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SURVEYING RESEARCH LANDSCAPES: REVEALING ATTRIBUTES IN THE PHYSICAL SCIENCES OF KAZAKHSTAN

Abstract

This article presents a comprehensive survey-based analysis of the current research landscape within Kazakhstan's academic community. Drawing from responses collected from 265 researchers and academics across various universities, the study unveils insightful demographic profiles and research attributes across four distinct subject areas. While encompassing a broad spectrum of disciplines, particular attention is directed towards the characteristics and trends within the physical sciences domain. The survey explores Kazakhstan's physical sciences research landscape, revealing a focus on international collaborations, particularly with Western academics, to enhance research visibility. Challenges include limited emphasis on partnerships with governmental or non-governmental organizations, adverse working conditions, and disparities in resource access, notably in high-performance computing facilities. This research provides a detailed understanding of the current state of academic research within the country and offers a nuanced perspective that can inform strategic planning, policy formulation, and future research endeavors.

Key words: research activity, science, Kazakhstani universities, publication activity, science development, collaboration, physical science.

Introduction

The development of higher education institutions plays a crucial role in shaping the trajectory of a nation's progress, with profound implications for its socio-economic landscape and global standing. Over the years, scholars and policymakers alike have recognized the pivotal role of universities in driving scientific advancement, technological innovation, and human capital development. The establishment and growth of internationally renowned higher education institutions are intrinsically linked to the overall development of a nation. Indeed, universities serve as engines of knowledge creation, hubs of intellectual discourse, and catalysts for societal transformation [1]. Brekke [2] described universities as central hubs for generating and sharing knowledge, highlighting their essential role as primary participants in research advancement to address societal demands and stimulate economic development.

In the context of Kazakhstan, a country with a burgeoning higher education sector and aspirations for socio-economic development, the role of universities takes on added significance. The research activity of scientists in modern Kazakhstan is one of the areas of development of human capital, which saw significant improvements in the 1990s when crucial reforms were carried out in higher education and science [3]. These reforms aimed primarily at integrating local science into the international scientific community [4]. Further substantial reforms were implemented in March 2010

when Kazakhstan joined the Bologna Process, a move that underscored the nation's efforts to align its higher education system with international standards. The necessity for researchers to publish in peer-reviewed journals indexed in prestigious databases such as Scopus underscores Kazakhstan's commitment to enhancing its research output and global visibility.

The literature on the role of universities in driving scientific advancement and economic growth is extensive and multifaceted, spanning various disciplines and research contexts. Scholars such as Agasisti et al. [5] have explored the economic implications of university research, emphasizing the role of academic publications in driving knowledge spillovers and fostering innovation. As Kazakhstan seeks to transition to a knowledge-based economy, the strategic importance of universities in promoting research and innovation becomes increasingly apparent. However, the realization of Kazakhstan's aspirations for scientific and technological advancement is not without its challenges. Issues such as limited access to research funding, inadequate research infrastructure, and brain drain pose significant obstacles to the country's research ecosystem. Addressing these challenges requires a multifaceted approach, including policy interventions, investment in research infrastructure, and the promotion of collaboration between academia, industry, and government.

As a former Soviet Union country, Kazakhstan has inherited a focus on several research fields, particularly the so-called "hard sciences" like physics and mathematics [6]. This emphasis has created a significant gap between these and other fields of research, a disparity that remains evident today [7]. Despite a noted decrease in the share of published works in the natural sciences [6], fields such as natural sciences, engineering, and technology continue to dominate research output. It is globally recognized that research is produced by universities and non-university research institutes, with the latter focusing primarily on research activities [8]. In Kazakhstan, research efforts have increasingly shifted towards universities, driven by recent policy changes that target the research potential of scientists, develop academic programs transitioning from Soviet-era qualifications to Ph.D. degrees, and invest in human capital development [9].

