OPTIMIZING SOCIO-ECONOMIC SYSTEMS IN THE UNION STATE OF RUSSIA AND BELARUS

R & D, HIGHER EDUCATION, AND LABOR MARKETS IN THE DIGITAL ECONOMY

COLLECTIVE SCIENTIFIC MONOGRAPH

Editors

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FOREWORD

In an era defined by rapid technological advancement, geopolitical realignment, and unprecedented economic integration challenges, the quest to understand and optimize complex socio-economic systems has never been more critical. The Union State of Russia and Belarus represents a fascinating case study in economic integration, one that exists at the intersection of historical ties, contemporary geopolitical realities, and forward-looking digital transformation.

This volume, meticulously compiled under the leadership of Professors Galina V. Astratova, Maxim Vlasov, and Chigozirim Onwusiribe, emerges as a vital contribution to our understanding of how integrated economies can navigate the complexities of the digital age. It brings together a remarkable assembly of scholars across multiple disciplines, merging theoretical frameworks with practical applications to address pressing questions about optimal development pathways in interconnected economic systems.

What distinguishes this work is its comprehensive approach to examining the intricate relationships between seemingly disparate yet fundamentally connected sectors: the research and development services market, higher education systems, and evolving labor markets. The authors have admirably tackled the challenge of identifying optimal parameters for these systems' functioning through sophisticated methodological approaches, data mining, multifactor analysis, and economic-mathematical modeling, resulting in a work of substantial theoretical and practical significance.

Moreover, this book emphasizes the importance of fostering innovation ecosystems that leverage the unique strengths of both nations. By highlighting successful case studies and best practices, the authors provide a roadmap for enhancing collaboration between government, academia, and industry, which is essential for driving sustainable economic growth.

The timing of this research is particularly noteworthy. As economies worldwide reassess traditional models of growth and development in light of digital transformation, the insights presented here extend well beyond the specific case of the Russia-Belarus Union State. The mechanisms designed and analyzed throughout these pages offer valuable frameworks for policymakers, academic institutions, and economic strategists globally who are grappling with similar challenges of integration and optimization.

The authors' interdisciplinary expertise shines through in their treatment of creative human capital development—perhaps the most critical element in any knowledge economy. Their exploration of how educational institutions must evolve to meet emerging labor market demands while simultaneously driving innovation presents a balanced view that acknowledges both the transformative potential and inherent challenges of digitalization.

For researchers, this book provides a rigorous analytical foundation; for practitioners, it offers actionable insights into designing systems that can thrive amid constant change. The extensive international collaboration evident in this work also serves as a powerful reminder that academic inquiry transcends political boundaries, bringing together diverse perspectives in the service of shared knowledge advancement.

As we navigate the complex terrain of economic development in the twenty-first century, works like this—grounded in data, enriched by interdisciplinary thinking, and focused on practical applications—will prove indispensable guides. The authors have made a significant

contribution to our collective understanding of how socio-economic systems can be optimally designed not just to weather change, but to harness it for sustainable development, ensuring that both Russia and Belarus can emerge as leaders in the global digital economy.

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PREFACE

The book addresses the optimal development of complex socio-economic systems within the Union State of Russia and Belarus, focusing on the research sector, higher education, and the labour market in the digital economy. The main scientific problem it tackles is identifying the optimal parameters for these systems' functioning, using methods such as data mining, multifactor analysis, and economic and mathematical modelling. The project aims to develop technologies for designing these systems based on the author's achievements in economic modelling and various analytical methods.

The most important aspects of modernity are considered, including 1) the mechanisms of development of complex socio-economic systems in new economic conditions (using the example of the Union State of the Russian Federation and the Republic of Belarus); 2) the problems and prospects of digitalization of the economy in new economic conditions; 3) topical issues of human capital development in the digital economy. The results of the authors' long-term theoretical and applied research are presented. The book is intended for specialists in the fields of education and science, research and teaching staff, graduate students, and undergraduates studying the problems of digitalization, modern higher education, and the labour market, as well as students of economic, sociological, and managerial specialties in Russia and Belarus.

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ACKNOWLEDGEMENT

The ideological inspirer and organizer of the team of authors for writing this book, as well as the developer of the general research methodology and the author of a number of research methods (for example, consumer behavior) was Professor Galina V. Astratova, whose range of research interests is extremely wide: from the problems of public administration to market management mechanisms of the R&D sector, higher education, digital economy and labour market.

An irreplaceable contribution to mathematical data processing and the development of new research methods was made by Dr. Chigozirim N. Onwusiribe and Professor Maxim V. Vlasov. A significant contribution to the literary and scientific translation of Russian-language texts, as well as the technical editing of electronic files, was made by Dr. Chigozirim N. Onwusiribe and Longinus D.N. Nnadozie. Each of the authors of the chapters and sections has made a full-fledged contribution to the writing of this monograph, as they are recognized experts in the stated problems. For example, Professor Natalia A. Simchenko and Associate Professor Airat M. Izmailov specialize in the sectoral problems of the labor market in the context of digitalization, as well as topical issues of the innovation infrastructure of the Union State of Russia and Belarus.

Professor Evgeny V. Sinitsyn and Associate Professor Viola A. Larionova are well-known experts in the field of mathematical modeling of socio-economic systems and innovation infrastructure.

Representatives of Belarus, Associate Professors – Irina A. Shamardina, Lyubov I. Tararyshkina, Boris A. Zhalezko – are also known for their work on a wide range of economic problems of Belarus and Russian-Belarusian economic relations.

INTRODUCTION

Galina V. Astratova, Chigozirim Ndubuisi Onwusiribe, Maxim V. Vlasov

In 2024, exactly 25 years have passed since the creation of the Union State of the Russian Federation and the Republic of Belarus, one of the most successful integration entities in the post-Soviet space in the 21st century1. In the context of the global formation of the knowledge economy and the digital transformation of society, as well as the creation of a unified scientific and technological space in the Union State of Russia and Belarus, a particular relevance are the issues of finding a source of financing for these transformations and, accordingly, state regulation, coordination and interaction of the higher professional education system, R & D and the labour market, which reflect the results of our earlier research[2].

The current situation is due to a number of factors described in detail in our previous studies[3], namely:

1. The global change in the role of the public sector and the importance of government regulation in sectors of national economies.
2. The introduction of digital (information) technologies into the business models of organizations in the commercial and non-profit sectors, which has become global and universal, defining the format of "digital life";
3. Changes in the formats of educational institutions, changes in the nature of the work of researchers and teaching staff of universities, as well as changes in the nature and conditions of students' education.
4. Changing consumer behaviour in the digital environment in general and in the educational services market, in particular.
5. A change in the role of human capital in society due to changes in the requirements for the qualifications and competencies of employees related to the knowledge, skills, and abilities of an individual in the digital environment, which led to a significant change in the nature of the work of employees in both commercial and non-commercial sectors.
6. The transformation of the innovation infrastructure of the Union State of the Russian Federation and the Republic of Belarus into a key factor in import substitution, sustainable development, and growth in new economic conditions.

1: The Union State: 25 years of integration – results and new tasks. June 06, 2024. – [Electronic resource]. [Available From: https://forumspb.com/programme/businessprogramme/131433/#broadcast] (accessed: 06.06.2024). (In Russ.).

2: Astratova, 2023b; Astratova, et al., 2022; Bengraf, et al., 2024; etc.

3: Astratova, et al., 2024; Astratova & Bekshaev, 2024; Astratova & Izmailov, 2024; Astratova & Sinitsyn, et al. 2024; Astratova, 2023 and 2023b; Astratova, et al., 2023; Astratova et al., 2022; Astratova et al., 2021; Bengraf, et al., 2024; Larionova et al., 2019; Simchenko et al., 2023; Shamardina, 2022; Sinitsyn et al., 2022; Tararyshkina, 2019; Tolmachev et al., 2019; Yanovskaya & Simchenko, 2024; Zhalezko et al., 2020; etc.

At the same time, both in the Russian Federation and in the Republic of Belarus, there are many controversial issues related to digitalization that need to be resolved in the very near future:

1. The nature of work, employment structure, and unemployment in the context of the use of digital/ information technologies;
2. Factors of discrimination and benefits for employees due to the use of digital / information technologies;
3. Problems of the use of digital/information technologies by civil servants, *etc*., where theory and practice are in the process of active formation.

Obviously, these issues should become an urgent research problem and be considered by scientists in the very near future.

Consequently, the need for a comprehensive, interdisciplinary study of complex socio-economic systems – higher professional education, R & D, and the labour market of the Union State of the Russian Federation and the Republic of Belarus—and the problems of sectoral state regulation of these systems in the context of the digitalization of the economy are becoming increasingly urgent. That is why the team of authors of this monograph attempted to consider some aspects of the stated problems.

The collective monograph presented to the readers is structured into four interconnected parts, addressing the core challenges of integration and digital transformation:

Part 1: General issues of integration and socio-economic systems examines the theoretical aspects of complex socio-economic system development, including mathematical models and mechanisms; traces the historical creation and evolution of the Union State; analyzes modern directions of Russian-Belarusian economic cooperation; and assesses key indicators within the R & D sector, Higher Education System (HES), and labour market of the Russian and Belarusian digital economy. These issues are described in detail in chapters:

CHAPTER 1 THEORETICAL ASPECTS OF THE DEVELOPMENT OF COMPLEX SOCIOECONOMIC SYSTEMS(MATHEMATICAL MODELS AND MECHANISMS).

CHAPTER 2 THE HISTORY OF THE UNION STATE OF THE RUSSIAN FEDERATION AND THE REPUBLIC OF BELARUS: CREATION AND EVOLUTION

CHAPTER 3 MODERN DIRECTIONS OF ECONOMIC COOPERATION BETWEEN THE RUSSIAN FEDERATION AND THE REPUBLIC OF BELARUS

CHAPTER 4 SOME ASPECTS OF THE MAIN INDICATORS ASSESSMENT IN THE CONTEXT OF THE COMPLEX SOCIO-ECONOMIC SYSTEMS DEVELOPMENT (R&D SECTOR, HES, AND THE LABOR MARKET) IN THE RUSSIAN AND BELARUSIAN DIGITAL ECONOMY

CHAPTER 5 ASSESSMENT OF THE DEVELOPMENT PROCESSES OF COMPLEX SOCIOECONOMIC SYSTEMS IN THE DIGITAL ECONOMY OF THE UNION STATE

Part 2: Development of the Science, Technology, and Innovation (STI) sector focuses on the innovative infrastructure of the Union State as a key factor for import substitution and development; explores public management of this infrastructure in the digital economy; identifies bottlenecks limiting public administration effectiveness in HES and R & D; analyzes economic mechanisms for stimulating scientific and innovative activity; discusses indicative planning in innovation activity management; and addresses the challenges of creative human capital. These issues are described in detail in chapters:

CHAPTER 6 INNOVATIVE INFRASTRUCTURE OF THE UNION STATE OF THE RUSSIAN FEDERATION AND THE REPUBLIC OF BELARUS AS A KEY FACTOR OF IMPORT SUBSTITUTION AND DEVELOPMENT IN NEW ECONOMIC CONDITIONS

CHAPTER 7 PUBLIC MANAGEMENT OF THE USRB INNOVATION INFRASTRUCTURE IN THE DIGITAL ECONOMY

CHAPTER 8 IDENTIFICATION OF BOTTLENECKS LIMITING THE EFFECTIVENESS OF PUBLIC ADMINISTRATION IN HES AND R&D SECTORS IN RUSSIA AND BELARUS

CHAPTER 9 ECONOMIC MECHANISMS FOR STIMULATING THE SCIENTIFIC AND INNOVATIVE ACTIVITY OF THE USRB

CHAPTER 10 INDICATIVE PLANNING IN THE PROCESS OF SMA'S MANAGEMENT OF INNOVATION ACTIVITY AT THE USRB

CHAPTER 11 THE CHALLENGES OF CREATIVE HUMAN CAPITAL IN THE DIGITAL ECONOMY

Part 3: Development of the higher education system and interaction investigates sectoral state regulation of higher education amid digitalization; consumer behavior characteristics, motives, and impact factors in the digital educational environment; the application of Artificial Intelligence and Data Analytics in educational process organization and quality assessment; comprehensive semantic and sentiment analysis for evaluating digital educational technologies in Russian universities; and human capital development within the integrated R & D and higher education context of the Union State digital economy. These issues are described in detail in chapters:

CHAPTER 12 SECTORAL STATE REGULATION OF THE HIGHER EDUCATION SYSTEM IN RUSSIA AND BELARUS IN THE CONTEXT OF DIGITALIZATION

CHAPTER 13 CONSUMER BEHAVIOR IN THE DIGITAL EDUCATIONAL ENVIRONMENT: MAIN CHARACTERISTICS, MOTIVES, AND IMPACT FACTORS

CHAPTER 14 ARTIFICIAL INTELLIGENCE AND DATA ANALYTICS IN THE ORGANIZATION OF THE EDUCATIONAL PROCESS AND QUALITY ASSESSMENT OF HIGHER EDUCATION

CHAPTER 15 EVALUATING DIGITAL EDUCATIONAL TECHNOLOGIES: A COMPREHENSIVE SEMANTIC AND SENTIMENT ANALYSIS IN RUSIAN

UNIVERSITIES

CHAPTER 16 HUMAN CAPITAL DEVELOPMENT IN THE CONTEXT OF INTEGRATING R & D AND HIGHER EDUCATION IN THE USRB DIGITAL ECONOMY

Part 4: Other cooperation issues between Russia and Belarus explores the labour market as a complex socio-economic system through mathematical modelling; the socio-technological nature of labour organization in the Union State's digital environment; the use of digital technologies in state and municipal administration; and synthesizes policies for advancing socio-economic integration and innovation. These issues are described in detail in chapters:

CHAPTER 17 THE LABOUR MARKET AS A COMPLEX SOCIO-ECONOMIC SYSTEM: SOME ASPECTS OF MATHEMATICAL MODELLING IN THE LABOUR MARKET OF THE UNION STATE

CHAPTER 18 THE SOCIO-TECHNOLOGICAL NATURE OF THE ORGANIZATION OF LABOR IN THE DIGITAL ENVIRONMENT OF THE UNION STATE

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CHAPTER 1

Theoretical Aspects of the Development of Complex Socio-Economic Systems (Mathematical Models and Mechanisms)

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Abstract: This chapter explores the theoretical foundations and methodological approaches to modeling and managing complex Socio-Economic Systems (SES). It examines simulation modeling as a powerful analytical tool for understanding system dynamics under conditions of uncertainty and environmental variability. The chapter discusses the challenges in developing accurate simulation models for SES, including parameter selection, adequacy assessment, and verification methods. Special attention is given to different classes of complex systems and their corresponding mathematical models, from deterministic to stochastic networks. The chapter also presents optimization methods for finding equilibrium states in multi-stakeholder systems, including Pareto optimization and the Groves group selection mechanism for resolving conflicts of interest. The proposed methodological framework enables policymakers to design effective economic mechanisms and control parameters that maximize system-wide efficiency while balancing the interests of all participants. This approach supports strategic decision-making in the rapidly changing environment of modern socio-economic systems.

Keywords: Decision-making, Economic mechanisms, Pareto optimization, Simulation modeling, Socio-economic systems, Stochastic networks, System optimization.

INTRODUCTION

Management of socio-economic systems is associated with significant difficulties associated with both the complexity of the system itself, characterized by many elements and the presence of cause-and-effect relationships of the system with the

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external environment, and the non-linearity of the processes occurring within it (Astratova & Klimuk, 2022; Bertalanffy, 1962).

At present, one of the key strategic state goals is to increase the effectiveness of managerial decisions in influencing socio-economic processes in a rapidly changing external environment[1] (Pasmurtseva, 2020). As it is well known, decision-making on the choice of a development strategy for a Socio-Economic System (SES) is based on a systematic approach to forecasting the future behaviour of the system, considering retrospective information, existing regularities of its dynamics, internal and external relations, opportunities and risks (Ansoff, 1989; Ermicheva, 2008; Lazimov & Nazarov, 2023; Pasmurtseva, 2020; *etc.*). Among the methods of research of complex SES, there are expert analysis methods, such as SWOT-analysis, Delphi method, structural and hierarchical expertise; methods of statistical analysis, including descriptive and inductive statistics, including factor analysis, correlation, and regression analysis; as well as a wide range of mathematical modelling methods (Golovko, 2020).

Among the methods of mathematical modelling, simulation modelling occupies a special place as a reliable tool for the analysis of complex SES, allowing for the study of their dynamics under conditions of uncertainty. In case of poorly structured interrelationships and variable external influences, Simulation Modelling (SM) allows a significant increase in the understanding of the development of the complex processes, and the results of the research can become the basis for management decision-making.

