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The Impact of R&D on Sustainable Development: a Literature Review

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ABSTRACT

R&D is seen as crucial to achieving sustainable development, as it promotes innovation and drives economic growth. The aim of this work is to identify primary indicators of research and development and conduct an analysis of the research and development situation in Kazakhstan. The methodology consists of a systematic literature review (13 articles) and statistical analysis of research and innovation development in Kazakhstan for the period between 2014 and 2020 and included indicators of R&D development in Kazakhstan: R&D Costs Total/ Internal/ External and Sources of funding. Results show that research and development investments have a positive impact on productivity, innovation, and economic growth. The results showed that the highest level of internal costs for innovative research and development is formed in the cities of Almaty and Astana and in the Mangystau region. However, the level of internal research costs in Almaty c. decreased by 22% in 2018. Positive dynamics were in Astana, East Kazakhstan, Atyrau, Mangystau, Pavlodar and Zhambyl regions. There was also observed a clear upward trend in the own funds of enterprises allocated to finance these costs. The findings suggest that policymakers should prioritize supporting research and development and innovation investments in both the public and private sectors. Analysis of research and development expenses shows that internal costs are the most crucial, as they reflect the innovation demand and potential of enterprises. Further analysis is necessary to examine the distribution of internal costs based on the types of activities carried out by companies.

KEYWORDS: Economy, Economic Growth, Education, Innovation, Sustainable Development, Aggregate Productivity, Economywide Studies

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ҒЗТКЖ-ның тұрақты дамуға әсері: әдебиеттерге шолу

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ТҮЙІН

ҒЗТКЖ тұрақты дамуға қол жеткізу үшін шешуші рөл атқарады, өйткені ол инновацияларды дамытады және экономикалық өсуді ынталандырады. Әдістеме жүйелі әдебиеттерге шолудан (13 мақала) және 2014-2020 жылдар аралығындағы кезеңде Қазақстандағы ғылыми-зерттеу және инновациялық дамуды статистикалық талдаудан тұрады және Қазақстандағы ҒЗТКЖ дамуының көрсеткіштерін қамтиды: ҒЗТКЖ шығындары Жалпы/ішкі/сыртқы және қаржыландыру көздері. Нәтижелер ғылыми-зерттеу және тәжірибелік-конструкторлық инвестициялар өнімділікке, инновацияға және экономикалық өсуге оң әсер ететінін көрсетеді. Нәтижелер инновациялық зерттеулер мен тәжірибелік-конструкторлық жұмыстарға ішкі шығындардың ең жоғары деңгейі Алматы және Астана қалаларында және Маңғыстау облысында қалыптасқанын көрсетті. Дегенмен, ішкі зерттеу шығындарының деңгейі Алматыда 2018 жылы 22%-ға төмендеді. Оң динамика Астана, Шығыс Қазақстан, Атырау, Маңғыстау, Павлодар және Жамбыл облыстарында болды. Сондай-ақ осы шығындарды қаржыландыруға бөлінген кәсіпорындардың меншікті қаражатының айқын өсу үрдісі байқалды. Қорытындылар саясаткерлерге мемлекеттік және жеке сектордағы ғылыми-зерттеу және тәжірибелік-конструкторлық жұмыстар мен инновациялық инвестицияларды қолдауға басымдық беруі керек екенін көрсетеді. Ғылыми-зерттеу және тәжірибелік-конструкторлық шығындарды талдау ішкі шығындардың ең маңыздысы екенін көрсетеді, өйткені олар инновациялық сұраныс пен кәсіпорындардың әлеуетін көрсетеді. Компаниялар жүзеге асыратын қызмет түрлеріне негізделген ішкі шығындарды бөлуді зерттеу үшін қосымша талдау қажет.

ТҮЙІН СӨЗДЕР: экономика, экономиканы дамыту, білім беру, инновация, тұрақты даму, жиынтық өнімділік, жалпы экономикалық зерттеулер

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Влияние НИОКР на устойчивое развитие: литературный обзор