The significance of scientific development for economic growth in Kazakhstan is underscored and it is argued that the research activity of scientists is a crucial component of human capital development, further reinforcing the integral role of scientific endeavors in shaping the nation's socio-economic landscape [3]. Universities are widely acknowledged as primary engines of knowledge creation, serving as incubators for groundbreaking research and innovation. According to Brekke [2], universities are crucial for creating new knowledge through research, which advances our understanding and technological progress. It is suggested that universities united with a shared vision for development can contribute significantly to regional development [10]. Freitas et al. [11] note that governments prioritize investing in research and training within educational institutions to enhance their entrepreneurial role, with research and education institutions playing a growing role in helping local businesses transition into more dynamic and promising industries [12].

In Kazakhstan, a positive trend is emerging, with a gradual shift of resources towards research and development within the higher education sector [13]. This shift is significant, given the strong correlation found between higher education sector investments in R&D and the creation of new technologies [14]. Efforts are underway to enhance the research capacity of universities as part of a government initiative aimed at fostering a competitive and innovative economy [15]. As a result, there has been a noticeable upward trend in the number of publications from Kazakhstani universities, as shown by the increase in papers published in the Scopus database from 1991 to 2022 (Figure 1) [15].

However, despite these significant contributions, challenges persist. Issues such as funding constraints, limited industry-academic collaborations, and the need for greater interdisciplinary research collaboration remain pertinent. According to OECD [16] research potential in Kazakhstan is constrained by ongoing challenges such as heavy teaching and administrative responsibilities, restricted availability of resources and databases, and inadequate proficiency in the English language. As the literature highlights the pivotal role of universities, it becomes evident that constant monitoring and assessment of the research landscape is crucial for fostering innovation, driving economic growth, and addressing societal challenges.

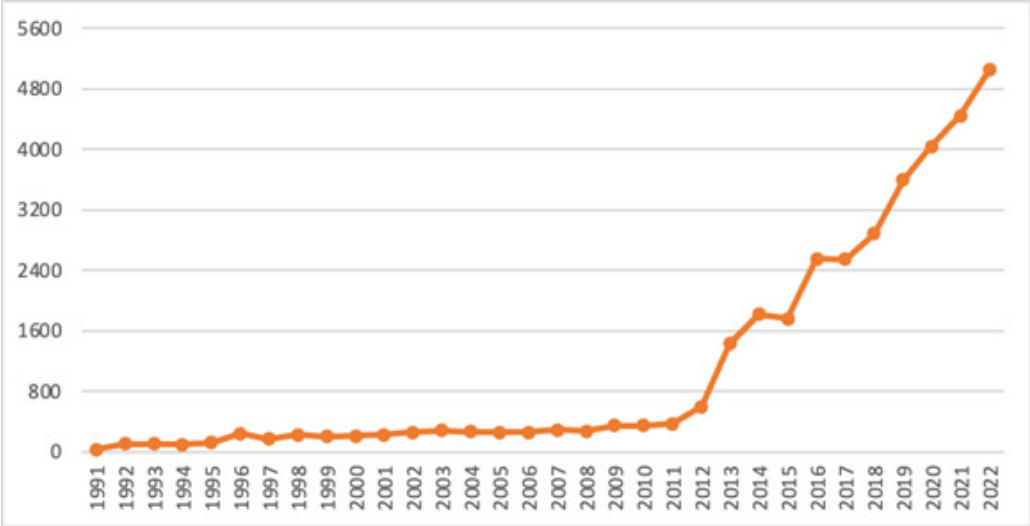

Figure 1 – Papers published in the Scopus database
affiliated with Kazakhstan in 1991–2022

Kazakhstan, like many post-USSR countries, maintains a strong emphasis on research in physical sciences, reflecting a historical bias towards these fields as the foundation of technological progress. In the study on disciplinary specialization, Kazakhstan has a relative strength in fields such as Applied Physics, a legacy of the USSR's prioritization and investment in physical sciences [17, 18]. Post-communist countries, including those in Central and Eastern Europe and the former USSR, continue to prioritize fundamental sciences, maintaining the highest Relative Citation Index (RCA) coefficients in these fields compared to other world regions [19].

To identify the current state of research activities undertaken by academics in Kazakhstan, particularly in the physical sciences, a survey was conducted focusing on their work environment and publication priorities. The findings aim to provide insights into demographic profiles, research attributes, and prevailing challenges, contributing to a better understanding of Kazakhstan's scientific development and its potential for future growth.