SM is a special case of mathematical modelling and represents the most effective tool for analysing the dynamics of the considered SES. These systems are characterized by high structural and functional complexity, the presence of formalized and non-formalized links with the external environment, uncertainty in predictive assumptions, and reactions to external influences.

Since the 1960s of the XX century, the rapid development of information technologies and experimental approaches to the management of socio-economic and production systems has contributed to the widespread use of SM, due to its practical significance as a tool for making managerial decisions. The theoretical foundations of SM include a set of methodological approaches and provisions, intuitive and formal methods, mathematical tools, and software for modelling and studying complex systems (Emelianov *et al.*, 2002; Bertalanffy, 1962).

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1 Decree of the President of the Russian Federation of 21.07.2020 № 474 "On the National Development Goals of the Russian Federation for the period until 2030". Publication number: 0001202007210012. Date of publication: 21.07.2020. - [Electronic resource]. URL: http://static.government.ru/media/acts/files/1202007210012.pdf (date of reference: 22.04.2024). (In Russ.).

Terminologically, "simulation" is interpreted as the reproduction of real characteristics of objects, phenomena, or processes using a speculative abstract or physical model. Simulation allows us to understand the nature of a phenomenon, describe the processes occurring in the original object, and predict the future state of the object without resorting to experiments on the real object (Bertalanffy, 1962; Emelianov *et al.*, 2002; Naylor, 1975; *etc.*).

SM uses abstract models described by logical and mathematical relationships that represent causal relationships between the properties of the object and external factors, and in the case of complex systems, the relationships between the elements of the system. Mathematically, the simulation model is a logical and mathematical description of the system $U = \{u_1, u_2. .u_k\}$ and dependencies of its functional properties (G) on endogenous and exogenous parameters, $V = \{v_1, v_2. .v_k\}$.

In a broad context, the goal of SM is to find such a function G that not only describes with a given accuracy the state of the system U at a known set of parameters V, but also steadily predicts the future state of the system when varying the parameters. The functional dependence G can be expressed in various ways using a number of analytical expressions, differential equations, sign graphs, state maps, networks, *etc.* Based on a properly constructed model, an inverse problem can be solved to determine the values of the system parameters that ensure the transition of the system to a given state with optimal characteristics. Optimization methods are used to solve this type of problem (Emelianov *et al.*, 2002).

Let us pay attention to some key problems in the development of SM to describe complex SES under conditions of risk and uncertainty of the external environment. At the current stage of economic development, SES are characterized by complexity, interconnectedness with other systems, instability, and susceptibility to the influence of many factors at both local and global levels. In this regard, the task of complex reproduction of such system characteristics in SM is practically impossible and significantly complicates calculations. It follows that when developing a model, it is necessary to include only those properties of the original object that largely determine the behaviour of the object within the set of research objectives. From this point of view, the sufficiency criterion for selecting the configuration of reproducible system properties is the optimal ratio between the relative calculation error and its labour intensity. As a rule, to simulate the properties of the original object, several simulation models are created, which are compared with each other according to this criterion, and then the best model is selected.

CHAPTER 2

The History of the Union State of the Russian Federation and the Republic of Belarus: Creation and Evolution

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Abstract: This chapter examines the historical development and evolving structure of the Union State of the Russian Federation and the Republic of Belarus (USRB), one of the most significant integration projects in Eurasia. The analysis traces the USRB's origins from the 1990 Agreement between the Russian and Belarusian Soviet Socialist Republics through subsequent treaties that established increasingly closer cooperation based on principles of sovereignty, territorial integrity, and peaceful relations. The chapter details how the 1999 Treaty on the Establishment of the Union State, which came into force in 2000, created the foundation for comprehensive integration across economic, political, and social spheres. The research demonstrates how the USRB experience served as a blueprint for broader regional integration, particularly in the formation of the Eurasian Economic Union (EAEU). It analyzes the implementation of numerous Union State programs in sectors including defense, customs infrastructure, agriculture, space technology, medicine, and environmental protection, highlighting the 35:65 funding ratio between Belarus and Russia. Special attention is given to the 28 union integration programs agreed upon in 2021, which represent a new phase in bilateral integration focusing on legislative harmonization, market unification, and coordinated policies across multiple sectors. The chapter concludes that the USRB functions as a crucial mechanism for ensuring economic security within the EAEU customs territory, while the ongoing implementation of integration programs continues to strengthen scientific, technological, and innovative development between Belarus and Russia, serving as a model for deeper Eurasian integration.

Keywords: Belarus-Russia integration, Bilateral treaties, Customs harmonization, EAEU, Supranational cooperation, Union State, Union programs.

INTRODUCTION

A particularly prominent example of a complicated socio-economic system is the supranational formation of the Union State of the Russian Federation and the

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Republic of Belarus (USRB), which is currently the most prominent integration project in Eurasia. The favourable situation that supports the effective functioning of the Union State of the Russian Federation and the Republic of Belarus was preceded by considerable preliminary work on good-neighbourly cooperation and interstate cooperation. The Union State of the Russian Federation and the Republic of Belarus has its initial basis in the Agreement between the Russian Soviet Federative Socialist Republic and the Belarusian Soviet Socialist Republic of December 18, 1990[1], which stipulates, "The Parties recognize each other as sovereign states and undertake not to take any action that would be to the detriment of the state sovereignty of the other Party".

Then, treaties were adopted in the framework of the Treaty of Friendship, Good-Nepourish and Cooperation between the Russian Federation and the Republic of Belarus of February 21, 1995[2], the Treaty on the Formation of Community of Belarus and Russia of April 2, 1996[3], the Treaty on the Union of the Republic of Belarus and the Russian Federation of April 2, 1997[4], on development of friendly relations and cooperation based on the principle of respect for State sovereignty and territorial integrity, inviolability of borders, peaceful resolution of disputes and non-use or threat of use of force, equality, non-interference in internal affairs, respect for human rights and fundamental freedoms, and conscientious fulfilment of obligations.

In December 1998, the Presidents of the Republic of Belarus and the Russian Federation signed a Declaration on Further Unity of Russia and Belarus[5] in addition to a Treaty between the Russian Federation and the Republic of Belarus on Equal Rights of Citizens and an Agreement on Creating Equal Conditions for Business Entities of the Allied States. These reports described concrete steps for the realization of actual bilateral interstate integration.

The Treaty on the Establishment of the Union State was signed on December 8, 1999 came into force on January 26 2000[6], and the Action Program of the Repub-

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1 The Agreement between the Russian Soviet Federative Socialist Republic and the Belarusian Soviet Socialist Republic dated December 18, 1990 [Electronic resource]. // Consultant Plus. Belarus / YurSpektr LLC, National Center for Legal Information. Republic Belarus. – Minsk, 2024. (accessed: 04/22/2024). (In Russian).

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4 The Agreement on the Union of Belarus and Russia dated April 2, 1997 [Electronic resource] // Consultant Plus. Belarus / YurSpektr LLC, National Center for Legal Information. Republic Belarus.– Minsk, 2024. (accessed: 04/22/2024). (In Russian).

5 The Agreement on the Union of Belarus and Russia dated April 2, 1997 [Electronic resource] // Consultant Plus. Belarus / YurSpektr LLC, National Center for Legal Information. Republic Belarus.– Minsk, 2024. (accessed: 04/22/2024). (In Russian).

6 The Treaty on the establishment of the Union State of December 8, 1999 [signed in Moskve08.12.1999] // National Register of Legal Acts of the Republic of Belarus, 14.01.2000, No. 4, 2/118, "Vedomosti of the National Assembly of the Republic of Belarus", 2000, No. 1-2, art. 1. (In Russian).

lic of Belarus and the Russian Federation for implementation of the Treaty on the Establishment of the Union State established the aims, objectives and main ideological directions for constructing the Union State[7] of Belarus and Russia which were included in the legal framework of the Treaty on the Eurasian Economic Union the Treaty of the EAEU on May 29, 2024[8] (hereinafter known as the EAEU Agreement) with the mechanisms for its implementation under the conditions of the customs territory of the Eurasian Economic Union (EAEU).

The findings of a comparative analysis of the basic provisions of the Treaty on the Establishment of the Union State and the EAEU Agreement are set forth in our previous study (Astratova *et al*., 2024). It is found that the strategic approaches outlined in the Treaty on the Establishment of the Union State to facilitate closer integration of the economies of Belarus and Russia by employing common competition rules and standards for consumer protection, a uniform monetary, currency, tax and pricing policies; a single trade and customs tariff policy in regard to third countries, international organizations and associations, and other ideological directions were encapsulated in the provisions of the EAEU Agreement.

The integration strategic objective is to ensure the free movement of goods, services, capital, and labour. Moreover, in the EAEU, there is considerable emphasis on the coordinated, aligned, or unified policy in the sectoral economy. The basis for establishing the Customs Union of the Republic of Belarus, the Republic of Kazakhstan, and the Russian Federation was the Agreement between the Governments of Belarus and Russia on the completion of unification and creating a unified system of tariff and non-tariff regulation in the Union State, dated January 29, 2001[9].

The Agreement establishes the intention to apply a single customs tariff (import and export) when trading with third countries. The customs regulation experience in the Union State became the basis for supranational customs legislation in the Eurasian Economic Union (EAEU). The EAEU customs territories rely on customs regulation principles, customs regulation, and customs administration

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7 The Action Program of the Republic of Belarus and the Russian Federation for the implementation of the provisions of the Treaty on the Establishment of the Union State [adopted in Moscow on 08.12.1999)] // Zvyazda, No. 236, 1999, "Soviet Belarus", No. 296, 1999. (In Russian).

8 The Treaty on the Eurasian Economic Union 01.10.2019) (with amendments and additions, intro. effective from 04/05/2022). – [Electronic resource] : [signed in Astana on 05/29/2014] // Consultant Plus. Belarus / YurSpektr LLC, National Center for Legal Information. Rep. Belarus.– Minsk, 2024. (accessed: 04/22/2024). (In Russian).

9 Agreement between the Government of the Republic of Belarus and the Government of the Russian Federation on the completion of unification and creation of a unified system of tariff and non-tariff regulation in the Union State dated January 29, 2001// National Register of Legal Acts of the Republic of Belarus, 2002, No. 41, 3/335. (In Russian).

CHAPTER 3

Modern Directions of Economic Cooperation Between the Russian Federation and the Republic of Belarus

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Abstract: This chapter examines the modern economic cooperation between the Russian Federation and the Republic of Belarus, analyzing their integration within the framework of the Union State. It explores the historical foundations and current dynamics of their bilateral relations, with particular focus on trade flows, investment patterns, and sectoral collaboration in areas such as manufacturing, energy, transportation, and education. The analysis reveals significant growth in bilateral trade turnover, which increased 2.6 times from 2005 to 2021, despite asymmetries in economic size and structure. The chapter details how Russia remains Belarus's key trading partner, accounting for nearly half of Belarus's foreign trade, while Belarus represents about 5% of Russia's trade turnover. Special attention is given to the implementation of 28 union programs across 11 sectors that form the backbone of their integration agenda for 2024-2026. The research also highlights challenges to full economic integration, including differences in institutional structures, sectoral legislation, and the predominance of the public sector in Belarus. Nevertheless, it concludes that global and regional developments, including sanctions against Russia and mutual policies of import substitution, are likely to accelerate cooperation between the two states, with digital transformation and the formation of a unified information space serving as key drivers of future integration.

Keywords: Belarus-Russia trade, Bilateral investment, Economic integration, Educational harmonization, Import substitution, Sectoral cooperation, Union State.

INTRODUCTION

Cooperation between the two states the Russian Federation and the Republic of Belarus has various prerequisites, including a common language, as well as geographical, cultural, political, and social factors, as well as deep historical roots.

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In the modern world economy, the internationalization of states is expressed in integration processes and formalized in relevant agreements. Internationalization is also facilitated by various international ratings comparing the economies of different countries Table **1**.

Table 1. The economic situation of the Russian Federation and the Republic of Belarus in 2023 in the global context, compiled by the authors based on the source.

Name of indicators	Russian Federation	Republic of Belarus
GDPonPPP $ bn.	4,649.7	202.0
GDP per capita, PPP$	31,967	21,709

(Dutta *et al.*, 2024, pp. 87 and 179)

Table **1** shows that both fraternal countries have good potential for mutually beneficial cooperation. After the collapse of the USSR, the countries continued to strengthen their relations within the framework of the activities of the CIS, then the Union State. As noted above, the signing of the agreement on the creation of the USRB in the 90s took place as part of the deepening of integration processes between these states, which are already members of the CIS.

The rapprochement of the Slavic countries was based on a willingness to cooperate more closely in various fields and increase the potential for cooperation and mutual benefit. Parameters indicating the effectiveness of such decisions are contained, first, in the statistics of trade relations[1].

Thus, over the period from 2005 to 2021, the total trade turnover between the two countries increased from $15,995.6 million up to $4, 3003,565.39 million, that is, 2.6 times since and maintains an upward trend. It should also be noted that under the conditions of Western economic sanctions against Russia, not only the division of foreign trade into “friendly” countries (including Belarus) and “unfriendly countries” took place, but also a noticeable increase in the total turnover of the Russian Federation. Thus, in the fundamental work of Alexander Knobel (Knobel&Firanchuk, 2023), it is noted that in 2022, Russia's total trade turnover amounted to $850.5 billion, and the positive balance increased to $332.4 billion. At the same time, exports reached a record level of $591.5 billion

1 Despite the fact that the Union of the Russian Federation and the Republic of Belarus has been functioning since the late 90s, statistics reflecting trade flows between the countries have been presented on the official websites of central banks since 2000. At the same time, in the period from 2005 to 2011, the balance of payments were compiled according to the MFB Methodology in the 5th edition, and with the transition in 2009 to the sixth edition of the Methodology, the recalculation of indicators was carried out until 2005. In addition, separate publications of central banks and the Standing Committee of the SG on the balance of Payments of the two countries for the period after 2021. There were none at the time of writing this monograph.

(+19.9%), and imports amounted to $259.1 billion, stabilizing at the end of 2022 at new levels: supplies from the UK and USA fell 6–7 times, from other large "unfriendly" countries by one and a half to two times; but most significantly Geographically close neutral countries Turkey and Kazakhstan have increased supplies to the Russian market.

Returning to trade with Belarus, it should be noted that due to the different sizes of the economies, the volume of trade is uneven. Russia remains a key partner of Belarus: the total foreign trade turnover of goods in 2021 amounted to $78.9 billion, of which almost half (49.9%) is accounted for by trade with the Russian Federation. The share of the Republic of Belarus in the trade turnover of the Russian Federation amounted to 4.9%.

In the period from 2005 to 2021, there was a negative balance of trade in goods and services in the balance of payments of the Republic of Belarus on an ongoing basis. The deficit of trade in goods between the Republic of Belarus and the Russian Federation has increased from $3.5 billion (5.7% of GDP) for 2020 to $7.4 billion. (10.8% of GDP) for 2021, mainly due to the outstripping growth of imports (by 44.6%) compared with the growth of exports (by 26.0%)[2].

There was an increase in exports by individual commodity groups (except fuel and energy products), which affected the supply of metals and products made from them (by $1.2 billion), chemical industry products (by $0.9 billion), machinery, equipment, and vehicles (by $0.6 billion). The most important for the Belarusian economy are supplies from Russia of mineral products (97.7%), ferrous and non-ferrous metals (73.9 and 54.6%), wood (54.1%), building materials (49.3%), machinery and equipment (40.1%).

In turn, the share of the Republic of Belarus as a consumer country of Russian goods is 4.7% of the total exports of the Russian Federation. The Belarusian market is the most significant for Russian exporters of textiles, leather raw materials, machinery, equipment, and vehicles; construction materials: the share of supplies to Belarus in the total volume of Russian exports for these commodity groups is 26.3%; 25.9%; 11.4% and 10.6%, respectively (Zhalezko *et al.*, 2020).

Exports of Belarusian goods to Russia increased by more than a quarter (by $3.3 billion), up to $16.0 billion, accounting for 23.4% of GDP and 41.0% of total exports of goods of the Republic of Belarus.

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2 Source: Balance of payments of the Republic of Belarus with the Russian Federation. The official website of the National Bank of the Republic of Belarus. –[Electronic resource]. URL: https://www.nbrb.by/bel/statistics/balpaybelrus (accessed: 02/28/2024). (In Russian).

