“Diversification of R&D results commercialization”

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DIVERSIFICATION OF R&D RESULTS COMMERCIALIZATION

Abstract

Due to the rapid growth of the market of scientific and technical products and the high level of competition, market appropriate solution becomes finding ways to commercialization of research products. The article substantiates the need for accelerated modernization of the Kazakh economy based on increasing the effectiveness of scientific research and introduction into industrial production of research results while diversifying the ways of commercializing R&D results. In this article, the authors analyze the current state of Kazakh science. As a result of the research, a new mechanism for multi-criteria selection of promising R&D results of scientific organizations has been proposed and a system of organizational and economic support for their commercialization has been substantiated. The results will be useful in the practical activities of both scientific and industrial organizations.

Keywords commercialization, high technologies, product, R&D, innovation, technological process, technological development, scientific and technical research

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INTRODUCTION

Commercialization is the process of developing and implementing a number of activities by which the results of research and development can be offered in markets for goods and services for commercial purposes. Commercialization of the existing scientific and technical developments in the technology market includes both the actual process of transfer and commercialization of scientific and technical developments in conjunction with the needs and requirements of the market and the consideration of support components contributing to this process and obtaining a commercial effect.

Thus, the commercialization of the results of scientific and technical activities should be understood as activities related to the practical use of intellectual property objects, as well as material objects obtained as a result of scientific and technical activities with the aim of involving them in the market turnover and making profit.

The success of the modernization and further innovation development of the Kazakh economy are significantly determined by the timing and quality of the transition from raw materials orientation to the creation and effective functioning of knowledge-intensive enterprises. The main prerequisite for such a transition is the diversification of the ways to commercialize R&D results. Thus, the President of the Republic of Kazakhstan, N. Nazarbayev (2018), in his traditional State of the Nation Address on January 10, 2018, "New Development Opportunities in the Context of the Fourth Industrial Revolution", noted: "Global trends show that it should be based primarily on the broad implementation of elements of the Fourth Industrial Revolution.

Industrialization should become more innovative, taking advantage of the new technological structure 4.0. It is necessary to develop and test new instruments aimed at modernizing and digitizing our enterprises with a focus on exporting products. They should primarily stimulate the transfer of technology" (State of the Nation Address, 2018).

Today, a number of system initiatives are being implemented in the country. Nevertheless, the share of Kazakhstan's high-tech products on the world market is practically zero, and this share is a generalized indicator of the effectiveness of scientific, technical and innovative activities. Compared with Kazakhstan, the share of the European Union in the world market of high technology products is 35%, the USA – 25%, Japan – 11%, Singapore – 7%, South Korea – 4%, China – 2% (National Science Board, 2018).

At the same time, a simple increase in spending on science does not automatically lead to the emergence of competitive high-tech goods and services. A necessary precondition for successful innovation development is the wide dissemination, development and use of advanced developments. The transformation of scientific ideas into a commercially successful product is a complex process in which an increasing number of economic agents participate. New technologies are a specific resource, and their use in production is fraught with high risks and transaction costs. Thus, it is necessary to diversify ways of commercializing R&D results.

The growing importance and relevance of the problem of technology commercialization determined the choice of the research topic.

The purpose of the study is to identify and justify ways to diversify the commercialization of R&D results. The subject of the research is the methods of increasing the efficiency of the commercialization of intellectual property (R&D) from ideas to projects, from projects to transactions in the conditions of the modern market.

1. LITERATURE REVIEW

The main form of promoting innovation is the commercialization of technology. Commercialization is the process of converting knowledge into a product, service or activity that can be used to generate profit. Canadian panel of experts on commercialization gives the following definition: "Commercialization refers to the series of activities undertaken by firms to transform knowledge and technology (whether developed in Canada or abroad) into new products, processes or services, in response to market opportunities" (The Prime Minister's Advisory Council on Science and Technology, 1999). Moreover, according to Rosa (2007), "Commercialization is an integral, rather than a separate, stage of the goods and services innovation process. On the other hand, commercialization is instead a completely separate process for which it is necessary to plan a strategy before and after the product is introduced onto the market" (Rosa & Rose, 2007).

According to Cambridge Dictionary (2017), commercialization means organizing something to gain profit. Actually, commercialization is "presentation of a product or service to market for earning profit" or "process of turning something into commercial activity". From another viewpoint, commercialization is the process of transferring knowledge and technology from research centers to the industries and new businesses (Aghajani & Yazdanpanah, 2005).