Materials and Methods

We employed a survey as our primary method of data collection. The research unfolded in two distinct phases: initially, data collection was undertaken following a specified set of procedures. Subsequently, the second phase involved organizing and interpreting the collected data. Drawing upon the findings of Amirbekova et al. [15], wherein the authors identified the top five authors in each subject area affiliated with universities in Kazakhstan from 1991 to 2022, we selected 18 universities (appendix 1) to which these top authors are affiliated. Subsequently, we gathered all accessible data concerning the academic staff at each university. As a result, information on academic staff was obtainable from the official websites of 16 of the selected universities. In total, 9425 contacts from these 16 universities, spanning various subject fields, were identified. Among these academic staff contacts, 5603 included email addresses; consequently, contacts lacking email addresses were excluded. Following random sampling of the remaining list, wherein 50% of academic contacts were selected at random from each university, a total of 2800 contacts remained.

The survey targeted academics from universities in Kazakhstan. Its primary focus was to analyze publication activities across these institutions. The survey encompassed subject areas classified by the Scopus database and 16 state and non-state universities across Kazakhstan. Comprising three sections and 40 questions in total, the questionnaire delved into various aspects: the first section, comprising 19 questions, aimed at understanding respondents' profiles and employment positions;

the second section, with 11 questions, focused on their research activities; and the third section, containing 10 questions, explored respondents' publishing strategies. Anonymously answered by 265 individuals, the survey provided insights into the academic landscape of Kazakhstan.

Results and Discussion

According to the Scopus, Elsevier's abstract and citation database, scientific works can be classified as four broad categories: Social Sciences, Medicine, Life Sciences and Physical Sciences. Upon examining the distribution of subject areas before dividing it into four Scopus categories, it is evident that subject area categorized as "Art and Humanities" constituted the largest proportion at 22%, followed by social sciences (12%), chemistry (11%), medicine (8%), engineering (8%), etc.

Following the categorization of subject areas into Scopus categories, there has been a shift in distribution across these categories. Physical sciences constitute the majority, accounting for 45% of all respondents, followed by social sciences at 41%, with medicine comprising 8%, and life sciences at 5%. Age distribution, demonstrates that discrepancies in age distribution in medicine and life sciences are less notable, largely attributed to significant differences in the number of respondents. In the category of social sciences, the prevailing age groups are "between 40 and 49", "between 30 and 39", and "between 50 and 59" (refer to Figure 2 for details).

In the realm of physical sciences, the majority of respondents fall between the ages of 30 and 39 (34%). Age groups "Between 40 and 49" and "Between 50 and 59" are also equally important, accounting for 25% each. There is a notable decrease in the number of individuals aged younger than 30 (5%) and those aged 60 or older (12%).