CHAPTER 4

Some Aspects of the Main Indicators Assessment in the Context of the Complex Socio-economic Systems Development (R & D sector, HES, and the labor market) in the Russian and Belarusian Digital Economy

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Abstract: This chapter examines the assessment methodologies and indicators used to evaluate Complex Socio-Economic Systems (CSES) development in the context of Russian and Belarusian digital economies, with particular focus on R & D, Higher Education Systems (HES), and labor markets. The chapter begins by establishing the theoretical foundation of indicators and indices, explaining their importance for measuring progress toward Sustainable Development Goals. It then analyzes specific indicator systems applied to evaluate scientific and technological development, including technological equipment measures, the ICT Development Index, and various university ranking methodologies. The authors present comparative data showing the relative positions of Russia and Belarus in global technological advancement rankings, revealing significant gaps between these countries and world leaders. Special attention is given to university rankings, where Russian institutions (with Moscow State University leading) are making progress but still lag behind Western counterparts, while Belarusian universities remain in lower tiers. The chapter further explores the digitalization of educational environments through electronic information and educational resources, examining how these technologies affect institutional effectiveness and rankings. Finally, the authors review labor market indicators in the

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digital economy context, discussing various measurement approaches, including composite indices that reflect intellectual development and creative work characteristics. The research concludes that while numerous methodologies exist, each has limitations that may distort empirical findings, particularly in transformational economies like Russia and Belarus.

Keywords: Complex socio-economic systems, Digital economy, Higher education rankings, Indicators assessment, Labor market metrics, R & D development, and Technological advancement indices.

INTRODUCTION

In its most general form, the indicator is derived from primary data that do not allow correct interpretation of changes in the external and/or internal environment of an economic entity, and secondly, correctly interprets the state and/or dynamics of changes in a number of variables. Economic, social, and environmental Indicators are used when it is necessary to describe "... phenomena or conditions of the natural environment" (Laverov, 2004, p. 43); and they "... always point to something that is beyond direct consideration" (Tarasova & Kruchina, 2006, p. 127). Together with indicators in socio-economic research, it is customary to use aggregated (weighted) indicators called indices, the use of which is justified in cases where the causal relationships between variables are well understood (Laverov, 2004, p. 43-76). The use of indices and indicators is due to many reasons, such as:

- The high cost (unavailability) of direct observation of the phenomenon under study;
- The importance of decisions for forecasting or developing strategic plans.
- Facilitating access to information for different categories and groups of users.
- Standardization and unification of the exchange of scientific and technical information.
- Simplification of data analysis and interpretation of observed phenomena, *etc*. (Borodin, 2023; Dudina & Tarasova, 2022; Laverov, 2004; Zhalezko *et al*., 2022; *etc*.).

Accordingly, indicators of the development of Complex Socio-Economic Systems (hereinafter referred to as CSES) are necessary to be able to measure, track (monitor), access, and analyze the pace, dynamics, and effectiveness of the movement of countries, regions, industries, and business entities towards achieving the Sustainable Development Goals (hereinafter referred to as SDGs). Moreover, development indicators allow adjusting the strategy and tactics of achieving the SDGs. It is also important that many development indicators appear

due to the fact that often the measurement of quality of life, happiness, personal hopes and personal progress, ethnicity and cultural affiliation, appearance or intelligence are absent from the generally accepted SDG indicator system, which does not allow "... to make the concepts of a safe and equitable space for humanity and the SDGs more inclusive and comprehensive" (Custodio, *et al*., 2023, p. 1).

Currently, the most developed indicators in the scientific literature characterize the achievement of SDGs. In this regard, two methods of their construction are known:

- *Creation of a development indicators system*, where each individual indicator illustrates individual aspects of SDGs achievement. As a rule, economic, social, environmental, and institutional subsystems of indicators are distinguished.
- *Development of an integral (aggregated) indicator* or index that allows assessing the degree of sustainability of socio-economic development. Usually, the aggregation of indicators is implemented based on three groups of CSES indicators: environmental, ecological-economic, and ecological-socio-economic (Laverov, 2004, p. 43-76).

With regard to such CSES as R & D, higher education, and the labor market in the context of digitalization, it should be noted that, on the one hand, these systems are reflected in separate SDGs indicators, for example:

A. Social indicators. Promoting education, training, and public awareness;
B. Human Development Index (HDI) that evaluates the level of average achievements of a country by three indicators: 1) a long and healthy life; 2) knowledge; 3) a decent standard of living (Tarasova & Kruchina, 2006, p. 138).

On the other hand, these CSES (R & D, higher education, and the labor market in the context of digitalization), due to their complexity, have their own indicators for assessing their development. Moreover, in the context of the development of the knowledge economy and the information society, the indicators of R & D and higher education are often considered together (Chugunov, 2011).

For example, to determine the place of a country in the world ranking of scientific and technological development, you can use two "sets" of indicators:

- Knowledge intensity (input parameters, which usually include the share of R & D expenditures in the country's GDP; the absolute number of researchers; the specific number of researchers in the country);

CHAPTER 5

Assessment of the Development Processes of Complex Socio-economic Systems in the Digital Economy of the Union State

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Abstract: This chapter examines the fundamental challenges in assessing Complex Socio-Economic Systems (CSES) within the digital economy of the Union State of Russia and Belarus. The analysis demonstrates that conventional approaches seeking to reduce CSES to a limited set of key indicators inevitably result in incomplete and often inadequate system descriptions. Using a mathematical model of migration between two countries as an illustrative case study, the research reveals how behavioral characteristics significantly influence system dynamics, producing dramatically different equilibrium states depending on migration preferences. The findings clearly establish that proper characterization of CSES requires not discrete numerical indicators but functional dependencies that capture the nonlinear, synergetic nature of these systems. This work contributes to the emerging understanding that complex socio-economic processes must be analyzed through the lens of nonlinear dynamics, accounting for behavioral factors and potential instabilities that can result in unexpected systemic responses to minor perturbations.

Keywords: Behavioral characteristics, Complex socio-economic systems, Digital economy, Functional dependencies, Migration modeling, Nonlinear dynamics, Union State of Russia and Belarus.

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INTRODUCTION

As it is well known, the definition and assessment of the objects' states of an economic system help to identify its level of development and enable operational corrections to shortcomings and the qualitative and quantitative improvement of the state of the object. This corresponds to the information materials of the KOMGOR project, "assessment is a systematic observation of an object and collection of data on it according to predetermined indicators for the purpose of further determining the value or dignity of this object according to certain criteria"[1].

According to the well-known quality management rule of the "lucky seven"[2], the average person controls 7±2 different factors, so the desire to simplify the description of Complex Socio-Economic Systems (CSES) as much as possible by reducing the tremendous set of their parameters to several (or even one) characteristics (indicators) is easy to explain psychologically. Consequently, an analysis and assessment of key indicators of CSES is a completely understandable task, allowing for identifying the key features of the methodology for their calculation and determining their advantages and disadvantages. Ultimately, the goal of such analysis is to establish the patterns of CSES's development.

The contemporary scientific literature available to us presents a set of indicators characterizing the achievement of Sustainable Development Goals (SDGs) of regions and countries. In addition, some consulting companies and rating agencies are developing their own indicators, tools, methods, and techniques for measuring the levels of scientific and technological development and digitalization of countries and individual sectors of national economies (for example, labor markets, HES, and R & D markets).

However, based on the key position of sustainable development as a driving factor of economic growth, social responsibility, and ecological balance[3], sooner or later, an understanding of the following points comes:

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1 Source: Information materials of the KOMGOR project. Criteria and indicators for assessing the effectiveness of stakeholder participation in the urban governance process using public discussions as an example. – [Electronic resource]. URL: https://ekapraekt.by/wp-content/uploads/2019/12/Infomaterial_Kovalkin1-min.pdf. – (date of access: 15.04.2024). (In Russ.).

2 As it is known, G.V. Miller derived the rule of the "lucky seven" (taking into account individual capabilities 7 ± 2), which suggests that in the learning process, by limiting information to the lower limit (5), the teacher will avoid general fatigue of the audience, but may cause discontent among "excellent students" (gifted listeners).

3 Source: Agenda for Sustainable Development. – [Electronic resource]. URL: https://www.un.org/sustainabledevelopment/ru/about/development-agenda/ (date of access: 18.07.2024). (In Russ.).

Firstly, E.N. Knyazeva notes: "This idea is directly related to the understanding of the world from the standpoint of nonlinear dynamics and synergetic—a complex, nonlinearly developing world, full of instabilities, crises and catastrophes, a world that very often presents us with surprises and whose future is open" (Knyazeva,2009, pp. 108-109). Similar positions on the nonlinear nature of the development of the CSES are also expressed by other authors (Ansoff, 1989; Bengraf *et al.*, 2024; Ermicheva, 2008; Lazimov and Nazarov, 2023; Pasmurtseva, 2020, among others).

Accordingly, for the socio-economic systems considered in this monograph (labor markets, HES, and R & D), *complexity is the essence of these kinds of systems, as CSES*. Therefore, by limiting the variables to only those 'key' factors proposed by a specific model, there is a risk of discarding essential data alongside the irrelevant information. Recent history is replete with cases demonstrating what happens when, for example, purely economic parameters are emphasized while social, cultural, historical, religious, and psychological characteristics of the inhabitants of certain territories are ignored.

Secondly, it is understood that an attempt to reduce the description of a complex system to several characteristics (indicators) is a path to "nowhere", *since the parameters and variables that describe CSES are not numbers, but functions.*

Indeed, from a synergetic position, sustainable development of systems is a self-sustaining and self-organizing development. If we talk about the CSES, then this is a development in which "... humanity as a whole and in each of its representatives shows concern for the future, constructs a desired future in which future generations should have starting conditions of life no worse than those of the current generation" (Knyazeva,2009, p. 109). It becomes obvious that in a synergetic context, the development of the CSEC cannot be described by finite set of "numbers" (indicators), but only by functions. This is very unusual (especially in the context of the economy of the USRB) and quite complex (even mathematically), and requires much more information and consideration of the behavioral aspects of the CSEC.

In connection with this, the authors[4] of a study made an attempt to implement some illustrations of the above-mentioned problems of evaluating key indicators of the development of complex socio-economic systems in the digital economy of the USRB.

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4 It should be noted that the key role in the development of the idea and content of this section of the monograph belongs to Professor E.V. Sinitsyn.

CHAPTER 6

Innovative Infrastructure of the Union State of the Russian Federation and the Republic of Belarus as A Key Factor of Import Substitution and Development in new Economic Conditions

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Abstract: This chapter examines the innovative infrastructure of the Union State of the Russian Federation and the Republic of Belarus as a critical factor for import substitution and economic development under new economic conditions. The research provides a comprehensive analysis of the concept of "Innovative Infrastructure" (InIn), from broad to narrow interpretations, and presents the authors' definition as "a system that includes the totality of all participants, relationships, products, resources, and types of innovative activities at the level of the world, countries, regions, and firms." The study traces the development of innovative infrastructure in both countries, highlighting the concentration of InIn elements in Russia's Central and Ural Federal Districts and the significant growth of technology parks from 101 in 2014 to 269 in 2019. Similarly, in Belarus, the authors note the successful implementation of the State Program of Innovative Development, which has established an effective network of science and technology parks, technology transfer centers, and other innovation subjects. Particular attention is given to universities as crucial elements of the innovation ecosystem in both countries. The chapter identifies key challenges for university-based InIn business entities, including short-term planning, sanctions

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pressure, and dependence on foreign investments, while also highlighting promising development forms such as business incubators and technology transfer centers. The research emphasizes the critical role of innovative infrastructure in import substitution efforts initiated since 2014 in Russia and recently intensified in Belarus. It outlines state mechanisms implemented in both countries to reduce dependence on foreign technologies and create domestic innovative enterprises. The chapter also identifies nine key factors hampering import substitution policies, with expert surveys revealing the most significant challenges as a lack of domestic investment, low management efficiency, and a shortage of qualified engineers. The authors conclude by proposing six strategic directions to enhance the effectiveness of import substitution policies for high-tech innovative products and services, including technology development, cluster organization for accelerated technology transfer, personnel training, targeted financing, improved public administration, and regulatory framework development.

Keywords: Innovative infrastructure, Import substitution, Industrial clusters, Technological sovereignty, Technology parks, Union State, University innovation.

INTRODUCTION

In modern scientific literature, there are different approaches to the definition of "Innovative Infrastructure" (InIn): from a "broad approach" (it is a conglomerate of all structures, buildings, bridges, transport systems, roads, logistics services, information networks and other systems necessary for the functioning and development of a set of innovative structures of companies and start-ups that promote the development of innovative activities in the country and/or in the region)[1] up to a "narrow approach" or a system consisting of a set of objects that contribute to the implementation of either the entire innovation chain (innovation cycle) at the level of regions or the country as a whole, or its separate stage—commercialization of developments (Kuznetsova, 2015, p. 222).

It is also important that the regulatory framework of the Russian Federation[2] and the Republic of Belarus[3] contains strategic documents, which present such

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1 Sources: Bengraf, *et al*., 2024; KorolevaandYermoshina (2014); Kuznetsova, 2015.; *etc*.

2 The strategy of innovative development of the Russian Federation for the period up to 2023. Approved by the Decree of the Government of the Russian Federation dated December 8, 2011 No. 2227-R. URL: https://z-motiv.ru/strategiya-innovatsionnogo-razvitiya-rf-do-2023-goda / (accessed: 14.12.2023). (In Russ.).

The concept of long-term socio-economic development of the Russian Federation for the period up to 2020 (approved by the decree of the Government of the Russian Federation dated November 17, 2008 No. 1662-r). URL: https://www.garant.ru/products/ipo/prime/doc/94365 / (accessed: 14.12.2023). (In Russ.).

Federal Law on Science and State Scientific and Technical Policy. dated 08/23/1996 N 127-FZ (last revision) on August 23, 1996 N 127-FZ. Adopted by the State Duma on July 12, 1996. Approved by the Federation Council on August 7, 1996. URL: https://www.consultant.ru/document/cons_doc_LAW_11507(accessed: 14.12.2023). (In Russ.).

The draft Strategy for Scientific and Technological Development of the Russian Federation until 2035 was prepared by the Center for Strategic Research Foundation on the instructions of the Ministry of Education and Science of the Russian Federation on May 5, 2016. URL https://strategy24.ru/files/uploads/cd2a43226e0ec13b325e4ff331e428c7.pdf (accessed: 14.12.2023). (In Russ.).

definitions as: “innovation”, “innovative product”, “Innovative Infrastructure”, *etc*., as well as identify priority areas for the development of InIn and RandD in the USRB.

After analysing various Russian, Belarusian, and foreign sources, we came to the conclusion that the “*Innovation Infrastructure*” is a system that includes the totality of all participants, relationships, products, resources, and types of innovative activities at the level of the world, countries, regions, and firms (author's interpretation) (Astratova *et al*., 2024). It can also be said that the innovation infrastructure consists of an interconnected set of innovation systems, implying networks of interaction between business units (firms), universities, and development institutes, research centers, support infrastructure, and other contractors within the framework of the innovation process.

It should be noted that there is not enough information in the public domain about the development of innovation infrastructure in both Russia and Belarus. Thus, in a continuous study of the subjects of the Russian Federation, it was revealed that at the beginning of 2016, the number of active InIn elements in the subjects of the Russian Federation amounted to 1,693, about two hundred more were at the stage of formation (Eferina *et al*., 2017). By 2016, the maximum concentration of InIn elements was observed in the Central Federal District, where a significant part of industrial production and scientific complex is located (548 units), as well as in the Ural Federal District, where 88 units of InIn are localized (Eferina *et al*., 2017, p. 195). The following types of economic activity are most in demand in the current economy (Feringa *et al*., 2017, pp. 197-198):

- Information and communication technologies, business incubators, educational centres; these areas are usually combined with the sphere of consulting services.
- Techno parks, territorial clusters, technology transfer centres, industrial parks, engineering centres, territories of innovative development; these areas are implemented in projects of the manufacturing industry and mechanical engineering.

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3 Decree of the President of the Republic of Belarus dated January 31, 2017 No. 31 "On the State Program of Innovative Development of the Republic of Belarus for 2016-2020" // ETALON Information Search system [Electronic resource] / National Center for Legal Information of the Republic of Belarus. (accessed: 19.02.2024). (In Russ.).

Decree of the President of the Republic of Belarus No. 1 dated 03.01.2007 (with amendments and additions dated 08/01/2022 No. 265) "On approval of the Regulations on the procedure for the creation of innovative infrastructure entities." URL: https://president.gov.by/bucket/assets/uploads/documents/2022/265uk.pdf (accessed: 14.12.2023). (In Russ.).

The National Strategy for Sustainable Socio-economic Development of the Republic of Belarus until 2030. – Approved by the Presidium of the Council of Ministers of the Republic of Belarus No. 10 dated 05/02/2017. URL: https://economy.gov.by/uploads/files/NSUR2030/Natsionalnaja-strategija-ustojchivogo-sotsialno-ekonomicheskogo-razvitija-Respubliki-Belarus-na-period-do-2030-goda.pdf (accessed: 14.12.2023). (In Russian).