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АННОТАЦИЯ

Сегодня НИОКР считаются критически важными для достижения устойчивого развития, поскольку они способствуют инновациям и стимулируют экономический рост. Целью данной работы является определение основных показателей исследований и разработок и проведение анализа ситуации с исследованиями и разработками в Казахстане. Методология состоит из систематического обзора литературы (13 статей) и статистического анализа исследований и инновационного развития в Казахстане за период с 2014 по 2020 годы и включает показатели развития НИОКР в Казахстане: затраты на НИОКР, общие/внутренние/внешние и источники финансирования. Результаты показали, что наиболее высокий уровень внутренних затрат на инновационные исследования и разработки формируется в городах Алматы, Астана и в Мангистауской области. Однако уровень внутренних затрат на исследования в Алматы снизился на 22% в 2018 году. Положительная динамика была в г. Астане, Восточно-Казахстанской, Атырауской, Мангистауской, Павлодарской и Жамбылской областях. Также наблюдалась четкая тенденция к увеличению собственных средств предприятий, направляемых на финансирование этих расходов. Полученные данные свидетельствуют о том, что директивным органам следует уделять приоритетное внимание поддержке инвестиций в исследования, разработки и инновации как в государственном, так и в частном секторах. Анализ расходов на исследования и разработки показывает, что внутренние затраты являются наиболее важными, так как они отражают инновационный спрос и потенциал предприятий. Дальнейший анализ необходим для изучения распределения внутренних затрат в зависимости от видов деятельности, осуществляемой компаниями.

КЛЮЧЕВЫЕ СЛОВА: экономика, экономический рост, образование, инновации, устойчивое развитие, совокупная производительность, общеэкономические исследования

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Introduction

Research and development (R&D) has significantly promoted sustainable development in many countries worldwide. According to numerous studies, research and development (R&D) is critical factor in achieving sustainable development, as it promotes innovation and drives economic growth (Olaoye et al., 2021). R&D helps create new knowledge, technologies, products, and services that can improve living standards, promote environmental sustainability, and address social challenges (Stern &Valero, 2021). Many countries around the world have recognized the importance of R&D in sustainable development and have invested heavily in it to achieve their goals

Countries that have invested in R&D have seen improvements in their economic, environmental, and social conditions. For example, South Korea has invested heavily in R&D and has become one of the world's leading innovative countries, with spending on R&D increasing from 2.3% of its GDP in 2005 to 4.5% in 2019 (Kim &Park, 2020). Sweden is another country that has invested heavily in R&D, achieving significant progress in sustainable development (Stanujkic et al., 2020). In some countries, investment in R&D has played a crucial role in promoting sustainable development, achieving significant progress in areas such as renewable energy, environmental protection, and disaster management (Majid, 2020).

Kazakhstan, a country located in Central Asia, has also recognized the importance of R&D in sustainable development. In recent years, the government has been investing in R&D and has made progress in various fields such as renewable energy, agriculture, and healthcare. Kazakhstan has set ambitious targets to increase its spending on R&D to 1% of its gross domestic product (GDP) by 2025 and to become one of the leading innovative countries in the region. As of 2019, Kazakhstan's expenditure on R&D had increased to 0.49% of GDP, up from 0.14% in 2005, indicating steady progress (World Bank, 2021). However, compared to other developed countries, Kazakhstan still lags in R&D spending, and more needs to be done to achieve its sustainable development goals.

To promote R&D, Kazakhstan has established the National Scientific and Technological Development Fund, which provides funding for R&D projects. The country has also collaborated with other countries and international organizations to promote R&D and technology transfer. However, there are still challenges that need to be addressed, such as improving the R&D infrastructure, addressing the shortage of qualified researchers and scientists, and strengthening the links between R&D and industry to translate research into commercial products and services.

Compared to Kazakhstan, many other countries have successfully promoted R&D for sustainable development. For example, South Korea spends 4.5% of its GDP on R&D, while Sweden spends 3.3% (World Bank, 2021). These countries have made significant progress in promoting innovation, developing new technologies, and addressing social and environmental challenges.

R&D plays a crucial role in achieving sustainable development, and Kazakhstan has recognized its importance. The country has been investing in R&D and making progress in various fields. However, more must be done to strengthen the R&D infrastructure and promote collaboration between industry and academia to achieve its sustainable development goals, as demonstrated by successful examples from other countries.

Literature Review

In recent years, there has been growing interest in the relationship between costs and innovation in various research fields. Many studies have investigated the impact of expenses on innovation, as well as the effectiveness of different types of innovation strategies in reducing costs and improving efficiency. This literature review aims to provide an overview of research on the effectiveness of costs and innovation in different contexts.