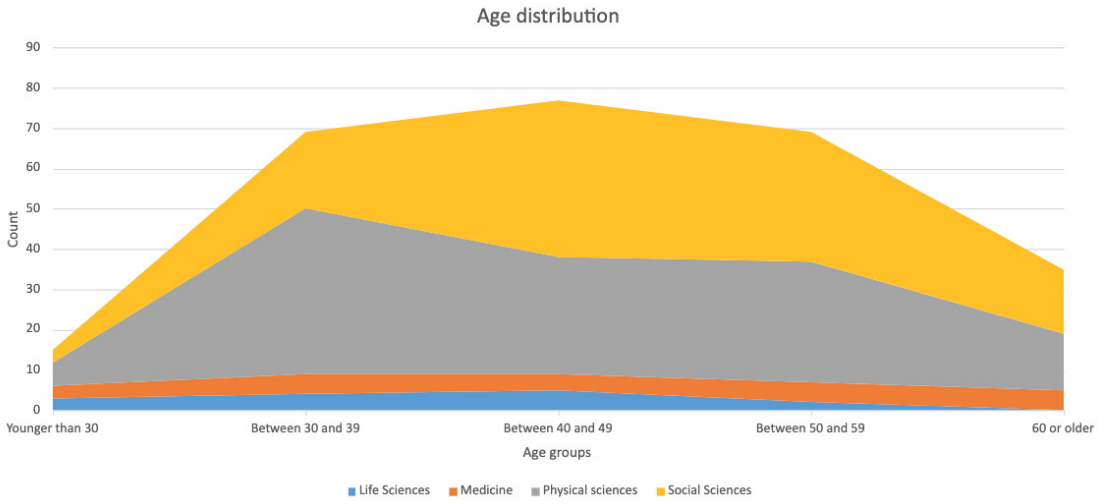

Figure 2 – Age distribution

Table 1 effectively demonstrates the working conditions of all respondents. Since respondents had the option to select multiple choices, the total number of responses amounted to 842. The most common response, "work is meaningful," was chosen by 193 respondents, accounting for 23% of the total. Similarly, this answer was the most common across all four categories. Looking at responses across all categories, other frequently selected answers by respondents from life sciences included "I enjoy considerable autonomy in my everyday working life" (14%) and "The competition among those working in my discipline is intense" (12%). In the field of medicine, these were "Academia offers me long-term opportunities for advancement" (15%) and "My salary is too low" (13%). In social sciences, common responses were "My workload is excessive" (15%) and "My salary is too low" (13%).

In physical sciences, respondents often chose “My salary is too low” (12%) and “I enjoy considerable autonomy in my everyday working life” (11%). The least frequent response pertained to the statement “In my subject area, there is considerable pressure to attract external funding” (for additional information, please refer to Table 2).

Table 1 – Working conditions in academia

Subject area broad	Physical sciences	Medicine	Life Sciences	Social Sciences
I enjoy considerable autonomy in my everyday working life	45	5	7	33
Academia offers me long-term opportunities for advancement	43	8	4	29
My salary is too low	49	7	2	42
My work is meaningful	95	13	12	73
The competition among those working in my discipline is intense	32	4	6	19
In my subject area, there is considerable pressure to publish	31	3	5	29
In my subject area, there is considerable pressure to attract external funding	21	3	4	19
My workload is excessive	51	5	4	49
If the idea is good and plausible, then publishing embellished results will do no harm	21	2	2	10
To survive in the competitive, “publish or perish” academic environment, you can’t always stick to all the rules.	28	3	3	21

The next question aimed to identify the strategies academics employ to stay abreast of current research in their field on a regular basis. Respondents were allowed to select multiple options. In total, there were 1117 responses. Table 2 illustrates that the most common response across all four fields was “I attend conferences or workshops,” with 200 respondents or 18% selecting this option. Upon examining the category of physical sciences, the second and third most frequent responses were “I read materials suggested by other academics” and “I follow the work of key academics”. The least frequently used tactic to keep up with current research was setting Google alerts for specific relevant keywords.

The subsequent question (Table 3) focused on access to specific resources or facilities provided by respondents’ institutions to facilitate research in their respective fields of work. The survey results revealed one prevailing answer across all four categories: online access to journals, databases, and books (28%). For physical sciences, other frequently accessed resources included research laboratories and equipment, along with a well-stocked library. The two least commonly chosen responses were “Institutional research ethics review board” and “High-performance computing facilities”.

Table 2 – Tactics to “keep up” with current research

Subject area broad	Physical sciences	Medicine	Life Sciences	Social Sciences
I follow the work of key academics	69	7	7	64
I regularly skim new issues of key journals	67	8	3	58
I read / skim book reviews	47	4	4	51
I regularly skim table of contents of key journals	53	7	6	46
I set google alerts for specific relevant keywords	34	0	6	21
I read materials suggested by other academics	77	9	4	67
I read materials rated highly by a relevant repository or research tool	53	3	2	33
I follow other researchers through blogs or social media	49	6	5	47
I attend conferences or workshops	89	16	8	87

Table 3 – Access to specific resources or facilities provided by respondents’ institutions

