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Analysis of Potential, Structure, Dynamics of Development of Kazakhstan's Science

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Abstract

This article analyzes the scientific potential, its structure, and dynamics of development in Kazakhstan to develop strategic recommendations for the further development of science. The main purpose of the scientific work is to obtain accurate data on the state of the dynamics of the development of Kazakh science. The main research methods were generalization, systematization, and the economic and statistical method. The statistical base of the study was the data of the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan for the period from 2010 to 2020. According to the analysis, it was revealed that the state budget plays the main role in the financing of R&D in the republic, and the priority direction of R&D is research in the field of engineering developments and technologies. While there are several problems in the field of social sciences and humanities in Kazakhstan: the tendency to reduce the sphere of social sciences, a low proportion of highly qualified personnel in the humanities, a low material and technical base of social and humanitarian research, which is manifested in a high share of labor costs. Positive trends in the growth of costs for R&D, the development of the entrepreneurial sector of science, as well as negative trends in reducing costs for medical sciences were revealed. It is shown that there is a critical situation with the reproduction of scientific personnel, especially highly qualified personnel. The results of the study may be of interest to government authorities in the field of science.

Keywords: science, potential, R&D, financing of science, internal expenditures for R&D, human resources.

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Қазақстандық ғылымның арналған әлеуетін, құрылымын, даму динамикасын талдау

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Түйін

Бұл мақалада ғылымды одан әрі дамыту бойынша стратегиялық ұсынымдар әзірлеу үшін Қазақстандағы ғылыми әлеует, оның құрылымы мен даму серпіні талданған. Ғылыми жұмыстың негізгі мақсаты – қазақстандық ғылымның даму динамикасының жай-күйі туралы нақты мәліметтер алу. Зерттеудің негізгі әдістері жалпылау, жүйелеу және экономикалық-статистикалық әдіс болды. 2010-2019 жылдар аралығында ҚР Стратегиялық жоспарлау және реформалар жөніндегі агенттігінің ғылыми даму бойынша Ұлттық статистика бюросының ғылым салалары (жаратылыстану, медициналық, ауыл шаруашылығы, әлеуметтік, гуманитарлық инженерлік әзірлемелер және технологиялар) бойынша статистикалық деректері талданды. Жүргізілген талдауға сәйкес республикада ҒЗТКЖ-ны қаржыландыруда мемлекеттік бюджет негізгі рөл атқаратыны, ал ҒЗТКЖ-ның басым бағыты инженерлік әзірлемелер мен технологиялар саласындағы зерттеулер болып табылатыны анықталды. Қазақстанда әлеуметтік және гуманитарлық ғылымдар саласында әлеуметтік ғылымдар саласының қысқару үрдісі, гуманитарлық ғылымдардағы жоғары білікті кадрлар үлесінің төмендігі, әлеуметтік және гуманитарлық зерттеулердің материалдық-техникалық базасының төмендігі сынды проблемалар бар. Бұл еңбекке ақы төлеуге жұмсалатын шығындардың жоғары үлесінде көрініс табады. Атап айтқанда, ҒЗТКЖ жұмсалатын шығындардың өсуінің, ғылымның кәсіпкерлік секторын, инженерлік әзірлемелер мен технологиялар және гуманитарлық ғылымдар салаларын дамытудың оң үрдістері, сондай-ақ медициналық ғылымдарға шығындарды қысқартудың теріс үрдістері анықталды. Ғылыми кадрлардың, әсіресе жоғары білікті кадрлардың көбеюіне байланысты қиын жағдай туындағаны көрсетілген. Зерттеуші жастарының арасында алшақтық бар, яғни 44 пен 55 жас аралығындағы зерттеушілер аз. Зерттеу нәтижелері ғылым саласындағы басқару органдарына қызықты болуы мүмкін.

Түйін сөздер: ғылым, әлеует, ҒЗТКЖ, ғылымды қаржыландыру, ҒЗТКЖ-ға арналған ішкі шығыстар, кадрлық әлеует.

