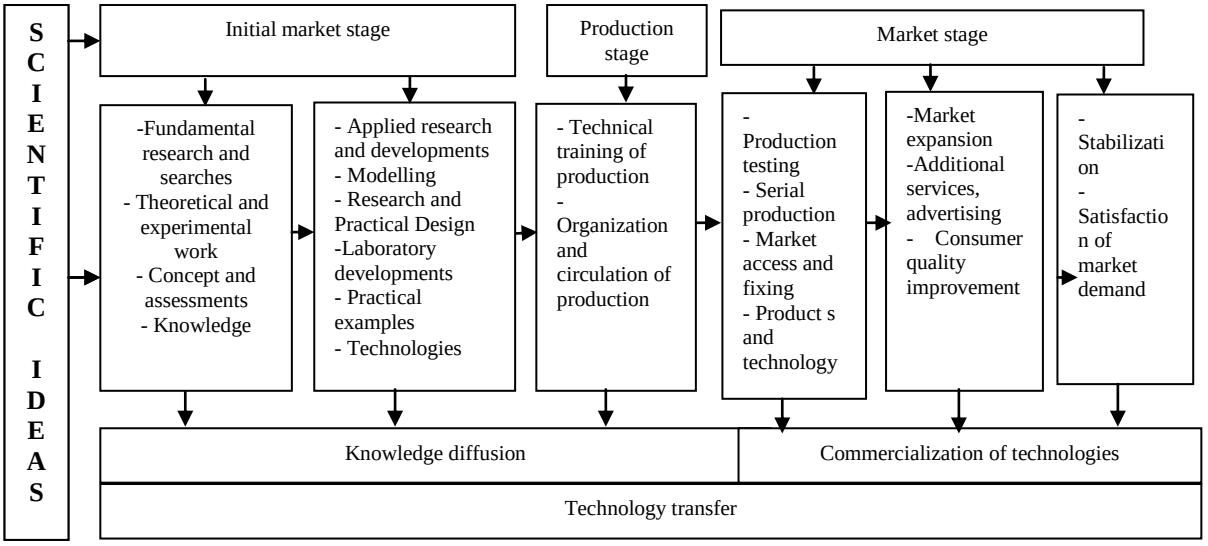

Fig.1. The Main Stages of the Innovation Process

The characteristics of the stages of the analyzed innovation process can be summarized as in the table 1. Generation of innovative ideas or opportunities of the use of new scientific achievements may occur during the fundamental research phase of the developments or during the applied research phase (Fig. 1). Mastering and creating a new technique begins with the basic research phase. This phase is directed to the acquisition of new

scientific knowledge and the determination of the most important objective laws. The main goal of this phase is to find new relations between events and processes, and to determine compliance development laws and principles of the society, as well as to adapt them to specific situations.

Fundamental studies can be both search and theoretical nature, as well. Theoretical study phases show themselves in the reasoning of new concepts of scientific discoveries, and in the creation of new theories. But, the new principles of creation of ideas and technology are developed in the studies of search nature. Such fundamental researches are limited to experimental verification and justification of the new methodologies. All fundamental researches of search nature are carried out both at universities and research institutions, as well as at the enormous scientific and technical organizations with high skilled specialists.

7. Classification of the Innovation Process in Technoparks

Innovation process is related to the acquisition, development and spread of innovation, and possesses different logical forms in technoparks: 1) simple intra-organization (natural), 2) simple inter-organizational (commodity), 3) expanded forms. The first type is a simple innovation process, which involves the development and the use innovation within an organization. In this case, the innovation does not have the form of a commodity. In the second type of a simple innovation process an innovation is the subject of sale. Such type of innovation process means the differentiation of the function of its developer and producer from the manufacturer. During the expanded innovation process a new innovation is developed, new innovation developers occur, and the initial production monopoly is violated, and the consumption criteria of production released due to increased competition is improved. The process of product innovation includes two economic entities: the manufacturer, and the demander. However, the technological process can include both the producer and the consumer within the same economic entity.

Classification of innovation processes according to the baseline characteristics, and the grouping of these characteristics are given in Table 2.