Subject area broad	Physical sciences	Medicine	Life Sciences	Social Sciences
Research laboratories and equipment	61	3	8	16
Internal research funding opportunities	34	8	4	29
Access to a well-stocked library	46	13	7	56
Online access to journals, databases, books	87	18	10	77
Dedicated research support staff (e.g., research assistants, staff to support you with funding applications)	22	3	0	16
High-performance computing facilities	16	2	2	5
Collaborative research spaces or centres	32	1	4	24
Access to specialised software or research tools	27	3	3	13
Institutional research ethics review board	14	3	5	19

On the question of which types of relationships have been the most important for respondent’s research development (Table 4), collaborations with academics from other institutions in Kazakhstan was the most frequent answer. For academics within the realm of physical sciences, collaborations occurring both within and beyond their institution’s borders hold significant importance. Notably, collaborations with fellow academics within their institution and with counterparts from other institutions within Kazakhstan are highlighted as crucial. Additionally, collaborations with academics in other post-Soviet countries emerge as equally vital for researchers in the field of physical sciences. In contrast, collaborations with government or non-governmental organizations are considered of lesser importance for academics specializing in the physical sciences.

Table 4 – Types of relationships have been the most important for respondent's research development

Subject area broad	Physical sciences	Medicine	Life Sciences	Social Sciences
Collaborations with academics at your institution	47	10	5	45
Collaborations with academics from other institutions in Kazakhstan	48	13	8	53
Collaborations with academics in other post-Soviet countries	47	5	4	36
Collaborations with academics in Western countries	54	7	8	44
Collaborations with academics in China, Japan, Korea	13	3	2	15
Collaborations with government or non-governmental organizations	10	4	1	16
Collaborations with industry or corporate partners	19	1	0	10

The least common responses to the question about the primary motivation to collaborate on research projects with colleagues from diverse backgrounds or institutions were international exposure (2%) and incentives from employers (2%). The most prevalent responses were networking and professional growth (23%) and intellectual curiosity (21%) (refer to Figure 3). All is true for physical sciences.

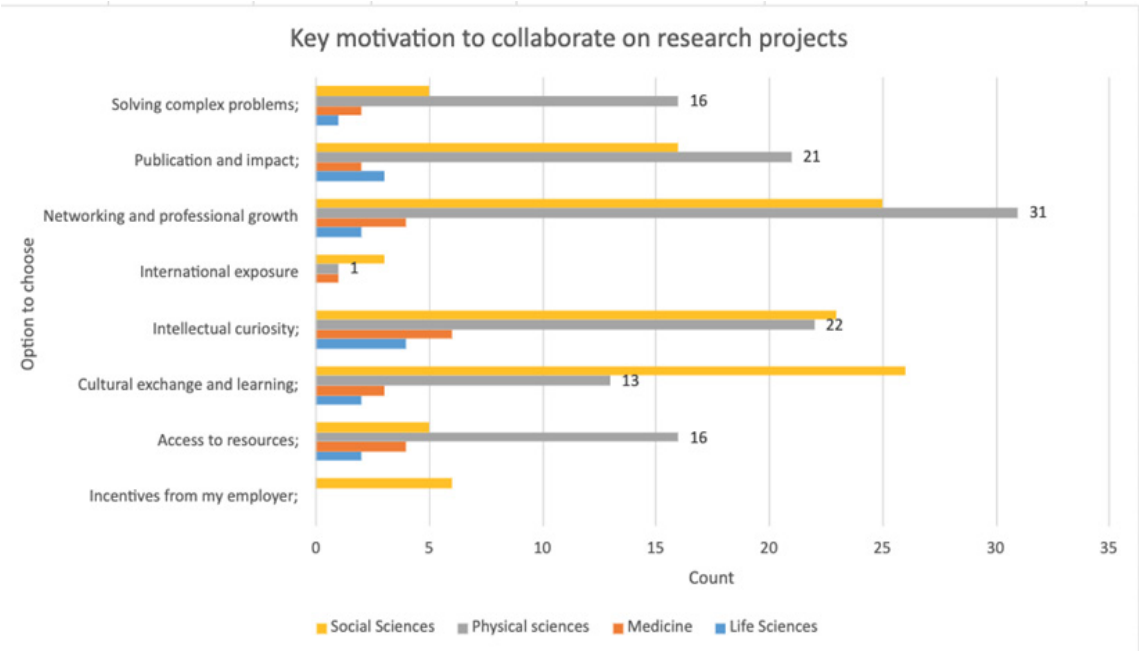

Figure 3 – Key motivation to collaborate on research projects

Regarding the criteria considered when selecting a journal for manuscript submission (refer to Table 5), the majority of respondents across all four categories prioritize the journal's reputation and impact factor. The least important criteria for academics of physical sciences was Journal publishing in Russian/Kazakh.