One area where costs and innovation are closely linked is developing and deploying renewable energy technologies. Some studies have explored the cost-effectiveness of different types of renewable energy, such as solar, wind, and hydropower, as well as the role of innovation in driving down costs and increasing efficiency. Moreover, they state that innovation has the potential to drive down costs and increase the efficiency of renewable energy technologies. Still, the effectiveness of innovation strategies may depend on factors such as the specific technology being developed, the policy and regulatory environment, and the availability of financing and investment. Adopting renewable energy technologies may also have broader economic and environmental impacts, such as job creation and reduced greenhouse gas emissions (Zhao et al., 2021). Che et al. (2022) examined the impact of innovation on the cost of solar photovoltaic (PV) modules, finding that innovation played a significant role in reducing costs and improving efficiency.

Another area where costs and innovation are closely linked is in the field of healthcare. Many

studies have explored the impact of innovation on healthcare costs, as well as the effectiveness of different types of innovation strategies in improving health outcomes and reducing costs. The studies suggest that innovation has the potential to improve healthcare outcomes and reduce costs. However, the effectiveness of innovation strategies may depend on factors such as the specific healthcare context and the types of innovations being implemented. In addition, the adoption of new technologies and practices may require significant investment and changes to organizational processes, which can create challenges for healthcare providers and policymakers. Overall, the relationship between costs and innovation in healthcare is an area of ongoing research and discussion in the healthcare industry (Deeny & Steventon, 2017). For example, a study by Jacobs et al. (2017) investigated the impact of healthcare innovations on healthcare spending in the Netherlands, finding that innovations that led to greater efficiency and improved outcomes were associated with lower costs.

In the field of manufacturing, there has been growing interest in the relationship between costs and innovation in the context of Industry 4.0. Many studies have explored the potential of new technologies, such as artificial intelligence, 3D printing, and the Internet of Things, to reduce costs and improve efficiency in manufacturing. The studies suggest that the use of Industry 4.0 technologies has the potential to reduce costs and improve efficiency in manufacturing, which in turn can lead to greater competitiveness and innovation. However, adopting these technologies also requires significant investment and changes to organizational processes, and the benefits may not be immediately apparent. The relationship between costs and innovation in the context of Industry 4.0 is an area of ongoing research and discussion in the manufacturing industry (Horváth & Szabó, 2019). Szász et al. (2021) investigated the impact of Industry 4.0 technologies on manufacturing costs, finding that these technologies could reduce costs and improve efficiency significantly.

In table 1, there are described the primary sources of innovative activities financing.

Table 1 - Source of financing for innovative activities

No.	Source of Financing	Description	Advantages	Disadvantages
1	Own Funds	Funds invested by the organization using its own financial resources	Autonomy and control over innovation activities	Limited financial resources
2	Credits and Loans	Funds borrowed from financial institutions to finance innovation activities	Access to a larger pool of financial resources	Debt and interest payments that impact financial performance and sustainability
3	Funds of Foreign Investors	Funds received from foreign investors to finance innovation activities	Access to a larger pool of financial resources and expertise	Relinquishing control over activities and strategic direction
4	Funds of the Republican Budget	Funds received from the government to finance innovation activities	Stable and predictable source of funding	Subject to political and bureaucratic influences

Note: compiled by the authors

The main sources of financing for innovative activities can be broadly classified into four categories: own funds, credits and loans, funds of foreign investors, and funds of the Republican budget. Each of these sources has its own advantages and disadvantages, and the optimal mix of funding sources may vary depending on the specific needs and circumstances of a given organization or project (Carayannis & Campbell, 2011).

Own Funds: This refers to the funds that an organization invests in its own research and development activities using its own financial resources. This source of financing offers a high degree of autonomy and control over the direction and pace of

innovation activities, but it may also limit the scale and scope of such activities due to the finite nature of the organization's resources.

Credits and Loans: This refers to the funds that an organization borrows from financial institutions, such as banks, to finance its innovation activities. This source of financing offers access to a larger pool of financial resources than own funds, but it also carries the risk of debt and interest payments that can impact the organization's financial performance and sustainability.

Funds of foreign investors refer to the funds that an organization receives from foreign investors, such as venture capitalists or private equity firms, to finance its innovation activities. This source of financing offers access to a larger pool of financial resources and can bring in expertise and networks from overseas. However, it may also entail relinquishing some control over the organization's activities and strategic direction (Lerner & Nanda, 2020).

Funds of the Republican Budget: This refers to the funds that an organization receives from the government through grants or other financial support mechanisms to finance its innovation activities. This source of financing offers a stable and predictable source of funding. However, it may also be subject to political and bureaucratic influences that can limit the organization's autonomy and flexibility in pursuing its innovation activities.

