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The innovation activity of higher educational institutions of the Republic of Kazakhstan

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The monograph examined the content of the concept of innovation activity and its role in the development of the higher education institution. Foreign experience in the development of the innovation activity of universities is systematized. The analysis of the legal framework of the universities' innovation activity and the evaluation of the scientific and research potential of the Republic of Kazakhstan were provided. A particular attention is paid to assessing the effectiveness of innovation in higher education. The interaction mechanism of the university with the business sector in the process of commercialization of university research at the regional level was presented. The prospects for the establishment of research universities in Kazakhstan are considered.

The monograph is intended for researchers, doctoral students, teachers, specialists of government bodies, students of economic faculties.

CONTENTS

ACRONYMS AND ABBREVIATIONS

R&D	Research and development
HEI	Higher educational institution
IA	Innovation activity
SIA	Scientific and innovation activity
FR	Fundamental research
AR	Applied research
NRU	National research university
USA	United States of America
UK	United Kingdom
IASP	International Association of Science Parks
IARU	International Alliance of Research Universities
DAAD	German Academic Exchange Service
ERC	European Research Council
OECD	Organization for Economic Co-operation and Development
PhD	Doctor of Philosophy
RK	Republic of Kazakhstan
PFD NIS	Program on the Formation and Development of the National Innovation System of the Republic of Kazakhstan for 2005 – 2015
NIS	National innovation system
JSC	Joint stock company
GDP	Gross domestic product
SPFIID	State Program of Forced Industrial and Innovative Development of Kazakhstan for 2010-2014
GVA	Gross value added
SPIID	State Program of Industrial and Innovative Development of Kazakhstan for 2015 - 2019 years
TTC	Technology Transfer Center
HSE	Higher School of Economics
TCO	Technology Commercialization office
EXPO	World exposition
QS	Quacquarelli Symonds
ARWU	Academic Ranking of World Universities
PUB	Total number of citations of the organization within Web of Science Core Collection
N&S	Number of articles published in the journals "Nature" and

	"Science"
SEC	Social-and-Entrepreneur Corporation
RVF	Regional Venture Fund
SME	Small and medium enterprises
NATD	National Agency for Technological Development
IQAA	Independent Quality Assurance Agency
bln.	billion
SEZ	Special economic zone

FOREWORD

In the transition to an economy based on knowledge, the implementation of the innovative potential of domestic higher education institutions is a prerequisite for effective social, economic and cultural development of the country. Science has a capacity and must be a source of innovative domestic technologies. In many countries, higher education institutions have become a source of innovation knowledge and breakthrough research ideas that are being implemented at an increasing rate in the industry creating high-tech product markets. Today universities are not only educational organizations; their role became broader. Universities along with the business and government are the main participants of the innovation process and the quality of their engagement in it highly depends on the management of the innovation activity within the organization.

Presently the efficiency of the modern institution of higher education largely depends on the degree of the innovation activity and the ability to respond to market needs, speeding the way from having a scientific idea to its practical implementation into production. For this, it is necessary that universities be embedded in the innovation system, actively develop a cooperation with the business taking on the role of catalysts and activators of economic and social development.

The majority of Kazakhstani universities is characterized with a high scientific activity; however, it is obviously a "technology gap" in the technology transfer chain related to the lack of the financial support and the adequate maintenance of the phase of prototyping and producing prototypes of high-tech products by local enterprises. Overcoming this gap is of great importance for the development of the innovation system of Kazakhstan, as the domestic R&D is involved in the whole innovation process and its implementation can bring a positive impact on all subsystems of the national innovation system.

The degree of involvement of scientific and research potential of Kazakhstani universities in the development of the innovation economy remains relatively low. The problem of the development of the innovation infrastructure of higher education organizations is not fully resolved. University graduates are mostly uninterested in working in the sphere of the scientific research and innovation. Higher education

institutions play a secondary role in conducting cutting-edge researches, which serve as a basis for elite university training. National priorities identify the university education as an outreach, auxiliary field, rather than as a productive and innovative one. However, the training of high-quality human capital is impossible without the development of science. Academic science, in isolation from education, economics and business, is bound to further stagnation.

In this regard, the creation and development of a comprehensive innovative university activity aimed at the establishment, development of the innovation infrastructure, as well as the commercialization of the results of its research and development carried out by the research and teaching staff become increasingly important. The infrastructure of the university innovation activity should ensure the creation of effective transfer of research and development results into the real economy: the evaluation of the commercial potential of elaborations and the development of strategies of research results commercialization; the legal protection of intellectual property; the development of business plans; marketing researches; the examination of innovative projects; advising on various aspects of innovation; the preparation and obtaining of license agreements.

Despite the fact that universities now train specialists in various fields for the national level of the country, it is important to understand the impact of the university on the social and economic development of the region in which it is located. The success of the university operation depends largely on how well the university forms connections with the other participants of the innovation system at the regional level. A higher educational organization today is not only engaged in relations with regional socio-economic institutions. The university provides new links, designate new areas of the mutually beneficial cooperation for all engaged parties.

Thus, today the formation of research universities in the republic on the basis of leading higher educational institutions is of great importance. They provide the development of innovation infrastructure, carry out extensive researches, conduct a relevant training for the innovation economy, and create new opportunities in the region. Research universities may attract research, industrial, innovative enterprises into their orbits, create new forms of the integration with the enterprises of the real sector of the economy, form the scientific-

innovation sphere.

The concept of the research (innovation, entrepreneurial) university emerged as a response to the new needs of a society that expects universities to contribute to the social and economic development. The research university is seen as a scientific and educational complex with a developed innovation infrastructure (training facilities, laboratories, research institutes, design offices, business incubators, technology parks, R&D organizations) carrying out a full cycle of innovations, which allows to get a profit and is able to carry out the training of specialists possessing skills of innovative entrepreneurship. It is important that the aim of the research university is organizing the relationship and co-existence in one physical space and interactive regime of the processes of education, a scientific research and the commercialization of its results, which may impact on the development of the innovative environment and high-tech clusters in the region.

The need for facilitating the innovation activity of higher educational institutions, the development of interactions between universities in the process of the commercialization of innovation developments with the participants of the innovation system determines the relevance of this monograph.

1 THE ROLE OF RESEARCH AND INNOVATION ACTIVITY OF HEIs IN THE DEVELOPMENT OF INNOVATIVE PROCESSES AT THE REGIONAL AND NATIONAL LEVEL

1.1 Theoretical aspects of the innovation and innovation activity

The scientific and technological revolution of the XX century has attracted the attention of economists to new phenomena that emerged in the process of technological changes in the production. One of these phenomena is the concept of "innovation". Appearing in scientific researches of the XX century, it originally meant the penetration of some elements of one culture to another (customs, ways of life, including production). In modern understanding, the innovation is an update, transformation of any activity, leading to the replacement of some of its elements by other, more advanced ones, or complementing the existing elements with new ones.

Innovations are means of solving industrial and commercial tasks of all economic agents. The interest of business entities to it is due to the desire to get a share of the effect of the outcomes of innovations. It is often a share of future profits from the sale of innovations, although the effect may act in any other form [1].

The works of Schumpeter and N.D. Kondratiev provide the basis of the theory of the innovation development.

Kondratiev made a great contribution to the development of the fundamentals of the innovation theory, being one of the first to highlight the key role of scientific and technological innovations in the country's economic development [2,3]. By analyzing a large amount of statistical data for the four countries (Germany, the UK, the USA and France), he came to the conclusion that the economy is marked by wide waves with a period of 40 - 60 years. As a result of the study, the researcher found a relationship between the beginning of the upward waves of large cycles and dramatic technological changes in society, that are expressed in the major inventions, the introduction of innovative technologies into production [3].

The theory of Kondratiev waves was developed in the studies of the Austrian scientist J. Schumpeter. According to him, innovations are accompanied by a creative destruction of the economic system, creating conditions for its transition from one state to another. This transition is

associated with changes in the dynamics of economic indicators. Also, Schumpeter put forward the hypothesis that the long-wave fluctuations of economic conditions are associated with the emergence of a concentration (clustering) of important innovations in relatively short periods of time. Thus Schumpeter paid a great attention to the role of the entrepreneur in the innovation process, which introduces innovations in periods of stillness and balance. These innovations result in a breach of continuity, require giving up all of the old things in favor of new unusual ones (products, forms of the organization) and are associated with a risk. With the displacement of the old the process of "creative destruction" begins. Schumpeter disclosed the main characteristics of innovation processes in conjunction with the cyclical development of the economy in "Business Cycles", published in 1939.

The followers of the innovative direction of the theory of long waves include Simon Kuznets, Gerhard Mensch, Alfred Kleinknecht and others.

The works of S. Kuznets played a major role in the study of innovations. He introduced the concept of "epoch-making innovations", which underlie the transition from one economic era to another one. The innovations such as modern science and its rapid pace of development are at the heart of any social transformation, its transition to a new stage of development. According to S. Kuznets, innovations can have both positive and negative sides. The state's function is to promote economic growth, the selection of the legal and institutional innovations [4].

In modern science there are some discussions on the definition of concept of innovation.

R. Nelson and N. Rosenberg define innovation as "the process by which companies create and implement in practice the products and production processes, new to the firm or to the country, or do not have analogues in the world" [5].

A.I. Prigozhin in his works shared concepts the "innovation" and "novelty". According to him, novelty is the subject of innovation, that is, development, design, manufacture, use and obsolescence. In turn, innovation is the emergence, diffusion, routinization (the stage at which innovation "is implemented in stabilized, permanent operating elements of relevant objects") [6]. We agree that the term "novelty" should be considered equivalent to the concept of "innovation". By innovation we

mean the process of contributing to the development and improvement of the innovation activity efficiency.

According to B. Twiss, innovation is a process in which an intellectual product - the invention, information, know-how or idea - gets its economic content [7]. The works of some authors emphasized social usefulness of changes, technological changes, which can be considered as innovation. Thus, V.N. Lapin understands innovation as a complex process of the creation, dissemination and use of new practical tools to better meet the specific needs of the people [8].

The most comprehensive definition of innovation as a process was made by B. Santo, where innovation is a public, technical and economic process, the practical use of the ideas and inventions, which leads to the creation of the best properties of products, technologies, focused on the economic benefits with additional income which covers the whole spectrum of activities - from research and development to marketing [9].

The works of some scientists reflected the interpretation of innovation as a result of the realization of knowledge in the finished product. Thus, according to B. Milner, innovation is a creative process or a result of turning an idea into a useful product, service or method of performance; a method of organization to transfer knowledge into practical innovations to meet the needs of individuals and organizations, social groups and the whole society [8, p.22].

In the works of researchers S. Glazyev and Y. Yakovets innovation is considered in close relationship with scientific, technical and economic cycles. Innovation is the basis for periodic updating, which is necessary to overcome the crisis of any social system. At the same time Y. Yakovets defines innovation as "entering of new elements (types, methods) into a variety of human activities that improve the effectiveness of this activity" [10, 11].

The law of the Republic of Kazakhstan №135-III dated March 23, 2006 "On the state support of the innovation activity" defined innovation as "results of scientific and technological activities, received a realization in the form of new or improved products (works, services) or a technology, having the advantages of using quality in practice, compared with previous ones and having applied economic and (or) public benefit" [12]. In the law of the Republic of Kazakhstan № 534-IV dated January 9, 2012 "On the state support of the industrial and innovation activity» innovations are treated as a "result of the activity of

individuals and (or) legal entities, received their practical implementation in the form of new or improved production facilities, technologies, goods, works and services, organizational solutions of technical, production, administrative and commercial nature, as well as other socially useful results with a view to ensuring environmental safety in order to increase economic efficiency" [13].

Thus, in our opinion, under innovation should be understood the final result of human intellectual activity, embodied in the form of a new or improved product, which is used in practice and demanded by the market.

The literature presented sufficiently detailed classifications of innovation, depending on the novelty, the depth of the changes, and others. The most famous of them are the classifications of S.D. Ilyenkova [14], P.N. Zavlin [15], R.A. Fatkhutdinov [16].

Currently, the International Standards of Science, Technology and Innovation Statistics, as well as the national statistics contain the concept of technological innovation. Technological innovation is the activity of organization, related to the development and introduction of innovations. In particular, in the industry it is implementation of technologically new products and processes, as well as significant technological improvements in products and processes [17].

In turn, technological innovations in the industry are divided into product and process innovations. Product innovations include the development and implementation of technologically new or technologically improved products. The improvement is understood as the significant enhancement of technical product specifications, individual components, materials, and other functional characteristics.

Process innovations include the development and implementation of technologically new or significantly technologically improved production methods, including delivery of products [17, p.87]. These innovations include significant changes in technology, production equipment and / or software [18].

Indicators of expenditures on the technological innovation play an important role in innovation statistics, because of their economic importance for the assessment of the conditions and prospects of technological development.

Created innovations serve several socio-economic functions. The economic ones include the following three functions:

1. Reproductive.
2. Investment.
3. Stimulative.

The essence of the reproductive function is to make a profit from the introduction of innovation and the use of it for the further development of science and technology.

Profits derived from implementing innovations can be used in various fields, including capital. This capital may be used to finance new types of innovation. Thus, the use of profits from innovation for further investment is the content of the investment function of innovation.

The profit received by the entrepreneur from the introduction of innovation stimulates him/her to further innovation activity, becomes an incentive to improve the organizational and technological conditions of production, and to search for modern innovative management methods.

Innovations do not appear out of nowhere. As a rule, innovation is a product (final result) of an entrepreneur innovation activity, which belongs to a particular business entity.

Innovation activity is an activity aimed at the use and commercialization of the results of research and development to expand and update the range of products and improve the quality of products (goods and services), improve their production technology, followed by the introduction and effective implementation in the domestic and foreign markets [19].

Innovation activity involves a complex interaction of scientific, technological, organizational, financial and commercial activities, which together give rise to innovation.

At the heart of innovation is the scientific and technical activity, which is closely associated with the creation, development, dissemination and application of scientific and technical knowledge in all fields of science and technology. As a rule, scientific and technical activities are carried out in research institutions, including universities.

The process of creating and using innovation consists of several steps that make up the life cycle of innovation. The innovation cycle is a temporal sequence of equal steps, representing a combination of functionally separate activities at every stage. The life cycle of innovation and process-time characteristics are shown in Figure 1.

The innovation process begins with the stage of exploratory research that implements the results of basic research. Research work is

conducted in academic institutions and major scientific and technological organizations of the industry by qualified personnel. At this stage, the main sources of funding a research are the state budget funds allocated on an irretrievable basis.

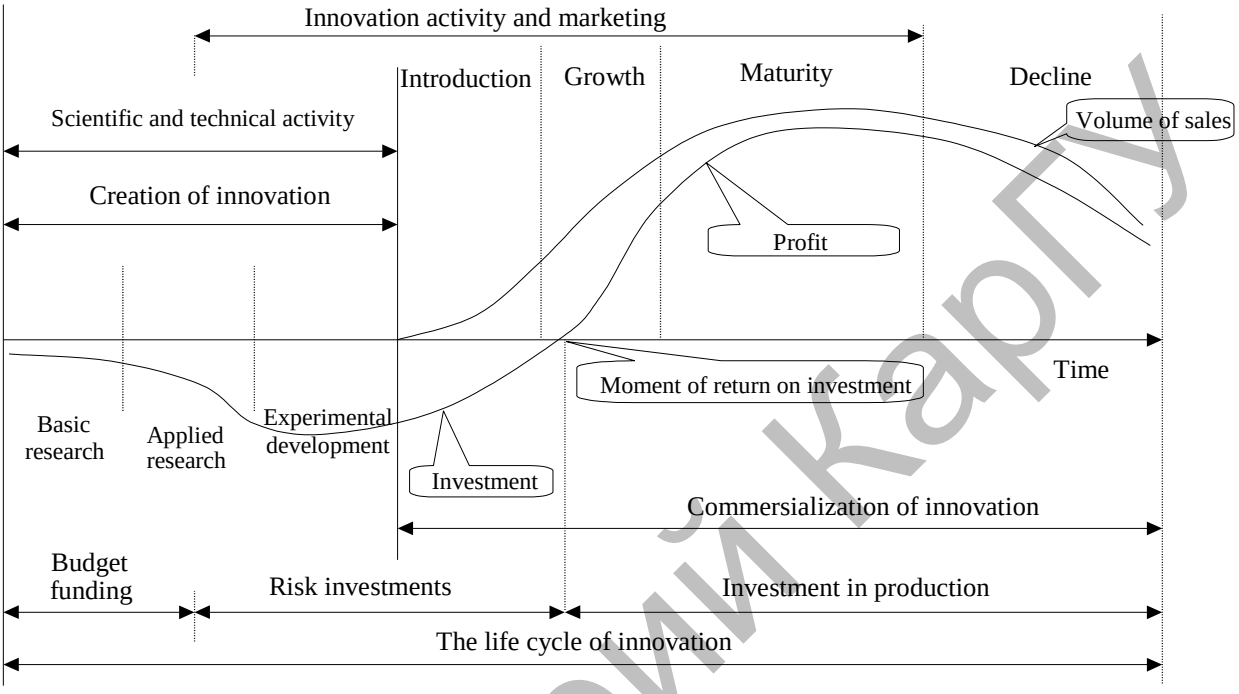


Figure 1 - The life cycle of innovation

Note - compiled by the author based on Vasiliev [20]

The second stage of the innovation process deals with carrying out an applied research (AR) that can be financed by third-party investors. Because funding of applied researches includes economic risk, the investment for these purposes is called risk investments. Any applied research is conducted by a scientific and technical organization of the industry and universities' departments in various spheres of research and development. The experimental developments are performed in the third stage of the innovation process.

The commercialization of a new product is carried out on the fourth stage. This stage requires a lot of expenses for the reconstruction of production facilities, training personnel, promotional activities, etc. At this stage of the innovation process of the market the reaction to the new product is not yet known, and investments continue to have a risk character.

The life cycle of an innovative product goes through four phases – the research and development for the creation of innovations, the technological development of large-scale production, stabilization of volumes of production, the gradual decline in production.

The creation and distribution of innovations in material production is achieved through the organization of innovation. Innovation activity is a mediating link between science and industry, a kind of productive force, the integration of scientific and material production, the implementation of technical and economic needs of economic entities through the use of scientific products.

After the work of Schumpeter much attention in a market economy was given to the entrepreneur (innovator), who was the main subject of the innovation, and is the driving force for change, disturbing the equilibrium of the economic system. However, today innovation activities cover all elements of the innovation system, either directly or indirectly involved in the creation of an innovative product. With regard to higher education institutions, universities, their innovation activities are carried out in close connections with researches, therefore, in the framework of universities such activity is essential and has a character of scientific innovation.

In the literature, there is no common definition of the innovation activity. Innovation activity can be defined as efforts to establish innovations [21], a process aimed at their creation and practical implementation [22], the process of transfer of new ideas into innovation [21]. The basic contradiction of the above points of view, that one includes the innovation activity as the creation and "implementation" of innovation whereas the other one - only the creation. While some experts believe it to be right to build the definition of innovation activity based on the concept of innovation, others give findings from the innovation activity, explaining that innovation is "the final product of the innovation" [22]. Proceeding from what has been said, it is necessary to focus on the definition of the innovation activity, possibly not depending on the concept of "innovation".

Thus, the innovation activity is an activity aimed at the practical development of research and development outcomes, the improvement of the efficiency of the production processes used in practice (including development of new products and technologies in production), and, also, at the practical development of the results of research and development, ensuring the creation of a new or improved products, sold in the market.

IA includes research and development, aimed at the achievement of commercial requirements to product, process, technology and other research results.