Table 5 – Criteria to consider when choosing a journal for the submission of a manuscript

Subject area broad	Physical sciences	Medicine	Life Sciences	Social Sciences
Reputation of the journal	93	10	8	77
Likelihood of acceptance	33	8	6	48
Journal publishing in Russian/Kazakh	7	8	2	17
Opportunity to reach specialist audience	23	9	0	18
International character of the journal	57	9	5	44
Short time between submission and publication	21	4	4	25
Journal impact factor (JIF)	97	9	10	78
Open access	21	5	6	14

The examination of the research landscape in Kazakhstan within the domain of physical sciences reveals several noteworthy insights and trends. This discussion section aims to delve into the implications of the findings, address the challenges and opportunities identified, and offer recommendations for future research endeavors and policy formulation.

One key observation from the survey data is the prominence of collaborations among academics within and beyond the borders of Kazakhstan. The high importance attributed to collaborations with academics in Western countries underscores the value of publishing research in international journals and using an internationally recognized language. This practice enables the dissemination of work at a global level. Another discovery regarding the selection criteria for publishing in journals further reinforces this argument. Researchers in the physical sciences emphasize the significance of the Journal Impact Factor (JIF) and the reputation of the journal the most while placing less emphasis on journals publishing in Russian or Kazakh languages. Furthermore, the significant emphasis on collaborations with academics from the respondent's institution, other institutions of Kazakhstan and post-Soviet countries suggests a broader regional integration and cooperation in scientific endeavors, which can foster networking and professional growth. However, the data also indicate a relatively lower emphasis on collaborations with government or non-governmental organizations among academics in the physical sciences. This finding may reflect the current funding landscape in Kazakhstan, where funding opportunities from governmental or non-governmental bodies may be constrained or less available in comparison to collaborations within close academic circles or across post-Soviet nations.

Another notable aspect of the research landscape is the demographic distribution of academic staff, namely concerning age groups. The observation of fewer individuals aged younger than 30 and those aged 60 or older suggests potential challenges related to workforce sustainability and knowledge transfer. Additionally, the survey results shed light on negative working conditions prevalent in the physical sciences sector, notably including low salaries and excessive workloads. These factors have the potential to discourage younger individuals from pursuing careers in the field of physical sciences. Similarly, the limited access to high-performance computing facilities highlights potential opportunities for infrastructure development and resource allocation to bolster research activities in this area.

Moving forward, several recommendations can be proposed to enhance the research landscape in Kazakhstan for the physical sciences. Strengthening collaboration networks, both within the country and across borders, could foster interdisciplinary research initiatives and facilitate knowledge exchange. Moreover, investment in research infrastructure, including high-performance computing facilities, and support for early-career researchers could bolster research capacity and innovation in the field.

Conclusion

In conclusion, this study provides a comprehensive examination of the research landscape within the physical sciences domain in Kazakhstan, shedding light on various aspects that influence research activities and outcomes. Through the analysis of survey data, several key insights have emerged, underscoring both the strengths and challenges within the research community.

The emphasis on international collaborations, particularly with Western academics, underscores the importance of global engagement for research visibility and reputation. However, the relatively lower priority given to collaborations with governmental or non-governmental organizations suggests potential limitations in accessing external funding sources. Adverse working conditions, such as low salaries and excessive workloads, may deter young researchers, posing a threat to the future workforce. Addressing these issues requires policy interventions to improve working conditions and financial support. Disparities in resource access, particularly in high-performance computing facilities, highlight the need for infrastructure development.

In summary, this study provides valuable insights into the current state of the research landscape within the physical sciences domain in Kazakhstan. By addressing the identified challenges and building upon existing strengths, Kazakhstan has the potential to emerge as a significant player in the global scientific arena, advancing knowledge and driving innovation for the benefit of society.