The optimal mix of financing sources for innovative activities may vary depending on the specific context and needs of a given organization or project. A combination of these financing sources may be used to create a sustainable and diversified funding model that enables an organization to pursue its innovation objectives while managing financial risks and constraints (Lukšić et al., 2022).

The literature suggests that a mix of financing sources is often the best organisational approach. The optimal mix depends on factors such as the nature of the innovation activity, the size of the organization, and the current economic climate. For example, small startups may rely on their funds and the funds of foreign investors to finance their innovative activities, while larger established companies may have more access to credits and loans and funds from the Republican budget (Hitt et al., 2011; Prijadi et al., 2020; Shkabatur et al., 2022).

The extensive literature on the impact of R&D and innovation costs on GDP covers a wide range of topics. Below are some key findings and insights from this literature, including examples of experiences in different countries.

Positive impact on GDP. Numerous studies have found a positive relationship between R&D and innovation expenses and GDP. For example, a study by Boeing (2022) found that R&D investments in Germany had a positive impact on GDP growth and that the impact was more significant for small and medium-sized enterprises. Similarly, a study by Castellani et al. (2019) found that R&D investments in the United Kingdom positively impacted productivity and GDP growth. In South Korea, R&D investments by the government and private sector have played a significant role in the country's rapid economic growth (Sawng et al., 2021).

Spillover effects. R&D and innovation expenses can also have spillover effects that benefit the broader economy. R&D investments by one company can lead to spillover effects that benefit other companies in the same industry (Hájek & Stejskal, 2018). Additionally, a study by Cimoli et al. (2009) found that R&D investments can lead to technology transfers and knowledge spillovers that benefit developing countries. For instance, India has benefited from knowledge spillovers and technology transfers through collaborations with foreign firms and multinational corporations (Kumar & Prakash, 2017).

Impact of government policies. Government policies, such as tax incentives or grants for R&D, can also impact the relationship between R&D and innovation expenses and GDP. Government subsidies for R&D in France had a positive impact on productivity and GDP growth. Moreover, tax incentives for R&D in the United States had a positive impact on innovation and GDP growth (Xin et al., 2021). In China, the government has invested heavily in R&D and innovation, including establishing special economic zones and providing tax incentives, which have contributed to the country's economic growth (Park & Kim, 2022)

Long-term impact. Finally, the impact of R&D and innovation expenses on GDP can be long-term and difficult to measure. A study by Bloom et al. (2020) found that investments in intangible assets, such as R&D and innovation, can significantly impact GDP growth over several decades. For example, Japan has invested in R&D and innovation for decades, which has contributed to its economic success, particularly in industries such as electronics, automobiles, and robotics (Kang & Motohashi, 2020).

The literature suggests that R&D and innovation expenses can have a positive impact on GDP through increased productivity, technology transfers, and knowledge spillovers. Additionally,

government policies can play a role in encouraging R&D. Overall, the research on the effectiveness of costs and innovation suggests that innovation can significantly reduce costs and improve efficiency in various contexts. However, the effectiveness of different types of innovation strategies can vary depending on the specific context and the type of innovation being deployed. Therefore it is essential to analyze the development of R&D indicators and the current situation in Kazakhstan.

Methodology

The research methodology of this paper consists of two steps. First, the goal was to conduct a systematic literature review on R&D's impact on GDP. This analysis will allow us to identify primary indicators various scientists use to analyze the impact and relationship of R&D and economic growth. The systematic literature review is a rigorous method used to identify, analyze, and synthesize existing research on a specific topic. It involves formulating a research question, planning the review process, conducting comprehensive literature searches, selecting relevant studies based on inclusion criteria, extracting data from selected studies, assessing study quality, and synthesizing findings. The goal is to provide a comprehensive overview of existing evidence and identify research gaps.

The systematic literature review included 13 articles, based on which there were identified primary indicators considered by various authors when analyzing R&D impact on GDP. The second step of the analysis included a statistical analysis of the current R&D and innovation development situation in Kazakhstan. The indicators used in this article are listed in Table 2.

Table 2 - Indicators of R&D Development in Kazakhstan

No.	Indicator	Source of information the data
1	Total R&D costs	Bureau of National Statistics
2	Internal costs (governmental, higher professional education, business, non-profit)	Bureau of National Statistics
3	Internal costs by regions	Bureau of National Statistics
4	External costs	Bureau of National Statistics
5	Sources of funding for domestic R&D costs	Bureau of National Statistics

Note: compiled by the authors

Conducted systematic literature review allows to identify primary indicators considered by various authors when analyzing R&D development. The indicators included expenses on R&D divided by internal and external costs and funding sources. Whereas internal costs were analyzed region-wise and by type of work conducted.

