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Mechanisms of human capital capacity management of higher education system of Kazakhstan in the context of green transition

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CONTENT

LIST OF ABBREVIATIONS AND DESIGNATIONS

2SLS	-	Two-Stage Least Squares
ABET	-	Accreditation Board for Engineering and Technology
AI	-	Artificial Intelligence
AMBA	-	Association of MBAs
ANU	-	Australian National University
ARC	-	Australian Research Council
BIM	-	Building Information Modeling
BREEAM	-	Building Research Establishment Environmental Assessment Method
CBA	-	Cost–Benefit Analysis
CEFC	-	Clean Energy Finance Corporation
CES	-	Constant Elasticity of Substitution
CISL	-	Cambridge Institute for Sustainability Leadership
CPD	-	Continuous Professional Development
CSR	-	Corporate Social Responsibility
CRC	-	Cooperative Research Centres
EAUC	-	Environmental Association for Universities and Colleges
EC	-	European Commission
ESD	-	Education for Sustainable Development
ESG	-	Environmental, Social and Governance
EU	-	European Union
FE	-	Fixed effects
FIBAA	-	Foundation for International Business Administration Accreditation
GBCA	-	Green Building Council of Australia
GDP	-	Gross Domestic Product
GUPES	-	the Global Universities Partnership on Environment for Sustainability
HDI	-	Human Development Index
HEFCE	-	Higher Education Funding Council for England
HEI	-	Higher Education Institution
HR	-	Human Resources
HRM	-	Human Resource Management
IAAR	-	Independent Accreditation and Rating Agency
IAQAE	-	Independent Agency for Quality Assurance in Education
ICT	-	Information and Communication Technologies
IoT	-	Internet of Things
IT	-	Information Technology
IRR	-	Internal Rate of Return
ISF	-	Institute for Sustainable Futures
KPI	-	Key Performance Indicators
LMS	-	Learning Management System
MSDI	-	Monash Sustainable Development Institute

NABERS	-	National Australian Built Environment Rating System
NPV	-	Net Present Value
NQF	-	National Qualifications Framework
OLS	-	Ordinary Least Squares
PLS-SEM	-	Partial Least Squares Structural Equation Modeling
QA	-	Quality Assurance
QS	-	Quacquarelli Symonds Rankings
RUS	-	Rete delle Università per lo Sviluppo Sostenibile
RE	-	Random effects
SBEnrc	-	Sustainable Built Environment National Research Centre
SDG	-	Sustainable Development Goals
SEM	-	Structural Equation Modeling
SES	-	State Educational Standards
SDSN	-	Sustainable Development Solutions Network
STARS	-	Sustainability Tracking, Assessment & Rating System
THE	-	Times Higher Education Rankings
TLS	-	Total Link Strength
UK	-	United Kingdom
UN	-	United Nations
UNSW	-	University of New South Wales
UNT	-	Unified National Testing
US	-	United States

INTRODUCTION

Relevance of the research topic. The relevance of the research is due to the growing global and national challenges associated with the transition to sustainable development and decarbonization of the economy. According to the World Economic Forum, 47% of employers plan to transform their business models amid the transition to a green economy, and about 39% of employees' key professional skills will change or lose relevance by 2030. Such trends indicate an increasing need for specialists with environmental, digital, analytical, and interdisciplinary competencies who can adapt to structural and technological changes in the economy. In addition, according to the United Nations Development Program, Kazakhstan ranks 60th among 193 countries and territories on the Human Development Index, which has a value of 0.837, and belongs to the group of countries with a very high level of human development. At the same time, the acceleration of technological modernisation, changes in the employment structure and the transition to a low-carbon development model are creating new requirements for the quality, adaptability and competitiveness of human capital. Under these conditions, its development is becoming one of the key factors for sustainable economic growth and the successful implementation of green transformation.

Kazakhstan, as a country with a high dependence of the economy on the raw materials sector, actively integrates the principles of sustainable development into its national economic policy. The priorities of environmental modernisation, increasing energy efficiency, developing renewable energy sources, and reducing the carbon intensity of the economy are set out in the Concept for the Transition of the Republic of Kazakhstan to a green economy and the Strategy for Achieving Carbon Neutrality of the Republic of Kazakhstan until 2060. The implementation of these priorities requires a transformation of the structure of the economy and the labour market, which, in turn, creates an increased demand for new-quality human capital with environmental, digital and interdisciplinary competencies. In this regard, the higher education system is of great importance as a key institutional mechanism for the formation, development and reproduction of human capital. Modern universities should not only perform an educational function but also act as centres for knowledge generation, scientific research, innovation, and training of personnel capable of developing and implementing solutions in the field of the rational use of natural resources, the reduction of environmental risks, and sustainable development. All this requires a corresponding transformation of educational programs, research activities, organisational culture and human capital management mechanisms of higher education organisations.