Innovation activity is a specific type of an activity for the creation, dissemination and reproduction of innovations in the economic sphere. It is a complex of scientific, technological, organizational, financial and commercial activities aimed at the commercialization of accumulated knowledge, technologies and equipment. The result of innovation activity is new or additional goods / services or goods / services with new qualities.

Exploring innovation activity of research institutions and universities, we believe that in any case, this assessment will be different from the estimation of IA of the industrial enterprises. The innovation activity of higher education institutions in many respects is identical to the innovation activity of scientific organizations. With regard to the innovation activity of scientific organizations and universities it is often named "scientific and innovation activity".

Under the scientific and innovation activity (SIA) we understand the innovation activity focused on creating and completing innovations by means of scientific activity, i.e. the scientific and innovation activity can be regarded as IA in a scientific (or mostly scientific) organization.

The State law of the Republic of Kazakhstan "On science" considers different types of scientific activities: fundamental research, applied research, experimental development.

Fundamental (basic) research (FR) is a theoretical and (or) experimental research aimed at obtaining new scientific knowledge about the basic laws of the development of nature, society, man and their relationship.

Applied research (AR) is an activity aimed at the acquisition and application of new knowledge to achieve practical goals and specific objectives.

Research and development (R&D) is a set of performances carried out during the creation or modernization of production, the development of a design and technological documentation for prototypes, the manufacturing and testing of prototypes and utility models.

The results of scientific activities must be protected by a protective document. The legislation of the Republic of Kazakhstan, in particular the "Patent Law of the Republic of Kazakhstan" dated July 16, 1999 №427-I, as well as international law in the field of intellectual property

formulate the next concepts for the objects of industrial property rights resulting from the scientific research and development.

A patent is a protective document certifying the exclusive right of authorship and priority of an invention, an utility model or an industrial design [23]. The validity of a patent in Kazakhstan depends on the object of patenting and ranges from 5 to 20 years. Patent may be extended for up to 5 years.

A patent for an invention shall be valid for twenty years from the filing date. In some cases the term of an exclusive license and a patent certifying this right can be extended at the request of the patent holder, but for no more than five years.

A patent for utility model is valid for five years from the filing date. A patent for an industrial design is valid for fifteen years from the filing date. Its validity may be extended at the request of the patent holder, but for no more than five years.

To develop scientific and innovation activities in the Republic of Kazakhstan and to increase the efficiency of its functioning, universities and scientific organizations that carry out this activity need the full support of the state.

1.2 The university as a subject of the innovation activity and a source of the scientific and technological potential of the country

Higher education system of the country includes both public and private higher educational institutions. Training of specialists at various levels and conducting of a research are carried out in the following types of higher educational institutions: national research university, national higher educational institution, research university, university, academy, institute and equivalents (conservatory, high school) [24].

University is a higher educational institution implementing educational training programs of higher education, master and doctoral studies in three or more groups of specialties, carrying out basic and applied researches, and acts as a scientific and methodical center. As a rule, the university implements training of specialists in a wide range of natural sciences, humanities and other areas of science, technology and culture. Most universities include in their structure several faculties, where they have a set of various disciplines that make up the foundations of scientific knowledge. In public life, the university plays the role of a conductor of scientific knowledge, culture and education.

Over the recent years, national research universities (NRU) were developed in Kazakhstan. NRU is a higher education institution which has a special status and development program for five years approved by the Government of the Republic of Kazakhstan. It implements self-developed educational programs of higher and postgraduate education on a wide range of specialties, using the results of fundamental and applied research for the generation and transfer of new knowledge. Thus, the difference of a research university is its focus not only on scientific activity, but also on its successful commercialization.

Academy is a higher education institution implementing educational training programs of higher and postgraduate education in one or two groups of specialties. Scientific researches at the academy are conducted mainly in one of the areas of science, technology and culture.

Institute is an institution of higher education, implementing educational training programs of higher education in several areas of science and technology and carrying out scientific researches.

The staff of the higher education sector of the republic science includes employees of universities and research organizations who are engaged in research and development or directly deal with research activities.

The activity of educational institutions, implementing educational programs of higher and postgraduate education of the Republic of Kazakhstan, regardless of the form of ownership and departmental affiliation is regulated by the Typical Activity Rules of higher and postgraduate educational institutions issued October 16, 2013 №420 [25] and is carried out in accordance with the Law of the Republic of Kazakhstan "On education" dated 27 July 2007.

According to the law "On science" the main activity carried out by the higher educational institution along with education is scientific, scientific-technical and innovation activity, including the realization of the rights on intellectual property, as well as conducting research and development activities. The law disclosed the concepts: fundamental research, applied research, experimental development.

Scientific research is carried out in universities in specialized research units (problematic and industrial laboratories, research institutes at universities) and the faculty departments. The main forms of participation of the teaching staff in university R&D is to draw them in combination to carry out the research of the state scientific grant

funding, contractual research topics, working part-time in the industry and problem laboratories, research initiatives.

However, at present the contribution of all universities in research and development conducted in the Republic of Kazakhstan, does not meet their human resource potential. More than 42.9% of all scientific and pedagogical workers of the country perform the amount of research not exceeding 20% of total expenditures on science, which is due to insufficient involvement of higher education institutions to carry out applied research and development work. A small amount of design and technological work does not contribute to the commercialization of existing research and development. Technical, scientific, laboratory, research and development base requires to be strengthening [26].

The basis of the innovation process is a process of creation and development of new techniques and technologies. At the beginning of this process there is the fundamental research aimed at obtaining new scientific knowledge and identifying the most significant laws. The aim of the FR is to uncover new links between phenomena, to know the laws of nature and society, regardless of their specific use. The fundamental research is the generator of new ideas and opens up new areas of scientific knowledge.

Today, there is a qualitative change in the role of basic science in the innovation process. Previously, fundamental research was carried out in research institutes not directly related to industrial production. Now basic research is an integral link in the whole innovation cycle. The transition to an innovation economy demands a rapid and large-scale embodiment of new research ideas into finished industrial products. In connection with this basic research must be carried out ahead of industrial needs.

Since fundamental research requires large amounts of funding, and the results do not always lead to concrete results, the funding should be mainly due to the budget, and, in part, large companies.

The next stage of the innovation process is the applied research. It aims to study ways of practical application of previously discovered phenomena and processes. Research work of applied character aims to solve the technical problems, clarify theoretical questions, obtaining concrete scientific results that can later be used in the development work. Also, the AR can be independent scientific research.

During the development work the results of applied research is applied to create (or upgrades, enhancements) the prototypes of new equipment, utility models. R&D is a kind of transition from laboratory and pilot production to industrial production. R&D include: development of design and technological documentation; development of prototypes of a new facility; development of technological processes, i. e. ways to combine physical, chemical, technological and other processes in an integrated system of labor (engineering works).

The final stage of the sphere of science is the development of industrial production of new products. The production includes scientific and industrial development, testing of new (improved) products, as well as technical and technological preparation of production.

The development stage is performed by experienced, experimental works on the basis of experimental science. Their goal is the manufacture and testing of prototypes of new products and processes.

After the development stage, the process of industrial production (IP) begins. The knowledge is materialized in the production of goods, and the study finds its logical conclusion. In a market economy, there is an acceleration of the implementation of the R&D and the stage of development of production. Innovative enterprises, as a rule, perform R&D contracts with industry.

Customers and performers are mutually interested in ensuring that the R&D results are implemented in practice and bring in revenue, i.e. they would be sold to the consumer.

Innovative process includes a cycle of working off of scientific and technical idea to its implementation on a commercial basis. Innovative processes to a greater extent than other elements STP are associated with market relations. Most of the implemented innovations are realized in the market economy by business structures as a means to solve industrial and commercial problems.

At present, the mechanism of continuity between science, technology and production, which existed under the planned economy, had been destroyed, while the new mechanism to support the innovation process only began to take shape, to adapt to the realities, due to the new socio-economic situation. For a long time high school science was detached from industrial production, enterprises introduced only a few developments of local scientists.

Today, the university is recognized as one of the main elements of the national innovation system. It not only provides replenishment of scientific personnel in the country, but also carries out fundamental and applied research, patent inventions, is involved in the process of commercialization of intellectual property.

The State Program of Development of Education of the Republic of Kazakhstan for 2011-2020 [27] formulated the long-term objectives of inclusion of higher education sphere in science, research and innovation processes. Accepted on 18 February 2011 the law of the Republic of Kazakhstan "On Science" laid the foundation for development in the country of research universities, whose distinctive feature is the integration of scientific research and educational process at all levels of higher and postgraduate education [28].

Research university independently develops and implements the standards of high school educational programs. The university has the right to impose additional requirements of profile orientation when applying for training programs of higher and postgraduate education.

Like all over the world, in Kazakhstan the higher education in its inseparable, organic connection with the science becomes more and more powerful driving force of economic growth, increasing the efficiency and competitiveness of the economy [29].

One of the most important specific features of high school, which has a direct impact on the development of innovative processes in the country, is its great innovation potential, which is based on high school science. Universities are that structures that have a major impact on the key factors of innovation development of a territory:

- training system of innovation has established and developed by the efforts of higher education institutions;
- higher educational institutions are the sources of research and development, innovative ideas;
- experts of higher educational institutions advise regional projects, regional development programs;
- a powerful intellectual and scientific-technical potential is concentrated in higher educational institutions.

Today the actual issue is the assessment of scientific and technological potential. This is important not only in theory but also for prediction its development. The potential allows to calculate the efficiency of scientific and technical activity, which does not reflect a

direct causal link between the results of these activities and their implementation in the economic and social spheres. As is known, the ultimate effectiveness of innovation can not be a global parameter for evaluating scientific and technical potential. However, so far it failed to establish a common methodology for quantitative and qualitative evaluation of the scientific and technical potential of the country, sector, region or organization.

The scientific and technical potential plays an important role in the solution of specific technical, economic and social problems. However, by itself the developed modern scientific and technical potential cannot guarantee the achievement of the real effect of a scientific and technological activity, which depends on external factors that are outside the scope of its activity. Restricting the scale of implementation of innovations in science and technology may be due to the unpreparedness of the innovation and production capacities or their constituents effectively and timely implement the opportunities provided by the scientific and technical potential.

Research in this section of the university, as the subject of innovation, revealed the basic role of higher education institutions in the formation of the scientific potential, providing an effective innovation in the regions.

Regions should promote such scientific and technological policy which is aimed at the development of competitive advantages of universities and industries located in the region. Today, the majority of administrative decisions in the field of innovation activities relies on the results of the world science and international experience in the development of innovation activity.

1.3 Foreign experience of the development of the innovation activity of higher educational institutions

The transition of the republic to a knowledge-based economy raises the issue of the intensification of innovative processes in the educational and scientific activity of universities. Practices of foreign countries in this field can be extremely useful for achieving this goal.

The innovative development of higher educational institutions is a purposeful activity that focuses on fundamental organizational and structural and content-educational transformation of HEIs, contributing

to a significant increase in the effectiveness of their educational, scientific, technological and entrepreneurial activity and allows to achieve significant scientific, technical and educational outcomes, a significant impact on the condition and quality development of the innovation economy in the country, as well as provides a high degree of competitiveness and the professional competence of graduates.

In present days, most universities of Europe countries, the USA, Japan, China, Singapore, Israel, Australia and many other countries are characterized by the innovative development of education and, in particular, higher education and post-graduate. Higher education is considered by the west countries as a priority of internal policy that attracts large amounts of funding from government and private sources. In particular, the program "National Goals of Education" which operates in the US, emphasizes that education is the main indicator of the quality of life, the core of the economic power and security, the creative potential of science, culture and art [30]. In many ways the result of this approach is the rapid development of innovation systems of these countries and the efficient functioning of the economy.

Along with that the higher educational institutions may use the following models of innovation development: entrepreneurial university, university-technopolis, university cluster, vertical and matrix universities, French, Swedish, Danish, Chinese, South Korean and other innovative development models of university development [31].

The experience of developed countries shows that the core of an effective innovation system is science parks with a research university in the center of the community and small innovative firms, including risky ones.

Research universities are the major centers of the world science, which functional specialization provides the production of new knowledge and the training of specialists and professionals of the highest class, who are able to orientate quickly and make the right decisions under conditions of uncertainty.

The examples of such universities are Oxford and Cambridge University in the UK, Yale University, Stanford University (Silicon Valley), Massachusetts Institute of Technology and Harvard University (Science Park "Highway №128») in the United States, the Sorbonne, and Sophia Antipolis in France, the Phillips-University in Germany, "Skolkovo", "Strogino" and Lomonosov Moscow State University in

Russian Federation, and others.

To enhance their capacity the research universities and science parks are united with alliances and associations. International Association of Science Parks (IASP) operates nowadays. It is the main and only international organization that brings together technological and scientific parks of the world, as well as national associations. Its activities are focused on the organization of cooperation between the leading experts of science parks around the world and provision of services that enhance the quality and efficiency of operation of the association.

In late 2005, the International Alliance of Research Universities (abbreviated IARU) was founded. It is an alliance of 10 leading science-intensive universities in the world. The alliance includes research universities of the UK, China, Singapore, the USA, Australia, Japan and Denmark. The members of the Alliance are collaborating on a number of research projects, including climate change, aging, sustainable urban development. The members of the alliance develop the student exchange programs, staff development and strengthening of inter-institutional relations.

Currently, there are three main types of models of the scientific and innovative development of industrialized countries:

- The country is focused on leadership in science, the implementation of large-scale targeted projects, covering all stages of the research and production cycle, usually with a significant scientific and innovation potential in the defense sector (the United States, UK, France);

- The country is focused on the dissemination of innovations, the creation of a favorable innovation environment rationalizing the entire structure of the economy (Germany, Sweden, Switzerland);

- The country that stimulates innovations through the development of the innovation infrastructure, ensuring sensitivity to the achievements of the world scientific and technological progress, coordinating the activities of various sectors in the field of science and technology (Japan, South Korea) [32].

Higher educational institutions abroad, especially universities, are the main centers of science. Some of them are now transferred to the leading research institutions of the national and even international scale.

The high level of the university research in the developed countries

largely determines their competitive advantages, allows a more efficient use of materials, financial and human resources to address the economic problems.

The system of public funding of science in higher educational institutions of Western countries has changed recent years. In absolute terms the cost of the state support for R&D activities is continuing to grow, but since the mid 70-s the share of the state support in the general amount of financial resources spent on R&D has been tending to decrease.

At the same time in this period the processes of the commercialization of the scientific research have been developed. Venture capital financing was developed also with the purpose to increase the funding of R&D of higher educational institutes. This also contributed to public policy incentives for the creation of technopolis and technology parks, research laboratories and research centers on the basis of leading universities.

Through the financial support of R&D field the developed countries plan to achieve the following strategic objectives:

- bring together science (universities) and private equity (enterprises) to promote the interaction of fundamental and applied sciences;
- create a favorable market mechanism of implementing research results of in the industry;
- use the scientific potential (scientific discoveries and technologies of dual purpose), accumulated in the military sector of the economy, for the needs of civil production [33].

Overall public expenditure on higher education, depending on the features of the state policy in the sphere of the national economy, ranges in the average from 40 to 80% of the total expenditures for higher education. At the same time, the scientific sector has got the most of the financing of high school.

In the US, the UK, Germany, and also in the newly industrialized economies (South Korea, Taiwan, Singapore, Hong Kong) a system of state grants for research has evolved.

Thus, for example in Germany, scientific research is supported by public services and various organizations, including major non-university research institutions, including private investors. The most important funding organizations in Germany are: the Government of

Federal States, funding departmental research and research projects; Academies, Otto von Guericke Society; research foundations and associations, including the Alexander von Humboldt Foundation; Funds support gifted young people; Leibniz Society; The Max Planck Society for the Advancement of Science; other funds in Germany and the German Academic Exchange Service (DAAD).

The European Union provides financial support for research activity in many different ways. This is action research programs, support for fundamental scientific research by the European Research Council, and support for young scientists exchange programs between European countries. The European Research Council (ERC) and the program of the European Commission's "Marie Curie Actions" support, for example, young scientists in Europe [34].

Today, the use of diversified sources of funding becomes a hallmark of higher educational institutions, actively developing the research activities. This multi-channel financial framework allows universities to act more independently and to find funding for research in different disciplines and areas.

The research of the practice of R&D organization in the leading universities of the world allowed the author to identify the following features of innovative development of the universities that are typical for most countries.

1. Strengthening the university autonomy. Financial autonomy of higher educational institutions is a major landmark in the world practice of the organization of education, despite the fact that in many countries the state is owned by the dominant role in the financial support of higher education. The increasing of the financial autonomy of universities shows a sharp decline in the share of state financial assistance. For example, in Germany and the UK requirements of higher education institutions to expand the autonomy of government links to the reduction of their funding from the state budget, reporting that if they want more autonomy, the universities need to make their own financial resources [35].

2. Careful development of innovative organizational models of universities. First of all, there is a transition from a linear (hierarchical structure) to a matrix one, which creates conditions for flexible, decentralized management [36]. Traditional universities are replaced by the following forms of organization of university activities: university-

technopolis, corporate universities, innovative entrepreneurial universities.

3. Compliance of the university training areas with the most demanded professions in society, as well as modern scientific and technological processes. In innovative universities, the training of personnel corresponds, and sometimes exceeds, the level of development of modern technological processes.

4. Formation of university interaction with the business sector in scientific and educational activities. Universities act not only as employers, representatives of professional education, but also become centers of innovative technological development of industry and social sphere through mechanisms of technology transfer, creation of innovation infrastructure, consulting organizations, etc.

5. The use of innovative online tools, forms and methods of teaching. The task of universities is not only the transfer of knowledge on the specialty, but also training of future specialists outside the box, flexibly and timely respond to changes that occur in the world. Much attention is paid to the problem-based learning, which provides for the development of skills to solve problematic situations that do not have a clear answer, independent work on the material and the development of skills to apply the acquired knowledge into practice.

6. Creation of innovative clusters. The cluster structure promotes around the university a belt of high-tech companies and high-tech industries, which create a unique opportunity for professional training in cooperation with partner companies. Within the cluster, major research projects, educational, economic, social and technological programs can be implemented.

7. Creation of inter-university centers of collective use of the equipment. Limited financial resources often do not allow universities to develop their own scientific infrastructure. In this context association and consortia of universities become relevant in the creation of specialized inter-university research centers [37]. Such centers, created on the basis of matching funds from different sources, are places of collective scientific use for all members of the consortium.

8. Internationalisation, transnationalisation and globalization of higher education; convergence of higher education systems of Western countries. The Bologna process has given impetus to the transformation of the university on the path of convergence with other universities.

Now there is opportunity of free movement between universities in the period of training (internships and international exchanges for teachers and for students, participation in international projects), as well as employment in any member country of the Bologna process, without the need for confirmation of the diploma or receiving additional education.

Thus, summing up the analysis of foreign experience of development of innovation activity of universities, it would be desirable to note the following. Research universities have received great development in the modern world. Their model is based on the interaction of three components: education, research and innovation. In this model, universities function as "knowledge centers", which aim to develop new features and innovations, especially at the regional level. In this model, universities are deeply embedded in the innovation system, are actively seeking to develop synergies and externalities, to link research with the introduction and commercialization, and take on the role of catalysts and activators of economic and social development.

Traditional functions for the university, such as training specialists and carrying out basic research, are complemented by its activities in transferring new technological developments to industry and the business sector. A complex of structures is formed around universities to ensure innovation activity of universities and close cooperation of the latter with industry and business.These structures include joint research and laboratory centers of universities and industry, science and technology parks, technology centers, industrial research consortia, centers of technology transfer and commercialization of intellectual property. Positive results of the functioning of universities as innovative university complexes reported in the United States, Western Europe, Japan and many other countries.