Commercialization is the process of turning new technologies into successful commercial products. In other words, commercialization covers a wide variety of arrays in technical, commercial, and financial areas, which transform a new technology to useful products or services (Reamer, 2003). This process includes activities such as obtaining ideas for technology commercialization, fostering those ideas, development of technology, building up a prototype, development of the new process or optimization of the current processes, supply

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of product to market, promotion, and creation of new infrastructures (APCTT, 2005).

The notion of "commercialization of technology" implies mandatory commercial use of information about technology, i.e. use with mandatory extraction of benefits (Kiselev, 2014). Most often, this benefit is measured in specific monetary units directly, much less often – in the same units, but indirectly, for example, through increasing the efficiency of another technology. However, money in these calculations are always present and are the determining criterion for the success of the process. At the same time, the question of who, which subject directly uses technology, is not paramount in commercialization, and in particular the author himself often attempts commercialization, the primary source of the new technology (individual or organization).

In practice, there are three main commercialization strategies:

1. Establishment of production of new products by the owner of the object of intellectual property.

2. Transfer of the entire volume of intellectual property rights to another person on a contractual basis.

3. Transfer of a part of intellectual rights to another person on a contractual basis (Conceição et al., 2002).

The choice of the strategy of commercialization by the owner of intellectual property is determined by many parameters, including quality of the product, market potential, feasibility and resource availability of technology, desire and "adventurism" of the technology proprietor. Therefore, the first strategy is more risky, resource consuming for the legal owner, but in case of success, it is capable to bring the greatest income.

Commercialization of technologies involves the economically effective (with profit for the developer and the recipient) implementation of technologies on an industrial scale, i.e. commercialization of technologies – the stage of commercial transfer where the consumer (buyer) pays a reward to the technology owner (developer) in accordance with the contract, and the term "technology transfer" is broader and can relate to both commercial and non-commercial transfer of research results. Organization of the process of technology commercialization should be carried out from complex positions, including organizational-information, marketing and financial-economic aspects. The development of innovations is a risky process, as the object of innovation is an intellectual product, which in turn causes both the complexity of the economic and financial evaluation and the problems of effective interaction of participants and requires carefully developed and continuously updated normative and legal support.

Some aspects of technology commercialization are explored by the renowned foreign scientists. Several researchers suggest that that technology commercialization is part of the innovation process (Dmitriev, 2014; Slater, 2006; Mukhtarova, 2017; Kim, 2011; Ziyadin, 2017; Rasmussen, 2008; Ismail, 2013; Markman, 2008, etc.), others as part of the diffusion of innovations into the market (e.g. Amadi-Echendu, 2011; Chen, 2009; Cho, 2013; Grimpe, 2010; Novikova, 2015; Markman, 2005; Jacobsson, 2013; Von Raesfeld, 2012; Gao, 2016; Mu, 2011; Weckowska, 2018, etc.). For example, Datta et al. (2015) define the commercialization of technological innovation as the key to the success of entrepreneurship, which consists of several entrepreneurial activities. Scientists identified six main steps that lead the technological innovations into the market, based on three main phases of the innovation process: ideation, development and deployment. Despite the significant number of scientific investigations in the sphere of commercialization of scientific and technical developments, there are many complex issues, which need further development. One of such issues is the diversification of R&D results commercialization ways.

2. METHODOLOGY

These circumstances predetermine the need to develop new mechanisms for multi-criteria selection of promising scientific research to assess the viability of scientific organizations R&D results using modern tools and their commercialization. This will improve the efficiency and quality of

management decisions in the field of scientific research, the effectiveness of innovative activities of scientific organizations, and will contribute to the development of their innovative potential and its realization in concrete results – innovative products and technologies (Larin & Zhilyakova, 2012).

The general trend of innovation policy in many foreign countries is the formation of cluster structures, which are understood as "geographically concentrated groups of interrelated companies, specialized manufacturers of finished products and service providers, companies engaged in related sectors, and organizations related to their activities, but at the same time leading and working together, the main purpose of which is to obtain additional profit" (Khrustalev & Ilmenskaya, 2012).

