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Research models and methods for science strategic planning

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**Topic of the thesis: Research models and methods for science strategic
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Declaration

I confirm that this is my own work and the use of all material from other sources has been properly and fully acknowledged.

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I would first and foremost like to sincerely thank my supervisor PhD. Atym-tayeva Lyazzat for her guidance, assistance and encouragement during the course of this research. Her support has been invaluable and much appreciated.

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Dedication

This thesis is dedicated to: my supervisor and me for improving this project. And, to my family and best friends, for they endless support throughout my life and for never ceasing to inspire me.

Abstract

The purpose of this thesis is research models and methods for strategic science planning, to develop a website to showcase potential partners from 520 international universities around the world, which further facilitates collaboration. I hope to contribute to the development of strategic planning in the field of science in Kazakhstan by establishing links between scientists and promoting international cooperation. Using methods of analysis and data collection from various sources, the study established links between Kazakhstan's scientists and the international scientific community. Using network analysis and statistical methods, the most positive areas of research in Kazakhstan and areas of international cooperation have been identified.

Аннотация

Цель диссертации - исследование моделей и методов стратегического планирования науки, разработка веб-сайта для демонстрации потенциальных партнеров из 520 международных университетов по всему миру, что еще больше облегчает сотрудничество. Я надеюсь внести свой вклад в развитие стратегического планирования в области науки в Казахстане путем установления связей между учеными и содействия международному сотрудничеству. Используя методы анализа и сбора данных из различных источников, исследование установило связи между казахстанскими учеными и международным научным сообществом. С использованием сетевого анализа и статистических методов были определены наиболее позитивные направления исследований в Казахстане и области международного сотрудничества.

Аңдатпа

Бұл тезистің мақсаты - ғылыми зерттеулерді стратегиялық жоспарлаудың модельдері мен әдістерін зерттеу, әлемнің 520 халықаралық университеттерінің әлеуетті серіктестерін көрсететін веб-сайт құру, бұл ынтымақтастықты одан әрі жеңілдетеді. Ғалымдар арасында байланыс орнату және халықаралық ынтымақтастықты ілгерілету арқылы Қазақстанда ғылым саласындағы стратегиялық жоспарлауды дамытуға өз үлесімді қосамын деп үміттенемін. Әртүрлі дереккөздерден алынған деректерді талдау және жинау әдістерін пайдалана отырып, веб-сайт Қазақстандық ғалымдар мен халықаралық ғылыми қауымдастық арасында байланыс орнатады. Желілік талдау мен статистикалық әдістерді қолдана отырып, Қазақстандағы зерттеулердің ең оң бағыттары мен халықаралық ынтымақтастық бағыттары анықталды.

Abbreviations

FPP - find a potential partner

UAT - User Acceptance Testing

API - Application Programming Interface

HTML - HyperText Markup Language

PHP - PHP Hypertext Preprocessor

XML - eXtensible Markup Language

ORCID - Open Researcher and Contributor ID

JSON - JavaScript Object Notation

et al. - and others

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Chapter 1

Background and motivations

1.1 Introduction

In the modern world, science plays a key role in the development of society, and international cooperation is becoming an increasingly important factor for achieving significant scientific results. Scientific cooperation between countries makes it possible to combine the efforts of researchers, share experience and resources, which contributes to accelerating scientific progress and solving global problems such as climate change, pandemics, the energy crisis, and many others. In the context of globalization and the increasingly close interconnection of countries and regions, international scientific cooperation is becoming not only desirable, but also necessary for the effective solution of complex tasks.

One of the most striking examples of successful international scientific cooperation is the work on the CERN project, where researchers from more than 100 countries work together to study the fundamental properties of matter. Another example is the International Space Station, where scientific experiments are conducted jointly by scientists from different countries, including the United States, Russia, Europe, Japan and Canada. These projects demonstrate how combining resources and knowledge can lead to significant scientific achievements.

However, despite the significant advantages of international cooperation, many local researchers face difficulties in finding suitable partners abroad. Despite the availability of a large amount of information in various sources, such as scientific journals, databases and professional networks, researchers still have to spend a significant amount of time searching and analyzing this information. Researchers should study multiple sources, verify the relevance of the data, evaluate the possibility of collaboration, and consider many other factors. This process can take several hours or even days, which significantly reduces the effectiveness of scientific work and distracts researchers from their main activities.

In Kazakhstan, scientists with doctoral degrees and other researchers seek to work with foreign authors of publications or colleagues with experience in certain fields. This collaboration allows the exchange of knowledge, ideas and techniques, which contributes to a deeper understanding of the issues under study and accelerates scientific progress. To help our researchers, we need to solve the problem so

that researchers can find their co-authors from foreign universities in a couple of clicks, and we need to make sure that the data coverage is large.

To solve this problem and facilitate the search for potential partners, we propose the "FPP" (Find Potential Partners) project. This project aims to create a comprehensive web platform that will allow researchers to easily find and establish contacts with colleagues both domestically and abroad. The platform will provide researchers with the opportunity to get acquainted with the profiles of other scientists, including information about their fields of specialization, previous collaborations and publication history. In this way, researchers will be able to quickly and effectively find suitable partners for collaboration.

1.2 Motivation and importance of research

The motivation of this research comes from the need to eliminate obstacles that make it difficult for Kazakh scientists to establish contacts with foreign colleagues. It is important to understand that scientific cooperation contributes to the development of science itself and has a positive impact on the economy, education and culture of the country. In the context of global competition for talents and resources, countries that are able to effectively integrate into the international scientific community gain significant advantages.

One of the main problems is the difficulty of finding and analyzing information about potential partners and their scientific activities. Although data can be found in various sources, such as scientific journals, databases and professional networks, the process of collecting and analyzing them requires considerable time. Researchers often do not know which of their international colleagues are working on similar problems, which leads to limited opportunities for sharing knowledge and experience. Moreover, the lack of effective tools for establishing and maintaining contacts between researchers from different countries creates additional barriers to cooperation.

The purpose of this study is to explore methods and models for strategic science planning and to develop a website that will showcase potential partners from 520 international universities around the world, which will further facilitate collaboration. This project aims to contribute to the strategic planning of science in Kazakhstan by establishing links between scientists and promoting international cooperation.

1.3 Research contribution

The present study makes significant contributions in several key areas:

Data Source analysis: The study provides a detailed overview of existing data sources that can be used to form a database of potential scientific partners. This includes evaluating various platforms, databases, and other sources, as well as defining criteria for data selection and analysis.

Data scraping methods: The study describes the process of data parsing, including collecting, cleaning and formatting data for future use. Various methods

and tools of parsing are considered, as well as examples of successful application of these methods in other studies.

Web Platform development: The contribution includes the development of a web platform that will be used by researchers to find and establish contacts with potential partners. The basic requirements for the platform, its functionality, architecture and technologies used are described.

Statistical analysis: The study provides the results of a statistical analysis of the collected data, which will allow us to assess the current state of international scientific cooperation, identify key research clusters and identify the most active areas of cooperation. This will involve ranking universities based on their publication output, identifying the most relevant research topics, and highlighting the top 10 universities that have collaborated with Kazakhstan's researchers.

Furthermore, our proposal includes the development of models to visualize collaboration networks between authors from Kazakhstan and authors from other countries. These models will provide insights into existing collaboration patterns, highlight potential areas for collaboration, and identify key research clusters.

By providing researchers with access to a comprehensive database of potential collaborators, visualizing collaboration networks, and analyzing university research output, we hope our proposal to support science strategic planning in Kazakhstan by fostering research collaboration, promoting interdisciplinary research, and enhancing the visibility of Kazakhstan's universities on the global stage.

In this thesis, the focus lies on optimizing research collaboration and strategic planning within the scientific community of Kazakhstan. The scope encompasses the development of a user-friendly web platform to facilitate the identification of potential research partners for Kazakhstan's scientists. The aim is to streamline the process of finding collaborators, thereby fostering stronger research networks and enhancing the impact of scientific endeavors in Kazakhstan.

The geographical area of focus is Kazakhstan, with an emphasis on connecting researchers within the country and establishing collaborations with international counterparts. The time period spans from the present day, with a focus on addressing current challenges and opportunities in scientific research collaboration.

Themes or aspects of the topic include the development of models and methodologies to analyze collaboration networks, the utilization of modern technological tools for data collection and analysis, and the implications of enhanced research collaboration for scientific advancement and innovation in Kazakhstan.

Research Questions:

- What are the main research directions that can be identified through networking university staff publications?
- What are the primary directions for international collaboration that can be established through networking university staff's publications?
- Which types of platforms are most effective in supporting research strategy in Kazakhstan?

By addressing these research questions, this thesis aims to provide valuable insights into optimizing research networking and collaboration strategies, both domestically and internationally, to advance scientific research and innovation in Kazakhstan.

In the area of scientific research and academia, the relevance and importance of this thesis lie in addressing the practical challenges faced by researchers in Kazakhstan and contributing to the advancement of scholarly understanding in the field. By focusing on the facilitation of research collaboration and the optimization of science strategic planning, this research endeavors to:

Solve Practical Problems: The process of finding suitable research partners can be arduous and time-consuming for scientists in Kazakhstan. By developing a user-friendly web platform to streamline this process, the thesis aims to alleviate these practical challenges, enabling researchers to connect more efficiently and effectively.

Address a Gap in the Literature: While there is existing literature on research collaboration networks and strategic planning methodologies, there is a dearth of research specifically addressing the challenges faced by researchers in Kazakhstan and proposing tailored solutions. This thesis seeks to fill this gap by focusing on the unique context of Kazakhstan's scientific community and offering practical insights and solutions.

Build on Existing Research: Drawing on established theories and methodologies in the fields of research collaboration, network analysis, and science strategic planning, this research builds upon existing scholarship to develop innovative approaches and models tailored to the Kazakhstan's context.

Propose New Understandings: By analyzing collaboration networks, assessing university research output, and visualizing research trends, this thesis aims to offer new insights into the dynamics of scientific research in Kazakhstan. Through empirical analysis and theoretical frameworks, it seeks to contribute to a deeper understanding of the factors driving research collaboration and strategic planning in the country.

In summary, this thesis seeks to bridge the gap between theory and practice by offering practical solutions to enhance research collaboration and strategic planning in Kazakhstan. By addressing practical challenges, contributing to scholarly understanding, and building on existing research, it aims to make meaningful contributions to the advancement of scientific research and innovation in the country.