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Анализ потенциала, структуры, динамики развития казахстанской науки

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Аннотация

В данной статье проанализирован научный потенциал, его структура и динамика развития в Казахстане для выработки стратегических рекомендаций по дальнейшему развитию науки. Основная цель научной работы получить точные данные о состоянии динамики развития казахстанской науки. Основными методами исследования послужили обобщение, систематизация и экономико-статистический метод. Статистической базой исследования послужили данные Комитета по статистике Министерства национальной экономики Республики Казахстан за период с 2010 по 2020 годы. Согласно проведенному анализу выявлено, что в финансировании НИОКР в республике основную роль играет государственный бюджет, а приоритетным направлением НИОКР являются исследования в области инженерных разработок и технологий. В то время как в области социальных и гуманитарных наук в Казахстане существует ряд проблем: тенденция сокращения сферы социальных наук, низкая доля кадров высшей квалификации в гуманитарных науках, низкая материально-техническая база социальных и гуманитарных исследований, что проявляется в высокой доле затрат на оплату труда. В частности, выявлены положительные тенденции роста затрат на НИОКР, развития предпринимательского сектора науки, а также негативные тенденции сокращения затрат на медицинские науки. Показано, что сложилась критическая ситуация с воспроизводством научных кадров, особенно кадров высшей квалификации. Результаты исследования могут быть интересны органам управления в сфере науки.

Ключевые слова: наука, потенциал, НИОКР, финансирование науки, внтуренние расходы на НИОКР, кадровый потенциал.

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Introduction

In the twentieth century, the role of science expanded significantly, which turned into one of the leading public institutions. Scientific discoveries in fundamental and applied fields, as well as new technologies in advanced countries are factors of economic growth, new ideas and knowledge make a significant contribution to the development of society. Scientific advances and new technologies bring about economic and social change, and serve to support socio-economic development aimed at seizing important opportunities or countering threats in a competitive environment. In general, new technologies are due to the organized social and economic efforts of countries to achieve breakthroughs aimed at supporting the national interests and well-being of the population [1].

According to the Frascati Manual, science is understood as a creative and systematic activity carried out with the aim of increasing the amount of knowledge, including knowledge about humanity, culture and society, as well as finding ways to use existing knowledge to achieve the practical goals of the development of society [2].

Modern economic and political debate revolves around understanding the reasons for the economic success of some countries, based on technological change and the strategic levers that must be used to increase the wealth of nations [3].The role of science in the modern economy is increasing, the development of an innovative economy, innovation is impossible without combining science and production [4]. Intensive development of science, technology and innovation leads to an accelerated transition to inclusive and environmentally sustainable economic development [5, 6].

As of today, you can find a lot of scientific papers on the role of science during a pandemic. As scientists note, the coronavirus pandemic - one of the largest health crises of our time - has given a great impetus to the development of education and science [7]. The countries with the greatest scientific potential have been able to develop a vaccine to tackle the pandemic, while the less scientifically developed countries are forced to queue up to purchase it.

Emphasizing the undeniable importance of the development of science for the state, society, culture, we have to admit that in Kazakhstan the innovative vector of development based on science is still very weak. Science and education in Kazakhstan have not yet become factors in the growth of technological innovation and productivity, although since Soviet times the republic has inherited a developed network of scientific institutions and universities [8].

For the further development of science, the Head of State K.Tokayev instructed to significantly increase funding, while taking drastic measures to qualitatively change the system. One of the key indicators of the State Program for the Development of Education and Science of the Republic of Kazakhstan for 2020-2025 is the achievement of the share of spending on science from the gross domestic product of 1%. For the qualitative growth of funding for science, it is necessary to analyze the existing state of scientific potential and the dynamics of its recent changes.

Thus, the main goal of this work is to analyze the scientific potential, structure and dynamics of the development of science in Kazakhstan in order to develop strategic recommendations for further financing science and determine sectoral and industrial priorities for its development.