As a rule, most scientific research is carried out in an uncertain environment, which requires the selection of adequate approaches to assessing their prospects based on the ranking of estimated R&D results, which consider the fuzziness, qualitative character of indicators and linguistic uncertainties associated with the formalization of expert knowledge about the innovative activities of scientific organizations. In these conditions, the application of the apparatus of fuzzy mathematics will be quite effective.

The proposed approach to the assessment of promising R&D results of scientific organizations is based on decision-making methods based on a fuzzy relational model of knowledge representation. Its use makes it possible to reduce the decision-making process to the problem of choosing the best alternative among the possible ones, which makes it possible to rank the alternatives according to a generalized criterion.

According to the fuzzy relational model of knowledge representation, if

$$X = \{x_1, x_2, \ldots, x_n\} = \{x_i,\ i = 1, n\}, \quad (1)$$

then many alternatives of promising R&D results, which are subject to evaluation and ranking, and

$$K = \{k_1, k_2, \ldots, k_m\} = \{k_j,\ j = 1, m\}, \quad (2)$$

the set of criteria for their characteristics, the degree of compliance of the alternative x_i with the criterion k_i is represented by the membership function:

$$\psi_{kj}(x_i) \to [0,1] \text{ or } \psi_{kj}(x_i) : X \cdot K \to [0,1]. \quad (3)$$

In our case, as alternatives to promising R&D results of scientific organizations, the options are considered: $X = \{x_1, x_2, \ldots, x_n\} = \{x_i,\ i = 1, n\}$ each of which is characterized by a set of unequal criteria $K = \{k_1, k_2, \ldots, k_m\} = \{k_j,\ j = 1, m\}$. In addition, each criterion k_j included in the set of criteria K, in turn, is characterized by a subset of particular criteria, namely:

$$K = \{k_{j1}, k_{j2}, \ldots, k_{jT}\} = \{k_{jt},\ t = 1, T\}, \quad (4)$$

moreover, the elements of these subsets are also unequal. The purpose of the study is to obtain the results of the evaluation of the promising results of R&D of the scientific organization of a systematic list of their options, ranked from worst to best:

$$\frac{X}{K} \to X^*, \quad (5)$$

where X^* is a systematized list of options for the multi-criteria evaluation of the promising R&D results of a scientific organization.

In order to solve the problem, we assume that

$$\{\varphi_{kj1}(x_i), \varphi_{kj2}(x_i), \ldots, \varphi_{kjT}(x_i)\} = \{\varphi_{kjt}(x_i), t = 1, T, j = 1, m\} \quad (6)$$

alternatives x_i to the particular criteria $k_{j1}, k_{j2}, \ldots, k_{jT}$ and

$$\{\omega_{j1}, \omega_{j2}, \ldots, \omega_{jT}\} = (\omega_{jt}, t = 1, T) \quad (7)$$

are the coefficients of the relative importance of these particular criteria. Moreover, for all particular criteria $k_{j1}, k_{j2}, \ldots, k_{jT}$, which characterize the criterion K_j, the condition

$$\sum_{t=1}^{T} \omega_{jt} = 1 \quad (8)$$

The solution of the problem itself is reduced to the following steps:

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Table 1. Definition of the membership function of alternatives $x_i\{i=1,n\}$ criteria $K_j,\{j=1,m\}$

Indicator	Alternatives	K						
		K_1			...	K_M		
		k_{11}	...	k_{1T}	...	K_{M1}	...	K_{MT}
X	x_1	$\varphi_{k11}(x_1)$	...	$\varphi_{k1T}(x_1)$	...	$\varphi_{kM1}(x_1)$	...	$\varphi_{kMT}(x_1)$
	...	...	...	...	...	...	...	...
	x_i	$\varphi_{k11}(x_i)$	...	$\varphi_{k1T}(x_i)$	...	$\varphi_{kM1}(x_i)$	...	$\varphi_{kMT}(x_i)$
	...	...	...	...	...	...	...	...
	x_n	$\varphi_{k11}(x_n)$	...	$\varphi_{k1T}(x_n)$	...	$\varphi_{kM1}(x_n)$	...	$\varphi_{kMT}(x_n)$
	...	$\varphi_{k1}(x_i),\ \{i=1,n\}$			...	$\varphi_{kM}(x_i),\ \{i=1,n\}$		