1.4 Review of the research methodology

The research methodology employed in this study demonstrates a systematic and structured approach aimed at achieving the objectives of the research. Here is a detailed review of each section: in introduction provides a comprehensive overview of the research methodology, outlining the stages and methods used for data collection, analysis, and platform development. It sets the stage for the subsequent sections and clearly defines the goals and objectives of the study.

The analysis of data sources is thorough and well-organized. The identification and evaluation of various data sources, including Scopus, Web of Science, Google Scholar, IEEE Xplore, professional networks, and university repositories, demonstrate a broad and diverse approach to data collection. The criteria for assessing the quality of data sources, such as peer-review status, update frequency, and reputation, are clearly defined. However, it would be beneficial to provide more

details on the specific evaluation criteria used for each data source.

The section on data parsing methods outlines the steps involved in developing scripts for data extraction from selected sources. The use of programming languages such as Python and libraries like BeautifulSoup, Scrapy, and Selenium for web scraping automation is appropriate for the research objectives. The process of data cleaning and formatting is well-defined, ensuring that the extracted data are accurate and consistent for further analysis.

The description of the development of the web platform is comprehensive and detailed. The outlined steps, including the design of the platform architecture, technology selection, user interface development, data integration, and platform testing, cover all essential aspects of platform development. The choice of technologies such as Laravel for the server-side, Vue.js for the client-side, and MySQL for the database is justified based on their suitability for building a robust and scalable web platform.

The section on statistical analysis provides a clear framework for analyzing the collected data. The steps involved in data collection, analysis, visualization, and interpretation are well-defined. The use of statistical methods and tools such as Python with libraries like Pandas, NumPy, SciPy, and visualization tools like Matplotlib, Seaborn, and Plotly is appropriate for deriving meaningful insights from the data. However, it would be beneficial to elaborate further on the specific statistical techniques employed for data analysis.

The research methodology demonstrates a rigorous and methodical approach to data collection, analysis, and platform development. The integration of multiple data sources, the use of advanced programming languages and tools for data parsing, and the adoption of modern web technologies for platform development reflect a comprehensive and innovative research strategy. However, providing additional detail on the evaluation criteria for data sources and the specific statistical techniques used for analysis would enhance the clarity and robustness of the methodology.

1.5 Expected results

The anticipated outcomes of this research project are multifaceted, encompassing both the technical achievements of the web platform and the broader impacts on the scientific community in Kazakhstan. Here are the detailed expected results:

1) Successful Development and Deployment of the FPP Platform:

Functional Web Platform: The completion of a fully functional and user-friendly web platform, "FPP" (Find Potential Partners), that facilitates the discovery of potential research partners based on various criteria such as country, university, research field, and author.

Advanced Search Capabilities: The platform will provide advanced search capabilities, allowing users to search for researchers and institutions by multiple parameters including authors name, areas, research topics.

2) Enhanced Research Collaboration:

Increased Networking Opportunities: The platform will enhance networking opportunities for researchers by providing an easily accessible database of potential

collaborators. This will help foster new research partnerships both within Kazakhstan and internationally.

Interdisciplinary Collaboration: By offering insights into various research fields and institutions, the platform will encourage interdisciplinary collaboration, potentially leading to innovative research projects and publications.

3) **Comprehensive Database of Researchers:**

Extensive Researcher Profiles: The creation of detailed profiles for researchers, including their affiliations, publications, citation metrics, and areas of expertise. This comprehensive database will serve as a valuable resource for identifying key researchers in specific fields.

Accurate and Up-to-Date Information: The platform will ensure that the data provided is accurate and up-to-date, sourced from reliable academic databases such as Scopus, IEEE Xplore, and Google Scholar.

4) **Statistical Insights and Visualization:**

Data-Driven Insights: The platform will offer valuable statistical insights into the academic landscape.

Visual Representation: The use of visualizations such as graphs, charts, and maps to represent data trends and patterns will make the information more accessible and easier to understand for users.

5) **Broader Impacts on Scientific Research:**

Global Collaboration: The platform will not only benefit researchers in Kazakhstan but also promote global collaboration by making it easier for international researchers to connect with their counterparts in Kazakhstan.

In summary, the expected results of this research project include the successful development of a robust web platform that enhances research collaboration, provides comprehensive researcher profiles, offers valuable statistical insights, and empowers the scientific community in Kazakhstan. The platform is anticipated to have a significant positive impact on the research landscape, promoting both national and international scientific collaboration and innovation.

Chapter 2

Literature review

Our journey into the heart of scholarly discourse begins with a quest to understand the intricate tapestry of collaboration between Kazakhstan's and foreign scientists. In navigating the vast expanse of existing literature, it becomes evident that while collaboration networks have been extensively studied within specific disciplines and regions, there remains a noticeable gap in the exploration of cross-border partnerships within Kazakhstan's scientific community.

While existing studies have delved into collaboration networks within specific fields or regions, such as departmental collaborations in business management or interdisciplinary partnerships in environmental activism, our inquiry seeks to carve out a distinct path by elucidating the intricacies of cross-border collaboration in the context of Kazakhstan's scientific landscape. This endeavor is propelled by the recognition of the transformative potential inherent in fostering international research partnerships, yet tempered by the paucity of literature addressing the unique challenges and opportunities faced by Kazakhstan's researchers in this endeavor. Moreover, the relevance of our research is underscored by the dearth of scholarship exploring the linkages between authors across disparate industries and academic disciplines. While studies abound on collaboration between authors within specialized journals or academic departments, the broader panorama of cross-disciplinary and cross-national collaboration remains relatively uncharted territory. By shining a spotlight on the nexus between Kazakhstan's and foreign scientists, we aim to fill this gap in the literature and contribute novel insights that transcend disciplinary boundaries.

In essence, our literature review serves not only to survey existing scholarship but also to highlight the distinctive contours of our research terrain. As we navigate through the troves of literature, we do so with a keen eye towards discerning patterns, identifying gaps, and laying the groundwork for our own scholarly contribution. In doing so, we reaffirm the relevance and significance of our research endeavor, poised at the intersection of collaboration, innovation, and global knowledge exchange.

In paper "Author Cooperation Relationship in Digital Publishing" by Xu et al. (2015)[1] delve into the dynamics of author cooperation relationships in digital publishing, employing social network analysis to unravel the intricacies of collaborative

research endeavors. By scrutinizing co-authorship patterns and collaboration networks, the study illuminates the pivotal role of cooperation in enhancing research productivity and knowledge dissemination within the digital publishing domain. Through a meticulous examination of collaborative ties among authors, Xu et al. underscore the significance of fostering interdisciplinary collaboration and knowledge exchange to propel scientific innovation and scholarly advancement in the digital era.

And also this article "The Co-authorship Network of Published Articles in Web Research Conferences" by Alavi and Lajevardy (2020)[2] embark on a journey to unravel the intricate web of co-authorship networks within the realm of web research conferences. Through a comprehensive analysis of published articles and collaboration patterns, the study unveils the underlying structure and dynamics of collaboration networks among web researchers. By shedding light on key collaboration patterns and influential researchers within the field, Alavi and Lajevardy provide valuable insights into the collaborative landscape of web research, paving the way for enhanced collaboration and knowledge exchange among researchers in the digital domain.

In this study "Building and Analyzing a Global Co-Authorship Network by Chen (2017)[3] delves into the construction and analysis of a global co-authorship network, leveraging data from Google Scholar to map out collaborative research endeavors on a global scale. Through a nuanced examination of collaboration patterns across geographical regions and disciplinary domains, Chen elucidates the interconnected nature of global research networks and the inherent dynamics driving collaborative research efforts. By unraveling the collaborative ties that bind researchers across borders and disciplines, Chen's study offers valuable insights into the mechanisms underpinning global knowledge exchange and scientific collaboration, fostering a deeper understanding of the collaborative landscape in contemporary academia.

Also in "Co-authorship in Information Technology" by Noor (2014)[4] embarks on a quest to explore co-authorship patterns and their implications for research performance in the field of information technology. Through an in-depth analysis of collaborative research endeavors, Noor sheds light on the collaborative dynamics shaping research productivity and impact in the realm of IT. By unraveling the collaborative ties among researchers and institutions, Noor underscores the pivotal role of collaboration in advancing scientific knowledge and fostering innovation in the fast-paced domain of information technology. Through a nuanced examination of co-authorship patterns and collaboration networks, Noor's study offers valuable insights into the collaborative landscape of IT research, paving the way for enhanced collaboration and knowledge exchange among researchers in the field.

In paper "Publication Network Analysis of an Academic Family in Information Systems" by Grahl et al. (2021)[5] embark on a scholarly endeavor to analyze the publication network of an academic family in information systems research. Through a meticulous examination of co-authorship patterns and collaboration networks, the study sheds light on the collaborative dynamics within academic lineages, highlighting the influence of mentorship and knowledge transfer on research productivity and impact. By unraveling the collaborative ties that bind

researchers within academic families, Grahl et al. offer valuable insights into the mechanisms underpinning collaborative research endeavors and scholarly lineage in the field of information systems. Through a nuanced examination of publication networks and collaboration patterns, Grahl et al.'s study contributes to a deeper understanding of the collaborative landscape in information systems research, paving the way for enhanced collaboration and knowledge exchange among researchers in the field.

This article "Coauthor Network Analysis of Journal Articles" by King and Settle (2021)[6] embark on an insightful journey to analyze the co-author network of articles published in the Journal of Applied Communications. Through a comprehensive examination of co-authorship patterns and collaboration networks, the study sheds light on the collaborative dynamics within the field of applied communications, highlighting key contributors and research clusters. By unraveling the collaborative ties that bind researchers within the field, King and Settle offer valuable insights into the mechanisms underpinning collaborative research endeavors and scholarly exchange in applied communications. Through a nuanced examination of co-authorship networks and collaboration patterns, King and Settle's study contributes to a deeper understanding of the collaborative landscape in applied communications research, paving the way for enhanced collaboration and knowledge exchange among researchers in the field.

In study "Coauthorship Network in Transportation Research" by Sun and Rahwan (2017)[7] embark on an enlightening exploration of the co-authorship network in transportation research, unraveling the collaborative dynamics shaping research endeavors in the field. Through a meticulous examination of collaboration patterns and network structures, the study sheds light on the interconnected nature of collaboration networks within transportation research, highlighting key contributors and research clusters. By unraveling the collaborative ties that bind researchers within the field, Sun and Rahwan offer valuable insights into the mechanisms underpinning collaborative research endeavors and knowledge exchange in transportation research. Through a nuanced examination of co-authorship networks and collaboration patterns, Sun and Rahwan's study contributes to a deeper understanding of the collaborative landscape in transportation research, paving the way for enhanced collaboration and knowledge exchange among researchers in the field.