CHAPTER 7

Public Management of the USRB Innovation Infrastructure in the Digital Economy

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Abstract: This chapter examines the public management of innovation infrastructure in the Union State of the Russian Federation and the Republic of Belarus (USRB) within the context of the digital economy. Through comparative analysis of R & D and higher education sectors in both countries, the research identifies key challenges and opportunities for enhancing scientific and technological development. The study reveals that despite significant investment in R & D (1.1% of GDP in Russia and 0.8% in Belarus), both countries face declining effectiveness of research outputs, with patent applications decreasing by approximately 41% in Russia and 50% in Belarus from 2015 to 2022. Survey data from experts, government officials, and students highlight three critical factors for transforming university research into practical innovations: cooperation with enterprises, adequate compensation for scientists, and creation of coordinated R & D market databases. The chapter also analyzes the impact of digitalization on higher education, noting a positive trend in student interest in technology-related programs, with enrollment increasing from 25,000 to 68,000 in Russia and from 12,000 to 30,000 in Belarus between 2020 and 2023. The findings underscore the need for strategic reforms in taxation policies for businesses implementing R & D results, improved financial support for scientific laboratories, and stronger synergy between higher education, R & D, and labor markets to unlock the full potential of digital innovation in the USRB.

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Keywords: Digitalization, Higher education transformation, Innovation infrastructure, Public policy, R & D management, Technological development, USRB.

INTRODUCTION

In recent years, the Union State of the Russian Federation and the Republic of Belarus (USRB) has increasingly acknowledged the important role of the state in governing R & D and higher education in the context of the restructuring of the labor market relating to digitalization, as well as economic purposes of stimulating economic growth and gaining international competitiveness for the country (Astratova *et al.*, 2024; Bogdan *et al/.*, 2020). While the research sector of the Union state contributes meaningfully to supporting various sectors of industry (Petrov, *et al/*, 2022), it also imposes a pressing need to develop and implement sectoral policy instruments in the state sector that promote greater research collaboration, increased research funding, and better commercialization of researchers based results for optimal impact in relation to economics (Astratova, 2023b; Ferile, *et al/*, 2008; Smith and Jones, 2020; Znamensky, 2012).

As we already mentioned, the Russian Federation is keen to turn its attention to the area of innovation, which is evidenced by a series of regulatory documents. For example, the Strategy of Innovative Development of the Russian Federation for the period up to 2023 (hereinafter referred to as the Strategy) [1] is developed on the basis of the provisions of the Concept of Long-term Socio-economic Development of the Russian Federation for the period up to 2023[2] and takes account of the Federal Law "On Science and State Scientific and Technical Policy"[3] stipulating that the Strategy is developed to respond to challenges confronting Russia in the area of innovative development, to specify the aims, priorities, and mechanisms of state innovation policy. The Strategy also establishes guidelines for long-term development for subjects of innovation activity, guidelines for financing the area of fundamental science and applied science, and support for the commercialisation of developments. Moreover, the

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1 The strategy of innovative development of the Russian Federation for the period up to 2023. Approved by the Decree of the Government of the Russian Federation dated December 8, 2011 No. 2227-R. URL: https://z-motiv.ru/strategiya-innovatsionnogo-razvitiya-rf-do-2023-goda/ (accessed: 12/14/2023). (In Russ.).

2 The concept of long-term socio-economic development of the Russian Federation for the period up to 2020 (approved by the decree of the Government of the Russian Federation dated November 17, 2008 No. 1662-r). URL: https://www.garant.ru/products/ipo/prime/doc/94365/ (accessed: 12/14/2023). (In Russ.).

3 Federal Law on Science and State Scientific and Technical Policy. dated 08/23/1996 N 127-FZ (last revision) on August 23, 1996 N 127-FZ. Adopted by the State Duma on July 12, 1996. Approved by the Federation Council on August 7, 1996. URL: https://www.consultant.ru/document/cons_doc_LAW_11507/(accessed: 12/14/2023). (In Russ.).

Strategy is based on the results of a total assessment of a nation's innovation potential coupled with a long-term scientific and technological forecast. The provisions of the Strategy are to be acknowledged whenever concepts and programs for the socio-economic development of Russia are developed.

A draft Strategy for Scientific and Technological Development of the Russian Federation[4] until 2035 has also been developed, providing scenarios and mechanisms for innovative development, as well as the choice of priority areas of economic activity in the Russian Federation, including:

- Focus on global, "big challenges" facing the country and society, and enshrined in regulatory documents.
- Finding opportunities for both large-scale socio-economic development and potential threats and risks of a systemic nature.
- Obtaining new results with scientific novelty and based on the development of radically innovative technologies.
- Striving for long-term planning, development, and implementation of large-scale projects based on cross-country cooperation, interdepartmental, and interdisciplinary research.

Therefore, the main directions of development of the Russian Federation in R & D focus on both the thematic focus of research and development and on including an indicator of the mission and purpose of that research and development in terms of solving the most important social and state problems or of enabling an opportunity for social and economic development.

With respect to the Republic of Belarus, it is a country that has presently chosen the intellectual route of development as a path. The Scientific Strategy of the Republic of Belarus, for instance, defines the period that will last until 2040. The main predictions of the future intellectual economy, the main objectives of state policy on science and innovation, the tools to stimulate the scientific and technological development of the national economy and the predicted results of the implementation of the Strategy, will allow the country to reach a global level of competitiveness in a number of areas on the base of the development of innovative technologies, intellectualisation and digital industrial revolution.

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4 The draft Strategy for Scientific and Technological Development of the Russian Federation until 2035 was prepared by the Center for Strategic Research Foundation on the instructions of the Ministry of Education and Science of the Russian Federation on May 5, 2016.URL https://strategy24.ru/files/uploads/cd2a43226e0ec13b325e4ff331e428c7.pdf(accessed: 12/14/2023). (In Russ.).

CHAPTER 8

Identification of Bottlenecks Limiting The Effectiveness of Public Administration in HES and R & D Sectors in Russia and Belarus

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Abstract: This chapter investigates the key challenges and "bottlenecks" limiting the effectiveness of public administration in Higher Education Services (HES) and Research and Development (R & D) sectors in Russia and Belarus. Through a comprehensive analysis of World Bank and United Nations data on e-government development, corruption control, public administration effectiveness, and educational expenditures, the research identifies systemic inefficiencies affecting these knowledge economy sectors. The study employs correlation analysis and expert surveys (N=83 for Russia; N=25 for Belarus) to evaluate the impact of global trends—scientific-technological progress, budget sequestration, and decision-making optimization—on sectoral governance. Findings reveal that while both countries demonstrate positive attitudes toward digital transformation in public administration, Belarus significantly lags behind Russia in harmonizing with global trends in HES governance. The research identifies bureaucratic inefficiency, corruption, and insufficient digital competencies among civil servants as primary bottlenecks hindering effective public administration. Despite fluctuating government expenditures on HES and R & D in both countries, the e-Government Development Index (eGDI) shows gradual improvement, indicating positive trends toward digital governance. The study concludes that priority reforms should focus on enhancing transparency, accountability, and citizen representation in government bodies to improve management efficiency and institutional development in the knowledge economy sectors.

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Keywords: Bureaucratic bottlenecks, Digital transformation, E-government, Higher education services, Knowledge economy, Public administration, Research and development.

INTRODUCTION

The "knowledge economy" as a special branch of the national economy, which is formed by the R & D services sector and the higher education services sector, is one of the most difficult objects of implementing the sectoral principle in public administration (Astratova, 2023b). Sector HES plays a very special role in the knowledge economy, since the final stage of formal education is being implemented in the HES system (Astratova *et al*., 2022; Astratova *et al*., 2021; Panikarova *et al*., 2020; Tatarkin and Pilipenko, 2007), and also because HES has a dual content, being at the same time a socially significant good and the totality of the competencies of professional development, both of an individual and of the whole society (Astratova, 2023b, p. 3).

From the point of view of systems theory, the public sector is a complexly integrated organizational structure and has interrelated components that interact both internally and externally (Economics in Context Initiative, 2021; Eucken, 1990; Felício *et al*., 2021). Consequently, the "knowledge economy" industry and its main elements (higher education and R & D) are the basis for analyzing the complex relationships between key stakeholders, policies, resources, and processes.

It should be noted that in the HES sector, systems theory is one of the tools used to understand the problems existing at the university, including insufficient funding, differentiated teaching levels, poor-quality infrastructure, *etc*. A systematic approach is especially relevant in the implementation of innovative technologies and the creation of innovative infrastructure, where universities play a crucial role (Abiona and Sodeinde, 2022; Vasiliev *et al*., 2020). At first glance, it seems that these problems are not interconnected, but in fact, they are interconnected and hinder effective public administration in providing high-quality education. The main task of systems theory is to ensure the integrated and systematic provision of educational services that eliminate structural gaps, collaboration of participants, and policy coherence to achieve better results, which applies to HES as well. We find similar positions on this issue in the works of other researchers (Vasiliev *et al*., 2020; Helbing, 2012).

It should also be noted that in addition to systemic approaches to public administration at the end of the 20th century, the scientific literature began to talk about the need to reform the public sector, in connection with which such terms as "new public administration" appeared, as well as new models of this

management: “Public Administration”, “New Public Management”, “NPM” and “Good Governance”, *etc*. (Barabashev, 2016; Dolgikh, 2017; Maratova, 2022; Pollitt and Bouckaert, 2000). This led to the consistent reform of the public sector in the OECD countries, starting in the 90s of the XX century (Pollitt and Bouckaert, 2000). In order to improve the efficiency of work in public institutions, focus on results and strengthen public sector accountability (Hood, 1995).

The popularity of the concept of “New Public Management” (NPM) has led to the industry application of this public administration tool, including in the HES system. This led to the emergence of the term: “new public administration of higher education” (Shibanova, 2023). Moreover, the role of higher education in society has increased so much that by now they are talking about its new positioning (“repositioning” or “repositioning”) (Broucker, 2022).

Despite the generally recognized importance of the HES and R & D sectors, public administration in these branches faces serious challenges in the Russian Federation and the Republic of Belarus. It is known from the practice of other countries that inefficiency of bureaucracy, corruption, and political interference are the main obstacles to effective governance, constraining innovation in research initiatives (Agbazuere, 2020; Inakefe *et al*., 2021; Olojede and Ann, 2023). Similarly, the problems of Russian public administration include issues of legitimacy, corruption, efficiency of bureaucracy, and digitalization, which focus on the difficulties faced in the process of transforming social institutions and achieving economic results under global pressure (Avdeev D.A., 2021; Borenstein and Pozdnyakova, 2022; Nemeryuk *et al*., 2020). In the Republic of Belarus, the problems facing public administration cover a number of issues, including digital development in the knowledge economy[1], as well as corruption, the effectiveness of administrative and tort policies[2], the dynamics of relations with the Russian Federation and the transition to the principles of sustainable development, the implementation of which requires comprehensive strategies for managing political dynamics and promoting effective development (Gavrikov, 2022; Palchik *et al*., 2020; Pilgun and Leshenyuk, 2021).

Accordingly, our research is aimed at identifying “bottlenecks” that limit the effectiveness of public administration in the Russian Federation and the Republic

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1 The concept of digital transformation of processes in the education system of the Republic of Belarus for 2019-2025. Approved by the Minister of Education of the Republic of Belarus I.V. Karpenko on March 15, 2019. (Electronic resource). URL: https://crit.bspu.by/wp-content/uploads/2021/08/concept.pdf (accessed 03/25/2024). (In Russ.).

2 Tort policy is a system of concepts, ideas and views on legal and organizational and tactical issues of combating administrative offenses.

CHAPTER 9

Economic Mechanisms for Stimulating the Scientific and Innovative Activity of the USRB

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Abstract: This chapter examines the economic mechanisms for stimulating scientific and innovative activity within the Union State of Russia and Belarus (USRB). The authors analyze three primary theoretical frameworks for understanding economic mechanisms: mechanistic, process-based, and institutional approaches. Through expert surveys conducted in early 2024, the study reveals that experts from both countries overwhelmingly support building the economic mechanism on mutually beneficial relations (89.81% of Russian and 96.43% of Belarusian respondents). The research identifies four key development scenarios for the USRB economy: socio-economic integration, diversification of foreign economic activity, creation of a unified scientific-educational space, and constitutional reform. The majority of experts (48.15% Russian, 39.62% Belarusian) view socio-economic integration as the most likely development path, with significant support for unified scientific space formation (25% Russian, 26.42% Belarusian). The study extensively analyzes the evolution of innovation models from the original "Triple Helix" (university-government-business) to expanded models incorporating society ("Quadruple Helix") and environmental factors ("Quintuple Helix"). These models are examined as frameworks for innovation policy and regional development strategies, with particular attention to their applicability in developing countries like Russia and Belarus. Expert survey results indicate strong consensus (89.81% Russian, 96.43% Belarusian) that the innovative infrastructure management mechanism for USRB universities should integrate four key elements: government, universities, industrial enterprises, and student youth. International cooperation between the fraternal countries is identified as the crucial catalyst for creating synergistic effects in this integrated system. The chapter emphasizes the

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critical role of higher education institutions in driving innovation and economic development, proposing a comprehensive economic mechanism that aligns scientific and innovative activities with sustainable regional development goals.

Keywords: Economic mechanism, Innovation management, Regional economic integration, Scientific development strategy, Triple Helix model, Union State of Russia and Belarus, University innovation infrastructure.

INTRODUCTION

The essential content and development of the economic mechanism for the development of national economy facilities is one of the key and actively controversial issues, the relevance of the study of which does not weaken over time.

This is due, in our opinion, to two reasons: 1) the relative novelty of the use of the term "economic mechanism" and 2) the ambiguity of the interpretation of its content, based on mechanistic concepts, process, and institutional approaches. This allows us to imagine the evolution of the category of "economic mechanism" as a sequence of "mechanistic", "process", and "institutional" concepts (Table **1**).

Table 1. Analysis of the concepts of "economic mechanisms" proposed by various researchers, in the author's interpretation (Bengraf *et al.*, 2024, p. 189).

Name of the concept	Description of the concept
1. The mechanical concept	The possibility of obtaining a positive effect from the use of various resources is described. The technical analogue is movement, a gain in effort when using mechanical tools.
2. Process approach.	The "mechanism" (the 1st element of the process) is considered, which allows using "control" (the 2nd element of the process) to implement the function of the process (the 3rd element of the process), that is, to convert the "input" into "output". The essence of an economic mechanism is defined as a set of economic resources and ways of their interaction for the implementation of a specific economic process.
3. Institutional approach.	When developing an economic mechanism, the focus is not on purely economic issues, but on the interrelation of economic problems together with non-economic factors: social, political, ethical, and legal problems.

From Table **1**, it can be concluded that the Economic Mechanism (EM) is an instrument of the economic laws of social reproduction, that is, production, exchange, distribution, and consumption. There are other ideas about the essence of EM in the literature, which were discussed in more detail in our earlier study (Bengraf *et al.*, 2024).

The results of our expert survey[1] show that the economic mechanism for the development of the Union State of Russia and Belarus should be based primarily on building mutually beneficial relations with a fraternal country—89.81% of respondents from the Russian Federation and 96.43% of respondents from the Republic of Belarus answered in the affirmative (Fig. **1**).