Market relations dictate a new competitive format for higher educational institutions. With the decline in the share of public funding, universities are learning to independently raise funds through the organization of interaction with members of the regional innovation system, as well as through intensification of the process of commercialization of their own scientific research. The practice of such activity may be used in developing countries, such as Kazakhstan, which has a great scientific and technical potential and developed educational system.

1.4 The role of universities as generators of new ideas and centers of innovation clusters of the region

Today the role of university in the society is increasingly changed. The development of knowledge-based environment demands the new functions of the higher education organization which are mostly focused on the creation of effective collaborations with many actors of the regional or national innovation systems and on the impact of the university on the socio-economic development of the nearby territory.

University may participate in economic and social processes on different levels. Education organizations are included into the innovation system on national level because they prepare the high quality specialists for the different branches of the economy and increase a fundamental knowledge by research process. Many HEIs, especially the older universities (such as Oxford and Cambridge in Britain) play a significant role in the process of nation-building and the formation of a national identity (OECD 1999)[38]. But there are a lot of new developing universities which have no significant effect on national level of economy but they may be more important in small regions and communities.

According to Sánchez-Barrioluengo (2013)[39]university not only prepares the qualified human capital but also provides technological capital and knowledge stock. These effects promote university involvement in regional economic processes in addition to the traditional functions of teaching, research and transfer of knowledge. Meanwhile, Chatterton & Goddard (2000) [40] explain the increasing importance of universities in regions by the fact that the economy itself becoming more regionalized. Along with processes of internationalization of production and mobility of global capital flows there is a decline in regulatory capacity of nation-state. A shift to the integration of production at regional level and decentralization of large corporations into smaller clusters with medium and small business is becoming more obvious.

Last two decades many conceptions about the role of university in new economic conditions were considered in the literature. Among them there are the concepts of research (innovation, entrepreneurial) university by G. Etzkowitz (2000) [41], “engaged” university (Holland 2001), conception of “third mission” of University and others. Different approaches are connected with different functions and activity of

university which it produces on a national and regional scale.

Considering the evolution of the role and mission of the university in social and economic life, Youtie&Shapira [42] describe 3 models: traditional, present and evolving (Figure 2).

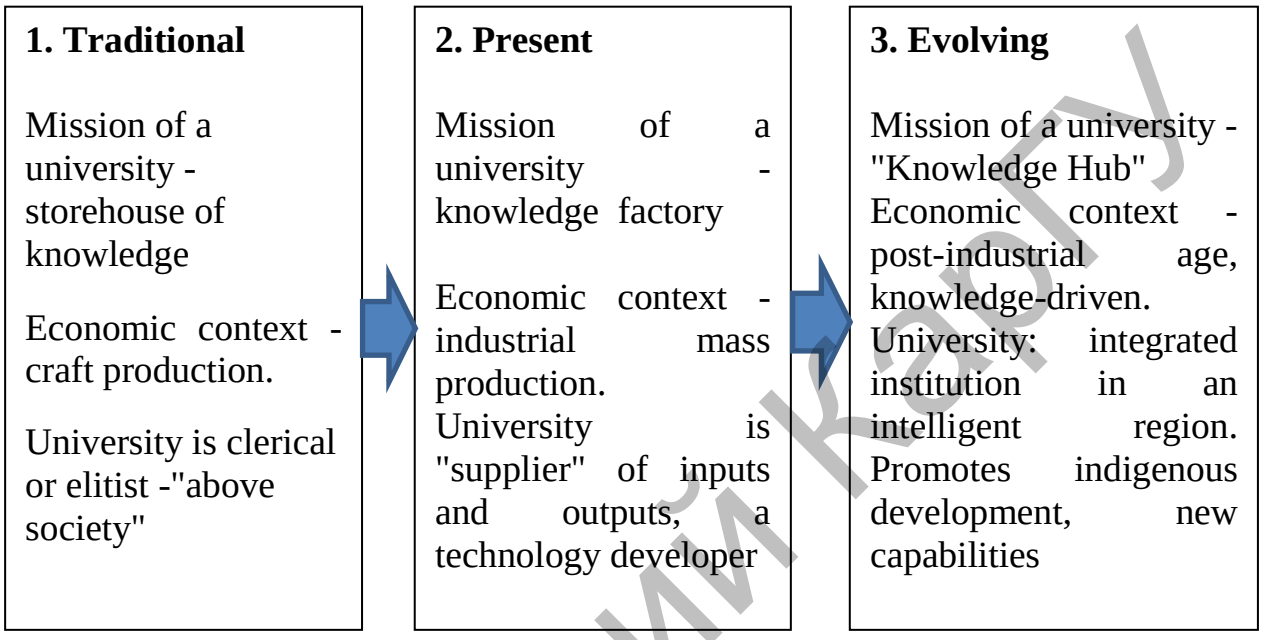


Figure 2 - Evolution of the models and the mission of a university
Note - Source [42]

The third model of universities appeared in recent decades. In this model universities function as "knowledge hub", which aim to develop new opportunities and innovation, particularly at the regional level. In this model universities are deeply embedded in the innovation system, actively tend to develop synergies and spillovers to link research with the implementation and commercialization, and act as catalysts and activators of economic and social development. Universities, of course, have always been institutions of knowledge, but in the third mode, the institute aims to use knowledge actively to contribute to the development and creation of new opportunities in the region and beyond.

We should to note that not only university may change the territory but the region environment also may impact the higher education organization activity. The relationship of university with its territory is more ambivalent then that of, for example, public authorities with a legal entity [40, p.478]. Strong and effective economy of the region will

contribute to the creation of competitive university and developed university, in its turn, will have more to offer to the region.

The new role of universities embedded into creation of new relations and economic development in the region additionally to traditional teaching and research was called “the third role” of university [43] (Holland 2001). Researchers [40] meant under third role of the university mostly its contribution into civil society through the external activities of individual staff like arts, politics, media and other. Benneworth & Hospers (2007) are aware to emphasize the impact of universities *on* their regions but consider *how* universities can construct interactive relations with other regional partners to build local or global networks with benefits for regional development [44]. Now researchers recognized the important role of university in regional innovation systems and its influence both on the economic and social life of the region, but the issues about which processes it may impact and which way are still discussed.

First of all, the university as important actors of RIS was clear presented in the Triple Helix conception by G. Etzkowitz with L. Leydesdorf (1997)[45]. It becomes the main center of focus of the state efforts on the development of innovation, organizes the cooperation with industry, business, largely by taking the functions of their research units. Classical university turns into an entrepreneurial (innovation) university, which focuses on the development of business principles in students along with academic knowledge.

This conception formulates only restricted regional aspect of the university activity. It is connected only with relations of university which may occur through the formed innovation infrastructure of the organization. Interaction with the society includes only the preparation of qualified specialists for the knowledge-based economy. Benneworth & Cunha (2015) [46] argues that Triple Helix model excludes an important element in innovation, namely civil society, necessitating a “quadruple helix” model (Leydesdorff and Etzkowitz, 2003; Leydesdorff, 2012) [47, 48].

Another conception, “engaged university’, appeared in the literature several years later and also was focused on the regional role of university. Holland (2001) [43] gave the definition of engaged institution which “is committed to direct interaction with external constituencies and communities through the mutually-beneficial

exchange, exploration, and application of knowledge, expertise, resources, and information". But the difference of this conception from Triple Helix was in adaptive responses of university which includes regional emphasis on its traditional functions – teaching and research (Gunasekara 2006) [49]. In the work of Trencher et al (2014) [50] university has received broader functions – societal transformer and co-creator.

Gunasekara (2006) divided all regional roles of university by two venues - generative and developmental. According to their names, first direction of university activity is devoted to accumulation of knowledge and development of advanced programs for preparation of specialists for regional business structures. The second venue is more developed and broader. It also includes academia responds to the needs of the region which embodies in regionally-focused teaching, research and social activity (Appendix 1).

Generative role proposed the impact of university's regional activity on the different actors and institutes within traditional economic networks prevailing in the territory. Developmental role is much broader in that sense that it shows the capacity of the higher education organization to create new relations and subsequent increase in capabilities of all representatives of the socio-economic environment.

Uyarra E. (2010) [51] greatly expanded the classification of models and social roles of university proposed by previous researchers. The paper examines the role and key characteristics of the five models of universities cooperating with regional agents in relation to their contribution to regional innovation (Table 1).

According to the first role university impacts on the environment using traditional functions – preparing the specialists and accumulation of knowledge. In the next model university initiates bi-directional links with industry to share knowledge between academia and firms. This model provides opportunities for the commercialization of university research. The financial aspect became crucial in the Entrepreneur University which rebuild its own organization to include some new commercialization structures.

In the fourth model university is actively included into the innovation processes of the region and has effective relation with key actors of its regional innovation system.

Table 1. Summary: roles, determinants and engagement modes of universities

Model	Knowledge "factory"	Relational university	Entrepreneurial university	Systemic university	Engaged university
Main role of universities	Production of scientific knowledge	Exchange of knowledge	Active commercialization role	Boundary-spanningrole	Develop-mental role
Main unit of analysis	Innovation outputs	Linkages	Intermediaries (e.g. TTOs)	Systems/ networks	Spaces of governance
Main partners/ beneficiaries	High-tech firms located in proximity to universities	Large manufactu-ring firms	Large manufacturing firms; Spin-off firms	Regional clusters Regional SMEs	Regional stakeholders
Directionality of engagement	Unidirectional (implicit)	Bi-directional (implicit)	Bi-directional (explicit)	Triple-helix (universities, industry and government)	Responsive
Dominant methodology	Industrial surveys Citation count Production function analysis	Industrial surveys, Case studies	Surveys of university TT managers	National and regional innovation surveys Case studies	Case studies
Key factors influencing impact	Research intensity/ Inputs Geographical proximity	Structural factors (size of firm, age, sector, R&D intensity) Innovation strategy	Organizational structures/ forms Managerial practices Faculty behaviour/ incentives	Regional system configuration Regional policy Institutional capacity of universities	Number and synergies between universities University leadership Joined up policies/ incentives
Policy implications	Co-location of firms and universities	Increased funding for research Some links should be promoted vis-a`-vis others	Intermediaries and organizational arrangements/incen tives are needed to ensure links	Institutional arrangements are important to ensure linkages	Joining up of universities missions and other policies at different levels

Note - Adapted from Uyarra [51]

In the fifth model, and more embedded role, university not only collaborates with regional environment but impacts the socio-economic

life of the region and may develop new types of relations with local firms and authorities.

Presented in the table 1university's roles are not strictly separated from each other and may be reflected by the organization to lesser or greater extent.

In some spheres of its activity university may be fully "engaged" (creation of synergy between research and business) but in another ones (exchange of knowledge) it may adhere the role of relational university or, even, the traditional "knowledge factory". This corresponds to Uyarra comprehension about the boundaries of university. Universityis often considered as monolithic regional actor with single voice while this type of organization consists of multiple groups of experts and academics.

So, engaged university is most preferable form of higher educational organization, because it embodies developmental role in the region but not only the production of scientific knowledge. The concept of engaged university helps to see the new vision for the university development as the provider of cultural and social changes in the society.

2 ANALYSIS OF SCIENTIFIC AND INNOVATION ACTIVITY OF HIGHER EDUCATIONAL INSTITUTIONS OF KAZAKHSTAN

2.1 General characteristics of the scientific and research capacity of Kazakhstan

The role of the scientific potential in the economic development of Kazakhstan is increasing from year to year. This is due to the intensification of industrial and innovation activity in the country, the formation of a knowledge economy. The transition to an innovative model of development requires that the state ensures conditions of training for the innovation-driven economy, as well as the formation of a powerful source of innovative ideas and technologies in the research organizations of various sectors of the economy. The availability of advanced scientific potential, developments and deployment of new technologies in the industry largely ensure the improvement the competitiveness of the economy, increasing the position of the country in the world rankings.

In the literature the scientific potential is interpreted as "the ability of accumulated resources with the use-value, serve as the scientific and technical development of society" [52].

However, today's scientific and technological development shows the limitations of a purely resource nature of the scientific potential. Today it is necessary to consider it as a complex of the available resources, and as the capacity of different stakeholders to effectively use them for research purposes.

In Kazakhstan, the concept of scientific potential and its structure is presented in the approved in 2005 year the Program on formation and development of the national innovation system of the Republic of Kazakhstan for 2005 - 2015 years. According to the program, the scientific potential includes:

- Public research organization - the organizations of ministries, departments, organizations of government bodies of the republic, regions, cities and local governments;
- Universities and other institutions of higher education, research institutes, engineering and design organizations of higher educational institutions;
- Industrial research institutes, industrial enterprises, small and

medium enterprises engaged in research;

- Scientific staff, individual scientists and inventors;
- Material and technical base for scientific research.

At present, the scientific potential of the republic is represented by scientific organizations of the Ministry of education and science, industrial research institutes, design and project design organizations in the higher education sector as well as in the business sector, and project design and construction surveying organizations, research institutes and other public organizations.

The scientific potential is one of the major subsystems of the national innovation system, which also includes such subsystems as innovative entrepreneurship, innovation infrastructure, financial infrastructure. Below author will consider the main indicators characterizing the efficiency of the scientific potential.

After receiving the independence of the country in the transitional period the existing scientific and technological potential of the republic has been largely lost. Scientific and project developments were not in demand, in result of lower financing many industrial research institutes, design organizations were liquidated. Human resources of science were also significantly decreased [53].

In recent years, in the country there is a tendency to reduce the overall number of organizations engaged in research and development. According to the Statistics Committee of the Republic of Kazakhstan in 2016 there were more than 380 state, public and private research institutions, project and design organizations, higher educational institutions and enterprises (Table 2).

Compared with 2008 the number of organizations decreased by 38 units or 9.9%, while for the entire reporting period the largest number of organizations were registered in 2010 and amounted to 424 units. In 2012, significant reduction in public sector organizations is observed because of reducing the number of republican ministries and departments. Also there is a trend of increasing number of organizations performing R&D in the private non-profit sector (by 24%).

Total number of organizations of business sector, despite the sharp decline in 2012, by 2014 has greatly increased. The structure of the sector has shown an increase in number of industrial research institutes. The number of organizations that perform research and development on the basis of industrial enterprises also increased, albeit slightly.

Table 2 - Number and structure of organizations engaged in research and development

Sectors	2008		2010		2012		2014		2016		Growth rate 2016/ 2008
	Unit	%	Unit	%	Unit	%	Unit	%	Unit	%	%
Total number of organizations	**421**	**100**	**424**	**100**	**345**	**100**	**392**	**100**	**383**	**100**	90.1
Public sector	104	24.7	95	22.4	69	20	101	25.8	100	26.1	96.2
Sector of higher professional education	126	29.9	121	28.5	121	35.1	105	26.8	103	26.9	81.7
Business sector	166	39.5	108	25.5	105	30.4	149	38	149	38.9	89.8
Private non-profit sector	25	5.9	100	23.6	50	14.5	37	9.4	31	8.1	124
Note – composed by author based on the data of the Statistics Committee of the RK (www.stat.gov.kz)											

In the developed countries the entrepreneurial sector has the largest number of research organizations in comparison with other sectors. This allows to intensify the innovation process, to introduce the products developed at the enterprise into production.

In 2016, the share of business sector research organizations was 38.9% of all research organizations. This is a positive trend compared with 2010, when the number of research organizations in enterprises fell to 25.5%.

According to the statistic data of Table 1 lets define a linear coefficient of absolute structural shifts (with a constant base of comparison) the number of R&D organizations by sector of the economy by the following formula:

$$L_B^{Ab} = \frac{\sum_{i=1}^{n} \left| d_j - d_0 \right|}{n} \qquad (1)$$

where
d – weight of characteristics;
n – number of grades in structures;
j – current period;
0 – base period.

$$L_{16/08}^{Ab} = \frac{|26.1 - 24.7| + |26.9 - 29.9| + |38.9 - 39.5| + |8.1 - 5.9|}{4} = 1.9$$

The value of the coefficient falls within the range from 0% to 2%, indicating the small structural changes in the number of organizations that perform research and development in the country by sectors of economy. The reason for changes is an increase in the number of organizations in business sector, decrease in the share of higher professional education organizations and research organizations in private non-profit sector.

This fact testifies the great disparities in the structure of the placement of scientific organizations. Research and development structures provide the development of new breakthrough technologies that will eventually be implemented in industry, and that's why the

speed and efficiency of the commercialization of new ideas and developments depend largely on their placement. The absence of such organizations at industrial enterprises makes them unable to conduct research and development that excludes them from the process of innovation development. Many industrial enterprises of Kazakhstan still live in survival mode and focus only on technology transfer, as they do not have the financial resources to carry out the whole cycle of R&D and implement the innovation in production.

Most of the scientific organizations of Kazakhstan are characterized by deterioration of the material and technical base, the aging of the research staff. In recent years, the obsolescence of the material and technical base of institutes in the field of analytical, laboratory, computer support, etc., has become obvious, which prevents domestic scientists and engineers from working in a competitive, market space. There is a discrepancy between the qualities of scientific production with international standards. The existing level of technical equipment of research institutions and their experimental bases, of course, limits the ability to perform world-class research [54].

Along with research organizations, the scientific potential of the country includes highly qualified professionals capable of producing ideas, which are then transferred into innovative products and technologies. Innovation economy makes high demands on the number and skill level of scientific workers.

Below we consider the distribution of number of researchers by types of organizations (Table 3).

Table 3 - Number of personnel engaged in research and development

Type of organizations	2008	2010	2012	2014	2016	Growth rate 2016/2008,%
Total	**16304**	**17021**	**20404**	**25 793**	**22 985**	141
Public sector	6604	6557	4 921	7 608	7643	116
Sector of higher professional education	4828	5232	9 405	10 961	9791	203
Business sector	4525	3749	4 718	5 786	4222	93
Private non-profit sector	347	1483	1 360	1 438	1329	383
Note – composed by author based on the data of the Statistics Committee of the RK (www.stat.gov.kz)						

In the period from 2006 to 2009, the number of personnel in the

field of R&D has declined steadily. In 2009 it was recorded the lowest number of people employed in this sector - 15 793 people. This is due to a significant reduction (almost by 2 times) of personnel in the public sector, namely in the organizations of the republican ministries and departments. Since 2009, there was the positive dynamics of the number of personnel engaged in research and development. In 2014 compared to 2009 there was a growth in the number of employees by 10 000 persons or 63.3%.

In 2016 compared with 2008 the growth rate was 141%. But compared to 2014 the number of personnel was decreased.

Since 2012 in the structure of personnel engaged in R&D the proportion of the higher education sector significantly increased, which is associated with an increase in employment in organizations such as universities and other higher educational institutions (more than by 2 times in comparison with 2006). Now it is a dominant sector by the share of engaged R&D personnel. The number of researchers in the public sector (Table 4) was significantly decreased.