In paper named as "Study of Co-authorship Network of Papers in Medical Sciences" by Zare-Farashbandi et al. (2014)[8] embark on a scholarly quest to study the co-authorship network of papers published in the Journal of Research in Medical Sciences. Through a comprehensive analysis of collaboration patterns and network structures, the study sheds light on the collaborative dynamics shaping research endeavors in medical sciences, highlighting key contributors and research clusters. By unraveling the collaborative ties that bind researchers within the field, Zare-Farashbandi et al. offer valuable insights into the mechanisms underpinning collaborative research endeavors and knowledge exchange in medical sciences. Through a nuanced examination of co-authorship networks and collaboration patterns, Zare-Farashbandi et al.'s study contributes to a deeper understanding of the collaborative landscape in medical research, paving the way for enhanced collabo-

ration and knowledge exchange among researchers in the field.

Also in "University Rankings and Social Science" by Marginson (2017)[9] embarks on a scholarly exploration of the role of university rankings in shaping research collaborations and knowledge exchange in the social sciences. Through a comprehensive analysis of the impact of university rankings on academic mobility, research funding, and institutional strategies, the study sheds light on the intricate relationship between university rankings and research collaborations in the social sciences. By unraveling the mechanisms through which university rankings influence research collaborations, Marginson offers valuable insights into the implications of rankings on scholarly exchange and collaboration in the social sciences. Through a nuanced examination of the role of university rankings in shaping research collaborations, Marginson's study contributes to a deeper understanding of the collaborative landscape in social science research, paving the way for enhanced collaboration and knowledge exchange among researchers in the field.

By De Wit-de Vries et al. (2018) in the paper "Knowledge Transfer in University–Industry Research Partnerships" [10] embark on an insightful exploration of knowledge transfer in university–industry research partnerships. Through a comprehensive analysis of knowledge transfer models, collaboration barriers, and strategies for enhancing collaboration effectiveness, the study sheds light on the intricate dynamics of university–industry research partnerships. By unraveling the mechanisms through which knowledge is transferred between academia and industry, De Wit-de Vries et al. offer valuable insights into the collaborative landscape of university–industry research partnerships. Through a nuanced examination of knowledge transfer mechanisms and collaboration strategies, De Wit-de Vries et al.'s study contributes to a deeper understanding of the collaborative dynamics in university–industry research partnerships, paving the way for enhanced collaboration and knowledge exchange between academia and industry.

In this study "Bibliometric Analysis of Data Sources and Tools for Shoreline Change Analysis and Detection" by Ankrah and Monteiro (2022)[11] conduct a bibliometric analysis focusing on data sources and tools for shoreline change analysis and detection in coastal engineering. By examining trends in publication output and collaboration patterns, the study sheds light on the evolving landscape of research in coastal engineering. Through a comprehensive analysis of data sources and tools utilized in shoreline change analysis, Ankrah and Monteiro provide valuable insights into the state-of-the-art methodologies and technologies driving research in coastal engineering, paving the way for enhanced collaboration and knowledge exchange in the field.

In paper named as, "Análise da colaboração científica departamental através de redes de coautoria" by Bordin, Gonçalves, and Todesco (2014)[12] delve into the analysis of scientific collaboration at the departmental level through co-authorship networks in the context of Brazilian business management. Through a meticulous examination of collaboration patterns and network structures, the study sheds light on the collaborative dynamics within departmental units, highlighting key contributors and research clusters. By unraveling the collaborative ties that bind researchers within departments, Bordin et al. offer valuable insights into the mechanisms underpinning collaborative research endeavors and knowledge exchange in

Brazilian business management. Through a nuanced examination of co-authorship networks and collaboration patterns, Bordin et al.'s study contributes to a deeper understanding of the collaborative landscape in Brazilian business management, paving the way for enhanced collaboration and knowledge exchange among researchers in the field.

In study "Youth activism in climate change: an investigation of motivations and involvement" by Lee, Kim, and Smith (2020)[13] embark on an investigation into youth activism in climate change, exploring the motivations and involvement of young people in environmental advocacy efforts. Through a comprehensive analysis of youth engagement in climate activism, the study sheds light on the factors driving participation and the impact of activism on societal change. By unraveling the motivations and involvement of young people in climate change activism, Lee et al. offer valuable insights into the dynamics of youth engagement with environmental issues, paving the way for enhanced understanding and support for youth-led climate action initiatives.

This article "How do young people engage with climate change? The role of knowledge, values, message framing, and trusted communicators" by Corner, Roberts, Chiari, and Völler (2015)[14] delve into the mechanisms through which young people engage with climate change, examining the role of knowledge, values, message framing, and trusted communicators in shaping attitudes and behaviors. Through a comprehensive analysis of factors influencing youth engagement with climate change, the study sheds light on the cognitive and affective processes driving environmental concern and action among young people. By unraveling the complexities of youth engagement with climate change, Corner et al. offer valuable insights into effective communication strategies and intervention approaches, paving the way for enhanced engagement and participation in climate action initiatives.

In study "The importance of political polarization for climate change communication among young people" by Holmberg and Alvinus (2019) [15] explore the importance of political polarization for climate change communication among young people, investigating how ideological differences shape attitudes and behaviors towards environmental issues. Through a comprehensive analysis of the impact of political polarization on climate change communication, the study sheds light on the challenges and opportunities inherent in addressing climate change in politically polarized contexts. By unraveling the complexities of political polarization and its implications for climate communication, Holmberg and Alvinus offer valuable insights into the role of ideology in shaping public perceptions and responses to climate change, paving the way for more effective communication strategies and engagement initiatives.

In the end, this literature review underscores the need for further research on collaboration networks and research partnerships within Kazakhstan's scientific community (see the table 2.1). While existing studies provide valuable insights into interdisciplinary collaboration, university rankings, and youth activism in other areas as climate, geography, there is a notable gap in understanding collaboration dynamics specific to Kazakhstan. Future research endeavors should aim to address this gap, thereby contributing to scientific advancement and socioeconomic

development within the country.

Table 2.1 – Literature Review and Identified Gaps

Study	Focus	Identified Gap
Xu et al. (2015)	Dynamics of author cooperation relationships in digital publishing using social network analysis.	Lack of exploration of cross-border partnerships in Kazakhstan's scientific community.
Alavi and Lajevardy (2020)	Co-authorship networks in web research conferences.	Limited research on cross-disciplinary and cross-national collaboration specific to Kazakhstan.
Chen (2017)	Construction and analysis of a global co-authorship network using Google Scholar data.	Insufficient understanding of the collaborative dynamics unique to Kazakhstan's researchers.
Noor (2014)	Co-authorship patterns and their implications for research performance in information technology.	Need for studies focusing on the collaborative landscape in Kazakhstan's scientific community.
Grahl et al. (2021)	Analysis of publication network of an academic family in information systems research.	Lack of literature addressing collaborative research within Kazakhstan across diverse academic disciplines.
King and Settle (2021)	Co-author network analysis of articles in the Journal of Applied Communications.	Gap in understanding cross-disciplinary and cross-national collaboration within Kazakhstan.
Sun and Rahwan (2017)	Co-authorship network in transportation research.	Need for focused research on the collaborative dynamics within Kazakhstan's scientific community.

Zare-Farashbandi et al. (2014)	Co-authorship network analysis of papers in medical sciences.	Insufficient exploration of collaboration networks within Kazakhstan's scientific landscape.
Marginson (2017)	Impact of university rankings on research collaborations in the social sciences.	Lack of focus on Kazakhstan's unique challenges and opportunities in international research collaborations.
De Wit-de Vries et al. (2018)	Knowledge transfer in university–industry research partnerships.	Need for research on knowledge transfer and collaboration strategies specific to Kazakhstan.
Ankrah and Monteiro (2022)	Bibliometric analysis of data sources and tools for shoreline change analysis and detection in coastal engineering.	Limited studies on interdisciplinary and international collaboration in Kazakhstan.
Bordin, Gonçalves, and Todesco (2014)	Scientific collaboration at the departmental level in Brazilian business management.	Lack of literature on departmental and interdisciplinary collaborations within Kazakhstan.
Lee, Kim, and Smith (2020)	Youth activism in climate change: motivations and involvement.	Gap in understanding the collaborative efforts of Kazakhstan's researchers in global climate change activism.
Corner, Roberts, Chiari, and Völler (2015)	Mechanisms of youth engagement with climate change.	Limited research on the role of Kazakhstan's researchers in global environmental collaborations.

Holmberg and Alvinus (2019)	Importance of political polarization for climate change communication among young people.	Need for studies on the impact of political polarization on research collaborations within Kazakhstan.
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Chapter 3

Methodology

The research methodology is a structured approach used to achieve the objectives of this study. This section describes in detail the stages of research, methods of data collection and analysis, as well as the processes of developing a web platform and conducting statistical analysis. The main purpose of the methodology is to provide a systematic and reproducible approach to research that allows you to obtain reliable and relevant results.

3.1 Analysis of data sources

At the first stage of the study, an analysis of existing data sources is carried out. The main purpose of this stage is to identify and evaluate reliable and relevant sources that can be used to form a database of potential scientific partners. This stage includes the following steps:

3.1.1 Identification of Data Sources

Identifying potential data sources is an initial step in the analysis. The following sources were selected for this purpose:

1) Scopus

Description: Scopus is the world's largest database of scientific literature, containing annotations and citations of articles from scientific journals. This resource covers a variety of disciplines and provides detailed information about publications and authors.

Accessibility: Access is limited. If you are not logged in from a specific organization, you will not receive complete information. Access is required to download or read the article, or you can buy the article itself.

Search: The search is performed by author's name, ORCID, publication subject, publication title, source name, year of publication, affiliated organization, funding organization and publisher.

Author: When logging in from the organization, you can get full information about the author, including the number of documents, the number of citations and the h-index. In case of lack of access, information about the author is limited.

Publications: Access is required to download the publication. Without access, information about the publication is limited.

Publication statistics: Available.

Author Profile: Available and includes many indicators such as number of documents, number of citations, h-index, affiliated organizations, name spellings and co-authors.

2) IEEE Xplore

Description: IEEE Xplore is a digital library providing access to technical documents, scientific articles, conference materials and standards published by IEEE. It is a key resource for specialists in the field of engineering and technology.

Accessibility: Access is limited. Access is required to download the publication, or you can buy the article itself.

Search: The search is performed by keyword, author's name, title of the publication or book, volume, issue and page.