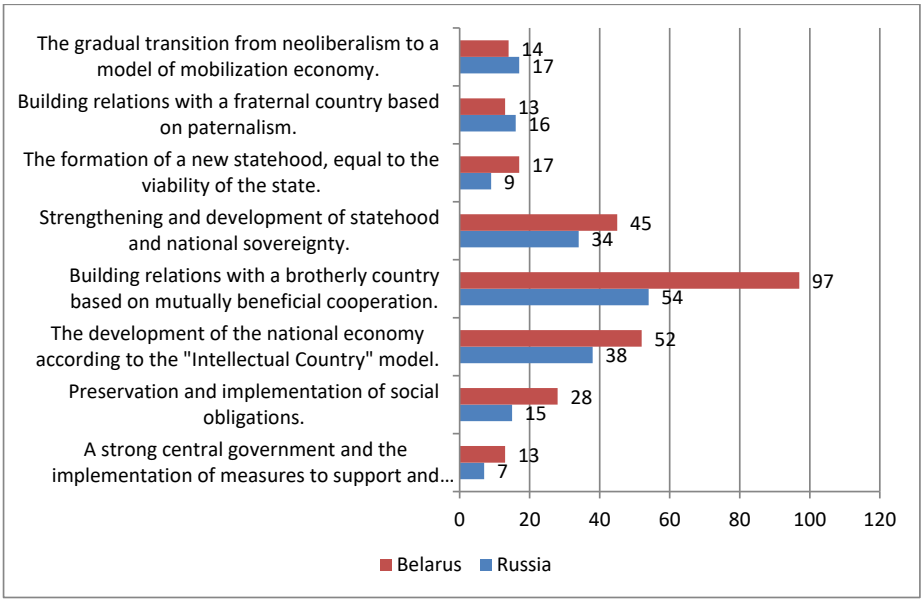

Fig. (1). Experts' answers to the question: "The mechanism of development of the Union State of the Russian Federation and the Republic of Belarus should be based on such tools as ... ", people; multiple choice is possible in the answers of respondents.
(*N_{RF}=111; n_{RF} = 108; N_{RB}=58; n_{RB}= 56; K_k = 0.21; K_c = 0.86)*

At the same time, the development of the national economy according to the "Intellectual Country" model also took very high positions: second place in the rating of responses, or 48.15% of respondents from the Russian Federation who answered in the affirmative, and 67.86% of respondents from the Republic of Belarus. Finally, the third position in the respondents' responses belongs to the strengthening and development of statehood and national sovereignty, respectively, 41, 67% and 60.71%.

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1 In January-April 2024, a survey of experts (university professors, research institute employees and heads of innovative enterprises) and government officials using Google docs, WhatsApp and Vkontakte was conducted.
The data of the Belarus responses were obtained based on the distribution of links to questionnaires in Google docs by e-mail and social networks and processing in Statistica.

CHAPTER 10

Indicative Planning in the Process of SMA's Management of Innovation Activity at the USRB

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Abstract: This chapter examines the role of indicative planning in managing innovation activities within the Union State of the Russian Federation and the Republic of Belarus (USRB). The research investigates how scientific activity and knowledge generation influence innovation systems' effectiveness. Through comprehensive analysis of economic indicators and econometric modeling, the study identifies significant correlations between scientific performance indicators (capital expenditures on R & D, internal R & D costs, patents for inventions, and utility model patents) and innovation activity metrics (costs of innovative activities, advanced manufacturing technologies used, volume of innovative goods and services, and developed advanced technologies). The findings confirm that scientific activity has a strong, sustainable impact on business entities' innovation performance, providing a solid foundation for indicative planning by state and municipal administration bodies. The developed econometric models offer practical tools for forecasting and strategic management of innovation infrastructure within the USRB.

Keywords: Econometric modeling, Indicative planning, Innovation management, Innovation systems, Knowledge economy, Scientific activity indicators, Union State of Russia and Belarus.

INTRODUCTION

One of the most important tasks facing the SMA management of the Union State of the Russian Federation and the Republic of Belarus is to achieve long-term development goals of ensuring a high standard of living for the population and the dynamic progressive development of all sectors of the economy. This vector of

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development is impossible without switching to an innovative type of development.

In this regard, the most important task facing the SMA management at the USRB, as we have already noted earlier[1], is the creation and effective functioning of an innovative infrastructure consisting of a set of innovative systems. The effective functioning of innovative systems is possible provided that innovative projects are implemented in a timely manner that meet the requirements of the external and internal environment and contribute to building up their own potential with the orientation of the company's activities for a long-term development perspective. The realization of the scientific potential of economic entities contributes to increasing the importance and role of R & D in their innovative activities. The results of scientific activity are becoming a decisive factor for obtaining long-term profits and productivity of an economic entity in a knowledge-based economy, as more and more organizations define their core competencies in the field of intangible assets.

In these conditions, the use of indicative planning tools becomes especially important—that is, the activities of SMA bodies to make forecasts and targets for output based on the use of a system of economic indicators (Andryushkevich, 2012; Nielsen, 2008; Nove, 1987, *etc.*). It should be noted that indicative planning is carried out by the state in an attempt to solve the problem of asymmetric information in a market economy through the coordination of investments by the state and private investors, based on forecasts and output targets. The final plans are aimed at obtaining valuable information from an economic point of view. As a result, this information acts as a public good, which is especially important for those cases when: a) the market cannot independently disseminate this information, and b) viable markets have yet to emerge. Accordingly, indicative plans will complement market information and serve to expand the market, but do not replace the market mechanism. That is why indicative plans are widely used in both market and mixed economies (Nielsen, 2008). When using indicative planning to influence the economy, the state uses such basic tools of "influence" as subsidies, grants, and taxes, but does not use tools of "coercion" in relation to economic entities (Nove, 1987). Moreover, indicative planning contrasts with directive or mandatory planning, when SMA bodies set quotas and mandatory requirements for production volume.

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1 See section 1.4.1. of this monograph.

It should be emphasized that in modern conditions, due to the strengthening of the position of private business and increasing the stability of market mechanisms, the method of indicative planning has become less frequently used. At the same time, targeted programs (strategies) and forecasts for the development of certain strategically important industries are used by SMA bodies as a very effective management tool.

Since the development of the knowledge economy and the creation of a unified scientific and technological space of the SRB is a pressing task of our time, it is therefore relevant to use indicative planning tools by SMA bodies to identify and assess the impact of the intensity of scientific activity in terms of generating fundamental knowledge on the effectiveness of innovative systems.

As we have already noted in previous sections[2], as a result of numerous scientific studies, it has been proven that innovations currently play an important role in the competitiveness of economic agents at all levels of management. The importance of innovations focused on the sustainable development of economic agents increases every year. However, the costs of innovative projects can pay off and contribute to economic development only if these projects are based on the results of serious scientific research (Siegel *et al.*, 2004).

According to Noack and Jacobsen (2021), in recent years, there has been an increasing relevance of scientific knowledge for production, requiring new tools to establish closer relations between the academic community and industry.

Also, in a study by Fayyaz *et al.* (2021), it was proven that the processes of knowledge generation and exchange between employees of an organization lead to faster innovation in organizations. As a result of the research conducted by these researchers, it was proven that the processes of knowledge generation and exchange are strongly related to the effectiveness of innovation in an organization (Fayyaz *et al.*, 2021).

Thus, we can conclude that, despite the importance of knowledge generation processes for the development of innovative systems, which has been repeatedly shown in numerous scientific publications (Kaihua and Mingting, 2014; Rajnoha, *et al.*, 2019; Secundo, *et al.*, 2016), the assessment of the impact of scientific results on innovation The activity of economic entities today is beyond the achievements of modern economics. Moreover, the assessment of the impact of the results of scientific activity on the innovative activity of business entities is

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2 See Chapter 1.4 of this monograph.

CHAPTER 11

The Challenges of Creative Human Capital in the Digital Economy

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Abstract: This chapter examines the evolving concept of creative human capital in the context of the digital economy and the fourth industrial revolution. As technological breakthroughs in artificial intelligence, robotics, and other digital technologies transform the labor market, there is a growing demand for workers with cognitive skills and creative thinking. The study explores how creative human capital becomes a strategic resource for social development, with particular focus on the health sector in the Russian Federation and the Republic of Crimea. The research analyzes the socio-technological infrastructure that supports creative human capital formation, identifies the challenges in the health sector workforce, and proposes strategies for enhancing productivity through creative human capital management. Special attention is given to the integration of the sanatorium-resort complex with the healthcare system in Crimea, highlighting its role in regional economic development and public health improvement.

Keywords: Creative human capital, Digital economy, Fourth industrial revolution, Healthcare workforce, Regional development, Socio-technological infrastructure, Sanatorium-resort complex.

INTRODUCTION

As it is well known, in the conditions of socio-economic development based on creation and application of digital technologies, society has defined trends of development of such technological breakthroughs as: artificial intelligence, the Internet of things, fully automated production, robotics, virtual and augmented reality, information storage and storage technologies, nanotechnology, and biotechnology *etc*. (Astratova, *et al*., 2022; Bengraf, *et al*., 2024).

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So, there is a gradual transition of the economy and society into the fourth industrial revolution. One of the features of the fourth industrial revolution is the appearance of supercomputers and robots, which allow the replacement of human labor by complex work performed by automated intelligent machines, and can further lead to job reductions while creating new ones. It's going to be targeted at people with cognitive skills and creative thinking. Thus, the concept of «creative human capital» is being introduced into the digital economy. The fact is that sectors such as industry, medicine (*e.g*., nanotechnology), financial and economic systems that use blockchain technologies are adopting digital currencies (cryptocurrencies) among the first to adopt new digital technologies (Yanovskaya and Simchenko, 2024).

At the same time, the digital economy is contributing to all positive factors and negative ones that need to be regulated at the state level (Astratova and Bekshaev, 2024; Astratova, 2023b; Bogdan *et al*., 2020; *etc*.). For example, the increased role of cybersecurity involves collecting and storing a huge amount of information, both personal and public. In addition, digital technologies and tools directly influence the transformation of labor markets and social-labor relations.

Let's note that the global world community is living an amazing time; a time of digitalization, in which innovations are being formed and implemented, inventions based on digital technologies and, therefore, in the future, the usual social life and activities will change radically: new methods and technologies applied in the management of organizations will appear, human capital, people's health, education, industry, information transmission and perception *etc*. In other words, for society, we are entering a new era of creative human capital formation and development based on digital content.

In the conditions of digital society, it is human capital that becomes a strategic resource for social development, where the development vector is directed towards the intellectual and creative activities of employees. At the same time, in the Russian Federation, the process of formation and management of creative human capital is the basis of many state-directed programs and national projects. However, in these programs, the region-wide component of the socio-spatial development of human capital and its potential comes to the fore. This fact is confirmed by the results of research conducted by L.S. Mazelis, *et al*. (2018), which investigated the question of the interrelation and interconditioning of development of creative human capital and trajectories of socio-spatial development of regions, because human capital forms the conditions for improvement, innovation, acceleration and efficiency in all spheres of economic development, in other words, human capital creates the prerequisites for incre-

asing production volumes, increasing the quality of life of the population, filling federal and regional budgets of the country» (Mazelis, *et al*., 2018).

Given the rapid spread of socio-technological infrastructure, the basis for the development of an innovative and digital economy is modern knowledge that allows for the creation, development, and expansion of human capital. In the digital economy, creative human capital is of particular importance.

Such human capital factors as intelligence, health, knowledge, and quality of life, as a result of the synergistic effect, generate creative innovation and entrepreneurial activity necessary for the growth of the digital economy. The complex and distributed mechanism of interaction of factors of development of creative human capital of the region ensures the functioning of its socio-technological infrastructure. The elements of socio-technological infrastructure are the first and second-level economic spheres in the mechanism of human capital formation of the region (Ganieva, 2022).

So, the first layer of socio-technological infrastructure includes areas directly involved in human capital creation and development. The funds invested in them by the multiplier effect are reflected in the growth of human capital:

- Education and science – includes the structure of the regional educational system, staffing, and support system for scientific activities.
- Health – competence of medical workers, quality of medical services, level of preventive and diagnostic provision, and technological component.
- IT-sphere – includes availability and sufficiency of information resources, level of digitalization of the branches of economy, innovation, and progressiveness of software (Ganieva, 2022).

The second level of socio-technological infrastructure is the spheres indirectly involved in the formation of human capital, but certainly playing a significant role in its creation, namely:

- Industry.
- Agriculture and agro-technological system.
- Transport and logistics technologies.
- Recreation, tourism, and sanatorium-resort complex (Ganieva, 2022).

At the same time, the assessment of the contribution of creative human capital is characterized by objective methodological limitations in the ecosystem of the region's development. Creative human capital is capable of accumulation and reproduction; that is, it has all the characteristics of a productive factor to be

CHAPTER 12

Sectoral State Regulation of the Higher Education System in Russia and Belarus in the Context of Digitalization

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Abstract: This chapter examines the sectoral state regulation of higher education systems in Russia and Belarus within the context of digitalization. It analyzes the organizational principles of public management with a focus on sectoral, intersectoral, and territorial management approaches as applied to Higher Education Services (HES). The study explores how the knowledge economy, particularly the HES sector, functions as a critical component of socio-economic development in both countries. The research identifies three key mechanisms of public policy in higher education management—financing, restructuring, and autonomy management—and presents expert opinions on their effectiveness in Russia and Belarus. The chapter further discusses challenges and opportunities in the digital transformation of educational governance, highlighting the need for innovative approaches to civil servant training and the development of digital competencies. The findings indicate that while the sectoral principle remains foundational in both countries' governance structures, the autonomy management model appears most promising for future development of higher education systems in the Union State of Russia and Belarus.

Keywords: Autonomy management, Digitalization, Higher education system, Knowledge economy, Public management, Sectoral state regulation, Union State of Russia and Belarus.

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INTRODUCTION

The specifics and essence of management processes in the public sector are reflected, as is well known, in scientific principles, which are, on the one hand, the "guiding idea" and, on the other hand, express the internal consistency of the structural elements of the public sector as a system (Bratanovsky & Demenchuk, 2018, p. 20-21).

Among the organizational principles of public management, industry affiliation plays an important role:

- The principle of sectoral management.
- The principle of intersectoral management.
- The principle of territorial sectoral management (Bratanovsky and Demenchuk, 2018, p. 25-26) (Table **1**).

Table 1. Description of the principles of public administration related to sectoral affiliation, compiled by the authors on the basis of various sources (Bratanovsky & Demenchuk, 2018; Manokhin, 2012; Yusupov, 2013, *etc.*)

Name of the Principal	Characteristics of the Principle	The Opportunities Provided to SMA Bodies by the Implementation of the Principle
1. The principle of sectoral management	It is implemented as a special system for building SMA bodies, where the SMA body and its structural divisions are assigned such management objects that are homogeneous and organically related to the nature of industry activities.	It allows you to focus the resources of SMA bodies on management facilities, as well as on the selection and placement of highly qualified personnel in public administration who know the theory and practice of working in the industry.
2. The principle of intersectoral management	It is carried out by interdepartmental (supranational) management bodies and is implemented as one management function applicable to certain areas of public administration (planning, organization, standardization, certification, *etc.*).	It provides an opportunity to strengthen coordination, regulation, and control between several industries and areas of management of a group of organizations.

(Table 1) cont.....

Name of the Principal	Characteristics of the Principle	The Opportunities Provided to SMA Bodies by the Implementation of the Principle
3. The principle of territorial sectoral management	It is implemented as an organic combination of sectoral and territorial principles in the construction of the activities of SMA bodies.	It allows you to consolidate the territorial competencies of SMA bodies in management sectors. For example, in the subjects of the Russian Federation, territorial bodies of federal executive authorities are being created in federal districts, taking into account the industry, the specifics of the region, the climatic and geographical and socio-economic characteristics of the region, *etc.*

It should be noted that the sector is "not only a complex of homogeneous structures with a common activity profile that meet the material and spiritual needs of society" (Astratova, 2023b). In the system of Russian statehood, the sectoral principle was initially laid down: "... at the stage of public administration of the affairs of society, the concept of an industry as a branch of public administration was formed, which entered into sectoral legislation, including constitutional legislation" (Manokhin, 2012, p. 82). In other words, the entire Russian SMA system is based on the sectoral principle, and this is not accidental, since for the Russian Federation, the largest state in the world (17,098,246 km2)[1], only "... thanks to the sectoral principle, it is possible to ensure effective communication and production links between organizations hundreds and thousands of kilometers apart as well as qualified management from one center" (Astratova, 2023b).

As for the Republic of Belarus, in fact and geographically, it belongs to the small states, despite very active discussions on this issue in the scientific literature (Browning, 2006; Mukhametov, 2020; Novikova, 2022; Potreba, 2019) (Table **2**).

1 Source: [Electronic resource]. URL: https://rosreestr.gov.ru / (accessed: 06/07/2024). (In Russ.).

2 Source: [Electronic resource]. URL: https://gtmarket.ru/ratings/world-population (accessed: 06/07/2024). (In Russ.).

3 According to the World Bank PPP data for 2018

CHAPTER 13

Consumer Behavior in the Digital Educational Environment: Main Characteristics, Motives, and Impact Factors

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Abstract: This study explores consumer behavior in the digital educational environment, focusing on its characteristics, motivations, and influential factors. Through surveys of Russian and Belarusian students, the research examines the shift from traditional to digital educational consumer behavior in higher education. The study reveals significant differences between Russian and Belarusian students' perceptions of higher education as a guarantee of success, with Russians being more skeptical. Both groups demonstrate similar preferences in additional education programs, course content expectations, and value assessments. The research identifies the challenges students face in distance learning, including excessive materials, inconsistent teaching, and technological difficulties. Marketing strategies targeting "Generation C" and "Generation Z" are analyzed, with findings suggesting that personalized educational offerings, online reviews, university ratings, and social media advertising significantly influence consumer choices in both countries. The study contributes to the understanding of digital educational consumer behavior as a complex social and digital phenomenon currently in the formative stage of theoretical and practical study.