Results and analysis

The analysis conducted is of significant importance as it sheds light on the impact of research and development (R&D) on the economy of Kazakhstan. The systematic literature review that was carried out provides a comprehensive understanding of the primary indicators that various authors consider when analyzing the relationship between R&D and GDP.

This, in turn, can guide decision-making regarding funding priorities for R&D initiatives and policies to encourage innovation and research. Furthermore, examining R&D costs and investment in different regions of Kazakhstan over six years (2014-2020) provides valuable insights into the distribution of resources and the effectiveness of R&D efforts across the country. This can help identify areas where additional investment or policy changes may be necessary to improve the impact of R&D on the economy.

The analysis carried out in this study is an essential step in understanding the role of R&D in the economic development of Kazakhstan and can inform future policies and decision-making in this area. By identifying and presenting these indicators in Table 3, this analysis helps inform policymakers, business leaders, and researchers about the key factors that influence the impact of R&D on the economy.

Table 3 - Systematic literature review: primary indicators considered by various authors when analyzing R&D impact on GDP

No	Study	Methodology	Results
1	Olaoye et al., (2021)	Empirical analysis	Higher R&D expenditures lead to higher productivity and GDP per capita, but only in the long run.
2	Stern &Valero (2021)	Empirical analysis	R&D investments positively impact economic growth, but the impact is more remarkable in developed countries than in developing ones.
3	Boeing et al. (2011).	Empirical analysis of German manufacturing firms	Basic research significantly impacts productivity more in low-tech industries, while applied research has a more significant impact in high-tech.
4	Xin et al. (2021)	Empirical analysis of European firms	Firms that invest in cleaner technologies tend to have higher productivity and R&D expenditures.
5	Majid (2020)	Empirical analysis	Environmental policies that promote clean technologies can increase R&D expenditures and improve economic performance.
6	Viglioni (2021)	Empirical analysis of Brazilian firms	R&D investments are positively associated with productivity and innovation performance, especially in high-tech industries.
7	Arora et al. (2021)	Empirical analysis	Firms that invest more in R&D tend to have higher profits and market values, indicating positive spillovers from innovation.
8	Sawng (2021)	Empirical analysis of South Korea's economy	R&D investments have a positive impact on economic growth, but the impact diminishes as the economy becomes more developed.
9	Bigliardi et al. (2020)	Empirical analysis of manufacturing firms	R&D investments are positively associated with innovation and firm performance, and foreign collaborations can enhance this.
11	Belitski et al (2020)	Empirical analysis of UK firms	R&D investments have a positive impact on productivity and profitability, and the impact is greater for firms with patents.
12	Habibi & Zabardast (2020)	Comparison of developing OECD and Middle East countries	Higher R&D investments have a positive impact on economic growth, but the impact is greater in countries with high levels of education.
13	Kang & Motohashi. (2020)	Empirical analysis of Japanese manufacturing firms over 20 years	R&D investments have a positive impact on productivity growth, and the impact is greater for firms that collaborate with others.

Note: compiled by the authors

The table provides a summary of recent studies on the impact of costs on R&D and innovation. Each study is briefly described, along with the methodology used, and the main results are presented. From table, it is clear that there is a consensus among the studies that R&D investments have a positive impact on productivity, innovation, and economic growth. However, the impact may vary depending on factors such as the level of human capital, the industry, the size of the firm, and the country's level of development.

Some studies also suggest that investments in cleaner technologies can improve both productivity and R&D expenditures and that R&D subsidies can have a positive impact on innovation and firm performance, particularly in high-tech industries.

The impact of R&D and innovation costs on GDP has been extensively studied by scholars and policymakers worldwide. The studies in the table provide essential insights into the relationship between R&D investments and economic performance, but several other factors can affect this relationship.

For example, the effectiveness of R&D investments may depend on the institutional environment, the level of competition, and the nature of

innovation systems in a country (Oluwatobi et al., 2020). Firms' financial constraints may also affect the relationship between R&D investments and innovation outcomes (Cassiman & Veugelers, 2002).

Moreover, the impact of R&D investments on economic growth may vary depending on the type of innovation, such as incremental or radical, and the extent to which it is diffused throughout the economy (Hao et al., 2020; Torres de Oliveira et al., 2022).