The need to modernise the higher education system and develop human capital is enshrined in the strategic documents of the Republic of Kazakhstan. The Message of the President of the Republic of Kazakhstan, K. Tokayev, dated September 8, 2025, "Kazakhstan in the era of artificial intelligence: current challenges and their solutions through digital transformation", emphasises that the development of human capital is a key factor for competitiveness and sustainable growth. The relevant priorities are also reflected in the Concept of Transition of the Republic of

Kazakhstan to a green economy for 2021-2030, the Strategy for Achieving Carbon Neutrality until 2060, as well as in the Concept of Development of Higher Education and Science of the Republic of Kazakhstan for 2023-2029, which provides for the modernization of educational programs and strengthening their integration with the economy. In general, these regulatory legal acts and government policy can be considered the institutional basis for the transformation of the higher education system and the development of human capital, with a focus on the requirements of the green economy.

At the same time, the existing mechanisms for managing the human capital of higher education institutions are insufficiently focused on the systematic development of green competencies, the integration of sustainable development principles into universities' personnel and educational policies, and the readiness of academic staff for environmental and technological transformations. There is still a need to coordinate university development strategies, professional development mechanisms for employees, motivation systems and performance assessment with the objectives of the transition to a green economy. Thus, the relevance of the dissertation research is determined by the contradiction between the increasing need of the Kazakh economy for human capital capable of ensuring green transformation and the lack of comprehensive management mechanisms for its formation and development in the higher education system. The solution to this scientific problem involves developing organisational and managerial mechanisms to foster green competencies, enhance the adaptability of academic staff, and strengthen universities' contribution to achieving sustainable development goals.

The degree of scientific development. The issues of formation, development and effective use of human capital have been widely covered in economic theory, management, higher education research, innovative development and sustainable transformation. At the same time, human capital management in higher education institutions in the context of the transition to a green economy is an interdisciplinary field at the intersection of several scientific approaches.

The theoretical foundations of human capital research were laid in the works of T. W. Schultz, G. S. Becker, J. Mincer, R. R. Nelson, E. S. Phelps, Y. Ben-Porath, G. Psacharopoulos, R. E. Lucas, P. M. Romer, R. Stehle, in which human capital was considered as the result of investments in education, vocational training and health, which determines labor productivity, employee incomes, social and economic development. In the research by R.R. Nelson, E. S. Phelps, R. E. Lucas, and P. M. Romer, human capital has been further developed as a factor in technological progress, innovation, and long-term economic growth. However, classical economic models mainly focus on assessing the volume of investment and the economic returns from education and, to a lesser extent, on revealing organisational mechanisms for managing the qualitative characteristics of universities' human capital. Further, the organisational and managerial approach to the study of human capital is presented in the works of C. Argyris, D. A. Schön, I. Nonaka, H. Takeuchi, L. Edvinsson, M. S. Malone and N. Bontis. In this area, human capital is considered a strategic resource of the organisation and an integral part of intellectual capital. In relation to higher education, the university was considered as

a learning and knowledge organisation that ensures the production, dissemination and practical application of knowledge.

The role of universities in the formation of innovative ecosystems is revealed in the research of H. Etzkowitz, L. Leydesdorff, B. Bozeman, M. Wright, P. C. Boardman, A. Faggian, P. McCann and R. Florida. In these works, universities are considered not only as educational organisations, but also as participants in the innovative interaction of the state, business and the scientific community. Researchers have substantiated the role of universities in the creation and commercialisation of knowledge, the development of entrepreneurial activity, the formation of regional human capital and increasing the innovation potential of territories. A separate area of research is related to the development of adaptive, digital, entrepreneurial and interdisciplinary competencies. In the works of J. R. Abel, R. Deitz, T. Johansen, T. Karlsson, C. Wigren, M. R. Marvel, A. A. C. Teixeira and a number of other researchers, human capital is considered as a dynamic set of knowledge, skills and abilities, changing under the influence of technological, institutional and structural transformations. This approach reflects the transition from a predominantly static understanding of human capital to a process approach, according to which competencies must be continually updated through learning, professional development, and organisational change.

In recent years, a scientific field has been actively developing, dedicated to green human capital, green competencies, and the role of education in achieving sustainable development goals. In the works of W. Ma, S. Yu, T. Yuizono, H. Yao, X. Gu, A. Hrebenciuc, A. Bazrkar, A. Sudolska, G. Chaberek, J. Ziolkowska, G. Al-Zohbi, M. A. E. Pilotti, Z. S. Younis, S. Menon, M. Suresh and other researchers address the issues of developing green skills, greening educational programs, implementing ESG principles, shaping environmentally responsible behaviour, and transforming universities into sustainable institutional systems. These studies confirm that a successful transition to a green economy depends not only on technological and financial resources, but also on the availability of specialists with relevant knowledge, values and competencies.

The Kazakhstani scientific literature explores issues of human capital development, modernisation of higher education, improvement of the quality of specialist training, development of university science, and the formation of competencies that meet the needs of the national economy. These issues are reflected in the works of K. A. Sagadiyev, L. S. Spankulova, G. Rakhimzhanova, O. Adilkhanov, D. Jonbekova, G. Berdykulova and other Kazakhstani researchers. At the same time, studies directly devoted to the mechanisms for managing green-oriented human capital in higher education institutions in Kazakhstan are limited.