Keywords: Consumer behavior, Digital educational environment, Distance learning, EdTech, Generation C, Higher education services, Marketing strategies.

INTRODUCTION

One of the key mainstreams of our time is the active introduction of Digital Technologies (DT) into both business and daily human life. This determines the

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prioritization of digitalization in the economic development of the Union State of the Russian Federation and the Republic of Belarus. In the realities of the digital economy, there is also a significant change in marketing tools and the relationship between consumers/buyers and producers/sellers in all markets, including in the markets of educational services.

Speaking about the changing relations between an educational institution and its client, a consumer of educational and intellectual services, it is necessary to highlight the three main trends, in our opinion.

Firstly, due to the strengthening of market mechanisms in the global HES system, students have been "conceptualized" as consumers (or customers) of higher education services (Naidoo and Whitty, 2014).

Secondly, if earlier universities offered clients "standard sets" of educational services[1], by now it is becoming almost impossible. In the context of widespread "commodification[2] of higher education" and increased competition, both in local and global educational markets, universities are forced to continuously develop new types of educational and intellectual products/services targeted at specific consumer groups: schoolchildren, applicants, college and university graduates, adult audiences, as well as those who want to improve their skills, change the direction of activity, learn foreign languages, as well as take up hobbies and master personal growth programs, *etc*. This trend is described in our earlier publications (Astratova and Izmailov, 2024; Astratova *et al.*, 2023; Astratova *et al.*, 2022; Astratova and Klimuk *et al.*, 2021; Astratova *et al.*, 2021; Astratova *et al.*, 2019a; Astratova *et al.*, 2019b; Larionova *et al.*, 2019; *etc.*), as well as in the works of other authors (Abrami *et al.*, 2011; Belenova and Arenkov, 2021; Ermakova and Bagrova, 2016; Research EdMarket, 2022; *etc.*).

Thirdly, the development of e–learning technologies (EdTech) using the Internet significantly contributes to the process of "commodification of higher education", which is especially important in the context of the current growth in the number of MOOCs offering mass online educational courses (Naidoo and Whitty, 2014). Indeed, the galloping development of the digital economy provides easy and fast access for individuals to various services *via* the Internet, including intellectual–intensive products and educational services (MOOCs, among others). This trend is described in the articles of a number of authors (Aguaded, 2013; Ainslee, 2018; Astratova & Izmailov, 2024; Research EdMarket, 2022, *etc.*).

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1 For example, in the pre-digital era, a student had the opportunity to receive only one basic educational program, and additional training programs took the form of electives, or were mastered after completing the basic program. In the digital age, a student can simultaneously master several educational programs, both basic and additional directions.

2 "Commodification" (from "commodity", i.e., "product") is a process in which an increasing number of different types of human activity acquires monetary value and becomes a commodity bought and sold on the market.

Thus, the above trends emphasize the increasing importance of knowledge of consumer behavior in the digital educational environment: the main characteristics and motives for choosing intellectual-intensive products and educational services, as well as marketing tools to influence consumer choice.

Moreover, as we have repeatedly noted earlier (Astratova & Izmailov, 2024; Astratova, 2023b; Astratova *et al.*, 2023; Astratova *et al.*, 2022; Astratova *et al.*, 2021; Astratova *et al.*, 2019a; Astratova *et al.*, 2019b; Larionova *et al.*, 2019; *etc.*), knowledge of the characteristics of consumer behavior in the digital educational environment, it is also important for universities that are exists in conditions of limited budgets and the need to optimize them in the process of choosing priority vectors of digital educational technologies and software, as well as the most cost-effective educational programs and courses.

At the same time, many questions on the stated issues are very debatable, and the theoretical and methodological basis of "digital behaviorism" in general, and in the educational services market, in particular, and in the sector HES, especially, is still being formed, both in the Russian Federation and the Republic of Belarus, and abroad. For example, as noted in a fundamental study by Güngör and Cadirci (2022), combining machine learning algorithms and bibliometric analysis, the key topics of journal articles in 5-year intervals and their evolution over time were identified. The results of the study of these authors show that digitalization has become an integral aspect of the main consumption patterns. Moreover, the study identifies three key areas of consumer behavior research in the digital environment, or "digital consumers."

- The use of well-known classical theories of marketing and consumption, as well as their application in the context of digitalization;
- Analysis of consumer behavior individually and in a group (transactional analysis) in a digital environment;
- The impact of marketing on the consumption of certain types and groups of digital goods and services (Güngör and Cadirci, 2022).

In this regard, we will consider some of the most important positions in our opinion concerning area number 3: "the impact of digital marketing on the consumption of certain product groups" (Güngör and Cadirci, 2022, p. 1829), namely: features of consumer behavior in a digital educational environment.

We will conduct the author's research according to the following plan: 1) portrait of the consumer of digital educational services (EdTech); 2) features of consumer

CHAPTER 14

Artificial Intelligence and Data Analytics in the Organization of the Educational Process and Quality Assessment of Higher Education

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Abstract: This paper examines the integration of Artificial Intelligence (AI) and data analytics in higher education, with particular focus on their applications in educational process organization and quality assessment. The research explores how generative AI technologies like ChatGPT and YandexGPT are transforming educational methodologies, student-teacher interactions, and assessment practices. Through theoretical analysis and application of information theory, the study presents mathematical models for evaluating Control and Measurement Materials (CMM) in educational settings. A framework for analyzing individual digital profiles of students is proposed, incorporating state vectors and Markov processes to predict learning outcomes and assess educational quality. The findings suggest that while AI presents challenges to traditional educational paradigms, its strategic implementation can enhance student engagement, support personalized learning trajectories, develop critical thinking skills, and improve overall educational quality when integrated with appropriate analytics tools and pedagogical approaches.

Keywords: Artificial intelligence, Educational quality assessment, Generative AI, Individual digital profiles, Information theory, Learning analytics, Markov processes.

INTRODUCTION

The advent of the 21st century was characterized by the rapid evolution of Artificial Intelligence (AI), which was introduced to a multitude of economic activities: medicine, banking, retail, security, science, education, *etc*. Today, the

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implementation of AI as a core tenet of business processes and its application as a decision-making tool is essential for sustaining market position and serves as a transformational force for entire industries. Further, the emergence of advanced generative models represents another revolution in the maturation of intellectual technologies (Lutsenko and Golovin, 2024), and a new stage in the transformation of the division of labor system that will produce inevitable changes in social and economic relations on a global scale.

Generative AI generates conditions to interact with machines on a natural language basis, allowing virtually any person, including people without specialized programming language proficiency, to extract useful information from the vast expanse of data at their disposal by leveraging the Internet. With a high enough level of computing power of modern computers, GPT almost becomes an accessible working tool for specialists regardless of their background or field of work. This prescribes its widespread application across a number of professional fields and the requirement of appropriate training to utilize this technology in the resolution of practical tasks.

ChatGPT, DALL-E, and the Russian YandexGPT are examples of knowingly accepted tools based on machine learning. According to statistics, more than 1.8 million visitors accessed ChatGPT[1] in April 2023. Of these, about 60 percent were aged 18 to 34. This apparatus does not just analyze and classify information, but also generates written or visual material. Yandex has announced the launch of the third generation of language models, which is more efficient in working with requests that have multiple conditions and is capable of providing a more extensive and accurate response to the user's task[2]. The Russian neural network YandexGPT, unlike ChatGPT, allows the user to ask a question by voice, but unfortunately, it has not come close to creating poems and translating texts like their foreign counterpart. New neural networks are excellent in customer service, online sales, digital communications, marketing, advertising, and personal management, and can even write in any programming language you ask for. However, you must always be mindful to recognize that a neural network can simply fabricate an illusion or a fake answer that has no relation to reality. This requires the user to be sufficiently immersed in the topic and to think critically to recognize and understand the mistake.

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1 Source: [Electronic resource]. URL: https://www.similarweb.com/website/chat.openai.com/#traffic (accessed 06/28/2024)

2 Source: [Electronic resource]. URL:https://yandex.ru/company/news/02-28-03-2024 (accessed: 06/ 28/2024).

Generative AI is yet another challenge for the education system. There is a heated debate in the international academic community regarding whether it is a threat (for example, to the traditional grading system) or whether it opens up new educational opportunities for students and can become an indispensable teaching assistant. Either way, generative AI is already disrupting the education system, introducing changes in the design of pedagogy and management of educational processes, the development of test materials, as well as student-teacher interaction (Walczak and Cellary, 2023). It is essential to think about how systemically higher education with GPT can co-exist and be utilized to enhance students' education engagement and development of professional competencies and soft skills, individualize educational trajectories, and overall increase the quality of learning.

This technology is most frequently applied to assess and provide feedback on student work in the higher education sector, including student essays and written work (Escalante *et al*., 2023), a variety of graphics, design, and other work (Almasre, 2024), and coding and programming work (Richards *et al*., 2024). For example, S.S. Biswas in his study illustrates how ChatGPT can be used for mediation of models, data analysis and interpretation, scenario and model assessment (Biswas, 2023). H..Marzuki and colleagues observed a positive effect of ChatGPT on the quality of students' writing work, mostly on the aspects of its content and structure of the writing (Marzuki, *et al*., 2023). Lastly, J. Qadir sees ChatGPT as a superior modern tool to create realistic in-action virtual simulations (Qadir, 2023). However, for the scholar, although a high level of engagement is provided through the technology, it is not necessarily an effective means of engaging in the strong possibility of developing realistic virtual simulations. In addition, it is doubly problematic that not only will it provide fictitious information and tailor the way in which learners engage, but it also provides defective information and a false sense of reality for students. A similar view regarding the possible conclusions regarding ChatGPT is that of R.W. Although not based on an extensive quantitative study, McGee (2023) argues that the actual intelligence displayed by AI during statistical analysis is virtually non-existent at this time.

AI is being used as a pedagogical design field by teachers to build educational programs/course content (Sridhar *et al*., 2023). For example, with neural networks, we can generate images such as Sberbank's Kandinsky neural network (https://fusionbrain.ai). Not only can we get high-quality and unique images, but we can do it without issues of copyright. Another way to use AI is to take a text file and convert it to a voice file for posting on a variety of platforms, a voice-over of a presentation, or collaborating on a project together. A good neural network for voicing text would allow you to set accents, add voice effects in a simple

CHAPTER 15

Evaluating Digital Educational Technologies: A Comprehensive Semantic and Sentiment Analysis in Russian Universities

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Abstract: This chapter examines the implementation and effectiveness of digital educational technologies in Russian universities through the lens of semantic and sentiment analysis. The digital transformation of Russian higher education represents a complex journey marked by significant progress alongside persistent challenges. While 88% of universities have implemented learning management systems, only 45% effectively utilize these resources for educational activities, revealing a considerable gap between infrastructure availability and practical implementation. Through a comprehensive analysis of theoretical frameworks, user experiences, and learning outcomes, this chapter explores how digital technologies are reshaping educational practices across Russia. The research reveals that student perspectives generally demonstrate positive attitudes toward digital innovation, while faculty members express greater ambivalence and a preference for traditional teaching methods. Online educational platforms show varied effectiveness depending on implementation quality, student preparation, and institutional support structures. The chapter identifies key challenges, including infrastructure limitations, pedagogical integration barriers, and digital literacy gaps, while highlighting opportunities for enhancement through strategic infrastructure development, comprehensive faculty training, student-centered design, and continuous improvement processes. Moving forward, Russian universities should pursue balanced digital transformation strategies that leverage technological affordances while preserving valuable educational traditions, ultimately enhancing learning experiences and preparing students for an increasingly digital future.

Keywords: Digital Educational Technologies, Higher Education Transformation, Learning Management Systems, Online Learning Platforms, Russian Universities, Semantic Analysis, Sentiment Analysis.

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INTRODUCTION

The landscape of higher education has undergone a profound transformation with the integration of digital technologies. Russian universities, following global trends, have increasingly embraced various digital educational tools to revolutionize their pedagogical approaches and enhance the learning experience for students (Schurig *et al.*, 2022; Grimalt-Álvaro and Usart, 2023). This shift toward digitalization stems primarily from institutional desires to create more adaptable, accessible, and engaging educational opportunities. Yet, amidst this digital revolution, a critical question emerges: How effectively do these technological innovations serve their intended purpose?

The digital transformation of Russian higher education represents a significant yet uneven journey. While substantial progress has been made in establishing digital infrastructure with data indicating that 88.51% of student residences provide internet connectivity and 88% of universities have implemented Learning Management Systems (LMS) the effective utilization of these resources remains a challenge (Statista, 2024). Only 45% of these institutions successfully employ LMS for educational activities, revealing a considerable gap between infrastructure availability and practical implementation.

Furthermore, the digital landscape across Russian universities exhibits notable disparities. Only 44% of institutions possess licenses for collaborative software platforms like Zoom, while 13% lack fundamental digital infrastructure components such as high-speed internet or specialized data storage systems (Statista, 2024). Perhaps most concerning is that only 11% of universities maintain digital infrastructure adequate for delivering comprehensive online education through their own resources (Peskova *et al.*, 2022). These statistics underscore the necessity for focused strategies to enhance both digital infrastructure quality and effective utilization.

The growing popularity of online coursework further emphasizes the importance of evaluating digital educational technologies. During 2019, the predominant online learning platforms in Russia included Coursera (15%), GeekBrains (8%), and National Open University INTUIT (7%), among others (Grimalt-Álvaro and Usart, 2023). The number of online education users has expanded dramatically, rising from 4.12 million in 2018 to 9.9 million by 2023. This substantial growth represents a broader shift toward digital learning approaches, necessitating robust assessment methodologies for these technologies.

This essay explores the complex landscape of digital educational technologies in Russian universities, examining their implementation, effectiveness, and impact on learning outcomes. Through a comprehensive analysis of semantic and

sentiment aspects of user experiences, we seek to understand how these technologies are perceived by students and educators, identifying both successes and challenges in their deployment. By exploring these dimensions, we aim to contribute to the ongoing dialogue about effective integration of digital technologies in higher education and provide insights for future development.

THE EVOLUTION OF DIGITAL EDUCATIONAL TECHNOLOGIES IN RUSSIAN HIGHER EDUCATION

Historical Context and Current Landscape

The integration of digital technologies in Russian higher education has followed a trajectory shaped by both global technological advances and local educational traditions. Historically, Russian universities maintained a strong emphasis on traditional face-to-face instruction, with technological integration occurring gradually throughout the early 2000s. The initial phase primarily focused on basic computerization equipping classrooms with computers and establishing internet connectivity rather than comprehensive digital transformation of pedagogical approaches.

The pace of digital adoption accelerated significantly after 2010, with Russian higher education institutions recognizing the potential of digital technologies to enhance educational quality and accessibility. This period saw the emergence of various digital initiatives, including the development of national educational platforms and the integration of international learning management systems. However, the transformation remained uneven, with leading universities in major urban centers adopting technologies more rapidly than regional institutions (Peskova *et al.*, 2022).

The COVID-19 pandemic served as a catalyst for unprecedented acceleration in digital adoption across Russian universities. The sudden necessity for remote education forced institutions to rapidly implement digital solutions, regardless of their previous technological readiness. This emergency transition revealed both the potential of digital educational technologies and significant gaps in infrastructure, skills, and preparedness across the sector.

Theoretical Foundations of Digital Education

The theoretical underpinnings of digital education in Russian universities draw from various pedagogical frameworks, with Constructivist Learning Theory (CLT) emerging as particularly relevant. CLT emphasizes learning as an active process where learners construct knowledge through experience and reflection rather than passive reception of information. Digital technologies, when

CHAPTER 16

Human Capital Development in the Context of Integrating R & D and Higher Education in the USRB Digital Economy

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Abstract: This chapter examines the critical role of human capital development in the integration of Research and Development (R & D) and higher education within the digital economy of the Union State of the Russian Federation and Belarus (USRB). The research identifies human capital as the most significant economic category and a key factor in the development of the knowledge economy, innovation, and digital transformation. The chapter analyzes current trends, challenges, and opportunities in human capital formation through a comparative assessment of innovation activity ratings, education spending, and labor market dynamics in both countries. Special attention is given to the regional aspects of human capital development and the structural transformations necessary for adapting to digital economy requirements. The findings reveal a significant potential for enhancing scientific and innovative capabilities in the USRB despite insufficient R & D investments, and highlight the importance of practice-oriented approaches in higher education for developing specialists capable of responding to contemporary economic challenges. The research provides recommendations for improving strategic management of human capital to address the qualitative gaps in the labor market and foster creative human capital necessary for sustainable economic growth in the digital era.