First step. Using the aggregation of criteria and particular indicators of the lower level, each criterion of the upper level is evaluated. Based on the equations (6) and (7), the convolution of the partial criteria $k_{j1},k_{j2},\ldots,k_{jT}$ is determined (Table 1) as the membership function of the alternative x_i to the generalized criterion $K_j,\{j=1,m\}$:

$$\varphi_{Kj}(x_i)=\sum_{t=1}^{T}\omega_{jt}\phi_{kjt}(x_i). \tag{9}$$

Second step. Based on the obtained $\{\varphi_{kj}(x_i),j=1,m\}$ for all alternatives $x_i\{i=1,n\}$, the membership function is determined for the generalized criterion K (Table 2):

$$\varphi_K(x_i)=\sum_{j=1}^{m}\omega_j\phi_{Kj}(x_i), \tag{10}$$

where $\omega_j, j=1,m$ – coefficient of relative importance of the corresponding criterion $K_j,\{j=1,m\}$.

Third step. An alternative is chosen for which the degree of belonging to the generalized criterion K is maximum: $\varphi(x^*)=\max\{\varphi_K(x_i),i=1,n\}$, where n is the number of alternatives. The selected alternative is "the best" and will occupy the first position in the ranked list of alternatives to innovative activities of a scientific organization (Tables 2, 3).

Table 2. Definition of the membership function of alternatives $x_i\{i=1,n\}$ to the generalized criterion K based on the membership function of alternatives to the criteria

Indicator	Alternatives	K				
		k_{11}	...	K_j	...	K_M
X	x_1	$\varphi_{k1}(x_1)$	...	$\varphi_{Kj}(x_1)$	...	$\varphi_{KM}(x_1)$
	...	...	...	...	...	...
	x_i	$\varphi_{k1}(x_i)$	...	$\varphi_{Kj}(x_i)$	...	$\varphi_{KM}(x_i)$
	...	...	...	...	...	...
	x_n	$\varphi_{k1}(x_n)$	...	$\varphi_{Kj}(x_n)$	...	$\varphi_{KM}(x_n)$
	...	$\varphi_K(x_i),\ \{i=1,n\}$				

Table 3. Ranked list of alternatives from worst to best

Indicator	Alternatives	K
X^*	x^*	$\varphi_{K1}(x_1)$
	...	...
	x_1	$\varphi_{K1}(x_i)$
	...	...
	x^p	$\varphi_{K1}(x_n)$

It is obvious that the alternative with the lowest score will occupy the last position in the list of alternatives, ranked from best to worst. For such an alternative $x^p \in X\varphi(x^p)$, the degree of membership of the generalized criterion will be minimal: $\varphi(x^p) = \min\{\varphi_K(x_i), i = 1, n\}$.

In order to evaluate and rank alternatives based on the proposed method, it is necessary to determine the coefficients of the relative importance of criteria characterizing alternatives, and their particular indicators, as well as the membership function of alternatives to particular indicators (degree of satisfaction of alternatives to particular indicators).

In order to determine the coefficients of the relative importance of the criteria and their particular indicators, the expert assessment method can be used, for example, using a 10-point system, or the pairwise comparison method of simultaneously considered criteria.

In order to determine the membership function of alternatives to particular indicators, mathematical formalization of particular indicators is implemented. The need to operate with information of both quantitative and qualitative nature has led to the use of elements of the theory of fuzzy sets for formalization of particular indicators. This approach allows to remove uncertainty and work with incomplete and inaccurate information, both qualitative and quantitative in nature. Thus, a person, when perceiving information, does not use concrete numbers, but translates them into concepts of the values of a linguistic variable. The use of fuzzy verbal concepts (few, many, significantly, few, most, etc.) that a person operates with enables to consider qualitative descriptions and consider the uncertainty of the problem being solved, to achieve a complete description of those factors that cannot be accurately quantified. The value of the linguistic variable is described by the membership function, which is individual for each individual.

In order to determine the degree of satisfaction of alternatives to particular indicators, or the membership functions of an alternative x_i to particular criteria $k_{j1}, k_{j2}, \ldots, k_{jT}$, where $K_j = \{k_{j1}, k_{j2}, \ldots, k_{jT}\} = \{k_{jt}, t = 1, T\}$, to each element of the subset of criteria K_j are assigned qualitative gradations corresponding to accepted linguistic estimates, and their fuzzy correspondences are determined.