The analysis of the scientific literature shows that a huge amount of theoretical and scientific-practical material has been accumulated, revealing the economic, organisational, institutional, innovative and competence aspects of human capital. However, existing studies mainly consider these aspects separately. Comprehensive approaches that combine strategic human capital management of universities, the development of green competencies, organisational mechanisms for professional development and sustainable transformation tasks have not been sufficiently

developed. In addition, the scientific literature lacks a unified methodological approach to assessing the green-oriented human capital of higher education organisations, the factors of its formation have not been sufficiently studied, and the mechanisms of interaction between the state, universities, employers, and the academic community in the process of developing relevant competencies have not been fully defined.

Thus, the scientific gap lies in the insufficient theoretical and methodological elaboration of integrated management mechanisms for the formation and development of green-oriented human capital in higher education institutions in Kazakhstan. The need to eliminate this gap determines the direction of the dissertation research and involves the development of an appropriate assessment methodology, a system of organisational and managerial mechanisms and practical recommendations for universities and government agencies.

Research aim and objectives. The aim of the dissertation is to substantiate the theoretical and methodological foundations of human capital capacity management in Kazakhstan's higher education system and to develop mechanisms for strengthening human capital capacity in the context of the green transition.

To achieve this aim, the following **objectives** are being solved:

– to analyse the evolution of theoretical approaches to human capital capacity management in the higher education system;

– to systematise the international experience of managing higher education systems in the context of the green transition and identify best practices applicable in the national context;

– to substantiate methodological approaches to human capital capacity management of the higher education system of Kazakhstan, considering the principles of sustainable development;

– to analyse the current state and level of development of the higher education system in Kazakhstan;

– to assess the structure, quantitative and qualitative characteristics, as well as trends in the development of human capital in the higher education system of Kazakhstan;

– to identify the key problems and limitations of human capital capacity management in the higher education system in the context of the green transition;

– to identify promising areas for the transformation of human capital capacity management in higher education in the context of the green economy;

– to develop an integrated approach to managing the development of human capital in the higher education system;

– to form and substantiate a system of mechanisms for improving the human capital capacity management of the higher education system of Kazakhstan in the context of the green transition.

The subject of the research is the organisational and managerial relations and mechanisms for the formation and development of human capital in higher education organisations in Kazakhstan in the context of the transition to a green economy.

The object of the research is the human capital of higher education institutions of the Republic of Kazakhstan.

Research methods. The methodological basis of the dissertation research is a mixed-methods approach combining quantitative and qualitative methods. The application of this approach has made it possible to comprehensively study the state of human capital in higher education organisations in Kazakhstan, the factors driving its development, and the management mechanisms in the context of the transition to a green economy.

The following methods were used in the research process:

– bibliometric analysis of publications used to identify the dynamics of scientific interest in the problems of human capital of universities, green competencies and sustainable development of higher education, identify key authors, thematic areas and clusters of scientific knowledge; bibliometric maps were built using VOSviewer software;

– a systematic review of scientific literature conducted in accordance with the recommendations of PRISMA 2020, which ensured a consistent search, selection, filtering and meaningful systematisation of publications on human capital management, sustainable development and the green transformation of higher education;

– an international comparative analysis used to compare human capital management models and practices for the development of green competencies in foreign higher education systems, as well as to identify opportunities for their adaptation to the conditions of Kazakhstan;

– methods of descriptive and comparative statistical analysis used to study the dynamics and structure of indicators of the development of the higher education system, academic qualifications, scientific performance, professional development and incentive mechanisms for teaching staff;

– correlation analysis used to identify the direction and closeness of the relationships between academic performance indicators, the use of a system of key performance indicators and mechanisms for material and non-material incentives for employees of higher education institutions; statistical data processing was performed using software packages SPSS and R;

– a sociological survey of the teaching staff of higher education institutions in Kazakhstan, which allowed us to obtain primary empirical data on professional characteristics, academic performance, institutional support, motivation system and employees' readiness for structural and competency-based changes;

– expert interviews with representatives of the academic community and management staff of higher education institutions aimed at identifying institutional barriers, management constraints and opportunities for human capital development in the context of green transformation; the interview materials were processed using thematic coding using Nvivo software;

– PEST analysis used to assess the impact of institutional, economic, social, and technological factors on the development of the higher education system and human capital management mechanisms;

– scenario analysis used to develop alternative trajectories for the development of human capital in higher education institutions, taking into account possible institutional, technological, social, economic and environmental changes.

The integrated application of these methods provided a consistent combination of theoretical, statistical and empirical analysis and allowed us to develop practical recommendations for improving the human capital management mechanisms of higher education institutions in Kazakhstan in the context of green transformation.

The empirical research design includes two complementary analytical levels. The first, quantitative level, aims to assess the state and dynamics of the human capital of higher education organisations and to identify relationships among academic performance, professional development, the effectiveness assessment system, and incentive mechanisms for teaching staff. The second, qualitative level, is aimed at studying the requirements of green transformation for the competencies and human capital management system of universities.