Keywords: Digital economy, Higher education, Human capital, Innovation development, Knowledge economy, R & D integration, Union State of Russia and Belarus.

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INTRODUCTION

Human capital is the most important economic category, implying a set of intelligence, knowledge, skills, and abilities used to meet the diverse needs of the individual and society. Human Capital (HC) is also an intensive productive factor in the development of the economy and society, including health, education, quality of life, and productive work. Moreover, in any organization, the most important resource is HC, that is, "collective knowledge, qualities, skills, experience, and health of the workforce" (Madgavkar *et al.*, 2022).

Currently, there are several types of classification of human capital, among which the following is the most common:

- Individual or personal HC;
- Human capital of the organization (firm);
- National/regional human capital.

In the context of our research, it is important, firstly, that HC is a key factor in the development of the knowledge economy, innovation, and digital economy. Indeed, the quality of human capital, as well as the level of development of education and science in the country, is able to ensure economic growth and the authority of the state on the world stage. Advanced knowledge, scientific research, innovative developments, and technologies contribute to improving the competitiveness of the national economy. Other authors also present similar positions on this issue (Bengraf *et al.* 2024; Eskindarov *et al.*, 2022; Ishmuratova, 2021; Madgavkar *et al.*, 2022; Panikarova *et al.*, 2020; Simchenko *et al.*, 2023; *etc.*).

Secondly, according to the results of a fundamental study by E. Fedorova and colleagues (2023) and by A. Yanovskaya and N. Simchenko (2024), it was found that HC plays a special role in the digital economy. It is true due to the presence of a number of causal factors:

♦ In the process of developing socio-economic and labor relations, new technologies and approaches to human resource management have been introduced at different periods of time. This led to the formation of theoretical and conceptual changes in the organization of labor, which manifested first in the primary displacement of physical labor[1], and then in the mass displacement of low-skilled mental labor[2] and its subsequent replacement with automated techno-

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1 *i.e.*, technology of the period of the 1st Industrial Revolution.
2 *i.e.*, technology of the period of the 4th Industrial Revolution.

logies. This leads to the fact that difficult work dominates the work activity, a person becomes an important resource, the need for intellectual and cultural qualities of an employee increases, and the concept of labor management focuses on HC, that is, on a person and is aimed at managing automated and robotic labor through digital technologies, synchronizing them with highly qualified personnel (Yanovskaya and Simchenko, 2024; p. 135 and p. 150);

♦ There are a number of factors illustrating the special role of human capital in a digital society, namely:

- An increase in publication activity, which indicates "... an exponential increase in scientific interest in the theory of human capital in the international scientific community" (Fedorova *et al.*, 2023, p. 1).
- The manifestation of the universal nature of the integration of digital technologies into the theory and practice of the development of national economies.
- Stimulating R & D in the development of HC management mechanisms by the State and Municipal Administration (SMA) in cooperation with institutions and businesses.

Thirdly, *the regional aspect of HC development is important*. In this regard, it is also relevant that many issues of HC's impact on current innovations, economic growth, and development still remain an incomprehensible "black box", especially in the regional context as a whole (Diebolt and Hippe, 2019; Eskindarov *et al.*, 2022; Fonseca and Pedro, 2019) and at the level of the Union State of the Russian Federation and the Republic of Belarus, in particular (Bengraf *et al.*, 2024; Kozopolyanskaya, 2018; Simchenko *et al.*, 2023; *etc.*). One of the key priorities of the innovative development of the Union State of the Russian Federation and the Republic of Belarus is the formation of a new type of knowledge-based economy. Knowledge is the basis for the development of human and scientific potential and contributes to increasing the knowledge intensity of production processes. During the transformation of the Russian and Belarusian economies to an innovative path of development, the scale of scientific research and technical developments increased, as we noted earlier, and, accordingly, the role of knowledge and its impact on national economies increased (Bengraf *et al.* 2024). Therefore, in the current conditions, special attention should be paid to the process of investing in knowledge in order to form, develop, accumulate, and reproduce it. Accordingly, if more recently the emphasis was on the quantitative component of education, now its qualitative and creative components are coming to the fore. Other authors also present similar positions on this issue (Bengraf *et al.* 2024; Eskindarov *et al.*, 2022; Ishmuratova, 2021; Panikarova *et al.*, 2020;

CHAPTER 17

The Labour Market as a Complex Socio-economic System: Some Aspects of Mathematical Modelling in the Labour Market of the Union State

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Abstract: This chapter examines the labor market as a complex socio-economic system, with a particular focus on mathematical modeling of labor migration between the Russian Federation and the Republic of Belarus within the framework of the Union State. The study proposes a stochastic model based on Markov processes to analyze cross-country migration flows, treating population movements as random processes determined by transition probabilities. Using historical data from 1997-2022, the research demonstrates how these migration probabilities have changed over time and identifies similar trends in migration patterns between both countries despite differences in magnitude. The model accounts for the factorization of population and capital movements, allowing for the calculation of equilibrium concentrations and the prediction of long-term population distribution. Special attention is given to working-age migration, which constitutes over 80% of total migration flows. The findings reveal a notable anomaly during 2005-2014 for Russia and 2006-2012 for Belarus, when migration trends would have led to significant increases in population concentration in both countries if maintained long-term. The chapter concludes by suggesting that further research could benefit from a more detailed clustering analysis of labor migrants by demographic and socioeconomic characteristics to enhance the predictive capabilities of the model.

Keywords: Labor market, Markov model, Mathematical modeling, Migration flows, Population equilibrium, Stochastic processes, Union State.

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INTRODUCTION

The labour market is a complex system of public economic relations between employers and employees in the processes of the labour services provision, as well as the negotiations about prices and working conditions, *etc*. The emergence and evolution of the labour market is a process of "... the emergence and growth of market potential through the formation of qualitatively new structural relations" (Babenkova, 2008, p. 45). It is well known that the labour market management mechanism is determined by the institutional environment and the structure of relations between the elements of the complexly organized economic system. Labour migration plays a special role in the system of labour market relations. It is not only a force that influences the demographic situation in a country or region and facilitates the influx of specialists lacking in the market, but it also creates the prerequisites for cross-cultural communication between the populations of different countries/regions. Moreover, "*... labour markets in the countries with a high standard of living are developing due to the constant influx of labour from other countries and regions. The labour markets of these countries are much more attractive than the labour markets in countries with an average standard of living, confirming the hypothesis about the economic nature of modern migration*" (Wang and Platonova, 2019, p. 1).

It should be mentioned that the problems of labour migration, mutual investments (capital flows), as well as export-import operations in the post-Soviet space, became relevant after the collapse of the Soviet Union. The problem of labour migration is especially relevant in the post-Soviet republics with a population close in language, religion, mentality, and cultural customs, and most of all, for the Republic of Belarus and the Russian Federation. The Union State Treaty between them will turn 25 years old in December 2024. All of the processes listed above are cross-connected and, anyway, affect all the spheres of economic, socio-political, demographic, and cultural life of the member countries in the interstate Union.

In the contemporary migration relations between Russia and Belarus, Belarus acts primarily as an exporter of labour (Vasilevskaya, 2019). Moreover, Belarusian labour migrants have become a "permanent component of the Russian labour market" (Poletaev, 2021). These trends are obviously illustrated in Fig. (**1**).

Migration flows differ in their structure based on various criteria: geographic location, time, gender, age, education, social status, *etc.*

The mathematical modelling of processes in the labour market as a whole and in relation to labour migration is relevant both for the predictive analysis of socio-

political and economic phenomena, and for the reliable planning of the socio-economic development of the USRB.

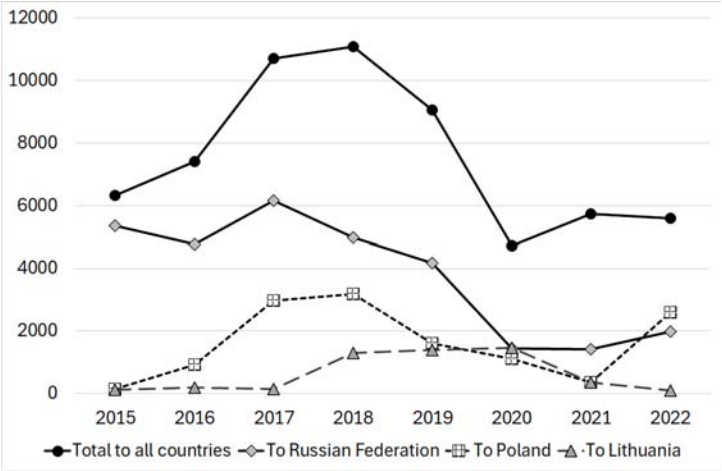

Fig. (1). Number of labour migrants from Belarus outside the country with the official work permissions, in 2015-2022, persons. *Source: authors' results based on the data from the Ministry of Internal Affairs of the Republic of Belarus. Available at: https://mvd.gov.by/ru/page/uchet-trudyashihsya-emigrantov-i-trudy-ashihsya-immigrantov (Accessed: 04/14/2024).*

The authors propose a mathematical model that allows identifying the complex dependencies and forecasting the processes of cross-country migration on the basis of historical data mining. Unfortunately, the authors have not had sufficient data to conduct a full analysis, but they hope that the capabilities of the model itself will be of interest to the economic community. The model is based on the theory of random processes in stochastic systems. The mathematical justification and basic formulas of the model are presented in our work (Astratova and Sinitsyn *et al.*, 2024), which presents a generalization of the model previously used (Sinitsyn *et al.*, 2022; Tolmachev *et al.*, 2019) in the study of intra-urban population migration processes, forecasting the demand for transport services, and a number of other socio-economic problems.

A. Data and Calculation Methods

Data on mutual migration of the population are presented in Figs. (**2** and **3**). As can be seen from Fig. (**1**), the migration from the Russian Federation to the Republic

As can be seen from Fig. (**2**), the migration from the Russian Federation to the Republic of Belarus reached a minimum in 2007-2012, after which it began to increase (although with significant dips in some years).

CHAPTER 18

The Socio-Technological Nature of the Organization of Labor in the Digital Environment of the Union State

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Abstract: This chapter examines the socio-technological nature of labor organization in the digital environment of the Union State of Russia and Belarus. As both countries transition toward innovative economic development models with an emphasis on digitalization, traditional labor organization approaches are being transformed. The study identifies how digital technologies are modifying labor content, processes, and relations, creating new employment platform models and ecosystem-based work organization structures. Particular attention is given to work rationing methods for IT specialists in digital environments, highlighting the convergence of analytical and summary approaches in modern practice. The research proposes functional points for IT project implementation on digital platforms and outlines factors affecting performance. The findings demonstrate that scientifically-based approaches to labor rationing on digital platforms can improve productivity, identify hindering factors, and create effective internal planning and control systems for project management in the Union State.

Keywords: Digital economy, Digital labor organization, IT specialists, Platform employment, Socio-technological transformation, Union State, Work rationing.

INTRODUCTION

Taking into account the influence of political, economic, and socio-technological factors, today the economic paradigm is changing in the Union State of the Russian Federation and the Republic of Belarus, and the model of economic development of fraternal countries is being transformed, focused on social and innovative development. In this regard, both countries have adopted a number of legislative acts related to the innovative and scientific and technical development

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of national economies and individual industries until 2020, and extended until 2025 and 2030.

In accordance with the strategic planning documents[1], a list of initiatives for the socio-economic development of the Russian Federation until 2030 has been approved; this includes the following areas of development: social sphere, construction, ecology, digital transformation, technological breakthrough, and the state for citizens. Also, within the framework of the National Program "Digital Economy of the Russian Federation", as a tool for the strategic development of the country, nine federal projects are being implemented aimed at regulating the digital environment, training personnel for the digital economy and developing the human potential of the IT industry, the development of digital technologies and artificial intelligence, digital public administration, *etc.*[2] Among the listed areas, trends are being traced, focused on the introduction of digital technologies in all spheres of socio-economic development of the country, and, importantly, this is training for the digital economy. In the process of training personnel for the digital economy, forms and mechanisms of labor organization in the digital environment should be developed and proposed, since the digital economy modifies not only the content of labor but also the type of labor processes. Thus, the subject of work in the digital environment is information and digital data, which are presented exclusively in digital format; the means of work are digital devices, digital programs, and the result of work is information products (Savelyeva, 2018).

Within the framework of the Union State, the labor market of the Russian Federation and the Republic of Belarus has a similar structure and similar development vectors in the context of digitalization, namely:

- Creation of new jobs
- Investing in the workforce
- formation of a decent income
- Providing employment for the population
- Promotion of high labor standards as conditions for competitiveness
- Provision of other social and labor guarantees (Bengraf *et al.*, 2024)

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1 On approval of the list of initiatives for the socio-economic development of the Russian Federation until 2030. Decree of the Government of the Russian Federation dated 06.10.2021 No. 2816-r (ed. from 03/14/2022) [Electronic resource].– URL: https://www.consultant.ru/document/cons_doc_LAW_397326/708a1dd4b9c098d56c63a4b0c948b8cdc3f39db0/ (accessed: 03/03/2024). (In Russ).

2 The digital economy of the Russian Federation. Ministry of Digital Development, Communications and Mass Media of the Russian Federation // Minutes of the meeting of the Presidium of the Council under the President of the Russian Federation for Strategic Development and National Projects dated 06/04/2019 No. 7. [Electronic resource]. – URL: https://digital.gov.ru/ru/activity/directions/858/?utm_referrer=https%3a%2f%2fwww.google.com%2f (In Russ.).

The team of authors M. M. Balog, S. E. Demidova, and V. V. Troyan noted that in foreign countries, there is a pronounced correlation between the use of digital technologies and labor productivity growth, but in Russia, such connections are absent due to imbalances in regional and sectoral development (Balog *et al.*, 2021).

In the Republic of Belarus, the problem of the relationship between the use of digital technologies and labor productivity growth is at the very beginning of its study. Nevertheless, there are known works showing that with the use of digital technologies, there is a redistribution of labor between humans and machines, partial replacement of human labor with machine labor, and the release of a significant share of the labor force, which ultimately increases labor productivity (Golovenchik, 2018; Maltsevich, 2023; *etc.*). It is also shown that labor productivity growth "... does not have a constant trend", but "... there are opportunities for its improvement within the framework of the concept of "Construction 4.0." (Maltsevich, 2023).

The author E.S. Sadovaya (Sadovaya, 2022) focuses on the fact that in the conditions of a new economic reality, "automation of business processes turns out to be a socio-technological prerequisite for employment platformization ... and labor relations are turning from social into computer algorithms" (Sadovaya, 2022). In other words, there is a transition from an industrial type of regulation of social and labor relations to a digital or platform type. A similar opinion was expressed by the authors E.V. Nekhoda and L. Pan, who emphasize that "the basic model of labor organization is the management of joint activities and empowerment of platform employment participants" (Nekhoda & Pan, 2021), that is, the organization of labor in a digital environment is carried out not on a vertical and horizontal division of labor, but on the basis of the integration of resources on a digital platform, with the help of which it is possible to attract more participants through online access, increase resources and form ecosystems by expanding the value chain.

It was considered necessary to supplement the changes and characteristics of the organization of work in the digital environment, compiled by scientists E.V. Nekhoda and L. Pan (2021). In their ecosystem-based work organization model (Nekhoda & Pan, 2021), changes in the content of work in the digital environment have led to transformations in the model, empowering all participants. Therefore, objects, means, labor results, and business processes acquire digital form and have a direct impact on the processes of distribution, exchange, and consumption in the digital economy. Also, in addition to technical and professional skills, employees in the digital environment are required to develop flexible skills aimed at personal development. In this regard, the process of digitalization transforms the labor

CHAPTER 19

The Use of Digital Technologies in the State and Municipal Administration of the Russian Federation and the Republic of Belarus

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Abstract: This study examines the implementation and usage of Digital Technologies (DT) in State and Municipal Administration (SMA) within the Russian Federation and the Republic of Belarus. The research investigates the current state, challenges, and potential benefits of digital transformation in the public sector compared to commercial enterprises. Based on expert surveys of civil servants in Yekaterinburg conducted in early 2024, the study identifies key applications of digital technologies in public administration, including process automation, automated decision-making systems, and manual task automation. The findings reveal significant gaps between the pace of DT adoption in public administration *versus* the commercial sector, primarily due to complex contracting processes and insufficient internal DT potential within government structures. Despite strategic policy documents in both Russia and Belarus aimed at creating innovative economies based on Big Data processing, the research highlights several unresolved issues in both the external application (public-facing electronic services) and internal application (management processes) of digital technologies. The study concludes by emphasizing the urgent need for solutions to enhance DT integration in public administration to improve efficiency, effectiveness, and productivity in government organizations.