3. RESEARCH RESULTS

In recent years, Kazakhstan has been implementing a number of active measures at the state level to develop knowledge-intensive sectors of the economy. However, Kazakhstan's expenditures on research and development work in 2016 amounted to 0.14% of the gross domestic product (Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics, 2017), while this figure is in Israel – 4.25%, Korea – 4.23%, Sweden – 3.25%, the United States – 2.74% (OECD, 2018).

Despite the general increase in the funding of science, a significant part of the results of research and development work is not implemented in the real sector of the economy, does not generate revenue for developers and does not provide revenues to the budget due to the lack of organizational and economic mechanisms for the commercialization of technologies and developments.

According to the Agency of the Republic of Kazakhstan on Statistics in 2016, of the 1,305 enter-

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Source: Compiled by the authors based on the Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics (2017).

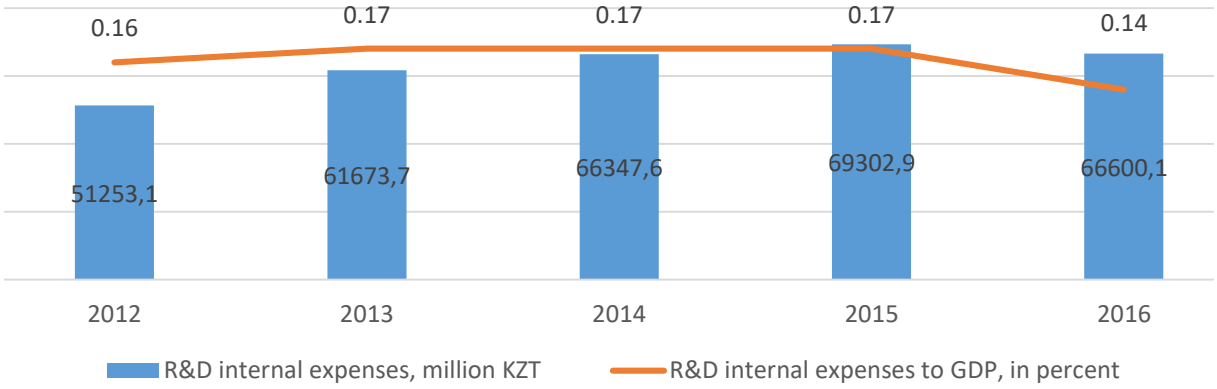

Figure 1. R&D internal expenses

prises reported, 383 were engaged in research and development (R&D), of which 100 were research institutions in the public sector, 103 were higher education institutions, 149 organizations of the business sector, and 31 non-profit organizations (Table 4).

Table 4. Number of organizations engaged in R&D, by ownership type

Source: Compiled by the authors based on the Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics (2017).

Ownership type of organizations	%				
	2012	2013	2014	2015	2016
Total	100	100	100	100	100
including	–	–	–	–	–
state property	29	28.7	28.6	27.2	26.6
private property	69.6	69.2	68.9	70.8	71.0
property of other states, their legal entities	1.4	2.1	2.5	2.0	2.4

One of the main problems of the development of science in the Republic was a low applied nature and low commercialization of the results of scientists' work (Table 5).

Table 5. R&D internal expenses by types of work

Source: Compiled by the authors based on the Ministry of National Economy of the Republic of Kazakhstan Committee on Statistics (2017).

Types of research	%				
	2012	2013	2014	2015	2016
R&D internal expenses	100	100	100	100	100
including	–	–	–	–	–
fundamental research	23.5	29.5	23.0	22.9	20.7
applied research	56.4	54.1	57.9	53.3	53.8
developmental engineering	20.1	16.4	19.1	23.8	25.5

The overall reduction in domestic costs has had the most negative impact on the financing of basic research. Compared to 2016, their volume fell by 12.8%, applied research fell by 3.0%. At the same time, it should be noted that the amount spent on development work increased by 2.7% and its share by 1.6 percentage points.

One of the most important indicators of the effectiveness of research and development is patent activity, reflecting technical and technological achievements in the country's economy. Patent activity is a proof of the innovative potential of the country, the level and prospects of scientific and technical development of the country.