Overall, the studies in the table provide valuable insights into the impact of R&D and innovation costs on GDP. However, several other factors need to be considered when analyzing this relationship. The findings suggest that R&D and innovation investments can be a crucial driver of economic growth, productivity, and innovation performance and that policymakers should prioritize supporting these investments in both the public and private sectors.

Next, there was conducted an analysis of the current situation of R&D development expenses based on the secondary data. Analysis of research and development costs showed that during the study period, research and development costs increased by almost 44.5 billion KZT, which is 60.5% of the base year level. Moreover, it is clear that the primary growth occurred precisely in terms of external costs, which show an increase of more than 3.7 times (284.5%) and amounted to about 27.4 billion KZT in the reporting period. Whereas internal costs increased over the same period by only 22.5 billion KZT, which amounted to 34.2% of the base level, reaching 89.0 billion KZT (Table 4)

Table 4 - Research and development costs

Indicator	2014	In %	2015	2016	2017	2018	2019	2020	In %	Growth rate 2014-2020	
										Mln. KZT	%
Total R&D costs	73556	100,0	86573	89510	92732	99707	118 071	116 743	100,0	43187	58,7
Internal costs	66348	90,2	69303	66600	68884	72225	82 333	89 029	76,3	22681	34,2
External costs	7208	9,8	17270	22910	23848	27482	35 738	27 714	23,7	20506	284,5

Note: compiled by the authors

During the reporting period, the total costs exceeded 116.7 billion KZT. Among these indicators, the internal costs of research and development are considered the most crucial as they reflect the innovation demand and potential of the enterprises. To analyze this further, it is essential to examine the distribution of internal costs based on the types of activities carried out by the companies. According to Table 19, domestic costs in the country increased by 34% (22.6 billion KZT), totalling over 89.0 billion KZT. The business sector had the largest share of these costs, accounting for 36.7% and 41.3% of all costs in the base and reporting years, respectively.

Further, the distribution of internal costs for R&D is given in Table 5.

Table 5 - Distribution of internal costs for R&D by types of activity

Indicator	2014	In %	2015	2016	2017	2018	2019	2020	In %	Growth rate 2014-2020	
										Mln. KZT	
Internal costs for R&D	66348	100,0	69303	66600	68884	72225	82333	89029	100,0	22681	34
Governmental costs	21696	32,7	20329	18640	20961	22092	24 291	28 847	32,4	7151	32
Higher professional education	14707	22,2	13486	11532	13179	11515	13 374	14 796	16,6	89	0
Business	24338	36,7	27791	28873	28665	30999	33 884	36 833	41,3	12495	51
Non-profit	5608	8,5	7701	7555	6078	7619	10 784	8 553	8,7	2945	52,5

Note: compiled by the authors

The public sector ranks second in terms of internal costs, accounting for over 32% of the total. The non-profit sector had the lowest expenses, with its share of expenses not exceeding 10% of the total. Notably, the sector of higher professional education exhibited a negative trend in both the share of costs and physical volume. In the reporting year, the universities' share of participation in internal costs was 16.6%, which decreased by 5.6%. The absolute value of costs incurred decreased by almost 1.4 billion KZT until 2019, and in 2020, the indicator was almost the same as in 2014, with a difference of only 0.89 billion KZT.

It is also important to note that the most significant positive changes occurred in the business sector, where the cost growth amounted to 51% or 12.5 billion KZT. On the one hand, these trends indicate that the business sector has begun to pay more and more attention to innovation processes. However, the growth rate of such attention does not fully meet the requirements of today due to the acceleration of all processes. On the other hand, the negative trend in the field of higher professional education is alarming, which in its essence should, on the contrary, be the flagship of innovative activity.

Such a multidirectional development of the priorities of innovation activity indicates that there are specific problems in the republic in forming an innovative ecosystem of entrepreneurship. We also consider it important to consider the issue of internal costs for research in the context of the country's regions. This will enable the researcher to identify the existing problems in the regions in order to identify the factor dependence on the specific conditions of each region and develop identified recommendations for increasing the level of innovative solutions in entrepreneurship.

To sum-up, the analysis of internal costs for research and development in Kazakhstan showed that the business sector is demonstrating positive growth, while the sector of higher professional education is experiencing a negative trend. The public sector is the second-largest contributor to R&D expenses, while the non-profit sector has the smallest share. The multidirectional development of priorities in innovation activity signals the existence of problems in the formation of an innovative ecosystem of entrepreneurship. Therefore, it is recommended to consider the issue of internal costs for research in the context of the regions of the country to identify existing problems and develop region-specific recommendations for increasing the level of innovative solutions in entrepreneurship (see Table 6).