Materials and research methods

The study is based on an integrated approach using economic and statistical analysis, methods of comparison and generalization. The basic method used is a descriptive method which respresents collecting, analysis and presentation of data and their characteristics. The statistical data of the Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan is a subject of the primary analysis and presentation in the paper. The collection and analysis of data on the state and dynamics of the development of domestic R&D sector over the past 10 years, from 2010 to 2020, was carried out in order to determine the potential and priorities for its development. The analysis was carried out in terms of indicators of gross domestic expenditures on R&D and R&D personnel, their structure and dynamics of development by sectors of activity and fields of research over the past decade.

The first part of descriptive analysis covers tracking dynamics of gross domestic spending on R&D through the last ten years and breakdown analysis by types (basic and applied research experimental developments) and sectors (governmental entrepreneurial, non-commercial and higher education), sources of funding (republican and local budgets, own funds, foreign investments, other sources) and fields of research (natural sciences, engineering, medicine, agriculture, social and humanitarian sciences).

The second part of descriptive analysis captures analysis of human capacity in R&D by the sectors (governmental entrepreneurial, non-commercial and higher education), sources of funding (republican and local budgets, own funds, foreign investments, other sources)

Literature review

In the context of the Fourth Industrial Revolution, the country›s scientific potential is a key factor in the formation of knowledge-based economy. The formation and effective functioning of knowledge economy depends on the creation, dissemination and use of knowledge, the results of research and development, information technology, etc. [9].

Many empirical and theoretical works emphasize that research and development (R&D) is an important factor in economic growth. R&D spending drives economic growth through its positive impact on innovation and overall factor productivity [10].In turn, the level of a country's technological and scientific potential determines the effectiveness of R&D. So, in less developed countries, there is a smaller effect from R&D [11].

Countries with high scientific potential have the greatest military, political and financial power and ensure a high level of well-being of their citizens. The basis of their influence is the huge amount of accumulated and created knowledge in all areas of activity. It follows that in the modern world it is science that is the basis of technological development, sustainable economic growth, spiritual modernization.

Thus, technology leaders maintain the indicator of the economy›s science intensity (the share of R&D expenditures in GDP) at 2.7-4.3%. The value of this indicator equal to 1% or less is considered critical for the scientific and technological security of the country [12].The share of science-intensive, innovative products in the production structure, which is also a generalizing indicator of the effectiveness of scientific, technical and innovative activities, in the European Union is 35%, the USA - 25%, Japan - 11%, Singapore - 7%, South Korea - 4% , China - 2% [13].

It was noted that the growth of R&D funding should be based on sound scientific and innovation policy, otherwise it will not give positive results. Policies aimed at increasing the return on R&D and optimizing their role in economic growth should take into account the following parameters: commercial R&D; new high-tech small and medium-sized enterprises; training and rotation of research personnel; technology transfer mechanism and R&D results; sound sectoral policies guaranteeing high profit margins and efficient technology transfer [14].Thus, reforms in science and technology in China have been effective in stimulating universities and research institutes, creating the innovative potential of enterprises and promoting the country›s industrial development [15]. Also, reforms and innovations in science and technology have contributed to significant growth in China›s GDP and accelerated progress in higher education, research and development. Thus, over the past three decades, China has launched and adjusted a wide range of science and technology policies that fostered the development of an innovation ecosystem and significantly increased the number of educated workforce, laying a solid foundation for socio-economic development [16]China has launched and adjusted a wide range of S&T policies which have nurtured an innovation ecosystem and significantly increased the size of the educated workforce, laying a solid foundation for future development. China has set a national target of becoming a leading innovative country by 2020. Reaching this target will require continued policy reform to further optimize the relationship between the government and market forces; to establish a more comprehensive innovation ecosystem; to nurture a legal and regulatory system that encourages investment in innovation and entrepreneurship by all sectors; and to foster open and fair competition among private, state-owned, and foreign enterprises.”,”author”:[{“dropping-particle”:””,”family”:”Casanova”,”given”:”Lourdes”,”non-dropping-particle”:””,”parse-names”:false,”suffix”:””},{“dropping-particle”:””,”family”:”Cornelius”,”given”:”Peter Klaus”,”non-dropping-particle”:””,”parse-names”:false,”suffix”:””},{“dropping-particle”:””,”family”:”Dutta”,”given”:”Soumitra”,”non-dropping-particle”:””,”parse-names”:false,”suffix”:””}],”container-title”:”Financing Entrepreneurship and Innovation in Emerging Markets”,”id”:”ITEM-1”,”issued”:{“date-parts”:[[“2018”]]},”page”:”69-80”,”title”:”The Impact of Science and Technology Policies on Rapid Economic Development in China * *This chapter is authored by Dongmin Chen,1 Shilin Zheng,2 and Lei Guo.3 The chapter has been adapted from an earlier version which appeared in the “Global Innovation I”,”type”:”article-journal”},”uris”:[“http://www.mendeley.com/documents/?uuid=dc42a6d5-e2e6-473d-9611-4e39da27f51e”]}],”mendeley”:{“formattedCitation”:”[18]”,”plainTextFormattedCitation”:”[18]”,”previouslyFormattedCitation”:”[18]”},”properties”:{“noteIndex”:0},”schema”:”https://github.com/citation-style-language/schema/raw/master/csl-citation.json”}.