Data from the World Intellectual Property Organization show that the number of international applications for patents filed in 2016 under the Patent Cooperation Treaty (PCT) increased by 7.3% to 233,000 applications. The US, in which 56,600 international patent applications were filed, remain the largest user of the PCT system despite a reduction in the number of applications in 2016 by 0.9%. Following the United States are Japan (45.2 thousand applications under the PCT) and China (43.2 thousand applications). The main growth in the total number of applications falls on China, Japan and Germany. In 2016, the list of leading PCT applicants was led by telecommunications companies, and ZTE Corporation (China), the developer and supplier of telecommunications equipment and network solutions with 4,123 PCT applications, was the first in this list. The Chinese company Huawei Technologies with

3,692 published applications also took the second place, while Qualcomm Incorporated, based in the United States, came in third with 2,466 applications under the PCT procedure.

In Kazakhstan, according to the data of the RSE "National Institute of Intellectual Property" (NIIP), in 2016, compared to the previous year, the number of applications for industrial property applications received increased by 5% and amounted to 6,948 units. The main share of applications received is for trademarks – 4,719 applications, 3111 of which were filed by national applicants, 1608 - by foreign ones. There were 1,221 applications for inventions, of which 990 were from domestic applicants, 31 from foreign applicants. For utility models, 716 applications were filed, 654 by national applicants, and 62 by foreign applicants (Table 6).

Table 6. Information on applications submitted to RSE "NIIS" for the issue of titles of protection for industrial property in 2016

Source: Compiled by the authors based on Annual Report of the National Institute of Intellectual Property (2017).

Industrial property objects	Applications received		
	From national applicants, %	From foreign applicants, %	Total, %
For inventions	81.1	18.9	100
For utility models	91.3	8.7	100
For industrial designs	37.2	62.8	100
For trademarks	65.9	34.1	100
For the name of places of origin of goods	33.3	66.7	100
To selective attainments	70.0	30.0	100

However, it should be noted that despite the overall increase in patent activity in 2016, the number of international applications for inventions has been reduced by 5 units under the Patent Cooperation Treaty, under the procedure of the Eurasian Patent Convention (EAPC) by 3 units, while the total number of applications very insignificant, in comparison with the leading countries.

Analysis of funding for research and development shows that the main source of investment in science, as in previous years, remains the state budget, while its dependence on this source is very high. The decrease in the flow of funds from this source by 5.3 billion KZT led to structural changes in both funding and the number of scientists (reduction). The role of own funds in supporting scientific research has increased, loans of banks and non-bank legal entities have increased, as well as loans and loans on preferential terms. Foreign companies, despite the dumping prices of scientific research and the high potential of personnel, are also in no hurry to order research or development from Kazakhstani scientists and engineers. Meanwhile, it is one of the ways to increase the high-tech GDP. In addition, as before, the interest of the business sector in the maintenance of the scientific and technical potential of the Republic is not traced.

Thus, one of the important issues of the scientific sphere is to increase the demand for scientific results in the real sector of the economy. It is necessary to increase the share of commercialized research results, to attract the private sector to finance research, as well as to increase the importance of experimental development, to create conditions for conducting semi-industrial tests and to ensure their implementation and use in production through preferential funding. In broad terms, it is necessary to resolve issues of legislative support for the introduction of the results of scientific research into production, which are in high demand among producers. At the same time, it is necessary to work out the mechanism for applying innovative achievements in production.

An important direction of the development of the scientific sphere remains involvement in the global scientific community, participation in international scientific projects. It is necessary to further expand cooperation with international organizations, publishing houses, scientists.

Expanding the features of innovation activity as an object of management and justifying the mechanism of multi-criteria selection of promising R&D results, we turn to the merits of the process of their commercialization, which is to bring to market new or improved products (services) using the rights to create it. It is not a secret that, due to the imperfection of the intellectual capital management system and organizational and economic support for the commercialization of domestic high-tech enterprises, many promising R&D re-

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Source: Built by the authors.