Author: Information about the author is available, including the number of documents and citations, topics of publications, name and city of the organization.

Publications: Publications are available for download if available.

Publication statistics: Available.

Author Profile: Available and includes information about publications, citations and co-authors.

3) Google Scholar

Description: Google Scholar is a popular academic literature search service that includes publications of various types and sources. It provides wide access to scientific papers, including articles, books, abstracts and reports.

Accessibility: Access is open. Publications can be viewed and downloaded for free.

Search: The search is performed by keyword, author's name, title of the publication or book, volume, issue and page.

Author: If you are logged in from an organization, you can get full information about the author. Otherwise, the information is limited.

Publications: Publications are available to view and download for free.

Publication statistics: Limited.

Author profile: Available and includes information on the number of documents and citations, co-authors and topics of publications.

4) Web of Science

Description: Web of Science is a leading database providing access to extensive information about scientific publications and citations. It includes scientific journals, conference materials and other academic resources covering a variety of disciplines.

Accessibility: Access is limited. A subscription is required to receive full information and download publications.

Search: The search is performed by keywords, author's name, publication title, year of publication, affiliated organization and other parameters.

Author: Full information about the author is available, including the number of publications, citations, h-index and affiliations.

Publications: Publications are available for download if you have a subscription.

Publication statistics: Available.

Author Profile: Available and includes detailed information about publications, citations, affiliations and co-authors.

5) ScienceDirect

Description: ScienceDirect is a scientific database that provides access to a huge number of scientific articles, books and other academic materials. It covers various scientific disciplines, including physics, chemistry, biology, medicine and social sciences.

Accessibility: Access is limited. A subscription is required to receive full information and download publications.

Search: The search is performed by keywords, author's name, publication title, year of publication and other parameters.

Author: Information about the author is limited, but includes affiliation and contact details.

Publications: Publications are available for download if you have a subscription.

Publication statistics: Limited.

Author's profile: Limited and includes basic information about affiliation and contact details.



Figure 3.1 – Scopus:Review of the author's page

3.1.2 Data quality assessment

After identification of data sources, their quality, relevance and reliability are assessed. The evaluation criteria include:

- Reviewability: Checking whether publications in databases are peer-reviewed and whether they are evaluated by experts before publication.
- Update frequency: An estimate of the frequency of data updates in each source, as it is important to have access to the most up-to-date information.
- Reputation: An analysis of the reputation of data sources based on the as-

10 из 984 результатов поиска авторов [Просмотр авторов в результатах поиска](#) ×

i Указанные профили могут быть связаны с этим автором, но в базе данных Scopus недостаточно информации для установления однозначного соответствия. Профили отсортированы по наиболее точному соответствию автору. ×

<input type="checkbox"/> Автор	Документы	Отрасль знаний	Организация	Город	Страна/ территория
<input type="checkbox"/> Mendes, Mateus Mendes, M.	3	Medicine;	Hospital Distrital de Leiria	Leiria	Portugal
Просмотреть последний заголовок ▼					
<input type="checkbox"/> Mendes, Mateus F.	1	Engineering; Agricultural and Biological Sciences; Chemistry; ...	Faculdade de Ciências Biológicas e da Saúde	Diamantina	Brazil
Просмотреть последний заголовок ▼					
<input type="checkbox"/> Mendes, Paulo M. Mendes, P. Mendes, Paulo Mendes, P. M.	185	Engineering; Computer Science; Physics and Astronomy; ...	Universidade do Minho	Braga	Portugal

[Выбрать все](#) [Отмена](#) Запросить объединение с автором

Figure 3.2 – Scopus:Review of the author’s page-2

assessments of the research community and their generally recognized reliability.

3.1.3 Selection of sources

After evaluating the quality of the data, the most relevant and reliable sources are selected for further use. Scopus, IEEE Xplore and Google Scholar will be used in this study, as they meet high quality standards and provide up-to-date information(see the table 3.1).

These sources have a high level of peer review and provide access to a wide range of up-to-date scientific information, making them an ideal choice for forming a database of potential scientific partners. gaps on sources for collaboration below:

Scopus (see Figure 3.1 , 3.2) is a bibliographic database containing abstracts and citations for academic journal articles. It provides extensive coverage of scientific literature, including peer-reviewed journals, conference proceedings, and patents. Scopus is widely recognized for its robust indexing and citation analysis features, making it a valuable resource for researchers seeking to identify trends and patterns in scientific collaboration. While Scopus allows users to view profiles of researchers and their publications, it does not specifically highlight the collaboration networks between authors or indicate potential research partners, particularly in relation to Kazakhstan’s authors. This limitation underscores the need for our specialized system that identifies these networks and potential collaborators explicitly.

IEEE Xplore is a digital library providing access to publications in the fields of engineering, computer science, and technology. It contains a vast collection of peer-reviewed journals, conference proceedings, and technical standards published

Table 3.1 – Data Source Analysis table

Parameter	Scopus	IEEE Xplore	Google Scholar
Accessibility	Limited access if not logged in from a certain organization	Limited access	Open access, view and download for free
Search	Author’s name, ORCID, subject, title, year, affiliation, funding organization, publisher	Books, conferences, courses, journals, authors, standards, citations	Keyword, author’s name, publication title
Author Information	Full information with organizational login	Author information available	Limited information, mostly university and email
Publications	Requires access for download	Available with access	Freely available
Publication Statistics	Available	Available	Not available
Author Profile	Available	Available	Not available
Profile Information	Number of documents, number of citations, h-index	Organization, name spellings, ORCID, h-index, publications, citations, co-authors	Citations, h-index, co-authors
Publication Information	Limited without access	Full information if accessed	Full information

by the Institute of Electrical and Electronics Engineers (IEEE) and other professional organizations. IEEE Xplore is renowned for its comprehensive coverage of research in engineering and technology-related disciplines, making it an indispensable resource for scholars and practitioners alike. However, IEEE Xplore does not offer functionality to analyze or visualize author collaboration networks, nor does it identify potential partners based on existing co-authorships, particularly those involving Kazakhstan’s researchers.

Google Scholar is a freely accessible web search engine that indexes the full text or metadata of scholarly literature across various disciplines. It provides access to a wide range of academic sources, including journal articles, theses, dissertations, and conference papers. Google Scholar’s broad coverage and user-friendly interface make it a popular choice for researchers seeking to discover scholarly content and track citations. Despite its extensive database, Google Scholar lacks tools to visualize collaboration networks and does not offer insights into potential research partners based on authors’ connections, particularly those involving Kazakhstan.

3.2 Data scraping methods

The second stage of the study includes the development of methods for parsing data from selected sources. This stage consists of the following steps:

- **Development of scripts for parsing:** at the first step of this stage, scripts are being developed to automatically extract data from various sources. The main programming language for these tasks is Python, thanks to its extensive library of web scraping tools. The data collection for this study uses a combination of web analysis techniques and client APIs to extract relevant information from online sources.

BeautifulSoup: Used for parsing HTML and XML documents, allows you to extract data from web pages.

requests: A library for sending HTTP requests, which allows you to interact with web pages and APIs.

Selenium: A tool for automating web browsers, allows you to interact with web pages as if the user were doing it, which is especially useful for sites with dynamic content.

```
from selenium import webdriver
from selenium.webdriver.common.by import By
from selenium.webdriver.common.keys import Keys
import pandas as pd
import time
from bs4 import BeautifulSoup
from selenium.webdriver.support.ui import WebDriverWait
from selenium.webdriver.support import expected_conditions as EC

# Initialize Selenium WebDriver
driver = webdriver.Chrome()

# Example function to scrape data from Scopus
def scrape_scopus_data(query):
    url = f"https://www.scopus.com/results/results.uri?query={query}"
    driver.get(url)
    WebDriverWait(driver, 10).until(EC.presence_of_element_located((By.ID, "result
    soup = BeautifulSoup(driver.page_source, 'html.parser')
    data = []
    for entry in soup.find_all('div', class_='result-item-content'):
```

Figure 3.3 – Scraping data from Scopus

- Clearing the data

An example of Python code using Selenium and BeautifulSoup to parse data from the Scopus site (see the Figure 3.3). The system will use APIs to access data from Google Scholar and Scopus, storing it in a relational database for efficient querying and analysis. The data collection process begins by identifying Kazakhstan's authors from Google Scholar based on their email domains, which typically end with ".kz," indicating their affiliation with Kazakhs universities. Subse-

```

# Извлечение данных
author_info = {}
author_info['name'] = soup.find('h1', {'data-testid': 'author-profile-name'}).text
author_info['university'] = soup.find('span', {'data-testid': 'authorInstitution'}).text
author_info['country'] = soup.find('span', {'class': 'Typography-module__Nfgvc'}).text
author_info['scopus_id'] = soup.find('span', {'data-testid': 'authorId'}).text

# Сохранение данных в JSON файл
with open('author_info.json', 'w') as f:
    json.dump(author_info, f, ensure_ascii=False, indent=4)

# Закрытие веб-драйвера
driver.quit()

```

Figure 3.4 – Scraping author info

quently, data are retrieved from Scopus, focusing on authors affiliated with Kazakhstan based on their country of origin. Additionally, data from IEEE Xplore are collected to obtain ORCID identifiers and author information (see the Figure 3.4) for individuals not included in Scopus. This ensures comprehensive coverage of Kazakhstan’s authors and their collaborations. After collecting information on Kazakhstan’s authors, the data are organized to include details such as name, university, country, Scopus ID, ORCID, and document titles. Subsequently, co-author information is gathered based on document titles, encompassing co-author names, links, countries, ORCID links, universities, and interest areas.

The data cleaning process includes several important steps:

Duplicate Removal: Detect and delete duplicate records. Raw data often contains inconsistencies, errors, and missing values that need to be addressed before analysis. Techniques such as removing duplicates, standardizing formats, and imputing missing values are applied to enhance data quality(see the Figure 3.5).

Error correction: Identification and correction of typographical and other errors in the data.(See the Figure 3.6) The script provided seems to be reading data from a JSON file containing information about authors and their publications, checking if each author is from Kazakhstan, and then checking if any of their co-authors are also from Kazakhstan.

Bringing data to a single format: Arranging data so that all records have the same format and structure.See the Figure 3.6)Finally, it adds new fields to the data indicating whether each author and each co-author is from Kazakhstan.