The study considers the transition to a green economy as an institutional and strategic context that introduces new requirements for the professional, environmental, digital, and interdisciplinary competencies of academic staff. Its substantive characteristics are investigated through analysis of scientific literature, international experience, expert assessments, and scenarios for the transformation of the higher education system.

The information and empirical base of the study was made up of official statistical data from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan for the period from 2000 to 2024, characterising the state and dynamics of the development of the higher education system, employment and the structure of human capital. The study also uses data from international ratings and analytical databases, including QS and THE, reflecting the positions of Kazakhstani universities in terms of scientific activity, publication effectiveness, citation, academic reputation, international cooperation and competitiveness. Additional sources of information included regulatory legal acts of the Republic of Kazakhstan, strategic documents in the fields of higher education, human capital development, sustainable development, and the transition to a green economy, as well as scientific publications indexed in the Scopus and Web of Science databases.

The empirical basis of the study was the results of a sociological survey of 958 representatives of the teaching staff of 32 organisations of higher education in Kazakhstan. The survey aimed to assess the professional and qualification characteristics of academic staff, the effectiveness of scientific and educational activities, the availability of professional development and institutional support, the incentive mechanisms used, and employees' willingness to adopt competency-based changes driven by green and technological transformation.

The quantitative data were supplemented by results from 12 expert interviews with representatives of the academic community, managers and administrative staff of higher education organisations, and specialists in sustainable development. Expert interviews enabled the identification of institutional and organisational barriers, the assessment of the need to develop green competencies, the assessment of universities' readiness to integrate the principles of sustainable development, and the clarification of promising mechanisms for human capital capacity management in the context of the transition to a green economy.

The combination of official statistical, rating, sociological, and expert data provided an opportunity for a comprehensive assessment of the state of human capital in higher education organisations in Kazakhstan and to substantiate areas for improving management mechanisms for its formation and development.

Scientific novelty. The scientific novelty of the dissertation research lies in the development of theoretical and methodological provisions and an integrated approach to managing green-oriented human capital in higher education organisations in Kazakhstan. During the research, the following scientific results were obtained, which have elements of scientific novelty:

- the theoretical approaches to human capital management of the higher education system are systematised, and the main stages of their evolution (classical, institutional, innovative, competence-adaptive and modern) are highlighted;
- the management models of the higher education system in the context of the green transition are systematised;
- a comprehensive combination of macro-indicator analysis, sociological data and correlation analysis was applied, which made it possible to identify the factors determining the scientific productivity of academic staff and the effectiveness of incentive mechanisms in universities;
- a multilevel model of interaction on the implementation of mechanisms for the development of human capital in higher education institutions is proposed;
- the conceptual basis of the policy of modernisation of the higher education system aimed at developing the human capital capacity is substantiated.

The main provisions submitted for defense:

– the author's interpretation of the term “green-oriented human capital in universities” refers to the accumulated knowledge, professional skills, interdisciplinary competencies, environmental values and behavioural capabilities of students, academic staff, researchers and administrative personnel that enable them to contribute to a sustainable, low-carbon and resource-efficient economy;

– a typology of management models of the higher education system in the context of a green transition, taking into account differences in the institutional environment, the level of centralisation, and mechanisms for integrating the principles of sustainable development;

– a combined methodology for assessing the factors of scientific productivity and the effectiveness of human capital capacity management at universities, based on the integration of statistical, sociological and correlation analysis, which allows for the identification of the relationship between indicators of publication activity, institutional conditions and the effectiveness of the incentive system for academic staff;

– human capital capacity management mechanisms of the higher education system in the context of the green transition, including institutional, educational, managerial, infrastructural, digital and social tools ensure the integrated development of the human capital of universities;

– a roadmap for the modernisation of human capital capacity management at universities in the context of a green transition, reflecting a phased transformation

based on the consistent formation of environmental, digital, managerial and transformational competencies.

The theoretical significance of the study. The theoretical significance of the dissertation research lies in the development of theoretical and methodological principles for human capital management in the higher education system in the context of the green transition. The paper systematises and integrates modern theoretical approaches to the analysis of human capital, thereby forming a holistic theoretical basis for the study. The proposed interpretation of green-oriented human capital and the developed conceptual approach to its development in the higher education system advance scientific understanding of universities' role as key institutions in the formation of human capital focused on achieving sustainable development goals. The results obtained also contribute to deepening theoretical research in the fields of educational economics, university management, and the sustainable transformation of social and economic systems.

Theoretical provisions and the research results can be used in the educational process in the preparation of students in the educational programs "Management", "Economics", "Human Resource Management", "State and local government", as well as in teaching the disciplines "Management in higher education", "Green Economy" and other related disciplines in higher education institutions. education of the Republic of Kazakhstan.