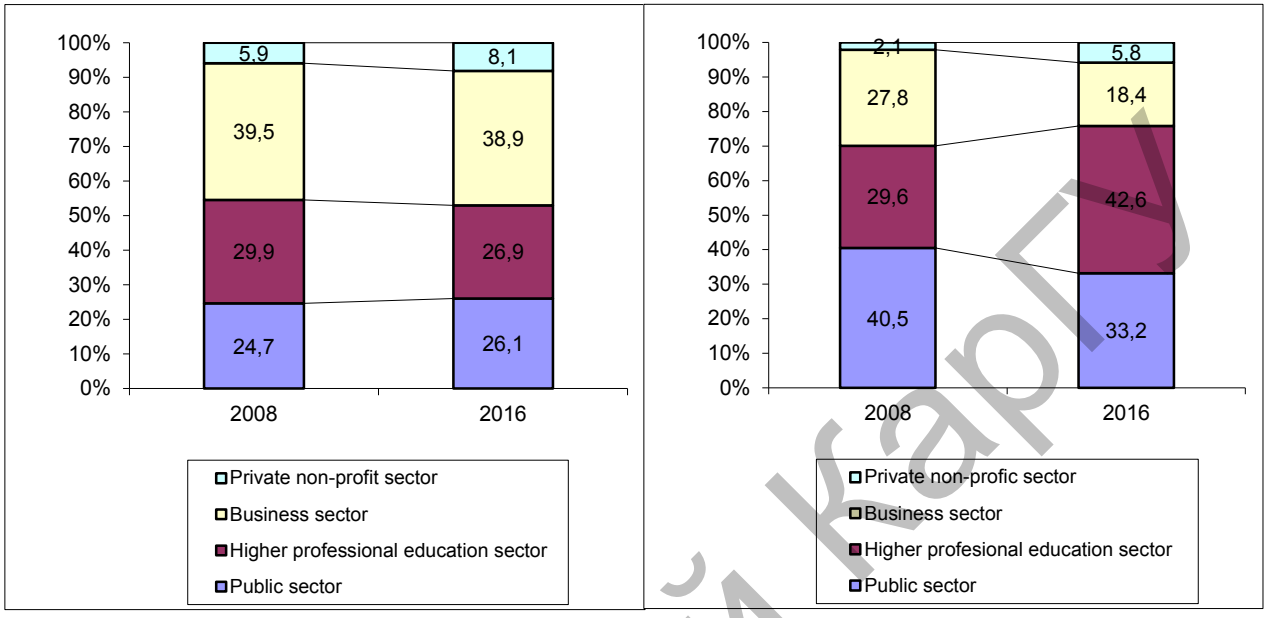
Table 4 - Structure of the distribution of the number of personnel engaged in R&D, %

Sectors	2008	2010	2012	2014	2016
Total	100.0	100.0	100.0	100.0	100.0
Public sector	40.5	38.5	24.1	29.5	33.2
Sector of higher professional education	29.6	30.7	46.1	42.5	42.6
Business sector	27.8	22.1	23.1	22.4	18.4
Private non-profit sector	2.1	8.7	6.7	5.6	5.8
Note – composed by author based on the data of the Statistics Committee of the RK (www.stat.gov.kz)					

Comparing the structure of distribution of organizations and personnel in the field of research and development (Figure 3) we can identify the following features of the development of innovative potential of the republic.

1. The big share (up to 39%) of the business sector in the structure of organizations engaged in R&D (by 12.8% more than the public sector); while the average number of people employed in this sector inferiors to similar indicator of public and higher professional education sectors. In other words, the research organizations of the business sector employ

few times less staff than in other sectors, which means that, despite their large number, they are not as large as organizations, for example, of higher education sector.



a) b)

Figure 3 - Structure of distribution of organizations (a) and personnel (b) engaged in research and development

Note – composed by author based on the data of the Statistics Committee of the RK (www.stat.gov.kz)

2. In terms of the number of people employed in the field of R&D, the sector of higher professional education retains its leading position, despite the tendency to reduce the number of R&D organizations in this sector.

To assess the quality of staff employed in R&D, we consider the dynamics of the number of researchers with doctorate or PhD degree (Table 5).

There is a tendency of reducing the number of researchers during 2006-2009 period, due to a decrease in the number of all personnel engaged in research and development in this period.

A positive trend is the increase in the number of researchers with scientific degrees. The proportion of researchers with scientific degree of PhD in 2010 in the total number of researchers was 0.5% and in 2016 – 2.7%, which indicates the improvement of the qualitative composition of the researchers.

Table 5 - Dynamics of the number of researchers with scientific degrees

Indicators	2008	2010	2012	2014	2016	Growth rate 2016/2008, %
The number of employees engaged in research and development (on the end of year), people	16304	17021	20404	25 793	22985	141
including:						
researchers	10780	10870	13494	18930	17421	162
where:						
Doctors of science	1191	1347	1065	2014	1829	154
Candidates of science	2861	3041	3629	5335	4754	166
PhD	-	59	131	335	462	-
Doctor on profile	-	-	719	610	509	-
Note – composed by author based on the data of the Statistics Committee of the RK (www.stat.gov.kz)						

The problem of aging of scientific personnel of the republic still remains urgent (Table 6). If the share of researchers aged over 60 reached 15.8% in 2008, then in 2016 the share of personnel close to retirement and retirement age was already17.0%.

Table 6 - Distribution of researchers by age

Indicators	2008		2016		Deviation
	persons	%	persons	%	%
Researchers	10780	100	17421	100	0
including:					
till 30	2396	22,2	3588	20,6	-1,6
31-39	2135	19,8	4264	24,5	4,7
40-49	2240	20,8	3599	20,7	-0,1
50-59	2301	21,3	3008	17,3	-4,1
60 and older	1708	15,8	2962	17,0	1,2
Notes – 1 composed by author based on the data of the Statistics Committee of the RK (www.stat.gov.kz) 2 Data for 2016 given in accordance with the age cut used in 2006 with the purpose of comparability					

The level of wages in the research area is largely determined by its appeal to young professionals. Table 7 shows the average monthly nominal wage of staff in the field of research and development in 2008-2016.

Table 7 - Average monthly nominal wages of personnel in the field of research and development in 2008-2016.

Indicators	2008	2010	2012	2014	2016	Growth rate 2016/2008, %
The average monthly nominal wage of employees by the type of economic activity, tenge:						
Research and development	81 810	103571	148 530	174225	208752	255.2
Higher education	50 877	71058	102 016	117600	136403	268.1
Average salary in economy	60805	77611	101263	121021	142898	235.0
Inflation	9.5	7.8	6.0	7.4	8.5	-
Notes – 1 composed by author based on the data of the Statistics Committee of the RK (www.stat.gov.kz)						

We see relatively high salaries of staff in the field of research and development compared with salaries in higher education sphere and average salary in economy. This fact is due to the share of private organizations in total number of R&D organizations with high salaries of employees. At the same time, salary of researchers of higher education sector is below the average for the economy, because most of the research is conducted in public universities, which are funded from the state budget.

Despite the annual increase in salary of researchers, the increase in wages adjusted for inflation remains insignificant. At the same time, in other countries the wages of researchers is one of the highest in the economy. For example, in the US the average wage of employees in sphere of research and development is almost 2 times higher than the average wage in the economy [55, p. 3-32].

Concluding the analysis of the scientific potential of the country, we can draw the following conclusions:

- The number of personnel engaged in research and development, despite the decline in 2006-2010, during the next6 years has grown significantly. At present, the total number of researchers is 41% higher than in 2008.

- The insufficient number of scientists is observed in the industry. The majority of researchers engaged in academic universities as well as in the public sector, which negatively affects the development of innovative industries and entrepreneurship.

- The salary of researchers is far from international standards, and,

despite of the positive trend in recent years, remains at a critically low level.

Thus, despite the extant scientific potential, as well as a significant increase in the number of researchers, there are a number of indicators with negative dynamics. The main negative trends are aging of fixed assets, low wages of scientists, increase in the average age of qualified personnel, lack of contribution of the national science to the economy.

The negative trends in the development of scientific potential can worsen the problem of "fixing" of researchers and scientists in research institutions. Countries with a clearly defined social orientation are able to unrestrictedly attract talents from other, less developed countries in order to strengthen their cultural and productive potential. To prevent "brain drain" both abroad and in other spheres of economic activity of domestic scientists, it is necessary to develop a set of measures that will promote more productive work of scientists. This, in particular, update the material and technical basis of scientific organizations and universities at the expense of the republican budget, the use of incentive measures for financial support for talented researchers (grants, bonuses, allowances on a result of 3-5 years of work), and others.

2.2 The analysis of the legal framework of the innovation activity of higher educational institutions

Participation of public research institutions and universities of different forms of ownership in innovation activity is governed by the current legislation in this area.

The formation of legislation in the sphere of innovation was carried out in several stages. At each stage, the government adopted normative legal acts, the main purpose of which was the formation of mechanisms to increase the innovation activity of economic entities.

First stage. Since gaining independence in 1991, it began the transition of the economy of the Republic of Kazakhstan from the administrative-command system to market economy, which is based on private property and competition. The most important legal act, which established transition to private enterprise priority, was the Law of RK "On the protection and support of private entrepreneurship". This legal act defined the notion of private enterprise, the limits of state regulation of it, the procedure for protection of rights of a private entrepreneur, the

rights and duties as private entrepreneurs and public authorities in relation to them [56].

The development Strategy "Kazakhstan-2030" was adopted in 1997. It marked the beginning of large-scale social and economic transformations in the country aimed at achievement long-term goals in priority areas of development, increasing the competitiveness of the domestic economy and the welfare of society. The law "On State Support of Small Business" was adopted in the same year. It identified such concepts as: innovation, small business infrastructure, venture capital firms.

Second stage. To create favorable conditions for development of innovation activity the government adopted a series of laws and regulations, which provided legal support to the development of innovation activity in the country. They include the following laws: "On Science", "On state support of small business", "Patent Law of the Republic of Kazakhstan", "On copyright and related rights", "On innovation activity".

The law "On innovation activity" was adopted in the republic for the first time on July 3, 2002, defining the basic principles, forms and directions of realization of the state innovation policy. In the future, it lost validity in connection with the adoption of the Law "On state support of innovation activity" in 2006.

This law provided the state support of innovation activity in the following forms:

1) the provision of subjects of innovation activity with innovative grants;

2) implement the funding of innovation activity by the institutions of development with complex measures;

3) investing in innovative projects on a return basis with the ability to return or redemption amounts of funding at cost;

4) creation of necessary conditions for the implementation of the state scientific, technical, economic and, if necessary, environmental expertise of innovative projects [12].

Within the framework of this law, such important for the development of the innovation system concepts as "innovation infrastructure", "technology park (technopark)", "innovation project", "innovation grant" were fixed.

Innovation grants are available for such purposes as performing development work, applied research, the feasibility study of the innovation project, acquisition of innovative technologies, as well as patenting inventions in foreign countries and international patent offices. The condition for obtaining a grant for the implementation of experimental design and applied research is the introduction of the results at the enterprises of the republic within three years.

In 2003 the Government developed and approved the Strategy of Industrial and Innovation Development of Kazakhstan for 2003-2015. The adoption of the Strategy marked the beginning of a new stage in economic development of Kazakhstan: the transition from an economy based on the exploitation of natural resources to the knowledge-based industrial innovation economy.

The main objective of the Strategy was to achieve sustainable development of the country, departing from the raw material orientation of the economy, by speeding up the processes of modernization, diversification and increase of competitiveness of the national economy.

The strategy was designed for the long term and included three interconnected stages, each of them adopted certain measures for the development of innovation infrastructure, the creation of science-intensive industries, improvement of legislation in the field of innovation [57].

The adoption of the Strategy contributed to the formation of new actors of the innovation system. So, the Government has established a number of institutions: the National Innovation Fund, the Kazakhstan Investment Fund, Kazakhstan Development Bank, the Export Insurance Corporation, the Center for Marketing and Analytical Research, Center for Engineering and Technology Transfer, as well as the Science Fund. Through development institutions, the state participates in projects aimed at creating chains of industries that produce competitive products with high added value.

The program initiated by the introduction into the curricula of universities of the Republic the discipline "Innovation Management". Organization of teaching of that discipline includes the preparation of teaching staff abroad and attraction of foreign specialists. The specialty "Innovation Management" was included in the classifier of specialties of undergraduate and graduate programs, as approved by the Committee of

Standardization, Metrology and Certification, as well as included in the classifier for doctorate PhD degree.

Adoption of Industrial and Innovation Development Strategy has created necessary conditions for the formation of the country's innovation system, under which could be promoted domestic high-tech production, based on the efficient use of intellectual and scientific potential of the country, the development of domestic scientists and innovators. In this regard, in 2005 in order to modernize the economy of the country a program on formation and development of the national innovation system of the Republic of Kazakhstan for 2005 – 2015 (PFD NIS) has been adopted. The program became a fundamental document for the creation and development of innovation activity of all actors of the innovation system.

The aim of the program was to create an effective innovation system capable to ensure the creation of competitive end products, using the scientific and technical potential (domestic and foreign), and activating the innovation activity of the business sector.

Among the objectives of the program are the following:

- Development of the country's scientific potential through the involvement of science in innovation activity;
- Formation and development of innovative businesses;
- Creation and development of elements of innovation and financial infrastructure, mechanisms of their functioning, expanding the range of grants, venture funds;
- Formation of a multi-level innovation infrastructure, which is based on the business incubators at universities, technology parks, etc.;
- Creation of mechanisms for effective interaction between elements and subsystems of NIS;
- Improvement of legislation in the field of innovation, protection of intellectual property rights [58].

To enhance the innovation activity of HEIs the program envisages a number of measures aimed at improving training in the field of innovation. Such measures included the creation of new directions for training specialists in the specialties relevant to the innovation economy, as well as the construction of a training system that includes undergraduate and postgraduate training, including abroad, as well as short-term courses, seminars, roundtables for further training of existing managers in the field of entrepreneurship and business.

For the expansion of the innovation infrastructure of the university the program provided the establishment of business incubators on the basis of the leading technological higher educational institutions, which could implement the innovative ideas of local scientists and developers. The program left open the question of the legal form of generated business incubators and the regulatory and legal basis of their functioning.

In general, with the adoption of strategy and the program on the development of NIS of Kazakhstan the government created basic institutions that provide innovative development of the participants of the innovation system:

- The National Fund, which provides a stable socio-economic development of the country;
- JSC "Fund of National welfare "Samruk-Kazyna", the main activity of which is to assist in the modernization and diversification of the national economy;
- Development institutions that facilitate the implementation of innovative projects, including innovative projects of university researchers;
- Technology parks of national and regional levels, special economic zones. There were technology parks at universities. Also, the legal framework was established for improving the investment policy and stimulation of investment.

Despite some positive results, the objectives of the Strategy and the Program had not been fully achieved.

The mechanism of redistribution of labor and investment resources in the non-oil sector has been ineffective. The structure of the economy has preserved a raw material orientation, and the structure of employment indicates the low efficiency of the country's labor potential. In 2009, 27.7% of the population was employed in agriculture, while the share of products of this sector to GDP was only 6.2%. During the period from 2005 to 2009 the share of manufacturing in GDP decreased from 10.5% to 9.9%, while the share of mining has increased from 17.7% to 18.5% [59].

The funds allocated by the government to diversify the economy were limited, and financing mechanisms were not developed, that did not allow the full implementation of innovative breakthrough projects. Development institutions do not form effective interaction mechanisms;

universities and research organizations were poorly involved in innovation activity.

Big corporations of Kazakhstan were focused mainly on a quick profit in the commodity sectors, rather than the creation of new innovative industries. At the same time, small and medium business sought to occupy niches in the market that guarantee a fast return on investment (trading and brokerage business, construction industry, services).

Third stage. In order to overcome the obvious differences in priorities of public policy and private business in 2010 the State program of forced industrial and innovative development of Kazakhstan for 2010-2014 was adopted in Kazakhstan (hereinafter - SPFIID). Within the framework of the program, the economy had to achieve the following results by 2014: GDP – the increase by 50% compared with 2008, the increase in labor productivity - 50% to 100% in some sectors of the economy, bringing the share of non-oil exports up to 40%, reduction of energy intensity of GDP by 10% from 2008 level, and an increase to 10% the share of innovative enterprises [59].

The program set the following tasks:

- Creation of environment for industrial development of the country;
- Development of priority sectors of the economy (agriculture, chemical and pharmaceutical industry, metallurgy, power generation, oil refining, construction industry, transport and communications, tourism, space)
- Strengthening of social efficiency from the development of priority sectors of the economy and the implementation of investment projects;
- Formation of centers of economic growth on the basis of large cities;
- Development of mechanisms of interaction between government and business to support the priority sectors of the economy.

In order to implement the Program certain mechanisms have been developed at the national and regional levels.

At the national level there were designed the sectoral programs that define priorities for the development of industries, the state support measures. Implementation of the program of industrialization of Kazakhstan till 2020 is based on four budget programs: "Productivity - 2020", "Investor - 2020", "Export - 2020", "Business Road Map - 2020" (Appendix 2).

Under this program higher educational institutions got the task to provide with qualified human resources the priority sectors of the economy (agriculture, chemical and pharmaceutical industry, metallurgy, power generation, oil refining, construction industry, transport and communications, tourism, space). The Program determined the number of required professions and institutions of higher learning for training for each of the priority sectors.

In November 2010, the Program for the development of science, innovation and the promotion of technological modernization for 2010-2014 was adopted. The program realized a systematic approach to the development of innovation activity in the country. The program set the tasks of building the system of technology transfer, promotion of technological modernization of industry; the development of an innovative environment for effective interaction between education, science, business and government. The development of Interdisciplinary Scientific and Technological Development Plan of the Republic of Kazakhstan was finished. It identified the main tasks in priority industries in the medium and long period.

Implementation of these programs included improvement of legislation in the field of innovation, in particular in such important aspects as R&D funding, provision of preferences to companies operating in the sphere of innovation, formation of the complex indirect measures to support the NIS actors and other. Thus, according to the Law of the Republic of Kazakhstan dated June 24, 2010 "On Subsoil and Subsoil Use" subsoil users are required to provide annually the funding for research, scientific, technical and (or) development activity provided by Kazakhstani producers of goods, works and services, in the amount of not less than one percent of the total annual income on contract base [60].

At this stage, there were innovative changes in the system of training of qualified personnel. 2010 was the final year for the protection of theses of Candidate and Doctor of sciences in the framework of the traditional system. Since 2011, the award of scientific degree in the country was made possible within the framework of the institute of doctoral study - PhD. Introduction of the institute of PhD in multilevel education system allowed to make a final transition to three-level model of training specialists: Bachelor - Master - PhD, based on the principles of the Bologna Declaration.

According to the Law "On education", doctoral study is "post-graduate education, educational programs of which focus on training for scientific, educational and (or) professional activities, with the award the degree of Doctor of Philosophy (PhD), Doctor on profile" [23].

A feature of doctoral study, as opposed to master, is that it implies a narrow and deep specialization, aimed at future teaching and research activity. The normative content of the PhD institute is reflected in the State educational standards of RK "Doctoral study. Main provisions. SES RK 5.03.003-2004" and "Requirements for minimum content and level of training of doctors of philosophy (PhD) in pilot training programs" and "Post-graduate education. Doctoral study. The main provisions. SES RK 5.04.034-2008" and other normative documents. The award of the degree of Doctor of Philosophy (PhD), Doctor on profile has been implemented in accordance with the Rules of awarding scientific degrees, approved by Order of the Minister of Education and Science of the Republic of Kazakhstan №127 dated March 31, 2011.

In addition, each university which implements PhD programs has received the right to develop and approve working curricula, academic calendars, to determine the path of learning and research, to develop an individual training program.

Until 2011, regulation of relations in the field of science and technology, definition of the basic mechanisms of functioning and development of the national scientific system of the country are regulated by the Law "On Science", adopted on July 12, 2001. Financing of fundamental and applied research was provided by the allocation of the national budget, as well as attracting other sources not prohibited by the legislation of the Republic of Kazakhstan.

In the new edition of the Law "On Science" dated February 18, 2011 the state system of financing scientific and technological activity has undergone significant changes. Law identified the following forms of financing:

- Basic funding;
- Grant funding;
- Program-oriented funding.