- Formatting the data: After cleaning the data, it is necessary to convert it into a structured json format, convenient for further analysis and integration into the web platform. Data formatting makes it easy to integrate them into the developed web platform and provides convenience for subsequent analysis. In end, we developed database includes 11,939 records with information on 520 international universities that collaborated with Kazakhstan’s authors.

```

import json

def add_interest_ids(data):
    interest_ids = {}
    for item in data:
        if 'interests' in item:
            interests = item['interests']
            for interest in interests:
                title = interest['title'].lower() # Convert title to lowercase for d
                if title not in interest_ids:
                    # Generate a unique identifier for the interest
                    interest_ids[title] = len(interest_ids) + 1
                # Assign the unique identifier to the 'id_Interests' key
                interest['id_Interests'] = interest_ids[title]

    return data

# Open the JSON file and load the data
with open('merged.json', 'r', encoding='utf-8') as file:
    data = json.load(file)

# Add unique identifiers to interests
new_data = add_interest_ids(data)

# Save the updated data to a new JSON file
with open('merged2.json', 'w', encoding='utf-8') as file:
    json.dump(new_data, file, ensure_ascii=False, indent=4)

```

Figure 3.5 – Scraping data: checking duplicate

3.2.1 Data Analysis Techniques

In this section, we elaborate on the specific data analysis techniques employed in our dissertation to derive insights from the processed dataset. The methodology encompasses statistical analysis methods, network analysis, and machine learning algorithms, tailored to uncover collaboration patterns, trends, and dependencies within the dataset. (See Figure 3.7 dataset on csv format) Statistical Analysis Methods: statistical analysis forms the foundation for understanding the dataset’s characteristics and relationships between variables. Descriptive statistics, such as measures of central tendency and dispersion, are utilized to summarize the dataset’s key features. Additionally, inferential statistics, including hypothesis testing and regression analysis, are applied to examine relationships and make predictions based on the data.

Network analysis serves as a powerful tool for studying collaboration networks among researchers. By representing authors and their collaborations as nodes and edges in a graph, network analysis enables the exploration of network structures and properties. Key network metrics, such as centrality measures and cluster-

```

import json

# Read data from the JSON file
with open('full__js.json', 'r', encoding='utf-8') as json_file:
    data = json.load(json_file)

# Process the data
for author in data:
    # Check if the author is from Kazakhstan
    author_country_kz = "Kazakhstan" in author["country"]

    for publication in author["publications"]:
        # Check if any of the co-authors are from Kazakhstan
        co_author_country_kz = any("Kazakhstan" in coauthor.get("country", "") for co

        # Add new fields to the data about each co-author
        for coauthor in publication["authors"]:
            if coauthor.get("country", "") == "can not get":
                coauthor["co_author_countryKZ"] = None
            else:
                coauthor["co_author_countryKZ"] = "Kazakhstan" in coauthor.get("count

        # Add new field to the data about the author
        author["Author_country_KZ"] = author_country_kz

# Write the processed data to a new JSON file with UTF-8 encoding
with open("processed_data.json", "w", encoding="utf-8") as outfile:
    json.dump(data, outfile, indent=4, ensure_ascii=False)

print("Data has been successfully written to processed_data.json with UTF-8 encoding")

```

Figure 3.6 – Scraping data: checking if each author

ing coefficients, are calculated to identify influential authors and research clusters within the network. D3.js is employed to create immersive data visualizations, including interactive graphs and charts that enable users to explore collaboration patterns and identify key research clusters. These visualizations enhance the platform’s usability and provide valuable insights for researchers.

3.3 Web Platform development

The third stage of the research is aimed at developing the FPP (Find Potential Partners) web platform. Development of a Laravel-based web system on a server, Vue.js on the frontend, with database integration via JSON. Overview of the technologies used:

- Laravel: PHP is a framework for developing web applications. It provides a

main_author_info						co_author_info				
name	university	country	scopus_id	orcid	document_title	co_author_name	co_author_link	co_country	co_orcid	co_author_country
Daniele Tosi	National Laboratory Astana	Astana, Kazakhstan	16647693600	Caesars c ORCID	Bite Force Mapping Based on Distributed Fiber Sensing Network Approach	Katrenova, Z.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Alokozheva, S.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Yergibay, M.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Tosi, D.	https://www.scopus.com	can not get	Caesars c ORCID	
					Functionalized optical fiber ball-shaped biosensor for label-free, low-limit	Molardi, C.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Rakhidova, G.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Tiliger, M.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Pham, T.T.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Belmurayeva, A.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Tosi, D.	https://www.scopus.com	can not get	Caesars c ORCID	
					Fiber-optic semi-distributed Fabry-Perot interferometer for low-limit label	Rakhimbekova, A.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Seitkamal, K.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Kudalbergenov, B.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Vangelista, L.	https://www.scopus.com	Pavia, Italy	https://orcid.org	false
						Tosi, D.	https://www.scopus.com	can not get	Caesars c ORCID	
					Rapid detection of vaccinia virus using biofunctionalized fiber-optic ball	Rakhimbekova, A.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Kudalbergenov, B.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Seitkamal, K.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Vangelista, L.	https://www.scopus.com	Pavia, Italy	https://orcid.org	false
						Tosi, D.	https://www.scopus.com	can not get	Caesars c ORCID	
					Reflector-less refractive index sensors based on etched-tapered high-scatt	Shamerdenova, M.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Molardi, C.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Blanc, W.	https://www.scopus.com	Nice, France	https://orcid.org	false
						Tosi, D.	https://www.scopus.com	can not get	Caesars c ORCID	
					Proof of principle for a sensitive, real time and label-free detection of pos	Seitkamal, K.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Kudalbergenov, B.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Dauletova, A.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Tosi, D.	https://www.scopus.com	can not get	Caesars c ORCID	
					Semi-distributed interferometers fiber-optic sensors for high-sensitivity re	Vangelista, L.	https://www.scopus.com	Pavia, Italy	https://orcid.org	false
						Kashyeva, S.	https://www.scopus.com	Astana, Kazakhstan	https://orcid.org	true
						Abdossova, A.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Moldabay, D.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Blanc, W.	https://www.scopus.com	Nice, France	https://orcid.org	false
						Tosi, D.	https://www.scopus.com	can not get	Caesars c ORCID	
					Spectral characteristics and interrogation of a fiber-optic ball resonator b	Sypabekova, M.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Amantayeva, A.	https://www.scopus.com	Astana, Kazakhstan	Caesars c ORCID	true
						Gonzales-Vila, A.	https://www.scopus.com	Mons, Belgium	https://orcid.org	false
						Caucheteur, C.	https://www.scopus.com	Mons, Belgium	Caesars c ORCID	false
						Tosi, D.	https://www.scopus.com	can not get	Caesars c ORCID	
					High bandwidth performance of multimode graded-index microstructure	Savović, S.	https://www.scopus.com	Kragujevac, Serbia	https://orcid.org	false

Figure 3.7 – dataset on csv format

variety of tools for convenient and efficient work with the database, routing, authentication, and other tasks.

- Vue.js: A progressive JavaScript framework for creating user interfaces. Vue.js allows you to create interactive and dynamic web applications by managing the view on the client side.

- JSON: A text-based data transfer format used for data exchange between the server and the client. In this case, JSON is used to integrate with the database and transfer data between the server and the client. A brief description of the development process:

Requirements analysis: Develop a web system in order to find potential partners for local researchers. The main functionality of Find Potential Partner:

- User registration/Authorization;
- Creating a list of authors' publications;
- Ability to search by author's full name, publication title;
- The opportunity to find a potential partner when choosing a country, university and destination.

Design: Development of the system architecture, database design and user interface. The interaction between the user and the system can be easily illustrated with a use-case diagram, As can be seen in the Figure 3.8, users can search for a research partner in a hierarchy by clicking on the buttons going to the following selections such as first a country from the list of countries, then a university from the list of universities, the next direction in which he wants to work and then select an author from the list of authors and so the user finds his publication partner.

Backend (backend) development: Creating the backend of a web system using Laravel, including the development of models, controllers and routing settings.

Development of the frontend (client side): Implementation of the client side of the web system using Vue.js, including the creation of components and the implementation of the logic of interaction with the server via the API.

Database integration via JSON: Creating migrations for the database, writing

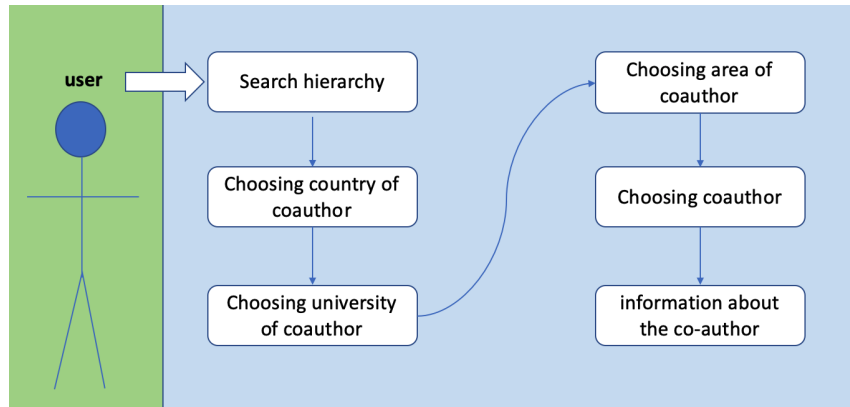


Figure 3.8 – A scheme of use cases for user-oriented design

seeders for initial data filling and implementing data access logic via the JSON API.

3.3.1 Testing and Evaluation

Before the web platform is deployed for public use, it undergoes comprehensive testing and evaluation to guarantee its functionality, performance, and security. Several types of testing are conducted to ensure that the platform meets the highest standards of quality and user satisfaction.

User Acceptance Testing (UAT) is performed to validate that the platform meets the requirements and expectations of its intended users. This involves real users interacting with the platform to assess its usability, functionality, and overall user experience. Feedback obtained during UAT is invaluable for identifying any usability issues or areas for improvement.

Usability testing evaluates how easily and intuitively users can navigate the platform and accomplish their tasks. Test participants are asked to perform specific tasks while their interactions with the platform are observed and recorded. Usability testing helps identify any usability challenges or user interface issues that may hinder user engagement or satisfaction.

Performance testing assesses the responsiveness, scalability, and stability of the platform under various conditions. This involves simulating high traffic volumes, concurrent user interactions, and other stress factors to evaluate how the platform performs under load. Performance testing helps identify potential bottlenecks, latency issues, or system errors that may affect the user experience.

Finally, security testing is conducted to identify and mitigate any vulnerabilities or weaknesses in the platform’s security architecture. This involves conducting penetration tests, vulnerability assessments, and security audits to identify potential threats and ensure that appropriate measures are in place to protect user data and system integrity.