Table 2. Classification of the Innovation Process in Technoparks

Basic attributes of classified objects	*Classification according to the defined attributes*
Content of innovations and innovation processes	Organizational, management, economic, technological, technical
Innovation degree	Absolute, relative, conditional, special
Organizational alternatives	Intra-corporate, by programs, by options
Innovation potential	Enhanced, combined, modified
Features of innovation processes	Intra-organizational, varied ones by phase duration, inter-organizational
Spread and development rate of innovations	International, state, regional, industrial, corporate, company
Spread and development sphere of innovations	Industrial, financial, commercial and mediation, scientific and academic, juridical
Specific features of innovations	Simple product, modification of an earlier technologically complex product, innovative products, services

There are two phases in the transformation period of an innovation process into a product. In the first phase, which covers the development of innovation includes the phases of research, experimental design work, practical production organization, sales organization, commercialization organization. Beneficial effect of innovation does not take place at this phase, only the base is prepared for it.

The second phase, which includes the spread of innovation, covers distribution of social efficiency among innovation producers and consumers. The benefits and speed of this process also depends on the improvement of communication channels, on the nature of receiving the information by the subjects, as well as on the ability of practical use of this data. The final of the innovation process, which includes diffusion of the innovation covers its dissemination and application in the new circumstances, and is closely interrelated with the proper surrounding social and economic environment [8]. Innovation and innovation processes may be reviewed from both dynamic and static aspects. The static aspect is the final consequence of scientific and production stage. As the final result of the process an innovation it can be applied to the production, and realized commercially, and so on.

8. Automation of the Innovation Processes in Technoparks

The nature of innovation processes is dynamic. These processes harmonize one another, and are oriented to the end product, i.e. innovation. Their efficiency directly depends on the ability to respond to fast-changing market conditions. Therefore, complex software should be provided to support the innovation processes within its entire life cycle. In this regard, the software (CAI - computer aided innovation) is called innovation process automation system (IPAS). As a new interdisciplinary scientific direction that combines variety of researches in the field of innovatics IPAS is aimed at increasing efficiency of developing new products [9, 15].

For the efficiency of the innovation processes, which are essentially very complex, iterative, multi-stage, multi-factor, the proposed IPAS must support all the stages from its innovative ideas to the market. Though there exist a lot of different software supporting all of these implementations, an integrated IPAS is very difficult to be developed. More than 160 software products attributed to IPAS can be divided into 3 groups: 1) idea management, 2) strategy management, 3) patents management (Fig. 2).

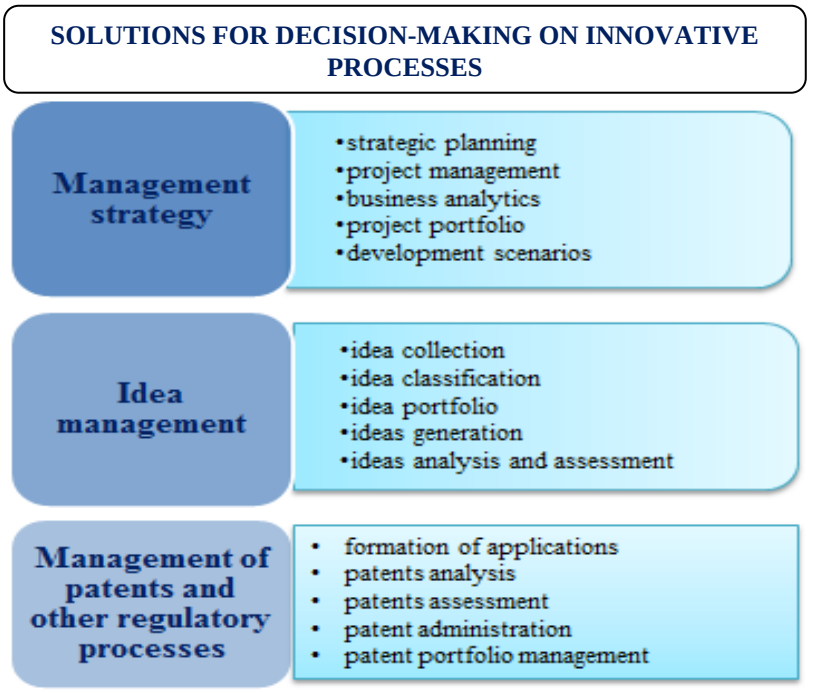

Fig.2. Classification of IPAS Tools

Integration trends of IPAS tools available on the market manifest themselves rather as software products on the idea and strategy management. Generally, the analysis shows that the complex automation of the innovation processes is in the process of formation, and there numerous tasks to be realized in this area. The stages of the innovation process must be coordinated with the complex performance objectives of the enterprise, and more efficient implementation mechanisms must be established.