Basic funding is intended to support the public and equivalent scientific organizations with funding for scientific infrastructure and property, labor and administrative staff, information access.

Specific research and projects funded by government grants. These

grants may be provided to scientific organizations, universities, individual researchers and research teams.

And, finally, the program-oriented funding, intended to contribute to the solution of strategically important state tasks outlined in the government programs and other normative documents.

Previously, the financial mechanism of the innovative project was very bureaucratic; the grant required undergoing mandatory review of several stages. The new law "On Science" presupposes the creation of the National Scientific Council, which makes a decision to give a grant for scientific research, thus reducing the procedure for examining the application to one step.

Researchers received significant benefits in the area of commercialization of research results. Now intellectual property rights obtained by researchers or research organizations as a result of scientific and technical activities financed from the state budget belong to scientific organizations, unless otherwise stipulated by the contract between them and the author(s) of intellectual property. Such legislation, when the rights on developments are assigned to a scientist or scientific institution, despite the fact that the research is financed from the state budget was adopted in the US in the early 80s of the twentieth century (the Bayh – Dole Act and the Stevenson-Wydler Technology Innovation Act) and contributed to the growth of research and, in general, the innovation activity in the country.

At this stage, new Law of the RK "On state support of industrial and innovation activity" on January 9, 2012 was adopted. The law fixed the following measures of state support of various national development institutions: loans, subsidized interest rates on loans, long-term lease financing, guaranteed order, the implementation of investments in the authorized capital, innovation grants, development and promotion of export of domestic processed goods, services, etc. [13]. First time the legislation identified the content of the conception of commercialization, including the commercialization of innovative technologies.

The power of local (provinces, major cities) executive body (akimat) was expanded. In accordance with the law, they can participate (or be founders) in the authorized capital of legal entities whose main activities are aimed at the development of innovations (for example, venture capital funds). It is planned to make amendments and supplements to other acts, directly or indirectly related to the

development of industrial-innovation activity in Kazakhstan.

In general, for the period of implementation of the program SPFIID the country managed to achieve a number of positive results in the sphere of industrial and innovative development:

- The level of innovation activity of enterprises has increased from 4.3% in 2010 to 8.1% in 2014;
- The volume of innovative products and services in GDP was 1.5% in 2014 (in 2010 this indicator was 0.7%);
- GDP growth by the end of 2014 compared to 2008 was 55.3%;
- Non-primary sector GVA in real terms increased 130.4% (2013) compared with the level of 2008 [61].

At the same time SPFIID program is not allowed to withdraw from the economy's dependence on mineral exports. According to the Statistics Committee of the Republic of Kazakhstan, the share of mineral products in the export structure for 2003 - 2013 years increased from 64.5% to 80%. With the growth of world prices for resources economy's dependence on natural resources may be exacerbated. At the same time the manufacturing industry of Kazakhstan forms less than 7% of employment and 11% of the GVA of the economy. Whereas, the level of performance in the manufacturing sector of Kazakhstan is 2 times lower than the average one in OECD member countries.

Taking into account the experience of the implementation of SPFIID Program in Kazakhstan for the next period the State program of industrial-innovative development of Kazakhstan for 2015 - 2019 years (SPIID) has been developed The program is a logical continuation of SPFIID program and performs a part of the industrial policy of Kazakhstan and is focused on the development of the manufacturing industry.

Thus, in the formation of the legal base of innovation activity of subjects of NIS of Kazakhstan, including universities, there are three interrelated phases. Every phase includes different government measures in development of scientific and technological potential of the country, creating necessary conditions for the development of high-tech industries.

At the first stage the government created necessary legal framework, legislated such thing as "private property", "private enterprise", "innovation", defined long-term priorities of economic development of the country.

Starting from the second phase, the government's efforts are aimed at the formation of the national innovation system in the country with the active involvement of all participants in the innovation process, including universities. In a framework of adopted Strategy and the Program PFD NIS there were identified mechanisms of the state to stimulate R&D and innovation projects, accepted measures for scientific potential development, innovative entrepreneurship, innovation and financial infrastructure. This is the stage which set the necessary elements of the innovation system as the public institutions and the development of venture capital funds. The transition to a three-tier system of education in the framework of the Bologna process was completed.

The third stage of the development of the innovation economy has become a logical continuation of the Government's course towards the formation of knowledge economy in the republic, the development of non-primary sectors of the economy. Based on the experience of implementing the first two stages, some mechanisms of state stimulation of innovations were revised. So, within the framework of the adopted GPFIIR program, conditions have been created for the transfer of new technologies taking into account the needs of industrial enterprises. Necessary conditions for updating the technical and technological base are created not only for large corporations, but also for small and medium-sized businesses through the mechanism of the "Roadmap of Business".

The mechanism of introduction of domestic innovations has changed. The Law "On Science" defines a new mechanism for financing research and development, simplified the procedure for reviewing scientific projects. The issue of the right to intellectual property obtained as a result of scientific and technical activity financed from the state budget is legislatively fixed.

In general, legislative acts and programs in the field of innovation activity adopted at various stages contributed to the formation of a legal framework and mechanisms of relations that arise between the state, business and scientific sector as a result of the creation, implementation and dissemination of innovations. The adopted legal framework laid the foundation for the training of scientific personnel within the master and PhD courses, the creation of mechanisms for financing the work of scientific innovators, and the consolidation of rights for created

intellectual property.

2.3 The experience of Kazakhstan in the creation of academia innovation infrastructure

Transition to an innovative economy, active inclusion of universities along with business and the state in innovative processes put the task of developing of innovation infrastructure at universities.

Innovation infrastructure is a complex of interrelated structures that ensure implementation of innovation activity of the university. Also, the innovation infrastructure can be considered as an integrative set of educational programs at different levels, as well as innovative structures and mechanisms for managing them, aimed at forming the complex of competencies necessary for successful innovation scientific and pedagogical activity [62].

The functions of the innovative structure of the university may vary depending on the university's strategy, place and role of the innovation process in the organization's activity.

In a number of cases, the objects of innovation infrastructure are understood as a set of business incubators, technology parks, technology transfer centers (TTCs), new innovative educational programs, etc. [63]. The presence of certain infrastructure facilities on the territory of the university depends on the material and technical support of the organization, the scientific orientation of the university, as well as the legislative framework within which the educational organization operates.

The researchers [64, p. 216] distinguish two main types of infrastructure:

- material (techno-parks, business incubators, technology-innovative centers, technology transfer centers, etc.);
- intangible (services for the protection of intellectual property, services for the promotion of intellectual products, outsourcing of "non-innovative" aspects of activity, etc.).

The intangible infrastructure is implemented in practice through the establishment of innovation and technology centers and commercialization offices on the basis of universities. They provide search services and promotion of competitive and commercially promising scientific developments to the market, assess the market

potential of development, and involve partners in the implementation of joint projects.

A number of researchers [65] singled out the functional components of the innovation infrastructure, which include production-technological, consulting, financial, personnel, information, integration and innovative components.

Researchers of High School of Economics [66] determined three approaches to the formation of innovation infrastructure, depending on the tasks that university decides:

- software;
- hardware;
- brainware.

Each approach corresponds to a specific purpose of the innovation infrastructure of the university.

Software. Within the framework of this approach, the innovation infrastructure provides information support to current innovation activities (advising on the establishment and protection of property rights on the results of R&D, promoting research results, stimulating the innovation activity of students and teachers, organizing seminars and meetings to increase literacy in the field of innovation and commercialization of research).

Hardware. In this case, the innovation infrastructure acts the foundation of the strategic development of the university. The functions of "software" are expandingwith tasks of the formation of its own production base, the establishment of long-term cooperation between the university and industry; implementation of training programs for specialists in the field of innovation.

Brainware. Approaches within the framework of "software" and "brainware" are complemented by the tasks of building an integrated system for managing of innovation processes of the university, developing an internal innovation environment and forming an external innovation ecosystem of the university.

The results of the functioning of the innovation infrastructure created in the university are determined by the degree of staff involvement in it and the emergence of an innovative culture in the university.

In general, the innovation infrastructure integrates four components of the university's intellectual activity [66]:

- education (innovative educational programs with a large share of masters and PhD doctorates);

- research and production facilities (student business incubator, student design bureaus, technopark, problem laboratories, etc.);

- structures supporting innovation (commercialization and technology transfer offices, scientific and technological centers).

- structures providing management of innovation activity and innovation infrastructure of the university.

The experience of developed countries shows that the innovation infrastructure of each individual institution is formed individually, taking into account its features and scientific direction. The development of the innovation infrastructure of the university is also influenced by the economic, resource, geographical features of the region where it is located.

In Kazakhstan universities innovation infrastructure began to be formed with the adoption of the Strategy of Industrial and Innovative Development of the Republic of Kazakhstan for 2003-2015. The strategy determined that the main organizational institutes of the innovation infrastructure of the NIS of Kazakhstan will be technology parks and business incubators that have the organizational structure, financial, personnel and logistical support necessary to support all stages and processes of innovative development. Since 2011, universities and research institutes of the republic with the support of JSC "NATR" opened commercialization offices. Their main purpose is support the process of commercialization of the results of scientific and technical activities of domestic scientists.

Table 8 shows the composition of the innovation infrastructure of the leading domestic universities, which rank first in the Webometrics-2015 ranking in the Republic of Kazakhstan, as well as the Nazarbayev University of research (the table is compiled on the basis of university websites).

The analysis of the data of the table allows to draw a conclusion that the leading universities of the republic created some elements of the innovation infrastructure (Table 8).

In practice, these elements include:

- Technology Commercialization office (TCO);

- technopark;

- student research and design organizations;

- scientific and educational programs on innovative directions.

Additional elements of innovation infrastructure, such as the departments of services for the protection of intellectual property, licensing, consulting, the department for collective use of equipment, are usually part of the commercialization office. TCO, in turn, is a structural subdivision of a scientific or technological park functioning at the university.

Table 8 – Innovation structure of universities

University	Commercialization office	Technopark	Student business incubator	Innovation educational programs
Al-Farabi Kazakh National University	Commercia-lization office	Technopark KazNU	14 Student business incubators	Innovative educational programs of master and PhD degree
Kazakh National Research Technical University named after K.I. Satpayev	Commercialization office	Technopark, 5 business incubators	8 student scientific societies, including the Student Design Bureau	12 research and education centers
L.N.Gumilyov Eurasian National University	Technology Commercialization Department	Innovation park	Youth Business Incubator	Innovative educational programs of master and PhD degree
Nazarbayev University	Commercialization office	Innovative Intelligent Cluster (Business Incubator; Experimental pilot plant, Technopark; Science Park)	Scientific research groups	Innovative educational programs of master and PhD degree
Note – composed by author				

The mission of the commercialization office is to organize effective management of the commercialization process for universities and research institutes in accordance with regional and industry specific features. The main tasks of TCO are as follows:

- creation of favorable conditions for the commercialization of promising scientific developments of scientists, doctoral students, undergraduates and students in the educational environment of the university and the economy of the region;
- creation and management of innovation infrastructure for the commercialization of technologies of university scientists;
- providing additional opportunities for all researchers in research and development projects aimed at creating products and technologies for a knowledge-based business with a view to the new generation of entrepreneurs in the field of science-intensive technologies;
- uniting the efforts of universities and research institutes with the production sector to meet the needs of the region's economy in innovative technologies;
- creation of a database of innovative projects, universities patents, investors and experts;
- provision of services for the protection and evaluation of intellectual property, licensing, consulting;
- search for investors and mediation with potential business partners;
- carrying out information activities to promote the idea of commercialization of technologies in the university and promoting the development of a technology commercialization system at the regional level [67].

Thus, the commercialization office serves as a connecting link between scientific institutions and innovative enterprises on the basis of universities, on the one hand, and large industrial enterprises and other infrastructure elements, on the other.

The most of the considered universities have technoparks. The purpose of creating a technopark is to promote innovation in the university and create favorable conditions for the organization and development of new start-up companies that ensure accelerated development of R&D results in the real sector of the economy, the creation of innovative technologies, goods and services, and bringing them to the consumer on a commercial basis. As a rule, technopark provides the following types of services:

- placement for industrial and commercial productions, start-up companies created as a result of the commercialization of projects and / or small and medium-sized businesses;

- business support (purchase, accounting, consulting services);

- provision of infrastructure (engineering networks, communications, logistics).

So, the technopark operating under KazNU al-Farabi supports young inventors and students by holding free trainings for young entrepreneurs, advising on legal issues, organizing support at all stages of project development. From 2013 to 2015, about 40 young start-up companies were accommodated in the technopark, of which 7 companies received grant financing. Six companies were further developed and get out the technopark [68].

Technopark at KazNTU named after Satpaev provides services for technological business incubation, which includes services of placement, provision of equipment, accounting, legal, information and consulting support, attraction of investments, project management, as well as other services necessary for the implementation of industrial and innovative projects. At present, there are 190 innovative projects in the technopark base, presented for potential investors [69].

Despite the presence of a large number of domestic developments, their access to the world market of innovative products is rather difficult. Among the main reasons the following can be identified:

- the need to translate all accompanying documentation for innovative products into English;

- significant differences in the standards for manufactured products;

- the high cost of patent registration in the US Patent Office (more than $10,000 for registration of the application);

- the need to quickly respond to customer requests in order to ensure product competitiveness;

- high costs of protecting innovative products from unauthorized copying [63, p. 58].

Nevertheless, international innovation markets provide much more opportunities for the introduction of innovative products for domestic scientists. To promote Kazakhstan R&D, the existing international technology transfer centers, which are established in Kazakhstan jointly with foreign partners, can be used. Such centers were established jointly with France, South Korea, the USA, Russia and China. Their task is to

establish cooperation between companies and research institutions of the two countries, search for investors, partners and technologies, coordinate joint research and innovation projects, organize joint training and development programs for personnel in the creation and management of innovations.

Student scientific societies, design bureaus, as well as youth business incubators are created to develop a new wave of innovators and entrepreneurs in the sphere of high technologies, to bridge the gap between fundamental and academic education, and to apply the acquired skills in practical entrepreneurial activities. Student scientific organizations contribute to the development of scientific and technical potential of youth, to improve the quality of training specialists through the introduction of new forms of training, as well as the inclusion of students in the innovation process.

Within the framework of student design bureaus and business incubators, it is possible to implement high-tech projects and developments. For example, Nazarbayev University students developed a number of innovative projects, among them "Smartphone application for people with impaired vision", "Modeling and optimization of the energy system in a hybrid "smart" house", and other projects. Student developments within the framework of the Eco-Village project aimed at energy efficiency and the use of modern technologies are planned to be submitted for consideration at the exhibition EXPO-2017 [70].

Scientific and educational centers at universities are created for the purpose of carrying out scientific research, training and retraining of personnel in the priority areas of the university. In the majority of leading universities of the republic innovative educational programs of master and PhD doctorate are realized. The Kazakh-French scientific and educational center "Geo-Energy" operates in KazNTU named after K.I. Satpayev, within the framework of which the specialists are trained in the international master's program with giving of two diplomas - Kazakhstan and France. Also, the Scientific and Educational Center "KazNITI-Apple" operates. It implements educational programs for the preparation of bachelors, masters and doctoral students in the field of IT-technologies.

The creation of an innovation infrastructure makes it possible to obtain additional funds through the commercialization of scientific developments, to attract large companies and enterprises to cooperation,

and this is a good incentive for the development of research and development potential and the retention of personnel.

Innovation infrastructure is considered as an organizational form, within the framework of which new ideas and knowledge are generated and a layer of enterprising people ready to create a small business is formed. The main result of the work on creating an innovation infrastructure is not the number of small innovative enterprises created, but the emergence of an innovative culture in the university. With this understanding, the innovation infrastructure is not only technoparks, innovative centers and business incubators that are familiar to everyone, but also the personnel school, which will determine the future entrepreneurial activity of the university.

At different stages in the formation of the innovation environment of the university, different components of the innovation infrastructure can be effective, which can gradually be transformed taking into account the sector and resource orientation of scientific research. Innovation infrastructure of the university should provide support to those innovative projects that take into account its specifics, the specialization of problem laboratories and innovative start-ups, which the university plans to create, as well as the features of the target markets to which the university is oriented.

3 MANAGEMENT OF INTELLECTUAL PROPERTY OF THE UNIVERSITY

3.1 The estimation of efficiency of the university innovation activity: indicators and bibliometric approach

Assessment of efficiency of innovation activity of the university is a necessary element of the whole system of management of innovation activity of the organization. Without a clear understanding of the results of scientific and innovative work of all departments of the university, it is impossible to adopt managerial decisions and implement the strategic and tactical planning.

To assess the effectiveness of research and innovation activities of the university it is necessary to define what is meant by the terms "effect" and "efficiency" in relation to the innovation activity of the university.

According to scientists [71] in the evaluation of innovation activities of the university two aspects can be distinguished:

- if we talk about the efficiency of management of scientific and innovation activity, then it is advisable to consider effectiveness as the degree of achievement of the objectives.

- if we talk about the efficiency of the results which, in particular, are products of innovation activities, it is advisable to consider efficiency from the standpoint of the relationship of the result (effect) to the cost.

In the traditional point of view, the meaning of "efficiency" is that the whole process of functioning of any entity shall be conducted with the least cost or greatest effectiveness (performance). Material, labor, information and other resources must be transformed into goods and services. The university, organizing its innovation activity, provides this transformation not only with benefit for the consumer, but also for itself.

The economic effect refers to the difference between the results of economic activity and their costs. It is obvious that to change the value of effect it is necessary to influence the factors determining it. However, various results of activities do not always provide the economic effect. Traditionally, management practices distinguish between these types of effect as economic, social and socio-economic. In relation to research and innovation activities in the modern research along with the traditional, there are also additional types of the effects. First and

foremost, this is a commercial effect obtained by the participants in the innovation process when using the results of research and innovation activities. Also of great importance scientific and technical effect, which is expressed in possibility of use of results of performed studies in other research and development activities and obtaining information needed to create new products. Innovations may also have environmental effect - the impact of the result (product of activities) on the environment (noise, electromagnetic field, lighting (visual comfort), vibration, etc.

Regarding innovation activity of the university, it can be noted that its results are products that are created during certain processes of university activity and necessary for certain stakeholders (the state, educational activity of the university, etc.). During the use of innovative products stakeholders receive different types of effects mentioned above.

In practice the university faces with the challenge of improving the efficiency of research and innovation activity. Thus, according to popular belief, efficiency, in contrast to the effect, defined as the relative value is equal to the ratio of the result, purpose or result (effect) to inputs that lead to this result [72]. In turn, the effectiveness of innovation activity of the university can be considered within a single concept of "efficiency", implying a degree of achievement of objectives in the field of science and innovation. This should be taken into account as the obtained results characterize the achievement of the goals and the spent resources.

Based on this, efficiency of innovation activity of the university can be considered as the ratio between of the results of scientific innovation that characterizes the degree of achievement of the goal of creating of scientific and innovation products to meet the requirements of stakeholders and cumulative resources used for that [71, p. 95].

Definition of the terms of effect and effectiveness of IA is the basis for the analysis and choice of methodology for assessing the effectiveness of IA as a key component in the management of IA of the university.

Currently, the literature presents different methods of complex estimation of innovation activity of the university. So, researchers [73, 74] developed the methodology, which includes 4 interrelated stages:

Stage I – definition, classification and grouping of indicators to assess the innovation activity of the university;

Stage II - comparative analysis of innovation activity of the university;

Stage III - definition of tendencies of development of innovation activity of the university;

Stage IV- a comprehensive assessment of the innovation activity of the university.