Practical significance of the research. The practical significance of the research lies in the potential to use the results to improve human capital management mechanisms in Kazakhstan's higher education system in the context of the green transition. The managerial and institutional mechanisms developed in the dissertation to form green-oriented human capital can inform state policy in higher education, university development strategies, and educational modernisation programmes. The proposed practical recommendations aim to develop the green competencies of students and teachers, integrate ESG principles into the university management system, improve the mechanisms for the professional development of academic staff, and increase the competitiveness of Kazakhstan's human capital in the context of the transition to a sustainable economy.

Approval and implementation of research results. The main results of the dissertation research have been published in 22 scientific papers, including 6 articles in international peer-reviewed journals indexed in the Scopus, 3 publications in scientific journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Republic of Kazakhstan, as well as 13 papers in domestic journals and international materials scientific and practical conferences.

The structure and scope of the dissertation. The dissertation consists of an introduction, three chapters, a conclusion, a list of sources used, and appendices. The total volume of the dissertation is 195 pages, including 23 tables, 21 figures and 4 appendices. The list of sources used includes 287 titles.

1 THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF HUMAN CAPITAL CAPACITY MANAGEMENT IN THE HIGHER EDUCATION SYSTEM IN THE CONTEXT OF THE GREEN TRANSITION

1.1 Evolution of the concept of human capital capacity management in the higher education system

The concept of human capital is central to higher education management. Its understanding has changed significantly since the mid-twentieth century. Early views saw individuals as carriers of productive knowledge and skills. Modern perspectives see individuals as agents of innovation, sustainable development, and social responsibility. At first, human capital was measured by the economic returns to education [1,2]. In higher education, universities were primarily institutions for training specialists to meet labour market needs. Effectiveness was measured by graduates' contribution to productivity and national income. Now, interpretations go beyond economics. They include intellectual, creative, digital, and environmental factors that shape competitiveness.

In the higher education system, human capital is considered not only as a result of educational activities but also as a strategic institutional resource requiring effective management mechanisms. Universities develop, accumulate, and manage human capital capacity through educational, research, and organisational processes involving students, faculty, researchers, and administrative staff. Accordingly, the management of human capital capacity is a crucial factor in determining the efficiency, innovation potential, and competitiveness of higher education institutions. It is also a fundamental element of the national innovation system. The evolution of the concept of human capital in the higher education system reflects the gradual transition from an economic interpretation of education to institutional, innovative, adaptive and sustainability-oriented approaches to human capital capacity management.

(1) The classical stage: economic interpretation of human capital

Empirical studies on human capital began in the 1940s. Stehle measured how individual abilities affect earnings, thereby launching the economic analysis of human attributes [3]. Mincer introduced the concept of "human capital" and modelled income distribution using education levels, linking income differences to education and experience [4]. By the late 1950s, the concept gained broad recognition, mainly due to Becker's work. He systematised existing approaches and popularised the concept of human capital. Becker estimated the returns on investment in education. He showed that investments in human capital are as important as those in physical capital. His research showed that wages rise with age and educational attainment, while unemployment is more common among people with lower levels of education. He also argued that spending on professional training—inside or outside organisations—should be seen as an investment that generates future returns[2]. However, these investments can involve risks such as labour mobility. The management of human capital capacity was viewed through

the prism of increasing the economic efficiency of labour by investing in employees' education and professional training.

Becker argued that as technology advances, education and worker qualifications drive productivity [2]. Schultz developed the concept of human investment. He noted that education, healthcare, and labour migration are forms of human capital accumulation [1]. These activities do not yield immediate economic benefits but contribute to long-term development. These ideas have led to the massification of higher education and a reevaluation of universities' roles as institutions of national growth. At the level of educational policy, this gradually contributed to the development of human capital management mechanisms that expanded access to education and improved the population's skills.

Nelson and Phelps expanded the classical approach. They saw human capital as more than a production factor. Educated people adapt to and spread new technologies, speeding up technological change [5]. Ben-Porath introduced a model showing that human capital accumulates after formal education. People keep learning and adapting on the job [6]. His ideas became key to lifelong learning, which was reflected in OECD educational policies. This approach has created the prerequisites for the transition to more continuous human capital capacity management mechanisms based on constant updating of competencies and professional development.

Within the classical school, human capital was viewed mainly as an economic indicator. It consisted of knowledge, skills, and health that enhance labour productivity and national welfare. The paradigm of the 1950s–1970s was based on rational individual choice. Individuals invest in education when expected returns exceed costs [7]. At the state level, expenditures on education and healthcare were interpreted as investments in economic growth. Figure 1 illustrates the formation of human capital through investments in education and health, as well as their impact on labour productivity.