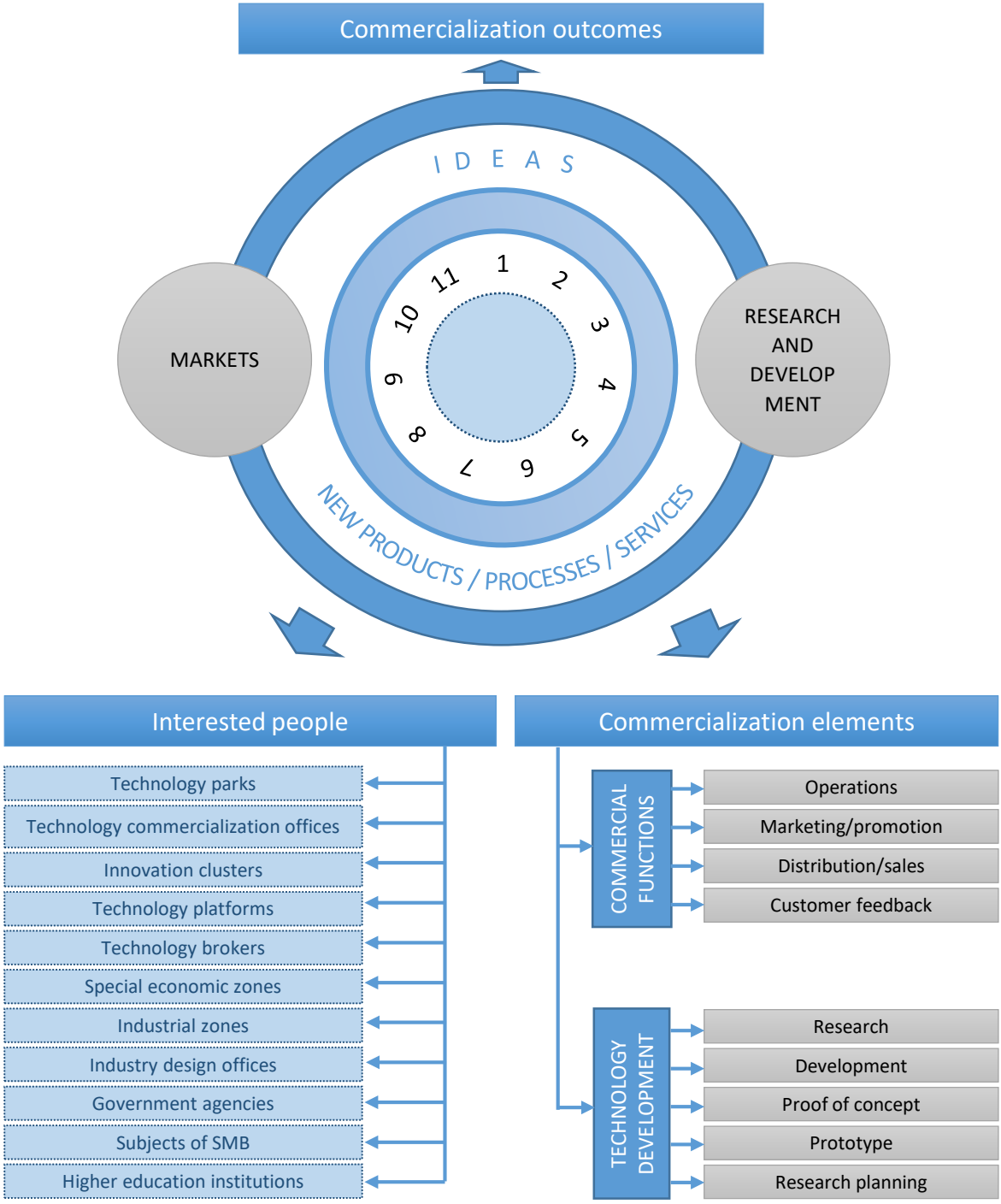

Figure 2. Diversification model of R&D commercialization

sults are often not brought to the stage of commercial realization in both the domestic and foreign markets. The way out of the current situation is seen in the need to develop new and efficient organizational and economic mechanisms for commercializing R&D results that are adequate to modern conditions.

In the context of modernization of the Kazakhstan economy, a model for the formation of an innovation support infrastructure based on the diversification of the interaction of cluster components with the formation of integration functional structures can be effective (Figure 2).

The proposed model is designed to present the different functions of the commercialization process in a non-temporal framework including all elements necessary to commercialization that firms may adopt on the basis of their individual needs.

The model, which is shown in Figure 2, describes the many components of the commercialization process and their relationship to each other. In this model, ideas are central to the commercialization process, which is a recurring cycle followed by stakeholders.

This cycle consists of the following elements: "technology (research and development)", "interested people" and "market". This model implies that ideas can arise at any stage of the commercialization process or product life cycle.