The first stage of evaluation of the university IA includes the grouping of evaluation indicators of innovation activity in three areas: statistical study of innovation activity, learning innovation and educational activity, stimulating the development of innovation. The second stage includes use of the method of T. L. Saaty and scale of desirability by E. Harrington for the comparative analysis of indicators of innovation activity of universities. The analytic hierarchy process by T. L. Saaty allows to make the ranking of indicators of innovation activity of universities, and along with the Harrington's scales of desirability establishes the correspondence between the physical and the psychological parameters of innovation activity of the university. For ranking indicators in selected areas of research a pass grade is provided (in the range from 0 to 1) on the rating scales presented for each indicator of innovation activity (table 9).

Table 9 - The standard mark on the scale of desirability by E. Harrington

Desirability	Mark on the scale of desirability
Very good	1.00-0.80
Good	0.80-0.63
Satisfactory	0.63-0.37
Poor	0.37-0.20
Very poor	0.20-0.00

The indicators of innovation activity are evaluated in the third stage according to the formula:

$$K_i = a_i * A_i \qquad (2)$$

where

K_i - evaluation of the i-th measure of innovation activities of the university;

a_i - the priority of the i-th index by T. L. Saaty;

A_i - scoring of the i-th indicator on the scale of desirability by E. Harrington.

The developed method simplifies the process of evaluation of innovation activities of the university and provides an objective view of the situation, as this assessment provides for the identification of a sufficiently large number of quantitative and qualitative indicators.

Then, the integral index of innovation activity of the university is calculated, taking into account the importance of each direction according to the formula:

$$I = \sum_{j=1}^{n} \mathrm{K}_i \times a_j \qquad (3)$$

where

I - integral index of innovation activity of the University;

K_i - evaluation of the i-th measure of innovation activity of the university in the framework of the innovation project;

a_j - the priority of the j-th directions of innovation activity of the university.

The resulting value of the integrated assessment allows you to judge the condition of innovation activities of the university. For the criteria of integral evaluation a scale of table 9 can be used. State of innovation is determined absolutely from very poor to very good.

The poor state of innovation activity of the university (0-0,37) is characterized by the following indicators: low performance in the creation of innovations determine the inability of the university to participate in the innovation cycle; training for innovation activities is at a low level, educational activity does not promote innovation. Strategy of development of innovation of that university should pay attention to the educational component of its work, which includes: training, retraining and skills upgrading of scientific-pedagogical staff; creation of centres for postgraduate education, research labs, sessions on innovation activities of the science sector on the basis of innovative enterprises; increasing qualification of the university teaching staff.

To improve the performance of innovation, it is necessary to plan a new cycle of improving in other indicators. It is necessary to consider

that the university must set goals that can be realistically achieved, i.e. in the beginning it is better to focus not on the best indicators of innovation activities of the university but on its average level.

Satisfactory state of innovation activity (0,37 - 0,63) is characterized as follows: working towards the creation of innovations is conducted at the secondary level; training for innovation activities carried out in the statistical average indicators; educational activity, stimulating the development of innovations, is carried out at a very high level as it has not a significant impact on the level of assessment. Planning the innovation activity of such university, it is reasonable to redistribute efforts to the process of creating innovations, as it will most effectively strengthen the innovative component of the university's activity.

Good and very good states of innovation activity (0,63 - 1,0) are characterized as follows: high level of activity in creation of innovations, respectively, and there are intense processes of learning of innovation activities and as a consequence consistently high level of educational activity, which stimulates the development of innovation.

The strategic task of such universities is to hold leading positions in the industry of the country and perhaps in the world. Perhaps these universities should be attributed to the leading ones with the opportunities of creation on the base of them the centres of development of innovation branches of the national economy.

Another approach for measurement of innovation activity of university was made by Larionova M.V. [75].The researcher, based on a comparative analysis of methodological approaches to assessing the results of innovation and research activities of universities from different countries, proposed the following system of indicators (table 10).

Table 10 - Indicators of basic measurements of innovation activity of universities

Indicator	**Description**
1	2
Productivity (effectiveness) of research activity	
Publications and other results	Number
Number of publications (and other results) per researcher	Equivalent of a full-time researcher ("academic researcher")

Table 10 continued

1	2
Quality and academic result	
Number and percentage of publications in highly-cited journals	Number of publications, impact factor
Citation	Citation indexes (Web of Science, Scopus, Google Scholar)
Reports at national and international conferences	Number of reports
Number of prestigious awards	Number of prestigious national and international awards in total or per researcher
Temporary international "appointments"	The number of positions held temporarily in other academic (non-academic) institutions (organizations)
Participation in editorial and expert councils of national and international journals	Number of positions held temporarily in the editorial councils and expert councils of national and international journals
Innovative and social achievements	
Income from research	External attracted funding
Percentage of grants received	Indicator of income from research
Employment of defended graduate and doctoral students	Indicator of contribution to the formation of labor market quality
Recognition of the user	Orders, contracts for various activity
Level of income per equivalent of one full-time researcher	The indicator provides an opportunity for interuniversity comparison
Commercialization of Intellectual Property	Indicator of income from patents, licenses and new businesses
Percentage of financing from contracts	Measure of profitability of recognition
Stability and scale	

Table 10 continued

1	2
The number of graduate and doctoral students	The ratio of the number of graduate and doctoral students to the equivalent of a full-time researcher
Inclusion of young researchers in teams	Number or percentage of young researchers included in projects and teams
Number of partnerships	Number of partnerships with national and international universities (from abroad) and organizations
Number of dissertations	Number of defended works
Research Infrastructure	
Research activity of academic staff	The number of active researchers in the total number of academic workers. It is determined through the establishment of a number of performance indicators
Percentage of academic staff involved in research activity to the total number of academic staff	Ratio of academic staff involved in research activity and total number of academic staff
Total investment in research and development	The volume of total investment in research and development, from all sources, including salaries and additions
Research infrastructure	Number of laboratories, books and electronic resources, their level of accessibility
Research Ethics	Processes providing promotion and use of ethical principles in research practice
Note – adapted from Larionova [75]	

Different approach was offered by Fedin et al [76]. Except measurement of internal infrastructure, the researchers take into account

the links between university and industry (company).

Today bibliometric (scientometric) approach to the study of efficiency of scientific activity becomes more and more popular among the scientific community. It appeared in the 60-70 years of XX century, however, began to be actively used only in the 90s of the last century. The development of the global information and communication technologies gave the impetus for the development of this method of assessment of scientific activity [77].

The term "bibliometrics" is more general and means a method for quantitative studies of documentary flows. As for the term "scientometrics", it is used to denote the applied research stream of scientific information taking into account its specificity. Despite the different definitions in literature, the researchers [77, 78, 79] agree that the terms "bibliometrics" and "scientometrics" largely mean the same. Thus, later in the monograph named concepts are treated as identical.

Scientometrics annually develops and tests in practice a large number of indicators that can be used to assess scientific performance. The results of the evaluation depend on how indicators are used and for what purpose.

Indicators conventionally are divided into three main groups [80]:

– indicators based on the number of publications;

– indicators based on the number of citations;

– indicators based on the number of citations and number of publications.

The most generalized indices are based on the number of publications is the total number of publications of a researcher or organization that can be extracted from bibliographic databases and shows the number of works that went into a database of appropriate information retrieval system. Often they take into account the number of publications in international databases Scopus and Thomson Reuter.

Currently the leading scientometric indicator based on the number of citations is citation index. It is a total number of references to the number of works of the author in scientific publications. Citation index shows:

–the degree of the relevance and importance of the studies for those areas of knowledge in which specific scientists or research teams work;

– high citation index to a certain extent serves as the official recognition of a particular academic research community and

confirmation of its priority;

– availability of scientists in scientific and educational organizations with a high index indicates a high efficiency and effectiveness of the organization as a whole [81].

The citation index is calculated within the specific database, which may be national or international one.

The indicators based on the number of citations and number of publications include the h-index and its modifications. However, the key indicator is the classical h-index, developed by J. Hirsch in 2005. The index is denoted by h and is calculated by the most databases. According to J. Hirsch, the index is more preferable than such criteria as the number of works divided by the total number of citations or the number of citations per one paper. According to the definition of h-index, a scholar with an index of h has published h papers each of which has been cited in other papers at least h times [82].

The h-index allows to take into account not only the number of publications of a particular author, but it also shows the demand for them from the scientific community. Thus, the index indicates the balance between the number of publications and number of citations received by each publication [81, p. 6].

The citation indexes as main indicators of efficiency of innovation activity of universities are included in the criteria for the various international University rankings.

Thus, the methodology of the ranking of the best universities in the world QS World University Rankings includes the assessment by six criteria, one of which is the citation index, which is used to assess the research and innovation activity of the university. Its weight in the overall assessment of the institution is 20% [83].

This criterion includes the number of citations of published research on the number of teachers and researchers working at academia as the primary place of work for at least one semester. From 2004 to 2007 the citation was calculated based on the database of Thomson, since 2007 - based on the bibliometric database Scopus by Elsevier. Index takes into the account published in the last five years the materials, excluding self-citation.

In 2015 citation index was optimized. This was due to the introduction of system that balances the performance of different scientific disciplines. The citation index has been considered in the

framework of the specific groups of scientific fields: Arts and Humanities; social Sciences, including management; Natural Sciences; Technical Sciences and Engineering; Life Sciences. This adjustment made it possible to more accurately correlate the indicators of various fields of knowledge.

Citation indexes are also used in the ranking ARWU - Academic Ranking of World Universities, known as "Shanghai". This rating takes citation into account not only in the rating methodology, but also in the selection of universities. The certain university has the right to take part in the ranking if it has among the staff of the university the scientists with high citation index according to Thomson Reuters database [84].

20% of the methodology of a rating is an indicator of the number of highly cited scientists, which is determined in accordance with the Essential Science Indicators (ESI) database from Thomson Reuters. Such indicators are separately considered:

- PUB - the total number of citations of the organization within Web of Science Core Collection (only "Science Citation Index-Expanded" and "Social Sciences Citation Index" databases(20%);

- N&S - the number of articles published in the journals "Nature" and "Science" by the authors from the university staff (20%).

Unlike the indicators of the QS, the ARWU measures absolute citation indexes and the publication activity of universities. The large and old universities have advantage in this ranking, because they have a large number of publications and citations.

Summarizing the above, we can conclude that in recent times there is the trend of the use of scientometric indicators for evaluating the effectiveness of research activity as of individual researchers and universities. Because of the access to Thomson Reuters and Scopus databases the data indicators are available both for scientists and the administration of scientific organizations and universities.

Scientometric indicators allow not only to assess the SIA of the individual university, but also to compare the results with the results of other scientific organizations. Despite the fact that some scientometric indicators were not known 10 years ago, they are already firmly entrenched in various methods of evaluation of innovation activity, including the recognized international ratings of higher educational institutions.

3.2 The development of the university cooperation with the business sector in the process of commercialization of university researches

In modern conditions of development of market relations, scientific research and development becomes specific sphere of commodity production where goods are objects of intellectual property. Moreover, innovation activity is considered as the main condition of modernization of economics, upgrade of material and technical potential and is one of the main factors of increase of efficiency of work of the scientific sphere. Commercialization of results of scientific research and development is a necessary condition for the strategic development of any organization because it provides the creation of new industries, expansion of range and improvement of product quality, improvement of technology of their manufacturing with the subsequent introduction and effective realization on the domestic and foreign markets.

Economic development today requires not only the deployment of production capacities for manufacturing of domestic goods, but increasing their capacity on the basis of a new quality of the process associated with the effective use of innovative capacity, expansion of volumes of realisation of innovations. As a consequence, the most important issue of improving innovation activity should be recognized the improving the forms of commercialization of its results, stimulating the innovation activity of organizations.

The literature provides various definitions of the concept of "commercialization". So, according to scientists [85] commercialization of innovation "is attracting investors to funding the implementation of this innovation which is based on participation in future profits in case of success". This definition emphasizes that the process of commercialization not only includes the production of a new product, but also a profit for all its participants.

G. Kozmetsky describes commercialization as a process, in a timely manner, transforming the results of scientific research and experimental design developments in innovative products and services in the market [86]. This approach points to the fact that any innovation must be quickly put into production to avoid losing subsequent profit.

The process of commercialization can include the transfer of rights for intellectual property to third parties. So, Monastyrnyi E. A. and Grik J. N. denotes the commercialization as the profit from selling the

innovations or profit from their use in somebodies own production [87]. According to scientists [88] commercialization of innovations is the process of allocating of financial resources for innovations and incremental validation of their expenditure, which includes the assessment and transfer of completed/mastered innovations in an industrial environment.

In the Law of the Republic of Kazakhstan "On commercialization of results scientific and (or) scientific-technical activities" the commercialization is defined as "the activity related to the practical application of results of scientific and (or) scientific and technical activity, including the results of intellectual activity, with the aim of bringing to market new or improved products, processes and services aimed at deriving income" [89].

Considering all the above views, commercialization can be defined as the process of transformation of research results into innovative products and/or services to the market in order to get profit from their sale. The commercialization process involves the search, evaluation (examination) and the selection of innovations for fundraising, legal confirmation of rights to future intellectual property (innovation), the introduction of innovations in production and further modification and maintenance of intellectual products [90].

Because commercialization is inseparably linked with innovative activity, it becomes evident that it is necessary to ensure their close relationship.

Today, such opportunity may be provided by primarily higher education institutions on the basis of which it is possible to create small innovative firms, venture capital high-tech structures of different ownership forms, as well as qualitatively new economic entities, such as innovation centers, business incubators, technology parks, engineering centers, training and project office, etc.

The commercialization process consists of several stages, which are presented in figure 4.

Commercialization includes the processes of search and selection of projects for implementation in production before the end of the research work is occurred. Innovative projects are carried out in accordance with the criteria applicable to them from the subject of commercialization. In particular, if the university serves as developer, the selection of innovative projects can be carried out according to the disciplinary

context of the university.

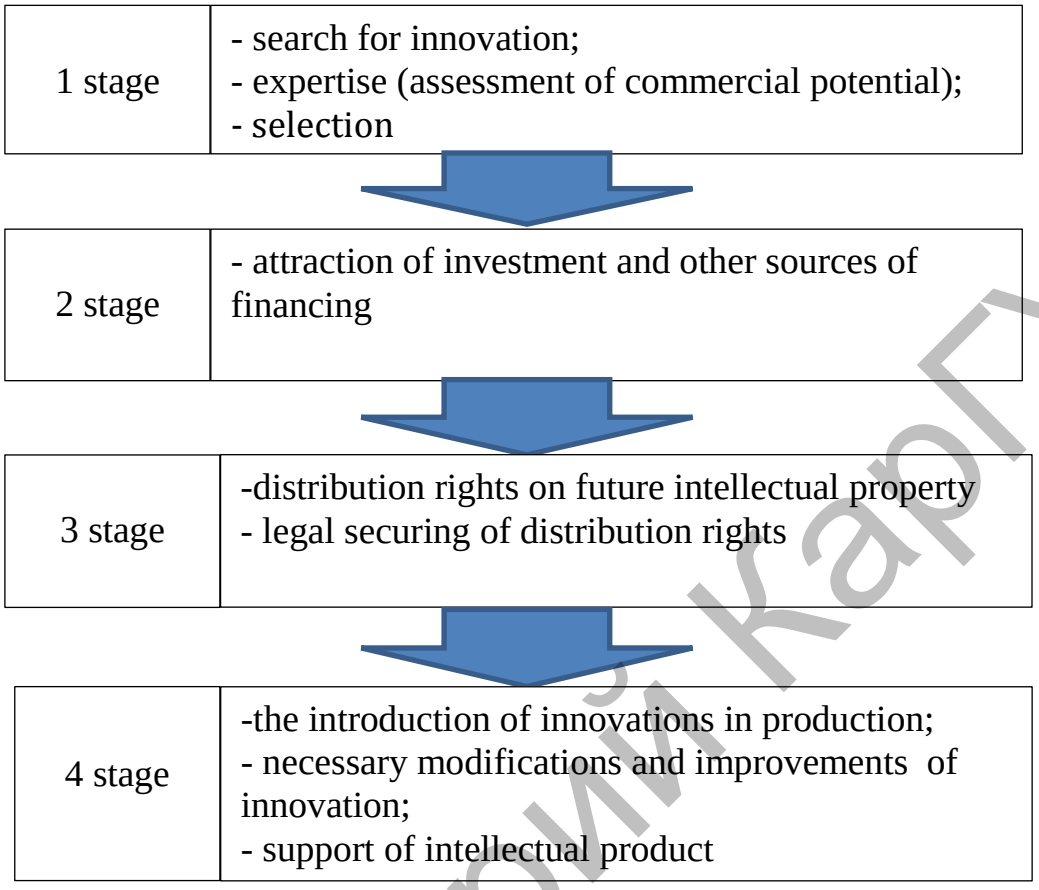


Figure 4 – Stages of the commercialization of innovation

Note - compiled from Kovazhenkov & Bryantceva [90]

Project appraisal is an assessment of potential benefits from project by number of criteria, on the basis of which a further selection of innovations are made. Conditionally, criteria are divided into external and internal ones. External criteria refer to needs of the society and various commodity markets. Internal criteria, in turn, include an assessment of innovative development potential, the calculation of economic efficiency of introduction of innovation as well as the term of its payback.

The participants in the commercialization process are divided into two main categories – developers of innovations and their buyers (investors). The developers of the innovation can be individual researchers, groups, developers, research institutes, small and medium enterprises. Meanwhile, the investors are public and private funds,

venture capital funds, business angels, medium and large enterprises.

The process of commercialization of innovations highly depends on the intermediaries between innovation creators and investors. Intermediaries are innovation centers, centers of transfer and commercialization of innovations, consulting firms and business incubators. These organizations provide services of different nature (consulting, legal) that involve work with intellectual property of developers: its protection and promotion.

Different organizations, funds, objects of innovation infrastructure actively participate at each stage of the innovation life cycle. The life cycle of innovation was considered in detail in Chapter 1, figure 1. With the purpose of commercialization the life cycle of innovation can be schematically divided into 3 blocks, that consist of a set of interrelated phenomena, processes, works, forming a complete circle of development in a certain period of time.

The first set of processes includes stages of basic research, the development of new ideas and applied research. At this stage of creation of innovation the institutes and academic universities play the activerole. Research organizations conduct basic and applied research, produce innovative ideas which can be implemented in practice in the form of new or improved technology, products.

At this stage, universities and research institutes can perform state order for scientific research of fundamental or applied nature, and also obtain funding to perform research through development institutions and venture funds. The active role of the universities is confirmed by publications of local scientists in journals with impact factor, and obtaining patents in domestic and foreign patent offices.

The second block includes the process of creating the prototype and testing the new technologies or products. At this stage the active role belongs to technology parks, industrial parks and the SECs. Technical equipment of a number of research institutes and most universities does not allow obtaining prototypes of new products. At this stage, it is necessary to involve laboratory equipment that has technological parks. However, laboratory equipment of technology parks is often not used at full capacity due to lack of demand from the private sector and the science sector. Meanwhile, some technology parks have not completed the installation of equipment purchased in previous periods and have legal problems with the rights on the use of this equipment.

Taking into account that the relationships between elements at the stage of creating a prototype are characterized as weak, the same relations arise at the stage of testing innovations, as only a small part of inventions reaches that stage.

The last block includes the introduction, the diffusion of innovation and the resulting growth and then a slowing and decline in production.

Thus, in the absence of technical support from technology parks, inadequate attraction of funding from venture funds, business angels and other sources, the introduction of university developments in the region's enterprises becomes difficult. It is necessary to support innovative developments at intermediate stages of the life cycle from the stage of completed scientific research to the introduction into serial production.