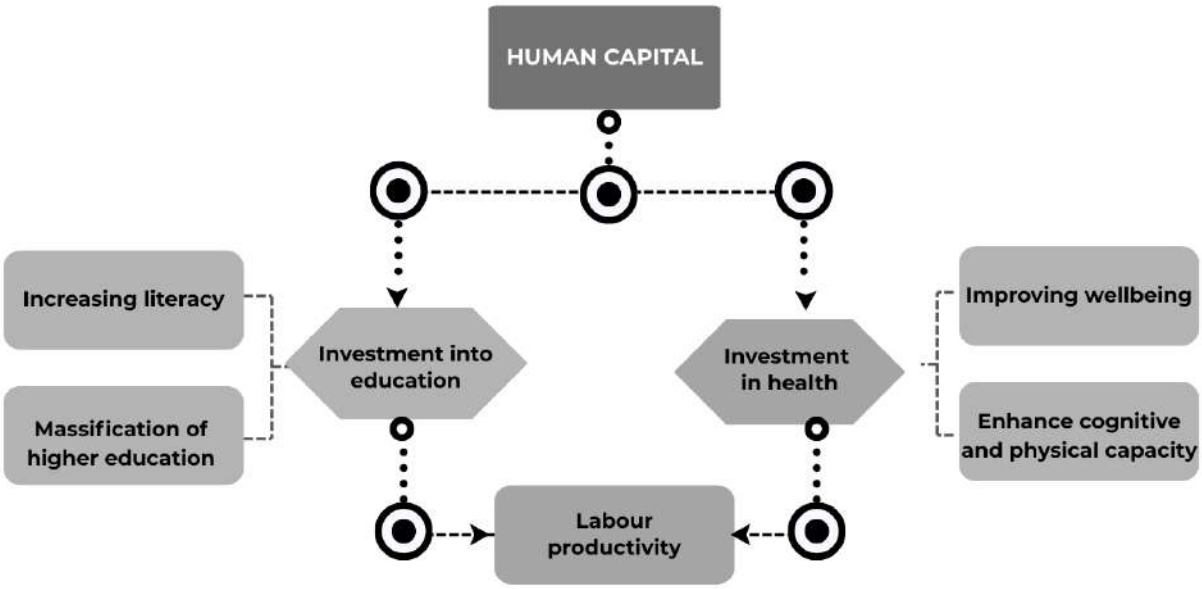

Figure 1 - Formation of human capital and its impact on labour productivity

Note - compiled by the author based on the literature review

The figure shows how human capital forms through investments in education and health. Rising literacy, expanding access to higher education, and improved well-being lead to stronger cognitive and physical abilities. These investments boost labour productivity, which supports economic growth. Universities were seen as places that produced a skilled labour force. The main goal of the higher education system was to supply the economy with a labour force with the necessary skills. Universities' effectiveness was evaluated with quantitative indicators such as the number of graduates and their employment rates. Higher education was seen as a tool for promoting economic competitiveness through the accumulation of knowledge and competencies. However, there was little focus on managing human resources within universities. Faculty members and researchers were not considered as strategic assets but as providers of educational services.

The classical concept laid the foundation for later theories, especially endogenous growth theory [8,9]. These theories view human capital as a key factor in the production of knowledge and innovation. In higher education, this changed how universities were viewed. They became both providers of skilled professionals and generators of innovation and intellectual capital. The classical stage established an economic focus in the analysis of human capital. Human capital capacity management was primarily focused on maximising the return on investment in education, skills, and public health.

(2) Institutional and organisational stage of human capital capacity management

Since the 1980s, researchers have focused more on organisational effectiveness and internal human capital development. According to Argyris and Schon, the sustainability and innovativeness of organisations depend on their ability to self-reflect, learn together, and update competencies [10]. Nonaka and Takeuchi saw an organisation as a knowledge-creating company. In this approach, human capital is not a static asset. Instead, it is a dynamic ability that ensures competitiveness through collective learning, knowledge exchange, and innovation [11]. In the 1980s and 1990s, human capital theory merged more with management science. This led to the development of Human Resource Management (HRM), which focuses on employee development, motivation, and retention. Unlike the classical stage, attention has been paid not only to the accumulation of human capital but also to the mechanisms of its organisational management, including the development of competencies, staff motivation, knowledge sharing, and the retention of qualified employees.

Edvinsson and Malone proposed a framework for measuring intellectual capital. This included not only employees' knowledge (human capital) but also organisational processes, databases, corporate culture, and partner relationships [12]. Bontis defined human capital as the sum of individual knowledge, skills, and abilities that materialise in innovation. He emphasised the importance of an environment that stimulates knowledge exchange and codification [13]. The identified trends indicate the need to develop an integrated human capital management system to ensure universities' adaptation to the challenges of the green transition and the knowledge economy.

Universities are now seen as knowledge institutions that combine education, research, and innovation. Etzkowitz and Leydesdorff started the Triple Helix concept. This describes how universities, government, and industry interact to create and share knowledge. Universities are no longer isolated academic institutions. They are now active players in innovation ecosystems. Managing human capital in universities now has a strategic focus. This includes developing research skills among faculty and students, offering continuous professional development (CPD), building a culture of learning and knowledge sharing, and encouraging networked academic collaboration. Universities now focus on creating knowledge together, rather than just passing it on. Faculty and researchers act as both carriers and intermediaries of organisational human capital [14]. As a result, the management of human capital capacity in universities has come to be seen as a strategic process aimed at developing research potential, innovation activity, and universities' institutional capacity to create and disseminate knowledge.