According to UNESCO research statistics, the structure of various types of scientific research and R&D funding in different countries is rather heterogeneous. For example, in countries such as Germany, Bulgaria, Croatia, Latvia, Argentina, Italy, the R&D sector is more focused on applied science. The volume of state funding for fundamental research in the structure of expenditures on research and development, in contrast to applied research and experimental development, has a smaller share. Countries such as China, Israel, Japan, Denmark, South Korea, Great Britain invest the most in experimental development.

Results and discussion

In Kazakhstan, there has been a tendency to increase the volume of research activities in the country since 2010, when the first shock of the global financial crisis was overcome and major reforms of the innovation system were launched.

Gross domestic spending on R&D is defined as the total expenditure (current and capital) on R&D carried out by all resident companies, research institutes, university and government laboratories, etc., in a country. It includes R&D funded from abroad, but excludes domestic funds for R&D performed outside the domestic economy.

In general, gross domestic expenditure on R&D (GERD) have grown in absolute terms by 2.7 times over the period under review. However, given that the value of the subsistence minimum for this period increased by 2.4 times, it seems incorrect to state a significant increase in the total gross domestic R&D expenditures. Nevertheless, expenses for basic research increased by 3 times, for R&D - 4 times, applied research - by 2.2 times, but taking into account inflation, it can be stated that there is no growth and even a decrease in costs for the latter (Table 1).

Table 1 - Gross domestic expenditure on R&D by type of research, KZT billion

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GERD	33 466,8	43 351,6	51 253,1	61 672,7	66 347,6	69 302,9	66600,1	68884,2	72224,5	82333,1	89 028,7
% of GDP	0,15	0,15	0,16	0,17	0,17	0,17	0,14	0,13	0,12	0,12	0,13
Basic research	4 759,0	7 682,9	12 063,4	18 197,0	15 260,7	15 838,8	13 809,2	10 785,9	10 628,9	11 044,3	14 143,7
Applied research	24 100,5	27 565,8	28 898,0	33 369,4	38 394,7	36 959,0	35 841,1	40 909,6	43 278,3	52 620,9	54 462,3
Experimental development	4 607,3	8 102,9	10 291,7	10 106,3	12 692,1	16 505,1	16 949,8	17 188,7	18 317,2	18 667,9	18 531,5

Source: compiled by the author using data from the Statistics Committee [17].

The share of experimental development costs increased by 7% in the total volume of GERD, while the share of applied research decreased by 11%, and basic research – by 2% (Figure 1).