The law of Kazakhstan "On commercialization of results of scientific and (or) scientific and technical activity" stipulates the following mechanisms of commercialization of results scientific and (or) scientific and technical activity, which include:

1) conclusion of the license agreement and (or) the contract of assignment of exclusive rights on results of scientific and (or) scientific and technical activities;

2) creating start-up companies;

3) implementation (use) of results scientific and (or) scientific-technical activities in its own production;

4) other methods stipulated by the legislation of the Republic of Kazakhstan.

This work suggests the following mechanism of interaction between universities and business with the participation of technoparks and regional venture funds at the stages of creating a prototype and approbation of innovations (figure 5). In this mechanism, services of technopark are not limited to business incubation, but include technological expertise and obtaining a test sample in the laboratory [91]. A special feature of this mechanism is the funding of the project at the expense of the state development institutions, and through regional venture Fund.

When considering the commercialization of university scientific research, we should note that any innovative project has a number of specific features focused on the region.

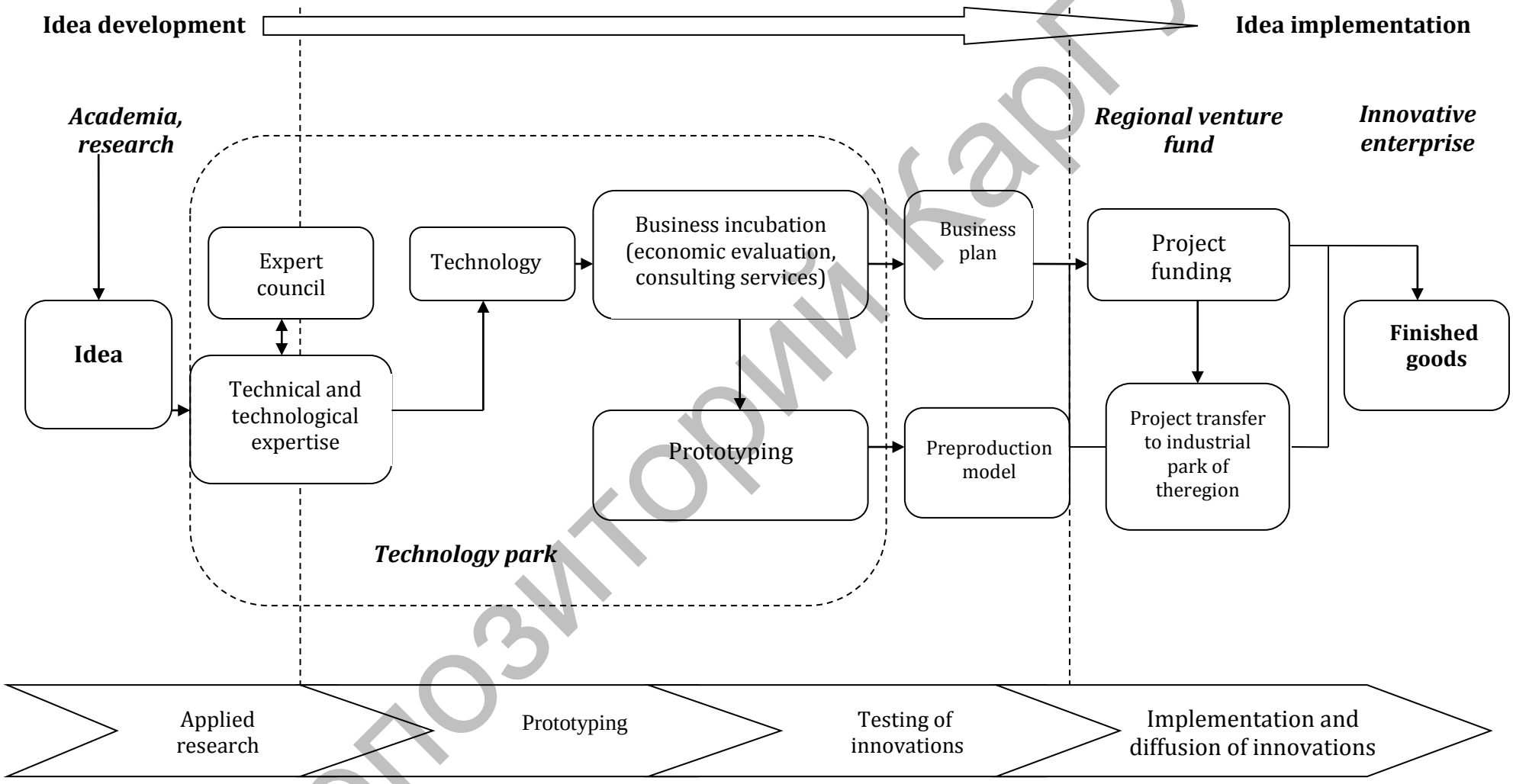


Figure 5 - Interaction between elements of NIS in the process of the commercialization of scientific results

Note – compiled by the author

Its success highly depends not only on the efficiency of regional system of support and funding from the development institutions, but also on the quality of the innovation infrastructure generated on the level of specific region and the business environment [92].

Thus, interaction of universities and industrial enterprises in the process of commercialization of innovations is largely based on existing innovative and financial infrastructure in the region.

In accordance with the Program [93], country forms the regional venture funds (RVF) on the principles of public-private partnerships.

The objects of the investment support must be private entrepreneurs operating in priority sectors for each region, with preference to business projects that just begin the implementation phase.

The purpose of regional venture funds is to invest the financial resources in the form of a contribution to the authorized capital of SMEs, fast-growing companies focused on the production of high-tech products. Also, regional funds have the ability to finance the development teams which have a prototype of a commercial product or objects of intellectual property.

Implementation of innovations in production is associated with large financial investment, so for small and medium-sized enterprises borrowing is the most urgent task. The mechanism of bank credit is often limited for SMEs by the lack of sufficient collateral and the lack of ability to use existing object of intellectual property as collateral. Thus, the financing of innovative small and medium-sized enterprises can be achieved by the formation of the mechanism of unsecured funding, which may be implemented through the regional venture capital funds.

Venture Fund provides financing in the form of investments, which are sent to the stock of the company, either in the form of investment credit provided for the long term, without collateral and at lower interest rates than a bank loan.

Regional venture Fund can be created in the form of a joint stock company, limited liability partnership or a non-profit organization.

In our view, the most appropriate organizational and legal form of a regional venture capital fund is a joint stock company. This form is the most attractive for private investors (founders) of the fund and allows to implement the market-based mechanisms of venture investment of strategic innovative projects in the region.

The founders of the Fund may be the developmental institutions and local bodies of state administration with the involvement of private investors. The Fund is administered by the Board of Directors, which determines the main directions of the Foundation, the allocation of profits between its participants. In our opinion, the contribution to the authorized capital of regional venture Fund should not be restricted to the financing from the Republican budget, it is necessary to involve the regional budget. Thus, local government bodies could directly participate in the management of venture Fund, to carry out the selection of projects that are in priority for businesses in the region. Only private investors should receive the income from the investments, the share of profit of development institutions and local governments is reinvested.

The university delivers an innovative project (intellectual property) to the Fund that has commercial potential. The Fund conducts a comprehensive assessment of incoming innovative projects, which can be both internal and external with the participation of invited experts. Comprehensive expertise includes scientific, technical, financial-economic and legal aspects and shall be applied to applications for funding that meet the requirements of the rules of the Fund. According to the results of a comprehensive examination the competitive selection of submitted innovative projects is carried out. Preference should be given to those innovative projects that are in demand in the region.

Application to the Fund may be submitted jointly by university and industrial enterprise, which guarantees the implementation of development. The advantage of venture Fund for SMEs in comparison with other mechanisms of support of innovative projects (e.g. equity funds), is in the possibility of obtaining project financing at an early stage, which contributes to its rapid development in a short time. Investor has a number of advantages from the funding through the venture fund. First, there is no need to search the promising innovative projects. Second, the private investor in the initial stages of investing can invest a fixed amount and, in the case of successful development of the project, to increase funding, thereby reducing his/her business risk.

The advantage for local government is financing the investment projects in scientific-technical sphere for their realization by small businesses in the region.

The opportunity of participation of representatives of local governments (akimats) in regional venture fund is currently

implemented in the state law "On state support of industrial innovation activity" on January 9, 2012.

For further effective development of venture financing of innovative projects it is necessary to introduce amendments to legislative acts of the republic concerning the development of investment and innovation activity. So, in our opinion, the law "On state support of industrial and innovation activity" should be supplemented with new provisions on the procedure of establishment and operation of regional venture capital funds. The capabilities of local authorities in relation to participation in venture funds as founder and/or investor of the occurrence of their representatives in the Board of Directors of the Fund should be expanded. Additions to the law should also concern the regulation of financial flows of the Fund, the allocation of profits received by the Fund taking into account the interests of all participants. There is no specialized legislation on venture capital funds in Kazakhstan, selected issues and investment activities of venture capital funds are regulated by laws of RK "On state support of industrial and innovation activity", "On investment funds", Government decisions of the Republic of Kazakhstan, in particular the Memorandum on the investment policy of JSC "NATD".

The expansion of investors of venture capital funds, especially regional ones, would make this mechanism of commercialization of domestic developments more flexible and tailored to the country's economy.

Currently, most small and medium-sized enterprises of Kazakhstan are characterized by precarious financial situation, lack of liquid collateral and the ability to provide any collateral for loans. However, some of them in the case of raising needed capital, including through regional venture capital funds could have a significant growth potential and attract investors.

Development of venture financing system will allow to intensify the implementation of developments of domestic universities at the enterprises of the region. The proposed mechanism of interaction of elements of innovation system at the regional level can be used for the formation of effective state policy in the field of venture capital investments and enhancing innovation activity of universities and enterprises on the regional level.

3.3 Prospects for the formation of research universities in Kazakhstan

All over the world today universities are recognized as key players in regional and national innovation systems. They are sources of knowledge and actively participate in the innovation processes of regions. The growing importance of universities in developed countries contributes to the fact that developing countries actively include in strategic plans the measures to stimulate innovation and research activity of universities and to develop the relations between universities, industry and other actors in the innovation system.

Research university is a special kind of institutions of higher education, which considers research activities as one of its main objectives. It generates knowledge and trains the professionals of the highest class, who have creativity and is able to find optimal decision in an unpredictable situation from the point of view of spontaneous scientific and technological development. Such universities are characterized by unique groups of scientists, a large number of research works, a multi-level system of education, modern logistics and information base.

The term "research universities" originated in the United States with a goal to differentiate higher educational institutions, which lead training in doctoral studies from those universities where there are only graduate programs and no undergraduate research activities [94]. Researchers [95] recognized the indicator of total expenditures on research as the main criterion for the allocation of university to research type. Data of the largest research universities in the USA show that the efficiency of such institutions depends largely on financial and material resources [96].

In the early 70-ies of the last century, the Carnegie Foundation had developed a Classifier of higher educational institutions of the United States [97], which contains the criteria of a research university:

1) the presence of doctoral programs, including a certain number of scientific disciplines, according to which the degree of Doctor of Philosophy is conferred;

2) a certain amount of Federal research and training grants received by the university;

3) the availability of training programs for university students;

4) joining the list of the best universities in terms of Federal financial support for scientific research and development.

Dezhina [98] identifies a number of features, compliance with which can attribute the university to innovative (research) type:

- a wide range of training areas, including natural science;
- orientation of the faculty on research and development, particularly for fundamental research with focus on perspective areas of science and innovation;
- orientation to the promising areas of science and innovation activity;
- developed system of training of master and PhD students;
- highly qualified teaching staff;
- invitation of leading foreign specialists for reading lectures on new scientific areas;
- susceptibility to global experience and flexibility to introduce new areas of research and teaching methodologies;
- a competitive approach in the recruitment of students;
- the development of the university's innovation infrastructure facilities, specific technical, scientific and economic space, relations with other educational and research institutions;
- developed corporate ethics, academic freedom in offering educational programs.

Thus, we can define the main features of research university. First, it is the orientation on research activity of the staff and high research expenditures. Second, it is active participation of students in research activity. It means that university develops post-diploma education like master and PhD studies. But two features are not enough to call the university the research one. Today research university should be involved into social and economic life of the region; it should not only create new knowledge but also transfer it into the economy and society.

The contemporary model of research university is built on the interaction of three components: education, research and innovation. The previous model combines two functions of the university - the development of fundamental science and fundamental education. The modern model of the university gets the third function - "flow" of information transmission in the community or "transfer of knowledge".

Considering the evolution of the role and mission of the university in social and economic life, researchers [42] distinguish 3 patterns:

traditional, modern and evolutionary.

In evolving model universities function as "knowledge hub", which aim to develop new opportunities and innovation, particularly at the regional level. In this model universities are deeply embedded in the innovation system, actively tend to develop synergies and spillovers to link research with the implementation and commercialization, and act as catalysts and activators of economic and social development. Universities, of course, have always been institutions of knowledge, but in the third mode, it aims to use knowledge actively to contribute to the development and creation of new opportunities in the region and beyond.

The traditional university functions as training and research complemented by its activities in the transfer of new technological developments at the industry and the business sector. There are many universities, which attract to the orbit of their activity the industrial, research, commercial and other firms. Interaction with business has allowed many universities to become the largest educational-scientific-innovative centres. An example is the University of Oxford, which interacts with more than 300 high-tech firms [96].

Another approach to the role of the university in economic and social life is associated with the model "Triple helix" developed by professor from Stanford University G. Etzkowitz together with L. Leydesdorf [99]. In this conception a university is recognized as a core of innovation activity [100].

It becomes the main center of focus of the state efforts on the development of innovation, organizes the cooperation with industry, business, largely by taking the functions of their research units. Traditional university turns into an entrepreneurial (research) university, which focuses on the development of research activity and business principles in students along with academic knowledge.

Today research universities become centers of innovation activity in Europe and the United States. The greatest development they had received in the United States, where currently there are about 260 research universities [101].

In Kazakhstan, opportunities for the establishment of research universities was fixed by the adoption of the Law of RK "On science" dated February 18, 2011. The main objective of a research university is

integration of scientific activity and educational process at all levels of higher and postgraduate education.

Today Kazakhstan has good scientific potential. The number of employees engaged in research and development in higher educational institutions significantly increased in 2016 compared with 2008. Although total R&D personal in the country had declined in the 2008-2010 [102], the higher educational institutions gradually increased the employees which says about stable development and attractiveness of this sector.

In legislation of Kazakhstan the research university is defined as higher education institution, implementing the approved by the Government of Kazakhstan program of development for five years, and self-developed educational programs of higher and postgraduate education on a wide range of training areas (specialties), using the results of fundamental and applied research for the generation and transfer of new knowledge [23], [28].

Today in Kazakhstan it is possible to identify several (up to 10) leading universities that have sufficient potential for obtaining the status of "research university" and set the task of staff training and conducting research for "breakthrough" development of the economy of the republic in priority areas. The government not only makes increased requirements to those universities, but also secures the appropriate status for them at the institutional level. This status guarantees the appropriate work schedules of staff, adequate payment of work, social benefits, increased scholarships for students, grants for post-graduate education and etc.

Table 11 presents the 9 universities of Kazakhstan, which have high national and international ratings in accordance with Webometrics and national ranking IQAA.

The four first places of universities explain that the national ranking estimates the higher educational organizations by groups according the nature of the universities: technical, medical, pedagogical, multi-disciplinary, art and humanities and economics.

Table 11 shows that the national ranking in general confirms the Webometrics ranking. Exceptions are Kazakh-British technical university which has 1 place in national ranking but only 16 in international one and Nazarbayev University which are not included in Webometrics ranking.

Table 11 - Ratings and bibliometric indicators of the top 9 universities of Kazakhstan

University	*Webometrics -2015*	National renking universities IQAA -2015	Articles indexed by Scopus (1991-2015)	
			Number	Share in total number of publications
Kazakh national university named after al-Farabi	*1*	*1*	*1855*	0,15
Kazakh national technical university named after K. I. Satpayev	*2*	*2*	*470*	0,04
Eurasian national university named after L. N. Gumilev	*3*	*1*	*992*	0,08
Kazakh national medical university named after S. Asfendiyarov	*4*	*1*	*146*	0,01
Pavlodar state university named after S. Toraigyrov	*5*	*5*	*148*	0,01
Karaganda state technical university	*6*	*3*	*118*	0,01
Karaganda state university named after Ye. A. Buketov	*8*	*4*	*246*	0,02
Nazarbayev University	*12*	*n/a*	*597*	0,05
Kazakh-British technical university	*16*	*1*	*252*	0,02
Note: compiled by the author according to the Scopus database (www.scopus.com), Webometrics (www.webometrics.com), the Agency IQAA (www.nkaoko.kz)				

Bibliometric indicators based on publications in international, peer reviewed journals can be used to characterize the current stage of a country's scientific development. According to universities, bibliometric indicator may characterize the research activity of the organization.

From 1991 scientists of Kazakhstan published totally 12553 articles in journals indexed by Scopus. The share of universities in country's total publications is presented in Table 11. The biggest share of publications belongs to the Al Farabi Kazakh National University and Gumilev Eurasian National University. The third place is taken by Nazarbayev University.

In December of 2014 the Satpayev Kazakh National Technical University received the status of research university. In December of 2015 the Government awarded this status to Nazarbayev University.

The research activity of the universities is characterized by the following:

1) the staff participates in the educational programs and in research (the teaching in average is taken about 25-75% of the work time);

2) high level of the research;

3) investments in the development of its research base (library resources, information technology, laboratory equipment, etc.);

4) the availability of undergraduate and postgraduate programs.

Education in research university includes both training of elite specialists (PhD), as well as students with basic higher education who do not plan to engage in professional scientific and educational activities in the future. Kazakhstan following the example of the leading international experience seeks to create research universities. At present, the legislative framework has been formed to create such universities.

Other Kazakhstani universities from top-10 have potential to become research universities. Especially they are Al Farabi Kazakh National University, Gumilev Eurasian National University and Buketov Karaganda State University. All those universities have master and PhD programs and developed R&D sector. Their publication activity is very high. As for Kazakh-British Technical University, it is planned that it will be integrated with Satpayev Kazakh National Technical University to create the biggest scientific and research center in the country.

It is important for the university to develop the scientific areas in which researchers and scientists of Kazakhstan have scientific results. Analysis of the publications of local scientists in specific areas of knowledge shows that the greatest number of articles in leading international journals with impact factor in 2009-2013 years was published in such areas as chemistry, physics and astronomy. They comprise over 50% of all published scientific articles [4].

Thus, at the current stage of development of innovation activity in the country it is necessary to involve the universities into the innovation system. Especially it concerns ones with significant potential in the education and research activities in natural science areas, in particular, in the field of chemistry and physics.

Involvement of the university in the region's innovation activity involves two tasks.

First, it is the development of intellectual potential of university-based training of experts in modern technologies and the involvement of the most capable ones in research activity;

Second, it is the generation and transfer of knowledge in order to accelerate the implementation of innovative technologies in various fields.

The major characteristics of innovation activity and the innovative environment of the university shall be the following indicators:

1) participation of innovative structures of the university, as well as research teams and individual scientists in innovation projects and developments (the number of ongoing studies, the number of applications for patenting, patents obtained, the number of projects and developments in cooperation with the enterprises of the region, the volume of revenues);

2) creation of innovation infrastructure in universities, providing effective commercialization of high-tech products and technologies (the amount of research, innovation and implementation structures, including industrial parks, business incubators, etc.);

3) support of innovation activity with material, technical and information base (laboratory equipment, the number of personal computers in high school; terminals with Internet access, access to the information resources of the world largest universities, the total number of storage units of the university library collection);

4) development of intellectual potential of the university (the total number of the teaching staff, staff with a PhD degree, the availability of training programs for masters and PhD students);

5) active participation of doctoral students and young scientists in the development and implementation of innovation projects and development (number of students and doctoral students, who participating on paid basis in research in the framework of the research, innovation and implementation structures);

6) cooperation with universities in the educational, scientific and research activities (student exchanges, joint training of PhD students, staff mobility, the holding of international scientific and practical conferences [103].