Table 6 - Domestic expenditures on R&D by regions of Kazakhstan

Region	2014	2015	2016	2017	2018	2019	2020	In %	Dynamics	
									Mln. KZT	%
Kazakhstan	66348	69303	66600	68884	72225	82 333	89 029	100	22 681	1,34
Akmola	827	1113	797	898	1694	1 609	1 655	1,9	828	2,00
Aktobe	735	702	763	839	975	1 061	1 177	1,3	442	1,60
Almaty	804	1054	942	871	1121	1 521	1 673	1,9	869	1,08
Atyrau	1886	2416	2753	3638	4495	5 135	5 802	6,5	3 916	2,08
West- Kazakhstan	672	753	1789	299	878	1 045	1 061	1,2	389	1,58
Zhambyl	1322	690	456	1024	732	759	2 156	2,4	834	1,63
Karaganda	4049	3598	4279	3488	3508	4 544	3 986	4,5	-63	0,98
Kostanay	574	599	562	1177	827	688	788	0,9	214	1,37
Kyzylorda	266	236	614	506	302	273	284	0,3	18	1,07
Mangystau	6161	7695	7800	8044	9849	9 714	10 428	11,7	4 267	1,69
Pavlodar	323	321	390	336	290	1 258	598	0,7	275	1,85
South-Kazakhstan	236	224	180	185	226	241	339	0,4	103	1,44
Turkestan	284	313	173	205	274	189	482	0,5	198	1,70
East- Kazakhstan	3041	3300	3475	5001	5319	7 082	5 412	6,1	2 371	1,78
Astana c.	10188	13452	13991	16298	14094	17 965	18 753	21,1	8 565	1,84
Almaty c.	34030	31791	26596	25358	26587	28 095	32 873	36,9	-1 157	0,97
Shymkent c.	950	1047	1038	719	1054	1 154	1 560	1,8	610	1,64

Note: compiled by the authors

The presented data showed that the highest level of internal costs for innovative research and development is formed in the cities of Almaty and Astana, and in Mangystau region, where these costs in the reporting year amounted to 36.9, 21.1 and 11.7%% or 32.8, 21.1 and 10.4 billion KZT, respectively. A similar picture was observed in the base period. Also, among the major investors in research and development, one can note such regions as East Kazakhstan, Atyrau and Karaganda regions, where the level of these costs amounted to 6.1, 6.5 and 4.5%% or 5.4, 5.8 and 3.9 billion KZT.

As for the dynamics of the studied indicator in the analyzed period, it can be seen that in the region with the highest costs, namely in Almaty, the most significant changes occurred, and it is important to note that a negative trend has formed. Thus, over the period under study, the level of internal research costs decreased by 22% in 2018 to a level of 26.6 billion KZT, and only in 2020 reached the level of 2014.

On the contrary, such regions as Astana, East Kazakhstan, Atyrau and Mangystau, Pavlodar, and Zhambyl regions demonstrate significant positive dynamics, where the growth ranged from 60% to more than 2.3 times.

Next, we will consider the issue of cost distribution by type of work performed, which will show the main trends in the direction of invested funds in Table 7.

Table 7 - Distribution of internal costs by types of work

Indicator	2014	2015	2016	2017	2018	2019	2020	Dynamics	
								Mln.KZT	%
Internal costs for R&D	66348	69303	66600	68884	72225	82333	89029	22681	1,34
Fundamental research	15261	15839	13809	10786	10629	11044	14144	-1117	0,93
Applied research	38395	36959	35841	40910	43278	52621	54462	16067	1,42
Experimental design	12692	16505	16950	17189	18317	18668	20423	7731	1,61

Note: compiled by the authors

The presented data showed that the most significant increase in the cost of research and development increased by 5.6 billion KZT or 61% of the level of 2014, and the emerging trend was stable throughout the period. Applied costs increased by 42% or 16.0 billion KZT and, in terms of total volume, account for more than 50% of all internal costs.

A significant issue that characterizes the quality of internal R&D expenditures is the sources of financing for these expenditures (see Table 8).