By subjecting the web platform to rigorous testing and evaluation processes, any issues or deficiencies can be identified and addressed proactively, ensuring a smooth and reliable user experience upon deployment.

Chapter 4

Results

This chapter presents the findings of the research conducted on collaboration networks within Kazakhstan's scientific community. The results are derived from the analysis of data collected through academic databases and the evaluation of the web platform designed to enhance these networks.

4.1 Data Analysis

The data analysis focused on identifying existing collaboration patterns, trends in interdisciplinary research, and potential areas for increased cooperation among Kazakhstan's researchers. The key findings are summarized as follows:

- Collaboration Patterns: Analysis of publication data from Scopus, IEEE Xplore, and Google Scholar revealed that collaboration among Kazakhstan's researchers is primarily concentrated within specific institutions and disciplines. There is limited evidence of widespread interdisciplinary or inter-institutional collaboration.

- Interdisciplinary Research: The data indicated a growing interest in interdisciplinary research, particularly in fields such as climate science, geography, and technology. However, the extent of interdisciplinary collaboration remains modest compared to international standards.

- International Cooperation: The analysis showed that Kazakhstan's researchers frequently collaborate with international partners, particularly from countries such as Russia, China, and the United States. These collaborations are often driven by large-scale research projects and international funding opportunities.

This chapter presents the findings of our study on collaboration networks within Kazakhstan's scientific community. The analysis includes statistical data on the top 20 universities in Kazakhstan by publication output, the top 10 well-known topics in research publications, and the top 10 foreign universities collaborating with Kazakhstan's universities.

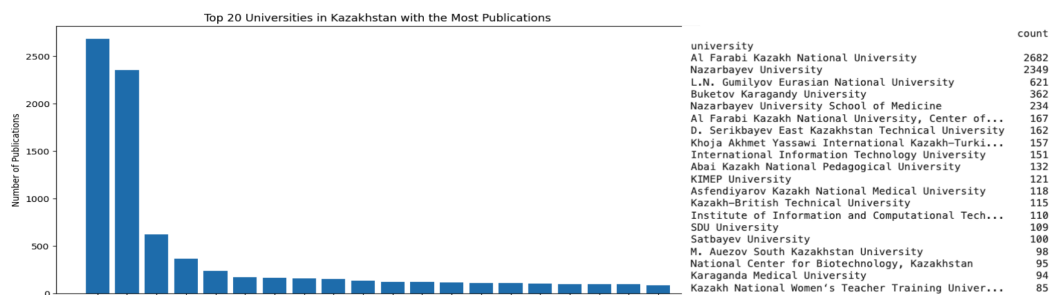


Figure 4.1 – Top 20 Universities of Kazakhstan by Publication

The following table lists the top 20 universities (see the figure 4.1) in Kazakhstan based on the number of publications indexed in the Scopus, IEEE Xplore, and Google Scholar databases. These institutions represent the leading research contributors in the country. The analysis of research publications revealed the most popular research topics among Kazakhstan’s researchers.(See the figure 4.2). The following are the top 10 well-known topics:

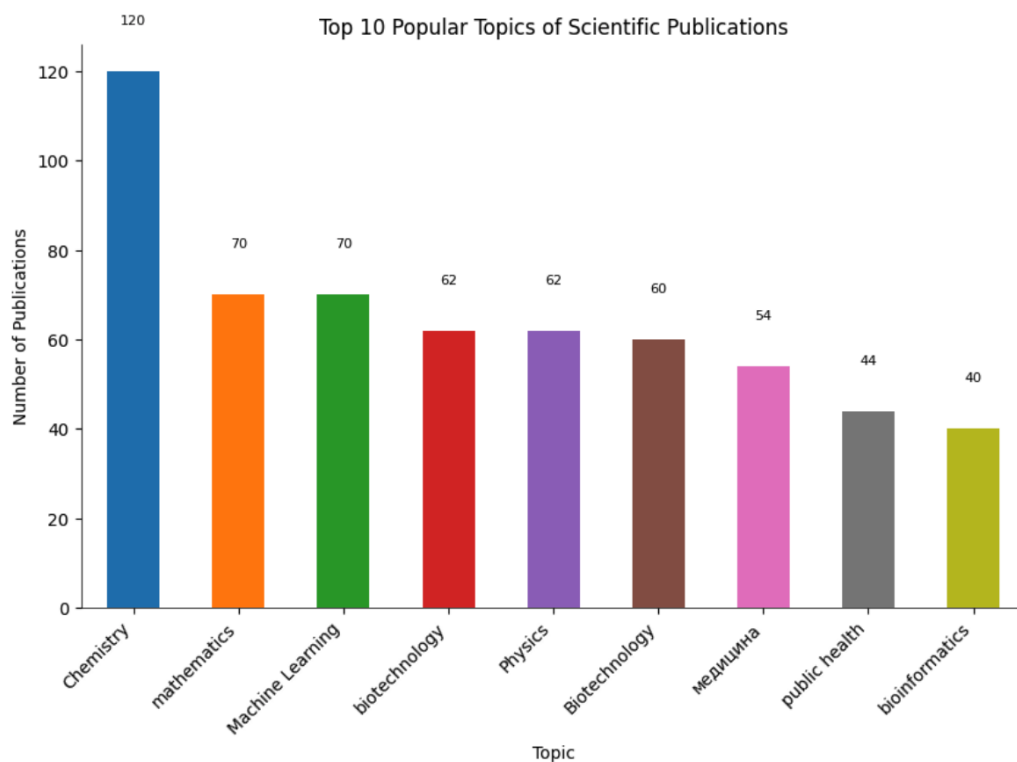
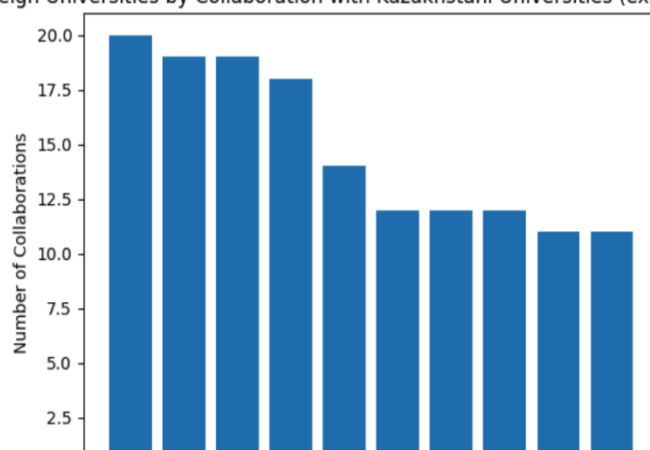


Figure 4.2 – Top 10 Well-Known Topics in Research Publications

Top 10 Foreign Universities by Collaboration with Kazakhstani Universities (excluding Kazakhstan)



1. North-West University: 20
2. Kazan Federal University: 19
3. Tomsk Polytechnic University: 19
4. Krasnodar Research Centre for Animal Husbandry and Veterinary Medicine: 18
5. Kyushu University: 14
6. Institute for Biological Problems of Cryolithozone SB RAS: 12
7. University of Hawai'i at Mānoa: 12
8. KU Leuven: 12
9. Helsingin Yliopisto: 11
10. National Research Nuclear University MEPhI: 11

Figure 4.3 – Top 10 Foreign Universities Collaborating with Kazakhstan's Universities

Kazakhstan's universities have established significant international collaborations (see the figure 4.3). The following table lists the top 10 foreign universities that most frequently collaborate with Kazakhstan's institutions based on co-authored publications. These results highlight the key players in Kazakhstan's scientific research landscape and the strong international collaborations that exist. They also underscore the diverse research interests that drive scientific inquiry in Kazakhstan.

4.2 Web Platform Evaluation

The web platform developed as part of this research aims to facilitate collaboration and enhance the visibility of research activities within Kazakhstan's scientific community. The platform's key features include researcher profiles, collaboration network visualization, and tools for identifying potential research partners.

Functional Web Platform: The "Find Potential Partners" (FPP) platform was successfully developed and deployed. The platform is fully functional and user-friendly, enabling researchers to find potential research partners based on various criteria such as country, university, research field, and author.

Advanced Search Capabilities: The platform provides advanced search capabil-

ities, allowing users to search for researchers and institutions by multiple parameters including author name, areas, and publication.

Increased Networking Opportunities:The platform enhances networking opportunities for researchers by providing an easily accessible database of potential collaborators.

Interdisciplinary Collaboration:The platform encourages interdisciplinary collaboration by offering insights into various research fields and institutions.

Comprehensive Database of Researchers:

- **Extensive Researcher Profiles:**Detailed profiles for researchers have been created, including their publications and areas of expertise.

- **Accurate and Up-to-Date Information:**The data provided by the platform is accurate and up-to-date, sourced from reliable academic databases such as Scopus, IEEE Xplore, and Google Scholar.

Statistical Insights and Visualization:

- **Data-Driven Insights:** The platform offers valuable statistical insights into the academic landscape, including trends in research output, collaboration patterns. These insights are crucial for policymakers and academic leaders in making informed decisions.

- **Visual Representation:** The use of visualizations such as graphs, charts.