Thus, the first block of indicators (1-2) describes the innovation activity of the university in the creation and implementation of its own scientific R&D, whereas the other indicators (3-6) characterize the innovative potential of the university and its possibilities in the educational activities that promote innovation.

Despite the fact that the university is the source of innovation, it is difficult enough for researchers to provide industrial implementation of their own R&D. Commercialization of R&D requires the establishment of partnerships and interactions with financial and innovation infrastructure of the region, in particular technology parks and regional venture funds. The model of regional venture funds is implementing now in Kazakhstan.

In our view, the provision by the technology parks of laboratory and test services does not solve the problem of commercialization of scientific research and requires increased cooperation in the following areas:

- the evaluation of commercial value and investment attraction of patented R&D;
- access to technopark technological base for manufacturing of experimental samples and pilot lots of high-tech products;
- the search for customers and assist to researcher in obtaining venture financing.

Getting the experimental samples largely determines the capabilities of scientists in obtaining funding from the venture capital funds that could invest in the project up to 100% of the required funds.

An important aspect of commercialization of scientific developments is evaluation of intellectual property by technology park with the aim of including of the patent into the share capital of the project. Later patents may be used as collateral in obtaining loans from commercial banks. The implementation of this measure will allow scientists along with venture funds and technology parks to become a full partner in the project.

Another important aspect for the development of the university is highly qualified teaching staff. The indicator of the high scientific

results of the university staff is a high publication activity in international journals with impact factor. According to the analytical Scopus database during the period from 1991 to 2015 the scientists from Kazakhstan published 11,872 articles in journals with high impact factor. The largest number of articles published in the fields of physics and astronomy (20.9%), engineering (14.3%), materials science (13.6%), chemistry (13.0%), which confirms the high scientific potential of the RK scientists on natural science areas (Figure 6).

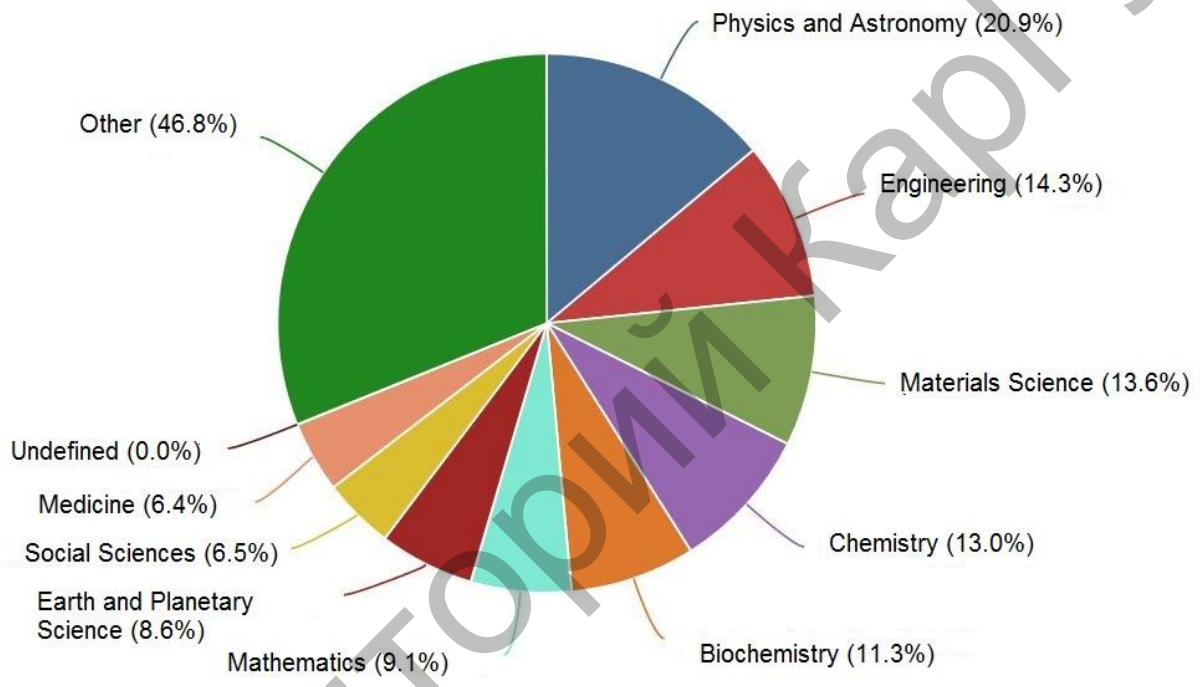


Figure 6 - Areas of publications of scientists of Kazakhstan in 1991-2015 years in journals with impact factor, indexed in the Scopus database

Note – complied by author based on Scopus data [104]

In our opinion the implementation of the following measures will contribute to raising of the intellectual potential of the research university:

- trainings of teaching staff of the university, including scientific internships at leading world universities, participation in scientific internships through the Government program "Bolashak";
- receiving the state educational order for training PhD students on new specialties in physics and chemistry, also increasing the number of

students on available programs with further employment at university;

- attract foreign scientists to conduct joint research projects, guest lectures, the creation of platforms for the exchange of experiences within the framework of international conferences.

At present, the Ministry of Education and Science provides a variety of grant schemes to support scientists and scientific organizations in the framework of Regulations of the grant, program-oriented financing of scientific and technical activity.

However, the size of grants for research and development remains small. For example, in 2014 the size of innovative grants for technological innovations in the country reached 1 485,9 bln. tenge, which amounted to only 0.3% of the total cost for this type of innovation (or 4% of the national budget expenditures). In our opinion, it is necessary to increase the amount of grant if the progress of the project has already achieved some results:

- if the application for grant is prepared in cooperation with scientist and entrepreneur. In this case, an increase in grant funding will be appropriate, because there is a guarantee of implementation of project on the production facilities of entrepreneur.

- if the application for grant is prepared by local scientists in collaboration with a foreign laboratory, when the part of the work carried out by foreign equipment and with the participation of foreign experts.

- if the application for grant is prepared by consortium of universities that will jointly implement the project in the fields of specialization of the region, developing production of value-added goods and services.

Thus, at present, the transformation of the classical academia into Research (Innovation) one requires the joint efforts of the actors of national innovation system within the "triple helix" framework at macro, meso and micro level.

On the macro level, the government represented by the relevant ministries, National Agency for technological development creates the necessary conditions for coordinating the work of all agents of the innovation system at the national level, including universities. Government orders scientific and technological research, allocated funds to upgrade material and technical base and innovation infrastructure of the university. The most important recommendations for the transformation of the university at this level, in our view, is the

introduction of schemes of grant funding for joint projects of research teams and businesses that allows them to implement R&D to production, increase the demand for domestic R&D by the business sector.

On the meso-level technological parks and regional venture capital funds are active participants of innovation activity. They help university to implement projects in priority sectors of the region. In our view, at this stage it is important that technopark becomes a technological base for experimental samples and pilot lots of high-tech products. Also it may search for customers and assist in obtaining venture financing of the research projects by the regional venture fund.

At the micro-level, in our view, priority task of a university is to develop a system of material and social incentives for academics and young scientists. Development of the system for the promotion of young scientists will increase the prestige of the scientist, attract in research the talented young people, ensure the continuity of teaching staff.

In the long-term period it is important for university, in our opinion, the creation of endowment fund, which is formed by attracting funds from individual and corporate donors (alumni, charities, patrons). If at the initial stages of the development of fund the funding is not great, then after 10-15 years, these funds can be a significant part of the budget of the university.

The transition from the classical model of university to innovation, research model based on the mechanism of interaction between science, education and production can not be finished in a short period of time. The realization of the goal requires implementation of project-oriented approach to university management, which is based on the promotion and support of initiatives of university staff, efficient institutional mechanism to ensure full using of considerable intellectual potential of a university [105].

The organizational structure of innovative university is constructed as a combination of a vertical hierarchy of educational and scientific departments and the horizontal subsystem, where units are project teams and creative teams. The composition of project teams of "horizontal university" can be formed from units of "vertical university."

The realization of these measures, in our opinion, will contribute to the active implementation of R&D at the enterprises of Kazakhstan, strengthen links in the chain of education-science-production through the development of innovative function. The innovation activity of

universities potentially allows to create the centers to generate innovation activity in the region and institutional framework of regional innovation system, and, on its basis, the national innovation system.

Today research universities play an important role in the preparation of high level professionals and researchers necessary for economy, as well as the generation of new knowledge in order to maintain national innovation system. The research universities should become regional knowledge hubs with strong industry and government links.

Research universities actively participate, mainly on a commercial basis, in additional postgraduate education, and offer multilevel programs for advanced training and retraining. Unlike narrow-profile commercial training institutions, universities are able to implement a variety of programs based on an interdisciplinary approach.

Modern research universities developing in our country must acquire uniqueness and regional identity, becoming centers of science, education and culture, where educational activities and research can be harmoniously combined. Such system is attractive for foreign partners in the targeted training of specialists for large-scale scientific and industrial international projects with the Republic of Kazakhstan, which ensure cooperation not only at the stage of performing specific works, but also in training specialists capable of successfully mastering foreign experience.

Kazakhstan has created a legislative base for the development of research universities; some universities have the necessary potential to receive in future the status of "research university". The main objective of such universities in Kazakhstan is the integration with higher education systems for research and development that is responsive for the economy, providing the international competitiveness of domestic education, human resources to the basic sectors of the innovation economy, commercialization of scientific research.

Conclusion

The issues of the innovation development and innovation activity were raised in the literature in XX century in the works of Schumpeter and Kondratiev. In their works they underlined key aspects of the scientific and technological development of the economy and society in modern conditions. Kondratiev's research helped to understand better the wave theory of the economic development, and based on it to predict technological changes in a society, that are expressed in the major inventions and innovative technologies. Schumpeter, in his turn, made an accent on the role of the entrepreneur in the innovation process, which introduces innovations in periods of stillness and balance. Taking innovative solutions, entrepreneurs create new, previously unknown combinations of factors of production. So, the works of these scientists underlined the wave and risky character of the innovation process and the importance of human capital for the development of innovations.

Since the work of Schumpeter in a market economy much attention is paid to the innovator, who is the main subject of the innovation activity. However, today the innovation activity covers all elements of the innovation system, either directly or indirectly involved in the creation of an innovative product. With regard to higher education institutions, universities, their innovation activity is carried out in close connections with the scientific work and researches. Therefore, in the framework of universities such activity has an innovation character.

Today the most important subjects of the innovation activity are higher educational institutions. They are the main provider of innovations in the society. Along with the education activity they conduct fundamental and applied researches, patent inventions and are involved in the process of the commercialization of intellectual property. But, despite the understanding of the important role of universities in the innovation process, there are some disproportions in the involvement of teaching staff of academia into research projects. Only a small amount of R&D of local scientists was commercialized. Technical and scientific laboratories, R&D base require strengthening.

Foreign experience shows that most universities of Europe, the USA, Japan, China, Singapore, Israel, Australia and many other countries are characterized by the innovative development of education and, in particular, higher education and post-graduate one. Higher

education is considered by the western countries as a priority of the internal policy that attracts large amounts of funding from government and private sources. Research universities play the central role of the world science. Their functional specialization provides the production of new knowledge and the training of specialists and professionals of the highest class, who are able to find the optimal solution in an unpredictable situation in terms of spontaneity of the scientific and technological development.

The development of knowledge-based environment demands new functions of the higher education organization which are mostly focused on the creation of effective collaborations with many actors of the regional or national innovation systems and on the impact of the university on the socio-economic development of the nearby territory. Universities may participate in economic and social processes by preparing highly-qualified specialists for different branches of the economy and increasing fundamental knowledge through research processes. The older universities (such as Oxford and Cambridge in Britain) play a significant role in the process of a nation-building and the formation of a national identity. But new developing universities which have no significant effect on the national economy level may be more important in small regions and communities. So, the ability of any university to impact regional processes and a society becomes more important than traditional educational schemes and practices.

The analysis of the scientific and research capacity of Republic of Kazakhstan has revealed a significant scientific potential embedded in a number of personnel and organizations engaged in research and development. The number of personnel engaged in research and development during the last 5 years has been growing steadily. But the insufficient number of scientists is observed in the industry. The majority of researchers are engaged in academic universities as well as in the public sector. This fact affects negatively the development of the innovation activity at industries and entrepreneurship. The salary of researchers is far from international standards, and, in spite of the positive trend in recent years, remains at a critically low level. Thus, despite the extant scientific potential, as well as the significant increase in the number of researchers, there is a number of indicators with negative dynamics. The main negative trends are the aging of fixed assets, low wages of scientists, and the increase in the average age of

qualified personnel, the lack of contribution of the national science to the economy.

Despite a large number of laws, programs and strategies devoted to the innovation development of the country in early period, the rights for intellectual property of local scientists were not taken into account in legislation at that time. The law "On Science", adopted in 2011, firstly defined the mechanism for financing research and development and simplified the procedure of the scientific projects review. The issue of the right to intellectual property obtained as a result of scientific and technical activity financed from the state budget was legislatively stated.

Universities' innovation infrastructure began to be formed with the adoption of the Strategy for Industrial and Innovative Development of the Republic of Kazakhstan for 2003-2015. The strategy determined that the main organizational institutes of the innovation infrastructure of the NIS of Kazakhstan will be technology parks and business incubators. Since 2011, the universities and research institutes of the republic with the support of JSC "NATR" opened their commercialization offices. Their main purpose is to support the process of the commercialization of the results of scientific and technical activities of domestic scientists. Although, many universities opened their own business incubation and technology parks departments, these structures operated nominally, providing only consulting services.

Today much attention is paid to the elaboration of approaches for the estimation of the academia innovation activity. Without a clear understanding of the results of the scientific and innovative work of all university departments, it is impossible to make managerial decisions and implement the strategic and tactical planning. The given work offers the approach based on the analytic hierarchy process by T. L. Saaty and scale of desirability by E. Harrington. At the end of the 4^{th} stage of the analysis, the integral index of the university innovation activity is calculated, taking into account the importance of each direction of the innovation activity.

Along with the comprehensive indexes, bibliometric (scientometric) indicators of the research and innovation activity both for researchers and research organizations are becoming very popular. Scientometrics annually develops and tests in practice a large number of indicators that can be used to assess scientific performance. The indicators based on the number of publications and the number of citations. The scientometric

approach has many advantages because bibliometric indicators may be delivered from databases for any period of time and any researcher. Also it is very easy to use them to compare the innovation performance of different researchers and organizations. They can be received through databases from any part of the world. Today these indicators are the inseparable part of many universities' rankings and awards.

The prospects of the innovation activity activation of Kazakhstan's higher educational institutions are connected with the formation of research universities and the strengthening of links between university and regional innovation system's actors. Today Kazakhstan has already started the process of creating research universities with qualified staff engaged in fundamental and applied researches. Meanwhile, the effective innovation process demands transfer of knowledge from the university to the regional environment. So, the better cooperation of the university with the government and the industry will help not only increase the number of implemented local R&D but also positively impact on the improvement of the innovation activity and the innovation management of higher educational institutions.

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Appendix 1

Table - Analyzing universities' contribution to the development of regional innovation systems

Key element of regional innovation system	Generative role	Developmental role
1	2	3
Regional agglomeration, or clustering, of industry	- Knowledge capitalisation and capital formation projects, centred on the firm formation and co-location of new and existing firms near the university	- Entrepreneurial activities, as well as regionally-focused teaching and research, not necessarily linked to capital formation projects
Human capital formation	- Integration of education and knowledge capitalisation activities, specifically, firm formation, through teaching incubators - Development of generic, advanced training programs to support firm formation and cross-institutional mobility by organizations and people	- Stronger regional focus on student recruitment and graduate retention - Education programs developed/adapted to meet regional skills needs - Learning processes regionally-informed
Associative governance	- Driver of regional innovation strategy, centred on knowledge capitalization and capital formation projects; by analyzing strengths and weaknesses and bringing together industry and government to forge innovation strategy	- Shaping regional networking and institutional capacity, through staff participation in external bodies; provision of information and analysis to support decision-making and brokering networking

Table continued

1	2	3
Regional cultural norms	- Tradition of university/industry linkages, involving knowledge capitalisation	- Tradition of university/industry linkages, involving knowledge capitalisation and other research collaborations
Note – adopted from Gunasekara (2006)		

Appendix 2

Table - Objectives and instruments of Kazakhstan industrialization programs

Program	Objective	Instruments
1	2	3
Productivity - 2020	increasing the productivity of existing enterprises and stimulation of investments.	- Subsidization of interest rates on leasing and loan to purchase fixed assets; - Provision of innovative grants; - Introduction of new products into production by design bureau; - Introduction of new management techniques in order to optimize the production processes.
Investor - 2020	creating necessary conditions to attract direct investment in non-raw export-oriented and high-tech manufacturing	- Investment agreements; - Service support of investments (holding information events to promote the investment opportunities of Kazakhstan, activities to support foreign investors); - Increasing the investment attractiveness of SEZs through the provision of tax incentives; the simplified mechanism of importing foreign labor; the provision of services within the principle of "one window"; the formation of a free customs zone regime in SEZ.
Export - 2020	promotion of domestic companies into foreign markets	- Grants to exporters, which provide 50% reimbursement of costs associated with the promotion of products for export, - Trade finance and insurance; - Service support of export (information and expertise provided by the manufacturer marketing and analytical information on export markets, and others)

Table continued

1	2	3
«Business Road Map - 2020»	development of small and medium-sized businesses, the creation of permanent jobs	- Interest rate subsidies on loans (subsidy of 3 years with the possibility of extension up to 10 years) - Credit guarantees (maximum size of not more than 50% of the loan amount); - Development of industrial infrastructure; - Service support for businesses; - Training staff for entrepreneurship.
Note – composed by the author [45]		

Appendix 3

Table – Measurements of the research activity of universities

Block of indicators	Indicators
1	2
Project and research activity	
Project and research activity	Number of international, republic and regional projects
	Number of program and technical elaborations, presented at national and international exhibitions
	Number of R&D, project, analytical and other works
Results of intellectual activity	Number of received domestic and international awards, prizes, grants
	Number of patents, author's certificates, inventions, know-how, etc.
	Number of small innovative enterprises organized at the university for the implementation of projects
Dissertation councils' activity	Number of dissertational councils
	Number of PhD theses defended at university and outside the university
Training of personnel for business	
Educational activity	Number of students enrolled in the target programs of companies
	Number of practitioners of companies involved in teaching at the university
	Number of company-oriented bachelor courses
	Number of company-oriented master courses
	Number of company-oriented PhD courses
	Number of foreign teachers invited for teaching
Results of educational activity	Number of graduates employed ин profession.
	Number of graduates holding executive positions in international companies.
	Number of scientific schools recognized at the world level.
	Number of graduates holding executive positions in domestic companies

Table continued

1	2
Formation of teaching staff	
University's component	Number of teachers and researchers with PhD (Candidate of science, Doctor of science) degree
	Number of scientific and methodological publications verified by an authorized body in the field of education
	Number of teachers and researchers who have practical work experience in private companies
Company's component	Number of staff working in companies
	Number of students working in companies
Note – adapted from Fedin et al [76]	