The institutional and organisational stage formed the foundation for a transition toward innovation- and sustainability-oriented human capital. Universities began to be seen as centres for developing human capacity. The management of human capital capacity of academic staff is a key element of the innovative and institutional competitiveness of universities.

(3) Innovation stage: human capital as a source of economic and technological growth

At this stage, the interpretation of human capital changed significantly. It became a key factor in technological change, innovation, and regional competitiveness. Models of endogenous growth by Aghion and Howitt were the first to link economic development with the economy’s ability to generate new knowledge. These models showed that human capital is fundamental in producing innovation [15]. Barro and Sala-i-Martin showed that technology diffusion can accelerate economic growth, though returns depend on the level of accumulated human capital [16]. Benhabib and Spiegel also supported this [17]. Jones noted that the scale of research activity and the growth in the number of researchers directly influence the generation of new ideas [18]. As part of the innovation phase, human capital capacity management has been seen as a tool to enhance universities' and research organisations' ability to generate knowledge, adapt technologies, and innovate.

According to Lee and Brinton, elite universities create specific forms of social capital that reinforce social stratification [19]. The practical application of HRM affects the sustainability of the academic environment in universities [20]. Bedard determined that educational signals often have a stronger impact on career trajectories than actual skills [21]. The institutional quality of universities significantly affects labour market outcomes, career opportunities, and researchers' mobility [22,23,24]. As a result of these processes, the role of strategic management of academic personnel has been strengthened, including support for research activities, human resource development, international cooperation and increased publication activity.

In high-income countries, human capital contributes to innovation and technology adoption, whereas in low-income economies, its impact is primarily evident at the imitation stage. In other words, the innovation effect occurs only after a certain level of development is reached [25]. International collaboration also plays an important role in the formation of scientific and technological human capital, facilitating knowledge flows between countries and continents [26,27]. Academic human capital is a significant factor for promoting patent activity and the effectiveness of knowledge commercialisation [28]. In turn, Wright et al. demonstrate that faculty form academic entrepreneurship, shaping the creation of university spin-offs and the impact of the institutional environment on innovation dynamics [29]. The human capital embodied in university faculty and researchers contributes to the development of innovation ecosystems through interactions between universities, industry, and government within the Triple Helix framework [30]. Universities generate regional knowledge, while the mobility of graduates strengthens the innovation potential of territories [31]. Thus, universities have a significant economic multiplier effect, creating additional jobs, stimulating local business development, and generating positive spillover effects that enhance regional economic development [32]. As a result, the management of universities' human capital capacity began to integrate with innovation and regional policies focused on developing research networks, commercialising knowledge, and strengthening interaction among universities, business, and the state.

According to Nafukho et al., investing in human development increases individual efficiency and organisational productivity and brings societal benefits [33]. However, Jacobs notes that, from an economic perspective, such investments are perceived as risky, so many delay making the decision to pursue an education [34]. Serneels shows that income growth is driven by both increased productivity and signalling effects, emphasising that increased access ("massification") alone is not enough without quality and selection mechanisms [35]. According to Lee, Florida, and Gates, the combination of human capital, creativity, and diversity leads to sustainable innovation [36]. At the same time, the importance of human capital quality management mechanisms is increasing, with a focus not only on expanding access to higher education but also on ensuring the effectiveness of personnel training and the development of creativity and innovative competencies.

Figure 2 presents a conceptual model illustrating the formation of human capital within universities and its contribution to innovation and economic development.