The model also suggests that it may take several iterations of the cycle to improve, develop ideas and business models before successful commercialization becomes possible. Ideas can include both completely new products and services, as well as additional improvements to existing ones, or their new applications, as well as the steps necessary to bring them to new markets.

Use diversification model of R&D commercialization in practice can open up new opportunities for obtaining synergistic effect from its operation due to the optimal use of generalized resource, personnel, organizational, informational and other support within the framework of a unified strategy of innovative development of an economic entity, region and country as a whole. Important advantages of this system are a high level of its sustainability, due to the possibility of controlled flow (diffusion) of various types of resources to the sector with the most effective development, and increased legal security of all participants in the innovation cycle.

CONCLUSION

One of the important issues in the scientific sphere is to increase the demand for scientific results in the real sector of the economy. It is necessary to increase the share of commercialized research results, involve the private sector in research funding, and increase the importance of developmental research, create conditions for semi-industrial testing and ensure their implementation and application in production through preferential financing. Broadly, it is necessary to solve the issues of legislative support for the introduction of scientific research results into production, which are in high demand among commodity producers. At the same time, it is necessary to work out a mechanism for applying innovative achievements in production. An important direction in the development of the scientific sphere remains involvement in the world scientific community, participation in international scientific projects. It is necessary to further expand cooperation with international organizations, publishers, scientists.

According to the draft Concept for the development of innovations until 2020, the main goal of developing an effective technology commercialization system in Kazakhstan is the commercialization of 90 technologies through 2014, 200 technologies until 2020.

To achieve this ambitious goal, it is necessary to apply a systemic, integrated approach to the development of a technology commercialization system in which the rate of mastering new knowledge can be significantly accelerated by combining multiple components. In this case, parallel implementation of the following interconnected components is necessary:

1. *Improvement of regulatory legal acts in terms of stimulating the commercialization of intellectual property*

Within the framework of legislative incentive measures, initiate a specialized bill on stimulating the commercialization of intellectual property, which, taking into account the world experience gained will provide a full package of incentive measures and will create the ground for the development of small innovative business in Kazakhstan. Since intellectual property is the basis of innovation, the paramount issue of the solution is

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to create basic conditions for motivation for research organizations and researchers that encourage participation in the commercialization of intellectual property created from budgetary funds.

2. *Creation of a professional network of commercialization support structures*

Within the framework of building a professional network of commercialization structures, support mechanisms can be implemented at two levels.

The first level is the national level, which includes coordination, development of legislative incentive measures, implementation of financial mechanisms and economic mechanisms, and consulting and methodological assistance. The National Methodological Center should act as the main information source and access point for the scientific community, national and foreign companies on the commercialization of technologies in Kazakhstan.

The second level is regional, where most economic mechanisms are implemented through pilot regional centers and technology commercialization offices. The regional centers will serve as representatives of the program for the commercialization of the National Agency for Technological Development in the innovation-active regions and will serve as a platform for interaction and networking of scientific organizations with the business sector. The centers will be the main suppliers of the flow of technology commercialization projects and will provide information support on the issues of applying for a grant for the commercialization of technologies. Their activities will be aimed at promoting technological developments in both local and global markets.

3. *Creation of an effective mechanism for financing the commercialization of technologies to ensure the flow of quality projects*

a) *Provision of consulting, methodological support, strengthening of human resources*

Within the framework of strengthening the human resources, it is proposed: all the above-mentioned mechanisms require significant human resources. However, a new system is under construction, and there are no fully trained staff, so these specialists need to be trained, including on the experience of practical work on specific commercialization projects. At the same time, it is very important to work out our competencies and to raise Kazakhstan specialists in the field of technology commercialization. In this regard, it would be advisable, within the framework of the "Bolashak" program, to introduce special professional internships in "Management of Innovations" in the advanced foreign centers for the commercialization of technologies to acquire practical skills and competences in the field of technology commercialization.

b) *The organization of partner networks for the effective exchange of information and the achievement of commercial links between the main players in the technology commercialization process*

Obviously, in the case of a successful commercialization system, the level of competitiveness of scientific organizations and companies will grow, and consequently with time they will need support for more complex tasks. Undoubtedly, in this situation, it will be necessary to change support instruments, it is possible to introduce new financial or economic mechanisms to stimulate commercialization, since the commercialization system must develop together with its participants and clients.

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