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ЗЕРТТЕУ ЛАНДШАФТТАРЫН ТАЛДАУ: ҚАЗАҚСТАННЫҢ ФИЗИКА ҒЫЛЫМДАРЫНДАҒЫ ЕРЕКШЕЛІКТЕРІН АНЫҚТАУ

Аңдатпа

Бұл мақала Қазақстанның академиялық қауымдастығындағы зерттеу ландшафтына сауалнама деректері негізінде жан-жақты талдау жасайды. Әртүрлі университеттердің 265 зерттеушісі мен ғалымдарының жауаптарына сүйене отырып, зерттеу төрт түрлі пәндік саладағы зерттеулердің терең демографиялық

профильдері мен сипаттамаларын ашады. Пәндердің кең спектрін қамти отырып, физикалық ғылымдардың сипаттамалары мен тенденцияларына ерекше назар аударылады. Сауалнама Қазақстандағы физика ғылымдарының зерттеу ландшафтын зерттейді, ол халықаралық ынтымақтастыққа, әсіресе батыстық ғалымдармен бірлескен зерттеулерді арттыруға бағытталған. Зерттеу мәселесіне үкіметтік немесе үкіметтік емес ұйымдармен серіктестікке шектеулі көңіл бөлу, қолайсыз еңбек жағдайлары және ресурстарға, әсіресе өнімділігі жоғары есептеу құралдарына қол жетімділіктің теңсіздігі жатады. Бұл зерттеу елдегі академиялық зерттеулердің қазіргі жағдайы туралы терең түсінік береді және стратегиялық жоспарлау, саясатты әзірлеу, болашақ ғылыми жобаларда қолдануға болатын нақты перспективаны ұсынады.

Тірек сөздер: зерттеу белсенділігі, ғылым, қазақстандық университеттер, жарияланым белсенділігі, ғылымды дамыту, ынтымақтастық, физика ғылымдары.

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ИЗУЧЕНИЕ ИССЛЕДОВАТЕЛЬСКИХ ЛАНДШАФТОВ: ВЫЯВЛЕНИЕ ОСОБЕННОСТЕЙ В ФИЗИЧЕСКИХ НАУКАХ КАЗАХСТАНА

Аннотация

Данная статья представляет всесторонний анализ исследовательского ландшафта в академическом сообществе Казахстана на основе данных опроса. Основываясь на ответах, полученных от 265 исследователей и ученых из различных университетов, исследование раскрывает глубокие демографические профили и характеристики исследований в четырех различных предметных областях. Охватывая широкий спектр дисциплин, особое внимание уделяется характеристикам и тенденциям в области физических наук. Опрос изучает исследовательский ландшафт физических наук в Казахстане, раскрывая фокус на международных коллаборациях, особенно с западными учеными, с целью повышения видимости исследований. Проблемы включают ограниченное внимание к партнерству с правительственными или неправительственными организациями, неблагоприятные условия труда и неравенство в доступе к ресурсам, особенно в высокопроизводительных вычислительных средствах. Это исследование предоставляет глубокое понимание текущего состояния академических исследований в стране и предлагает детальную перспективу, которая может быть использована при стратегическом планировании, разработке политики и будущих исследовательских проектах.

Ключевые слова: исследовательская активность, наука, казахстанские университеты, публикационная активность, развитие науки, сотрудничество, физические науки.

Appendix

№	Name of the institution
1	Nazarbayev University
2	Al Farabi Kazakh National University
3	Kazakh-British Technical University
4	Satbayev University
5	Karaganda Industrial University
6	Buketov Karagandy University
7	L.N. Gumilyov Eurasian National University
8	Astana Medical University
9	Kazakh National Medical University
10	Abai Kazakh National Pedagogical University
11	Sh.Ualikhanov Kokshetau University
12	Karaganda University of Kazpotrebsoyuz
13	International Information Technology University
14	Abylkas Saginov Karaganda Technical University
15	Innovative University of Eurasia
16	KIMEP University
17	Esil University
18	Astana International University

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