9. Factors Influencing the Development of the Innovation Process

A number of interrelated factors affect the innovation process. The most commonly encountered factors are: 1)objective, 2)subjective, 3)global, 4)local, 5)internal, external, and so on.

The factors hindering the development of the innovation process are as follows: 1) the lack of funds for the innovation financing; 2) poor material and scientific and technical base; 3)the lack of extra production capacities; 4)the prevalence of current production interests; 5)legislative restrictions; 6)recession of organizational structure; 7)excessive centralization; 8)authoritarian governance form; 9)the lack of organizational and interdisciplinary interaction; 10)the inconsistency of the interests of innovation participants, and etc. [10, 14]. Addition factors that lead to the introduction of innovation are as follows [11]: 1)availability of advanced technologies and logistics necessary for scientific-technical and economic infrastructure, 2)availability of financial resources, government support, or availability of legislative measures and concessions stimulating application of innovation 3)stimulation of innovation participants, expansion of their performance opportunities, 4)flexibility of organizational structures, democratic style of governance, decentralization, and the formation of the working group, and so on.

10. Organizational and Economic Mechanisms for the Implementation of the Innovation Process

It is also important to determine the efficiency of the implementation of the innovation process. Thus, the final of the innovation process, i.e. innovation needs to be obtained with the least cost, and make sure that the innovation is meets certain requirements specified by the entity [11-14]. If the innovation activities are carried out for a longer period with regard to the same entities and situations, as a rule, such process will be ineffective. Thus, assessment of the organizational and economic mechanisms of the innovation process implementation is based on 3 criteria: 1)effectiveness – achieving an innovation to reach the goal, 2)economy - reasonable rate of expenses spent for obtaining the necessary innovation, 3)time – obtaining the necessary outcome within the possible time interval.

The assessment of organizational and economic mechanism realization can be undertaken in three phases [13-17]: 1)the evaluation of the effectiveness of the implementation of the innovation process, 2)the methodological principles of the mechanism for the evaluation of the innovation process, 3)the effects of the first and second stages of the innovation on the basis of integrated evaluation.

In addition, it should be noted that the selection of indicators for the assessment of organizational-economic mechanism, the correctness of the information, may be controlled, the adequacy, accuracy, attention is given to the appropriateness of the goal. Evaluation of the effectiveness of the innovation process is carried out from 3 aspects: 1)organizational management, 2)social and 3)production. The aspect of organizational management reflects the optimization rate, co-ordination and subordination relation rate of manufacturing system hierarchy. The social aspect characterizes consumer and social importance of innovation process. The production aspect characterizes production and technological level of the enterprise, as well as the level of employees' performance.

The system of analyzed integrative indicators indicates the effectiveness of the innovation application. This application contributes to the long term development strategy of the enterprise in the organization.

11. Conclusion

In accordance with the requirements of globalization and information society, in order to develop the economy based on knowledge and technology we have to modernize scientific and technical infrastructure, to ensure the integration of science, education, and production, to increase the efficiency of innovation processes, and to develop an infrastructure of the innovation performance. From this point of view, in order to ensure sustainable development of the economy, as well as the industry, we have to pay more attention to non-oil sector, especially ICT and high-technology sector.

The structure and the nature of innovation processes are reflected in the generation of innovation idea, in the development of new product and operations, their realization in the market, and their transfer to other areas properly. In such circumstances, the practical realization of scientific and technical ideas and knowledge, in other words, their transformation into innovation processes needs to be organized and managed efficiently. In this case, taking into account above mentioned characteristics of each stage, the improvement of the process has to be achieved. Here, the systems that can be applied to the automation of available processes should be used. A strategic plan has to be developed basing individual factors that affect these processes, and regulations have to be carried out through proper corporate governance mechanisms. As a result of the complex implementations, scientific and technical ideas are transformed into innovations more effectively.

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