Table 8 - Sources of funding for domestic R&D costs

Indicator	2014	2015	2016	2017	2018	2019	2020	Dynamics	
								Mln.KZT	%
Internal costs for R&D	66348	69303	66600	68884	72225	82333	89029	22 681	1,34
Own funds	19858	25357	26389	28188	34251	37711	35541	15 683	1,79
Republican budget	43053	40425	35186	35338	31636	35966	45671	2 618	1,06
Local budget	291	295	254	642	510	750	580	289	1,99
Foreign investment	490	1255	1019	1272	1924	3338	2211	1 721	4,51
Other means	2656	1973	3752	3444	3904	4568	5026	2 370	1,89

Note: compiled by the authors

Through the definition of these sources, one can understand the presence or absence and the strength of the interest of sure participants in economic relations. Overall, this analysis provides valuable insights into the state of innovation in Kazakhstan and can inform future policies and strategies for promoting and supporting innovation activities in the country. As we can see from the presented data, there was a clear upward trend in the own funds of enterprises allocated to finance these costs. So, for example, over a period of seven years, companies financed innovative research and development in the amount of 35.5 billion KZT, which exceeds the baseline by 15.6 billion KZT or 79% of the 2014 level.

On the contrary, from significant negative changes, one can note a decrease in state budget funds for these purposes, namely by 73%, which is more than 11.4 billion KZT in 2018, but in subsequent years there was an increase of 45.6 billion KZT in 2020. Moreover, the largest increase in the companies' funds occurred precisely in the last year of the study period, when the companies' funds allocated for research and development increased by more than 6.1 billion KZT.

It is also evident that the R&D costs presented above are designed to ensure an increase in the efficiency of activities due to an increase in the level of the innovation component since it is innovations that carry a rational grain that provides an increase in productivity, quality, resource savings and other financial and economic characteristics.

Conclusion

In conclusion, the effectiveness of cost and innovation in Kazakhstan is a complex and multifaceted issue that depends on various factors, such as funding sources, regional disparities, and the overall economic and political environment. The analysis of the available data shows that while some regions, such as Almaty and Nur-Sultan, have high levels of internal costs for research and development, others, such as East Kazakhstan and Atyrau, are significant investors in innovative activities.

Moreover, the study highlights the importance of choosing the right mix of funding sources, as each source has advantages and disadvantages. Own funds provide autonomy and control, while credits and loans offer access to a larger pool of financial resources. Foreign investors can bring in expertise and networks from overseas but this may entail relinquishing some control, and funds from the government offer stable and predictable funding. However, they may be subject to political and bureaucratic influences. Finally, the analysis of the dynamics of the studied indicator shows that some regions have demonstrated significant positive growth while others have experienced negative trends. These disparities emphasize the need for a more targeted and regionally-focused approach to innovation policies and funding mechanisms in Kazakhstan.

The analysis of internal costs for innovative research and development in Kazakhstan over the period from 2014 to 2020 reveals both positive and negative trends in different regions. While some regions, such as Almaty, experienced a decrease in internal research costs, others, such as Nur-Sultan, East Kazakhstan, Atyrau, and Mangystau, showed significant positive dynamics. The increase in the cost of development and development, as well as applied costs, is a positive trend that indicates a growing interest and investment in innovation activities. However, it is crucial to consider the sources of financing for these expenditures to understand the interests and strengths of different economic participants.

Based on the study, the following recommendations can be made.

First, increase investment in research and development: Given the positive impact of R&D activities on innovation and economic growth, there is a need to increase investment in R&D, particularly in regions where the level of R&D costs is low. This can be achieved through a combination of public and private funding, as well as tax incentives and other policies that encourage innovation.

Second, encourage internal funds for R&D: While borrowing from financial institutions can provide access to a larger pool of financial resources, it is essential to encourage organizations to use their funds for R&D activities. This can help maintain greater control over the direction and pace of innovation activities and may lead to greater long-term sustainability.

Third, encourage collaboration between regions: Given the significant variation in R&D costs across regions, there is a need to encourage collaboration between regions to share knowledge and resources, notably between regions with high R&D costs and those with low R&D costs. Encourage the use of applied research: While basic research is essential, it is also important to encourage the use of applied research, which directly impacts industry and society. Policymakers can encourage the use of applied research by providing funding for research that is linked to practical applications, as well as by fostering collaboration between research institutions and industry.

Fourth, increase transparency in R&D financing: To ensure that R&D financing is used effectively, it is crucial to increase transparency in the sources and use of R&D financing. This can be achieved through the publication of annual reports that provide detailed information on R&D expenditures and through the establishment of clear guidelines for the use of R&D financing.

Overall, by addressing these challenges and promoting a more diversified and sustainable approach to financing innovation, Kazakhstan can unlock its full potential and become a leading innovator in the region.

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