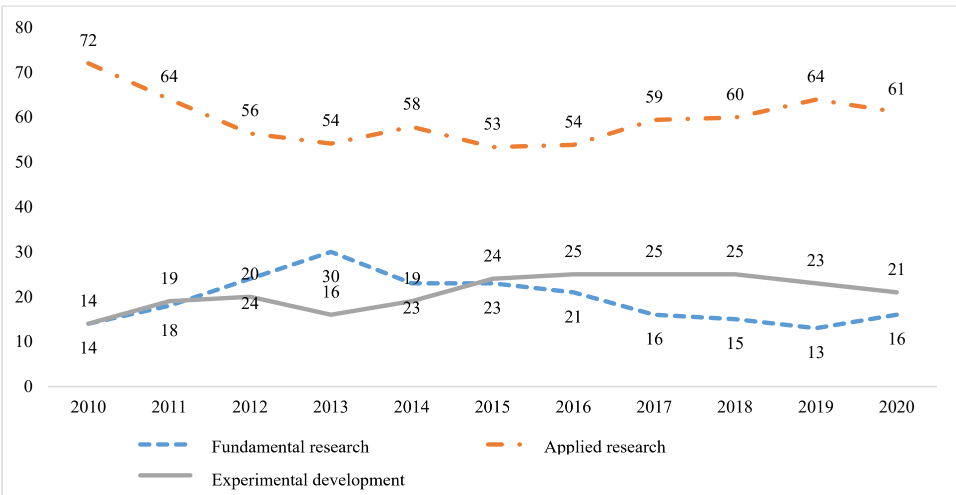

Figure 1 - Dynamics of the structure of GERD, 2010-2020

It is generally accepted to assess the dynamics of GERD in terms of the ratio to GDP. Over the past decade, the average annual value of the indicator of GERD in GDP was 13%. According to this indicator, Israel is the leader in the world - 4.93% and South Korea - 4.64%. Unsurprisingly, these countries are ranked 13th and 10th in the Global Innovation Index.

For 2010-2020, on average, the ratio between basic, applied research and experimental development was 20:60:20. Compared to 2000 (15:55:30), the structural proportions of the sphere have changed: the share of fundamental research has increased, the share of experimental development has significantly decreased. In economically developed countries, the emphasis is on experimental developments: USA - 16:21:63, Japan - 15:25:60, France - 21:35:44.

At the same time, one must understand that without sufficient funding for fundamental and applied research, it is impossible to ensure the required quality of R&D.

Some trends can be distinguished over the past 10 years: the share of R&D expenditures in the entrepreneurial sector increased by 13%, while the share of the public sector decreased by almost 13% (more precisely, by 12.54%) (Table 2).

Table 2 - Comparative analysis of the structure and growth rates of GERD by sector of activity and funding sources for 2010 and 2020

Indicators	2010		2020		Growth rate, 2020 to 2010,%	
	billion tenge	specific weight	billion tenge	specific weight	billion tenge	specific weight
GERD	33,5	100%	89	100%	265,67%	100%
By sector of activity						
Government sector	12,4	37%	28,8	32,4%	232,3%	87,5%
Entrepreneurial sector	12,3	36,6%	36,8	41,3%	299,2%	113%
Higher education sector	5,8	17,2%	14,8	16,6%	255,2%	96,7%
Non-profit sector	3,1	9,2%	8,55	9,6%	275,8%	104,4%
By funding sources						
Funds of the republican and local budgets	20,3	60,5%	46,25	52%	227,8%	85,9%
Own funds	7,5	22,4%	35,5	39,9%	473,3%	178,1%
Foreign investment	0,2	0,6%	2,2	2,5%	1100%	412%
Other funds	5,5	16,5%	5,03	5,6%	91,5%	34,2%

Source: compiled by the author using data from the Statistics Committee.

The share of R&D expenditures in higher education sector decreased slightly (by 3.3%). The share of the non-profit sector increased by 4.4%.