The platform’s visualization tools provide insightful representations of collaboration networks. Key visualizations include:

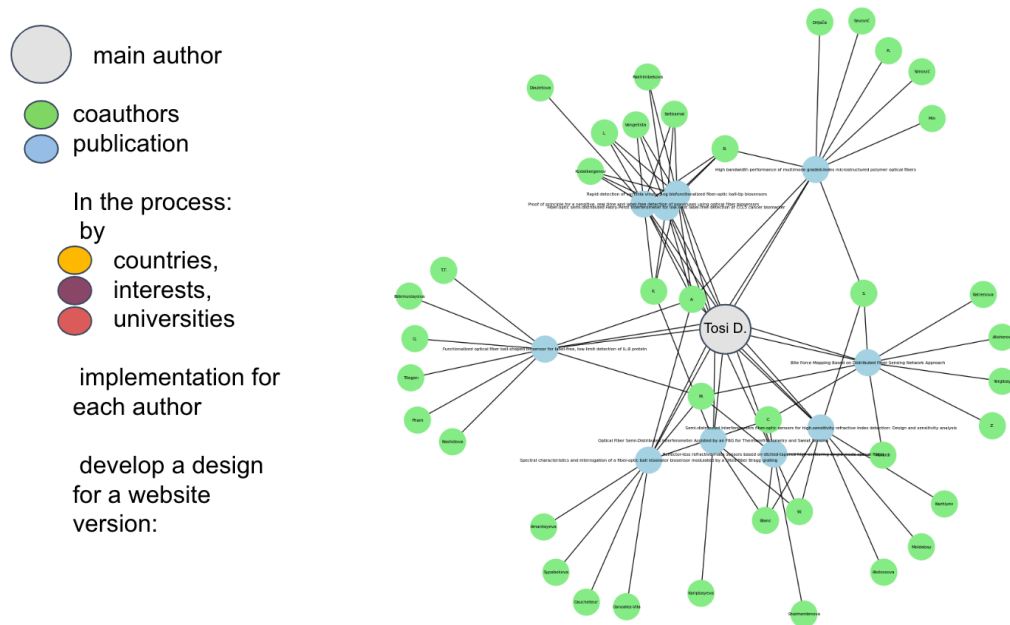
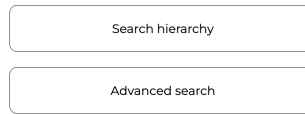


Figure 4.4 – Networking with authors



[ContactUS](#) [About project](#) [Recommendation](#)

Figure 4.5 – Screen page part of the FPP main page with the ability to search with hierarchy and advanced search

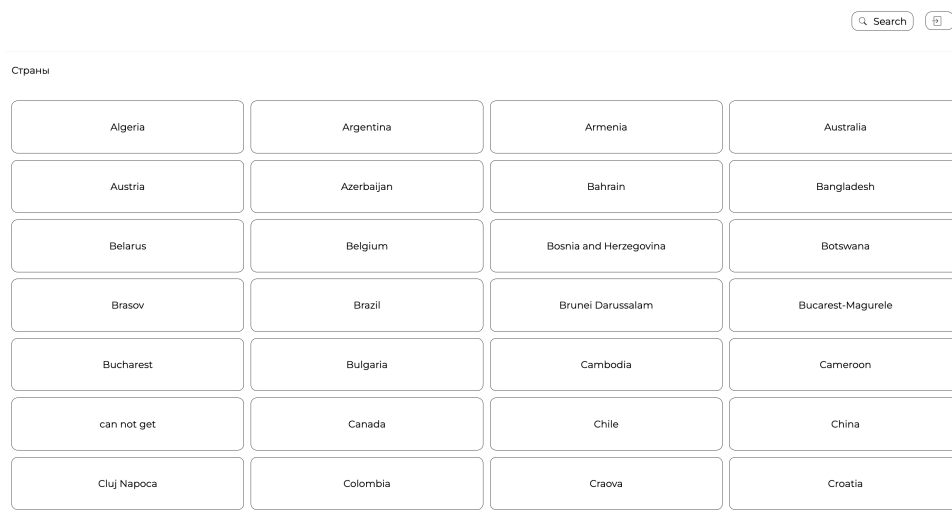


Figure 4.6 – Screen page of FPP on page for choosing country

Все университеты



Figure 4.7 – Screen page of FPP on page for choosing university

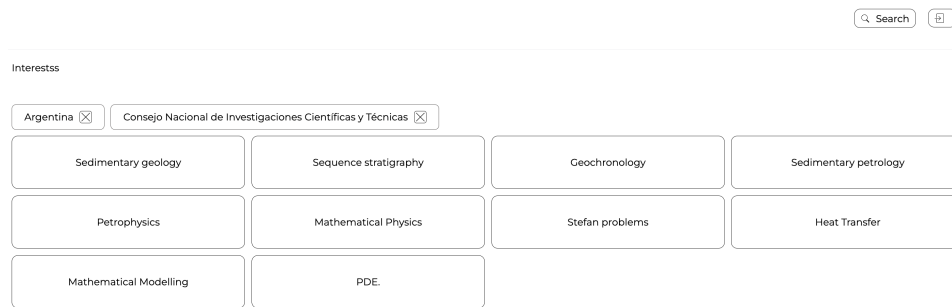


Figure 4.8 – Screen page of FPP on page for choosing area

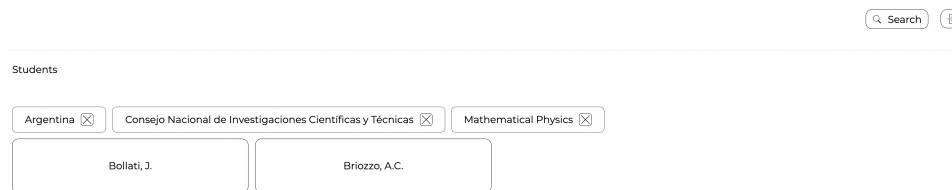


Figure 4.9 – Screen page of FPP on page for choosing partner

Author Networking in Figure 4.4 illustrates the network of authors within Kazakhstan, showing clusters of researchers who frequently collaborate. This visualization helps identify key researchers and potential gaps in collaboration.

As a result of the development of the system, the web application performs the search for a potential partner using the hierarchy of the subsequent user interface (see Figure 4.5)

Examples of search results are shown in Fig. 4.6. How it starts with the country selection.


Fig. 4.7 shows several university options.

In Fig. 4.8, the direction at the university is displayed in order and authors to choose from In Fig. 4.9, Fig. 4.10 output according to the user’s choice of the author with whom user b wanted to work. It is important to note that this author has already worked with Kazakhstan’s authors and below in Fig. 4.10 it is indicated with whom exactly and other co-authors are also presented. This Fig. 4.5 shows the main page where you can click the register and authorization button to go to the registration and authorization pages.

And if you click on the hierarchy search, then the result comes out as in the Fig. 4.6 there is a list of countries from these list you need to select one country, then go to the page as in the Fig. 4.7 list of universities and below the universities is a list of Kazakhstan’s universities with which they collaborated, for example, Consejo Nacional de Investigaciones Cientificas y Técnicas cooperates with Nazarbayev University, Kazakh-British Technical University.

After selecting one of the universities, the list of author areas/interests goes to the page as a Fig.4.8, and after selecting the area, it goes to the list of authors page in the selected direction as Fig. 4.9 and then it will be possible to select one



Global author
-Name: Briozzo, A.C.
University: Consejo Nacional de Investigaciones Cientificas y Técnicas
Scopus_id: 6506210149
Orcid: Связать с ORCID
Country: , Buenos Aires, Argentina
Scopus Link: 
Interests:
Mathematical Physics
Stefan problems
Heat Transfer
Mathematical Modelling
PDE.

Papers | 2

Co-authors 3







Document title: Mathematical model of thermal phenomena of closure electrical contact with Joule heat source and nonlinear thermal coefficients User:  Bollati, J. University: Consejo Nacional de Investigaciones Cientificas y Técnicas
User:  Briozzo, A.C. University: Consejo Nacional de Investigaciones Cientificas y Técnicas
User:  Kharin, S.N. University: Kazakh-British Technical University
User:  Nauryz, T.A. University: Kazakh-British Technical University
Document title: Two-phase Stefan problem for generalized heat equation with nonlinear thermal coefficients User:  Nauryz, T. University: Kazakh-British Technical University
User:  Briozzo, A.C. University: Consejo Nacional de Investigaciones Cientificas y Técnicas

Figure 4.10 – Screen page of FPP on page for chosen partner

author with whom the user would like to cooperate. Fig. 4.10 User can also get acquainted with author’s works and author’s data. And so, using our system, you can find authors and their connections.

4.3 Summary of Findings

The research highlights several key insights into the collaboration dynamics within Kazakhstan’s scientific community: 1. Limited Interdisciplinary Collaboration: There is a need to foster more interdisciplinary research to address complex scientific challenges.

2. Strong International Partnerships: Kazakhstan’s researchers benefit from significant international collaborations, which should be further encouraged and supported.

3. Platform Effectiveness: The web platform developed in this study effectively addresses the need for a centralized hub to facilitate collaboration and visualize research networks. The positive feedback from users underscores its potential to enhance scientific cooperation in Kazakhstan.

These findings underscore the importance of continued efforts to support and expand collaboration networks within Kazakhstan’s scientific community, leveraging both existing strengths and addressing current limitations.

Chapter 5

Discussion

This chapter discusses the implications of the findings presented in the previous chapter, highlights the contributions of this research to the understanding of collaboration networks within Kazakhstan's scientific community, and suggests potential directions for future research and policy development.

5.1 Interpretation of Findings

The findings of this study provide a comprehensive overview of the current state of collaboration within Kazakhstan's scientific community, highlighting both strengths and areas for improvement.

1. Limited Interdisciplinary Collaboration: - The data indicates a clear need to foster more interdisciplinary collaboration among researchers in Kazakhstan. This is crucial for addressing complex scientific and societal challenges that require diverse expertise. The lack of widespread interdisciplinary collaboration suggests potential barriers such as institutional silos, lack of funding for interdisciplinary projects, and limited platforms for cross-disciplinary engagement.

2. Strong International Partnerships: - Kazakhstani researchers have established robust international collaborations, particularly with institutions in Russia, China, and the United States. These partnerships are likely driven by international funding opportunities and large-scale research projects. The strong international ties are beneficial for the exchange of knowledge, resources, and best practices. However, there is also a need to balance international collaboration with the development of local research networks to ensure sustainable scientific growth within the country.

3. Effectiveness of the Web Platform: - The web platform developed in this study has proven to be an effective tool for enhancing visibility and fostering collaboration among Kazakhstani researchers. User feedback indicated high satisfaction with the platform's functionality and usability, particularly the visualization of collaboration networks. This tool can significantly contribute to breaking down barriers to collaboration by providing a centralized hub for researchers to connect and share resources.

5.2 Implications for Policy and Practice

The findings of this study have several important implications for research policy and practice within Kazakhstan:

1. **Promoting Interdisciplinary Research:** - Policymakers and funding agencies should prioritize and incentivize interdisciplinary research projects. This could involve creating dedicated funding streams, establishing interdisciplinary research centers, and organizing events that bring together researchers from different fields.

2. **Strengthening Local Collaboration Networks:** - While international collaborations are valuable, there is also a need to strengthen local research networks. Initiatives such as national research grants, collaborative workshops, and networking events can help build stronger connections within Kazakhstan's scientific community.

3. **Leveraging Digital Tools:** - The success of the web platform underscores the potential of digital tools to facilitate collaboration. Expanding the platform's capabilities, such as integrating more advanced data analytics and machine learning algorithms to predict potential collaborations, can further enhance its utility. Ensuring continuous user feedback and iterative improvements will keep the platform responsive to the needs of the scientific community.

5.3 Limitations of the Study

While this study provides valuable insights, it is important to acknowledge its limitations:

1. **Data Limitations:** - The analysis was based on data from Scopus, IEEE Xplore, and Google Scholar, which may not capture all relevant publications and collaborations. Some important collaborations might be underrepresented, particularly those not documented in these databases.