Keywords: Digital technologies, Digital transformation, E-government, Public services, Republic of Belarus, Russian Federation, State and municipal administration.

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INTRODUCTION

Digital technologies are understood in modern realities as "... a system of tools, methods and methods for creating, collecting, accumulating, storing, processing, transmitting and protecting information based on computer technology, used everywhere in various industries and spheres of economic activity" (Astratova & Bekshaev, 2024).

As a special information system, DT provides humanity with the following opportunities:

1. Increase the productivity/efficiency of management processes
2. Allow us to operate with a large amount of information (Big Data)
3. Increase the reliability of information
4. Give hope for the creation of an electronic model of universal system intelligent management (Astratova *et al.*, 2022; Bengraf *et al.*, 2024).

Using DT in the field of State and Municipal Administration (SMA) is extremely relevant in the context of the prospect of building an electronic state and the need for electronic communication between the state and society. In this regard, it is important that the digitalization of SMA is not only the development of public electronic services and web pages, but also the minimization of the time lag between obtaining results and the appearance of reporting data, reducing the risks of information security and data falsification, *etc*. (Astratova, 2023; Bengraf *et al.*, 2024; Dobrolyubova *et al.*, 2019; Kiselev, 2018; Lindgren and Veenstra, 2018; *etc.*).

Moreover, the use of DT in SMA also implies obtaining a number of additional features:

1. Involvement of all stakeholders at various stages of the development and implementation of public electronic services (Holgersson and Karlsson, 2014; Lindgren and Veenstra, 2018)
2. Understanding the needs, expectations, and values of users of electronic public services (Astratova, 2023b; Lindgren and Veenstra, 2018; Millard, 2015)
3. Transition of political communications to the Internet environment is a full-fledged digital marketing tool and a channel for interaction between the government and the population, political parties and society, which allows online "... analysis of opinions in social media about various party brands, personalities, analysis of the audience of blogs, *etc.*" (Chizhov, 2016, p. 335).

As the Yandex[1] query statistics show, the topic of digital/information technologies and their application in public administration is very relevant in Russia, since the number of requests is quite large (thousands and tens of thousands of requests, monthly) and it has an upward trend.

Moreover, the results of our expert survey[2] also show that the use of DT in the work of civil servants presents a lot of opportunities, and experts rate them very highly (Fig. **1**).

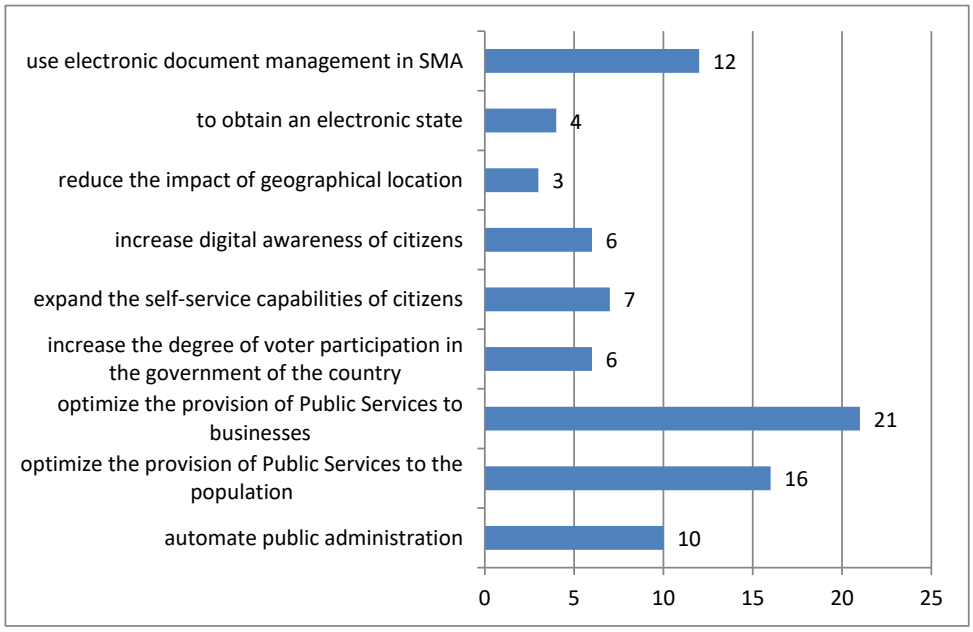

Fig. (1). Data from an expert survey of civil servants; respondents' answers to the question: "Do you think the use of digital technologies in state and municipal management allows ...", people (N=30; n=30; K_k = 0.21; K_c = 0.76). *Source: survey data in Google Docs and processing in Statistica; multiple responses from respondents were allowed.*

Fig. (**1**) shows that the use of DT in SMA, according to experts, allows optimizing the provision of public services to businesses (70.0% of respondents' responses)

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1 Source: search on the Yandex resource (https://wordstat .yandex.ru /) a query concerning keywords

2 Employees of the SMA bodies of the city of Yekaterinburg were selected to conduct an expert survey. The expert survey of civil servants was conducted in January-May 2024. A questionnaire was developed based on the use of standard measurement and scaling procedures, consisting of three blocks: 1) Introduction; 2) Main content (8 questions); 3) Personal questions (5 questions). Through the use of an e-mail mailing list with a link to a questionnaire in Google docs, employees of the Yekaterinburg SMA authorities took part in the survey. The representativeness of the sample was determined by well-known statistical methods (Malhotra, N.K., 2002); the minimum required number of respondents should be at least 9 people. As of 06/01/2024, 30 questionnaires have been collected. All survey data were processed using Google docs, Microsoft Excel, and Statistica.

CHAPTER 20

Policy Synthesis: Advancing Socio-Economic Integration and Innovation in the Union State of Russia and Belarus

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Abstract: This synthesis integrates key findings from the 19 chapters analyzing the Complex Socio-Economic Systems (SES) of the Union State of Russia and Belarus (USRB). It emphasizes the critical role of digital transformation, Innovation infrastructure (InIn), human capital development, and adaptive governance in advancing integration. Key challenges include bureaucratic inefficiencies, R & D underperformance, labor market imbalances, and digital adoption gaps. Strategic recommendations prioritize harmonized policies, enhanced collaboration, and targeted investments to foster a resilient, knowledge-based economy. The USRB's experience offers globally relevant insights into regional integration amidst geopolitical uncertainty and technological disruption.

Keywords: Bilateral Cooperation, Complex Socio-Economic System, Eurasian Economic Union (EAEU), Socio-Economic Integration, Union State of Russia and Belarus (USRB).

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INTRODUCTION

The dawn of the 21st century has witnessed an unprecedented acceleration in technological advancement and geopolitical realignment, fundamentally reshaping the landscape of regional integration and socio-economic development. Within this dynamic context, the Union State of the Russian Federation and the Republic of Belarus (USRB) stands as a pivotal experiment in post-Soviet reintegration. Born from deep historical, cultural, and economic ties formalized in the landmark *Treaty on the Establishment of the Union State (1999)*, the USRB represents more than a bilateral partnership; it embodies a strategic endeavor to create a cohesive socio-economic space capable of navigating global complexity and fostering shared prosperity. This Policy Synthesis Chapter consolidates critical insights from an extensive 19-chapter analysis, offering a comprehensive roadmap for transforming the USRB into a resilient, innovative, and globally competitive entity in the digital era.

The USRB's journey, spanning over three decades, has achieved significant milestones, notably a 2.6-fold increase in bilateral trade (2005-2021) and the implementation of ambitious joint programs like the 28 Union Integration Programs (2021-2023). These efforts underscore a commitment to deeper harmonization across defense, customs, agriculture, and technology. However, this integration occurs against a backdrop of intensifying global challenges: rapid digital disruption, fragile supply chains, geopolitical volatility (exemplified by sanctions regimes), and the imperative for sustainable development. While the foundational treaties and institutional frameworks provide a crucial scaffold, the Union State faces persistent and evolving bottlenecks that threaten its transformative potential.

This synthesis identifies these critical pressure points through rigorous analysis:

1. **The Innovation Paradox:** Despite substantial investments in R & D (averaging 1.1% of GDP in Russia, 0.8% in Belarus), outputs have markedly declined, with patent applications falling by 41% in Russia and 50% in Belarus (2015-2022). A disconnect persists between academic research and commercial application, hindering technological sovereignty and import substitution goals (Chapters 6, 7, 10).
2. **Governance Under Strain:** Bureaucratic inertia, complex contracting processes, insufficient digital competencies among officials, and corruption impede agile and effective public administration. These factors limit the responsiveness of State and Municipal Administration (SMA) to rapid socio-economic shifts and citizen needs (Chapters 8, 19, 12).
3. **Human Capital Mismatch:** While higher education enrollment surges,

particularly in digital fields (*e.g.*, tech enrollments rising from 25,000 to 68,000 in Russia and 12,000 to 30,000 in Belarus, 2020-2023), structural imbalances plague labor markets. An excess of general graduates coexists with acute shortages of skilled professionals in high-tech sectors. Migration trends further highlight this, with Belarus acting as a net labor exporter to Russia, driven by economic factors (Chapters 17, 13, 15, 16).

4. **Digital Divide:** Enthusiasm for digital education and AI tools (Chapters 13, 14, 15) contrasts sharply with implementation gaps. Critical infrastructure limitations, pedagogical integration barriers, and low effective utilization of digital platforms (*e.g.*, only 45% of Russian universities effectively use Learning Management Systems) hinder the digital transformation of public services and economic sectors (Chapters 19, 15).
5. **Integration Friction:** Asymmetries in economic size, institutional structures, and the dominant role of the public sector in Belarus create friction in deepening harmonization of legislation, standards (especially customs and technical), and financial markets, despite political commitment (Chapters 2, 3).

Simultaneously, external pressures, particularly comprehensive sanctions against Russia, act as a double-edged sword. They impose high economic costs and disruption, but also serve as a powerful catalyst, accelerating mutual import substitution efforts and reinforcing the strategic necessity of the Union State framework for economic security within the Eurasian Economic Union (EAEU) customs territory (Chapter 3). This complex interplay of internal challenges and external shocks defines the critical juncture at which the USRB finds itself.

The central question addressed in this synthesis is: How can the USRB leverage its unique integration framework, historical ties, and shared resources to overcome systemic bottlenecks, harness digital and innovation potential, and build a resilient, knowledge-based economy capable of thriving amidst 21st-century uncertainties? Answering this requires moving beyond conventional policy approaches. The analysis presented here treats the USRB not merely as a political union but as a Complex Socio-Economic System (SES), characterized by nonlinear dynamics, emergent properties, and intricate stakeholder interactions (Chapters 1, 11). Understanding these dynamics is paramount for designing effective interventions.

This chapter synthesizes evidence across diverse domains—from advanced simulation modeling of SES dynamics (Chapter 1) and the intricacies of economic cooperation (Chapter 3) to the transformative potential of AI in education (Chapter 14) and the socio-technological reorganization of labor (Chapters 17, 18). It presents a cohesive Strategic Vision for 2035: positioning the USRB as a globally competitive, digitally integrated knowledge economy anchored in

CONCLUSION

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The Union State of the Russian Federation and the Republic of Belarus is in unique conditions: a previously unprecedented global socio-economic and military-political crisis, intensified by such phenomena as the protracted special military operation in Ukraine, suffering the consequences of the coronavirus pandemic, and facing intermittent local conflicts.

On the other hand, the successful coexistence of two fraternal states in the Eurasian space for a quarter of a century is not only the success of integration education in the post-Soviet period, but also the recognition that only the friendship of fraternal, Slavic peoples allows the “Russian world” to withstand the global military and political danger.

Despite the danger of World War III, it must be admitted that the world as a whole is moving towards the formation of a global digital economy based on R & D, higher education, and human capital development, and the Union State is striving to create a unified scientific and technological space. This is due to a number of objective factors, such as:

1. The global change in the role of the public sector and the importance of government regulation by sectors of national economies (primarily labor markets, HES, and R & D).
2. The universal nature of the introduction of digital/information technologies into the business models of organizations in the commercial and non-profit sectors.
3. Changing the formats of universities' activities and the nature of the work of teaching staff and researchers, as well as changing the nature and conditions of students' education.
4. Changes in the requirements for the qualifications and competencies of employees in the context of digitalization, which led to significant changes in the organization and nature of the work of personnel in the commercial and non-profit sectors.
5. The acquisition of the innovative infrastructure of the Union State of the Russian Federation and the Republic of Belarus as a key factor in import substitution and the development of the knowledge economy in the context of digitalization.

In this regard, complex, interdisciplinary studies of complex socio-economic systems—higher professional education, R & D, and the labor market of the USRB—and the problems of sectoral state regulation of these systems in the context of digitalization of the economy become particularly relevant. This is due to the work of the author's team, which resulted in this monograph, which

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examines three key issues: 1) Designing mechanisms for the optimal development of complex socio-economic systems (on the example of the union state of Russia and Belarus); 2) Challenges and perspectives of using digital technologies in new economic conditions; 3) Current issues of human capital development in the digital economy.

As a result of the research, the authors made the following main conclusions:

CONCLUSION:

The state policy of the development of the Union State of the Russian Federation and the Republic of Belarus is conditioned by global trends shaping the knowledge economy, digitalization, and innovative infrastructure. It is revealed that the strategic goal of the state policy in the field of higher education is to increase the availability of high-quality education that meets the requirements of the innovative development of the economy of the USRB, the modern needs of society, and every citizen of Russia and Belarus. The necessity of state participation in the formation of the knowledge economy has been proved, which necessitates further research to explore issues related to determining the most effective share of state participation in the management of the higher education system and the R & D sector. It is shown that the use of digital technologies in public administration, both in Russia and Belarus, has currently revealed many issues related to both the effectiveness of public administration in industries (primarily the HES sector) and the external and internal use of DT in SMA bodies. These issues need to be resolved as soon as possible and without delay.

Modern realities form multifunctional mechanisms for the development of the SSEC, as well as various approaches to the methodology for assessing the main indicators of the development of the CSES. The issues of assessing the processes of development of complex socio-economic systems in the digital economy of the Union State are considered. It is shown that the stated problem lies in the need to search for and further study the dependencies and relationships between a large number of values, parameters, and variables of the CSES. The solution to this problem is the subject of further and independent research in the context of a new scientific direction.

It is shown that in the context of state management of the innovation infrastructure of the Union State, the interaction between the CSES (higher education, R & D sector, and the labor market) plays a key role in ensuring and stimulating sustainable economic development of fraternal countries in the context of digitalization. It is established that for the successful implementation of this approach and the activation of the relationship between R & D, higher education and the labor market, the introduction of the “Triple Helix model” is

required, where the spiraling interconnected and interdependent interaction between the elements of the innovation infrastructure – innovative agents of government, universities and enterprises – is carried out for the purpose of innovative production transformation and transfer of knowledge. It is concluded that higher education institutions are becoming a "crystallizing" core, a point of growth and development of innovative infrastructure. In the new economic conditions, the innovative infrastructure of the USRB is the basis for the further development of both countries and a key factor in import substitution.

The use of DT and AI in education, both in Russia and Belarus, has currently revealed many issues related to the technical and technological support of universities, as well as methodological, pedagogical, psychological, and educational problems. It is revealed that the behavior of the consumer of intellectual services (primarily HES and R & D) in the digital environment in modern conditions is a complex socio-economic, psychological, and digital phenomenon. The theory and practice of researching the main characteristics, motives, and factors of influence on the consumer are a problem area and are in the stage of active formation both in the Russian Federation and the Republic of Belarus, and beyond. The use of predictive, semantic, and sentiment analysis tools, as well as digital analytics methods in the process of evaluating the effectiveness of EdTech in universities, is also one of the urgent problems that requires a speedy solution.

It is revealed that the development of human capital—the key trigger of the innovative development of the SRB—should take place in the context of the integration of R & D and higher education in the digital economy. The socio-technological nature of the organization of labor in the digital environment of the Union State is revealed. The scientifically based approaches of work rationing in the implementation of projects on a digital platform are considered. The essence of creative human capital is considered, and the challenges of creative human capital in the digital economy are discussed. Finally, an assessment of key indicators of the development of complex socio-economic systems in the digital economy of the Russian Federation and the Republic of Belarus.

RECOMMENDATIONS:

To ensure the sustainability and further development of complex socio-economic systems in a turbulent external environment, scientifically based measures are needed that have a selective effect on key risk factors for the development of "critical points" of distress and take into account their long-term consequences.

In this regard, the authors consider it necessary to recommend further analyzing the developed strategies for the socio-economic development of the regions of

Russia and Belarus for the period up to 2035 from this point of view and making the necessary adjustments. Such measures and adjustments to strategies should be based on models and mechanisms similar to those outlined in this paper.

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