The volume of expenditures in these sectors in absolute terms over the past decade has increased by more than 2 times (the entrepreneurial sector - 3 times). Taking inflationary impact into account only indicates an increase in R&D spending in the entrepreneurial and slightly non-profit sector.

Analysis of the cost structure by funding sources indicates a real growth in R&D

However, the share of innovative products of domestic production is still extremely low: 2.4% of Kazakhstan›s GDP. For comparison, in the countries of the European Union this figure is 35%, the USA - 25%, Japan - 11%. One of the main reasons for this situation is that in the republic the programs of scientific institutions and innovation projects are not interconnected. Scientific organizations carry out research and development according to their own programs.

Despite the dominance of the engineering development and technology industry in the structure of R&D expenditures, it is necessary to state a decrease in its share of 6.4%, as well as the share of natural sciences (by 4.7%). The position of medical science is deplorable - the share of costs in this industry has decreased by more than 40% over the past decade. There is a slight increase in the share of expenditures on agricultural and social sciences - 20-26%. The humanities, on the other hand, have experienced a 3-fold increase in the share in a decade. It is obvious that the state has taken a course to support this industry, which is confirmed by the fact that 80% of the costs of this industry fall on the state (54%) and university (26%) sectors of activity (Table 3).

nditures by branches of science confirms the results of the structural analysis of expenditures. The cost of medical science has grown by only 1.5 times. Unfortunately, we have to state a decrease in real costs, since the value of the subsistence minimum over a 10-year period has grown 2.4 times, which indicates the same rise in prices and inflation. Given the rise in prices, the real costs of natural sciences, engineering and technology also grew slightly. Taking into account the inflationary component, one can state an increase in expenditures on agricultural and social sciences (by 130-150%), and to a large extent - on the humanities (by 580%).

Table 3 - Comparative analysis of the structure and growth rates of GERD by fields of research for 2010 and 2020

	2010		2020		Growth rate, 2020 to 2010,%	
	billion tenge	specific weight	billion tenge	specific weight	billion tenge	specific weight
Total	32 114,80	100	89 028,70	100	277,2	100
natural sciences	9 546,6	29,7	25 228,7	28,3	264,3	95,3
engineering developments and technologies	15 766,9	49,1	40 915,9	46	259,5	93,6
medical sciences	1 724,9	5,4	2 742,1	3,1	159	57,4
agricultural sciences	3 690,6	11,5	12 313,1	13,8	333,6	120,4
social sciencies	758,5	2,4	2 653,0	3	349,8	126,3
humanitarian sciences	627,3	1,9	5 175,9	5,8	825,1	297,9

Source: compiled by the author using data from the Statistics Committee.

Analysis of the dynamics of absolute R&D expeIn the modern world economy, the emphasis is not so much on material values as on intellectual potential. The nation›s ability to maintain a modern and efficient education system, to increase the intellectual potential of the workforce is becoming a critical factor in ensuring the country›s competitiveness [17].

In Kazakhstan today, 8031 specialists are employed in science with the academic degree of doctor, candidate of science, academic degrees of doctor in the field and PhD. Of these, at the age of 25-34 years - 552 people (7.5%), at the age of 35-44 - 1749 people (24%), at the age of 45-54 years - 1852 people (25%), at the age of 55-62 years - 955 people (13%), aged 63 and older - 2193 people (30%). Including 49% of doctors of sciences are in the older age group.

The number of researchers today is only 55.0% of the 1990 level. Over the past 10 years, there has been an increase in the number of scientific personnel, and over the past 5 years, the number has remained stable.

Over a 10-year period, the growth in the number of personnel engaged in research and development was only 133%, including researchers - 168%. The number of doctors of sciences increased by 40%, candidates of sciences - by 42% (Table 4).

In connection with the closure of the traditional school of training scientific personnel through postgraduate and doctoral studies in 2010, an increase in the number of doctors and candidates of sciences may be due to their arrival from other areas of activity (industrial, financial, public service, etc.), as well as the defense of dissertations in other post-Soviet countries space where the traditional system of training scientific personnel has been preserved (Kyrgyzstan, Russia, etc.). As expected, the number of doctors of philosophy PhD has grown - almost 30 times - in connection with the entry into force in 2010 of a new system of training scientific personnel.