2. **Platform Evaluation Scope:** - The evaluation of the web platform was conducted with a limited user base. A larger and more diverse group of users would provide more comprehensive feedback and uncover additional areas for improvement.

3. **Temporal Constraints:** - The study provides a snapshot of the current state of collaboration. Longitudinal studies would be beneficial to understand how collaboration networks evolve over time and in response to specific interventions or policy changes.

5.4 Future Research Directions

The study highlights several areas for future research:

1. **Longitudinal Studies:** - Conducting longitudinal studies to track changes in

collaboration networks over time and assess the long-term impact of policy interventions.

2. Expanded Data Sources: - Including additional data sources such as local academic databases, government reports, and social media analysis to provide a more comprehensive view of collaboration patterns.

3. Interdisciplinary Barriers: - Investigating the specific barriers to interdisciplinary collaboration and developing targeted strategies to overcome them.

4. Platform Enhancement: - Further developing the web platform to include features such as automated recommendation systems for potential collaborators, integration with social media for real-time collaboration updates, and advanced analytics for deeper insights into collaboration dynamics.

5.5 Outcome

In conclusion, this study provides a detailed analysis of collaboration networks within Kazakhstan's scientific community and demonstrates the potential of digital tools to enhance these networks. By addressing the identified gaps and leveraging the strengths of existing collaborations, policymakers and researchers can work together to foster a more connected, innovative, and productive scientific community in Kazakhstan.

Chapter 6

Conclusions and future works

6.1 Conclusions

This study has examined the state of collaboration networks within Kazakhstan's scientific community, highlighting both the existing strengths and areas that require further development. By employing a combination of qualitative and quantitative research methods, we have provided a comprehensive overview of the collaboration dynamics and proposed practical solutions to enhance these networks.

6.1.1 Key Findings

1. Current State of Collaboration: - The analysis revealed that while Kazakhstan's researchers engage in robust international collaborations, particularly with institutions in Russia, China, and the United States, there is a significant need for strengthening local and interdisciplinary collaborations. The existing collaborations are often driven by international funding and large-scale projects, underscoring the importance of maintaining these relationships while also fostering internal networks.

2. Role of Digital Tools: - The development and implementation of a specialized web platform have demonstrated the potential of digital tools in enhancing research collaboration. The platform has been well-received by the users, particularly for its functionality in visualizing collaboration networks and identifying potential research partners. This tool can play a crucial role in overcoming some of the barriers to collaboration by providing a centralized and user-friendly interface for researchers.

6.1.2 Implications for Policy and Practice

The findings suggest several actionable recommendations for policymakers, funding agencies, and research institutions:

1. Enhancing Interdisciplinary Research: - There is a need to promote interdisciplinary research through dedicated funding, establishment of interdisciplinary research centers, and organization of cross-disciplinary events. This will help in

addressing complex scientific and societal challenges that require diverse expertise.

2. **Strengthening Local Networks:** - While international collaborations are essential, there is an equally important need to build stronger local networks. National grants, collaborative workshops, and networking events can facilitate this by bringing together researchers within Kazakhstan.

3. **Utilizing Digital Platforms:** - Expanding the functionalities of the web platform to include more advanced data analytics, recommendation systems, and real-time updates can further enhance its utility. Continuous user feedback and iterative improvements will ensure that the platform remains relevant and effective in meeting the needs of the scientific community.

6.1.3 Limitations of the Study

Acknowledging the limitations of this study is crucial for contextualizing the findings and guiding future research:

1. **Data Limitations:** - The reliance on data from Scopus, IEEE Xplore, and Google Scholar means that some relevant publications and collaborations may not be captured. Including additional data sources could provide a more comprehensive view.

2. **Scope of Platform Evaluation:** - The evaluation of the web platform was conducted with a limited user base. A larger and more diverse group of users would provide more comprehensive feedback and identify additional areas for improvement.

3. **Temporal Constraints:** - This study provides a snapshot of the current state of collaboration. Longitudinal studies would be beneficial to understand the evolution of collaboration networks over time and in response to specific interventions or policy changes.

6.1.4 Future Research Directions

Based on the findings and limitations of this study, several areas for future research are identified:

1. **Longitudinal Analysis:** - Conducting longitudinal studies to track changes in collaboration networks over time and assess the long-term impact of policy interventions.

2. **Broadening Data Sources:** - Including additional data sources such as local academic databases, government reports, and social media analysis to provide a more comprehensive view of collaboration patterns.

3. **Investigating Interdisciplinary Barriers:** - Researching the specific barriers to interdisciplinary collaboration and developing targeted strategies to overcome them.

4. **Enhancing Digital Tools:** - Further developing the web platform to include features such as automated recommendation systems for potential collaborators, integration with social media for real-time updates, and advanced analytics for deeper insights into collaboration dynamics.

6.1.5 Final Thoughts

In conclusion, this study provides valuable insights into the collaboration networks within Kazakhstan's scientific community and demonstrates the potential of digital tools to enhance these networks. By addressing the identified gaps and leveraging the strengths of existing collaborations, stakeholders can work together to foster a more connected, innovative, and productive scientific community in Kazakhstan. This, in turn, will contribute significantly to the country's scientific advancement and socioeconomic development.

6.2 Future Works

The findings of this study lay a solid foundation for understanding the current state of collaboration networks within Kazakhstan's scientific community. However, there are several avenues for future research and development that can further enhance the impact and scope of this work. This chapter outlines potential directions for future research, system improvements, and broader applications.

6.2.1 Expanding Data Sources and Coverage

While this study primarily utilized data from Scopus, IEEE Xplore, and Google Scholar, future research should consider integrating additional academic databases and repositories. This will ensure a more comprehensive analysis of scientific collaboration and potentially uncover additional insights. Potential sources include:

- Web of Science: For more extensive citation and collaboration analysis.
- ResearchGate: For insights into less formal collaborations and ongoing research discussions.
- Institutional Repositories: For access to a broader range of local publications and grey literature.

6.2.2 Enhanced Collaboration Network Analysis

Future work should focus on refining and expanding the capabilities of the collaboration network analysis. This can include:

- Dynamic Network Visualization: Implementing interactive and dynamic visualization tools that allow users to explore collaboration networks over time.
- Network Metrics: Incorporating advanced network metrics such as centrality, betweenness, and community detection to identify key influencers and sub-groups within the network.
- Temporal Analysis: Analyzing how collaboration patterns evolve over time to identify trends and shifts in research focus.

6.2.3 Integration of Qualitative Data

In addition to quantitative analysis, integrating qualitative data could provide deeper insights into the motivations and barriers to collaboration. This could involve:

- Surveys and Interviews: Conducting surveys and interviews with researchers to gather qualitative data on their experiences and perspectives on collaboration.
- Case Studies: Developing detailed case studies of successful and unsuccessful collaborations to identify best practices and common challenges.

6.2.4 Platform Enhancements

To increase the utility and user engagement of the developed web platform, the following enhancements could be considered:

- Recommendation System: Implementing a recommendation system that suggests potential collaborators based on past publication history and research interests.
- User Profiles and Networking: Allowing researchers to create detailed profiles, share updates, and directly network with potential collaborators through the platform.
- Resource Sharing: Facilitating the sharing of resources such as datasets, software tools, and research methodologies.

Bibliography

- [1] X. Xu, W. Jia, M. Tang, Q. Feng, and Y. Li, "Author cooperation relationship in digital publishing based on social network analysis," *International Conference on Fuzzy Systems and Knowledge Discovery*, vol. 1, no. 1, pp. 1–89, 2015.
- [2] M. Alavi and S. A. Lajevardy, "The co-authorship network of published articles in conferences on web research based on social network analysis," *Journal of Web Research*, vol. 12, no. 3, pp. 45–62, 2020.
- [3] Y. Chen, "Building and analyzing a global co-authorship network using google scholar data," *The Web Conference Proceedings*, 2017.
- [4] M. Noor, "Co-authorship in information technology: A study of collaboration patterns and impacts on research performance," *Journal of Information Science*, vol. 36, no. 2, pp. 231–246, 2014.
- [5] J. Grahl, B. Sand, M. Schneider, and M. Schwind, "Publication network analysis of an academic family in information systems," *Journal of Information Systems Research*, vol. 25, no. 4, pp. 567–582, 2021.
- [6] A. King and Q. Settle, "Coauthor network analysis of journal of applied communications articles from 2008-2020," *Journal of Applied Communications*, vol. 45, no. 2, pp. 78–92, 2021.
- [7] L. Sun and I. Rahwan, "Coauthorship network in transportation research," *Transportation Research Part C: Emerging Technologies*, vol. 79, pp. 210–225, 2017.
- [8] F. Zare-Farashbandi, E. Geraei, and S. Siamaki, "Study of co-authorship network of papers in the journal of research in medical sciences using social network analysis," *Journal of Research in Medical Sciences*, vol. 19, no. 9, pp. 850–856, 2014.
- [9] S. Marginson, "University rankings and social science," *Institute of Education Journal*, vol. 30, no. 4, pp. 512–528, 2017.
- [10] E. De Wit-de Vries, W. A. Dolfsma, H. J. Van der Windt, and M. P. Gerkema, "Knowledge transfer in university–industry research partnerships: a review," *Journal of Knowledge Management*, vol. 22, no. 5, pp. 789–804, 2018.
- [11] J. Ankrah and A. Monteiro, "Bibliometric analysis of data sources and tools

- for shoreline change analysis and detection,” *Coastal Engineering*, vol. 58, pp. 123–135, 2022.
- [12] A. Bordin, A. L. Gonçalves, and J. Todesco, “Análise da colaboração científica departamental através de redes de coautoria,” *Revista Brasileira de Gestão de Negócios*, vol. 16, no. 3, pp. 308–323, 2014.
- [13] H. J. Lee, H. S. Kim, and N. Smith, “Youth activism in climate change: an investigation of motivations and involvement,” *Journal of Environmental Psychology*, vol. 69, p. 101434, 2020.
- [14] A. Corner, O. Roberts, S. Chiari, and S. Völler, “How do young people engage with climate change? the role of knowledge, values, message framing, and trusted communicators,” *Wiley Interdisciplinary Reviews: Climate Change*, vol. 6, no. 5, pp. 523–534, 2015.
- [15] A. Holmberg and A. Alvinus, “The importance of political polarization for climate change communication among young people,” *Climatic Change*, vol. 157, no. 2, pp. 267–279, 2019.