Table 4 - Human capacity of R&D of the Republic of Kazakhstan in 2010-2020

Index	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Personnel engaged in research and development, thousand people											
R&D staff Including:	17021	18003	20404	23712	25793	24735	22985	22081	22378	21 843	22 665
-researchers, of them:	10870	11488	13494	17195	18930	18454	17421	17205	17454	17 124	18 228
Doctors of Science	1347	-	1065	1688	2006	1821	1828	1818	1 740	1 703	1 883
PhD	59	95	131	218	330	431	456	589	856	1 045	1 757
Candidates of Science	3041	3286	3629	4915	5254	5119	4726	4541	4360	4 240	4 329
Doctors by profile	-	1 486	719	605	596	549	493	354	336	317	62
Technicians	1 078	1102	1310	3586	3 882	3 692	3 326	2 797	2 836	-	-
Other personnel	2 319	2 558	2 179	2931	2 981	2 589	2 238	2 079	2 088	-	-

Source: compiled by the author using data from the Statistics Committee.

An analysis of the human resources potential of science by sectors of activity shows the following (Table 5):

- scientific personnel are concentrated in the higher education sector - 41.5%, and the peak in the number of personnel in this sector was in 2013, then the attractiveness of the higher education sector steadily decreased and since 2019 there has been a certain rise in this indicator;

- the human resources potential of the business sector›s science had the same trajectory of change, but its peak was in 2014;

- in the public sector of science, the deepest decline in the number of scientific personnel occurred in 2012, and the peak - in 2018, in general, there is a positive trend;

- a positive trend continues in the non-profit sector with some undulating changes with a peak in 2015 and 2020

Table 5 - R&D personnel by sector of activity, thousand people

Index	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Government sector	6 557	5 909	4 921	5 516	7 608	7 157	7 643	7 574	7 998	7491	7221
Entrepreneur sector	3 749	5 164	4 718	5 036	5 786	5 258	4 222	3 934	3 852	4046	4177
Higher education sector	5 232	5 516	9 405	11 828	10 961	10 623	9 791	9 203	8 808	8856	9415
Non-profit sector	1 483	1 414	1 360	1 332	1 438	1 697	1 329	1 370	1 720	1450	1852

Source: compiled by the author using data from the Statistics Committee.

A comparative analysis of the structure and growth rates of the human resources potential of science by sectors of activity revealed the increased attractiveness of the higher education sector for scientific personnel: the share of this sector in the total number of scientific personnel in 2020 increased by 32% compared to 2010. Accordingly, the number of scientific personnel in this sector increased by 80%, which is 50% more than the overall growth of scientific personnel potential (Table 6).

In terms of growth in the absolute number of personnel, the higher education sector is followed by the non-profit sector (almost 25% growth), but the share of this sector also decreased by 5%.

The growth in the costs of the business sector, accompanied by an increase in financing from its own funds, may indicate the emergence of business interest in scientific research. Statistical data on science for 2020 confirms this fact - 84% of the costs of the business sector fall on the financing of design and technological work.

Thus, in Kazakhstan for the analyzed decade, there has been a significant nominal, but not real growth in R&D funding. The existing growth in R&D funding is provided by an increase in R&D costs, the share of which is still very small in structural proportions (20% versus 40 - 65% in developed countries).

The tendencies accompanying the growth of R&D costs are the growth of the share and absolute volumes of R&D costs of the entrepreneurial sector. Since the main source of costs in the business sector is own funds, it is logical that this source of R&D costs grows clearly.

The 11-fold growth in foreign investment was largely due to the World Bank›s investments in joint programs with the government of Kazakhstan to commercialize scientific research and stimulate productive innovation. The share of the state budget has tended to decline over the past decade.

Table 6 - Comparative analysis of the structure and growth rates of human resources in R&D by sector of activity for 2010 and 2020

Index	2010 г.		2020		Growth rate, 2020 to 2010,%	
	people	specific weight	people	specific weight	people	specific weight
Total	17021	100	22665	100	133,16	-
Government sector	6557	38,5	7221	31,8	110,1	82,6
Entrepreneur sector	3749	22,0	4177	18,4	111,4	83,6
Higher education sector	5232	30,7	9415	41,5	180,0	135,2
Non-profit sector	1483	8,7	1852	8,2	124,9	94,3

Source: compiled by the author using data from the Statistics Committee [18].

Analysis of structural changes in internal costs by industry revealed the deplorable state of medical science, the share of which was 3.1% in 2020.

Obviously a favorable position in the branch of the humanities, beats. the weight of which has tripled over the period under review and the volume of which has grown 8 times in nominal terms and 4 times in real terms.

The human resources potential of science is also contradictory. The number of researchers today is only 55.0% of the 1990 level. Despite the fact that over the past 10 years there has been an increase in the number of scientific personnel by 168%, over the past 5 years this trend has not been observed.

The new system of training scientific personnel copes with its task of reproducing scientific personnel: the number of doctors of philosophy PhD has grown almost 30 times.

The country›s scientific workforce is concentrated in the higher education sector. The analysis revealed the increased attractiveness of the higher education sector for scientific personnel. In the public and non-profit sectors of science, in general, there is a positive trend in the growth of personnel engaged in research and development.

Conclusion

Research in science, technology and society takes different directions as their intellectual and social history is seen as a complex interaction between several academic fields. At the same time, this area covers the assessment of the consequences of scientific research and technological discoveries not only for economic, but also for social, political and cultural contexts, including public policy [19]. In recent years, there has been an increase in interest in assessing the non-economic social outcomes of scientific and technological research. However, interest in the social impacts of scientific research has not yet led to the widespread adoption of useful and reliable methods for assessing such impacts. [20].

In the context of the global pandemic COVID-2019, this trend is only intensifying. The widespread spread of coronavirus infection COVID-19 not only does not remove the relevance of the development of science from the agenda, but also testifies the increasing role of sciences, especially medical ones, to combat the virus, and other branches of science, to overcome the problems and consequences caused by the pandemic and quarantine.

When assessing the role of science and technology in helping various civil society organizations to fight the pandemic, it was found that strategies that use evidence-based guidance and digital technologies provide the best benefits. These technology strategies can be created either to combat a pandemic or to support society during a pandemic, which in turn helps control the spread of infection. In addition to the technologies being introduced, untapped technologies are considered that have effective applications for managing the circumstances of the pandemic [21].

Based on the analysis of the scientific potential of Kazakhstan, it was determined that science, being the most important factor and priority in the development of an innovative economy, is underfunded. There is still insufficient emphasis on the development of R&D - its share in domestic R&D expenditures is 2-3 times lower than in developed countries. A wide range of programs are needed to support corporate efforts to develop new technologies to further stimulate the development of innovation. We consider the reduction of the share of the state budget for R&D to be unjustified so far. A decrease in the share of R&D expenditures in the public and higher education sectors signals weakening of the scientific potential of state scientific institutes and universities, despite the concentration of the country›s scientific personnel in the higher education sector.Implementation of the State Program for the Development of Education and Science for 2020-2025 can strengthen the remaining potential with the efficient use of resources [22].

The coronavirus pandemic has sharply highlighted the underdevelopment of the healthcare system and medical science in the country. The government must ensure the intensive development of medical science, the proportion of which has decreased by 40% over the decade and reached 3.1% in 2020.

Despite the fact that the new system of training scientific personnel (doctors of philosophy PhD) copes with the task of reproducing scientific personnel, the number of researchers today is still only 55.0% compared to the 1990 level. Over the past 5 years, there has been a stagnation of human resources in science. These facts indicate the need to adopt a separate government policy and program to strengthen the human resources of science.

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