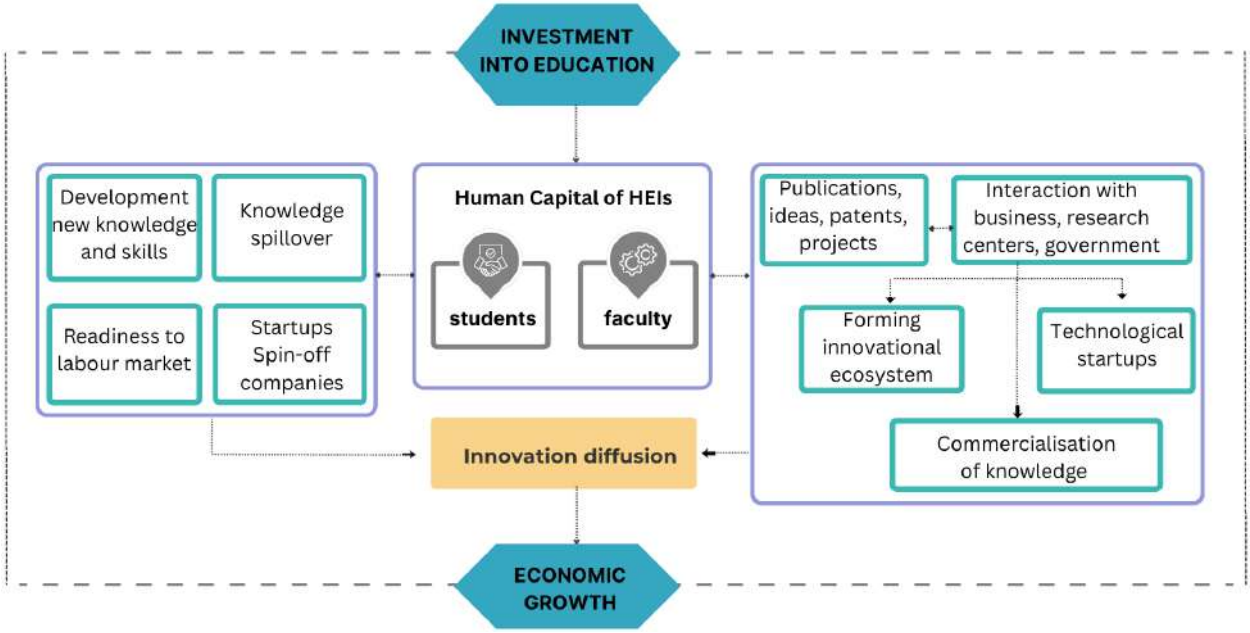

Figure 2 - Conceptual model of university human capital formation and its contribution to innovation and economic development

Note - compiled by the author based on the literature review

The presented model shows that investments in education strengthen universities' human capital capacity, encompassing both students and academic staff. Human capital contributes to the formation of an innovation ecosystem and facilitates the commercialisation of knowledge through research development, the creation of startups, scientific advances, and interactions with businesses and research units within the university. At the same time, human capital capacity management plays a key role in ensuring the development of universities' research potential, academic entrepreneurship, and innovation activities. Collectively, these processes ensure the diffusion of innovations and serve as an important source of sustainable economic growth.

(4) Stage of adaptive competencies

The period from 2010 to 2020 is characterised by a shift from interpreting human capital as a set of knowledge and qualifications toward understanding it as a dynamic system of competencies that enables universities, faculty members, and graduates to adapt to technological turbulence, global competition, and uncertainty. Human capital is increasingly viewed as a combination of interconnected cognitive, non-cognitive, social, entrepreneurial, and organisational resources that are formed and transformed within the university environment. Under these conditions, human capital capacity management is increasingly considered a continuous process of forming and renewing competencies that ensure institutional stability and universities' ability to adapt to technological, social and economic changes.

Many scholars emphasise the role of universities in regional development and the importance of mobile and innovation-oriented human capital. According to Abel and Deitz, universities increase regional stocks of human capital through graduate retention, while Pink-Harper confirms that education and professional competencies of human capital contribute to economic growth [37,38]. At the same time, the

competitiveness of human capital increasingly depends on the combination of disciplinary knowledge and social capital, including communication, collaboration, and adaptability [39,40,41]. Migration and mobility of human capital also serve as key mechanisms that enable skills to adapt to changing economic conditions [42,43]. Under these conditions, tools and mechanisms for developing human capital have become particularly important, contributing to the formation of flexible competencies, expanding academic mobility, and increasing graduates' ability to respond effectively to structural changes in the labour market.

Another important research direction concerns the development of entrepreneurial competencies within university ecosystems. The human capital of academic entrepreneurs includes not only experience and qualifications, but also the ability to find opportunities, strategic flexibility, and effective use of social media [44,45,46,47,48]. In the context of technological transformation, adaptability and entrepreneurial orientation become essential characteristics of modern human capital. As a result, universities have begun introducing more flexible approaches to human capital capacity management to foster entrepreneurial thinking, innovation, and adaptability among academic staff and students.

Several studies focus on the development of intellectual capital as an institutional resource of universities. Intellectual capital reflects universities' ability to generate, document, and utilise knowledge, stimulate organisational creativity, and build strategic alliances [49,50,51,52,53]. At the same time, performance metrics may also lead to the loss of human capital [54]. At the same time, there is an increasing need to balance mechanisms for evaluating effectiveness with the preservation of universities' human capital capacity, since an excessive focus on quantitative indicators can undermine the sustainability of human capital.

Internationalisation is also becoming an important element of the adaptive stage. Global student flows enhance the integration of educational markets, and foreign universities accelerate the accumulation of human capital in host countries [55,56]. Some research universities are purposefully building “global human capital” by integrating international competencies and mobility [57]. The result of these transformations was the strengthening of human capital management mechanisms through the development of international academic relations, the mobility of students and faculty members, and the inclusion of global competencies in educational and scientific practices.

Tan notes that human capital develops in conditions of cognitive and technological hybridity and largely depends on the quality of institutions that ensure its reproduction [58]. Caballero et al. emphasise the need to develop transversal competencies such as critical thinking, digital literacy, and interdisciplinarity [59]. In the context of technological progress and the transition to Industry 4.0, demand for highly skilled labour is increasing, contributing to rising inequality and requiring continuous skills upgrading as well as the development of new mechanisms for investing in human capital [60]. Accordingly, the management of human capital capacity is increasingly focused on developing adaptive, digital, and interdisciplinary competencies that ensure the sustainability of universities amid technological transformation.

Thus, the period from 2010 to 2020 reflects a transition from the traditional understanding of human capital toward the concept of adaptive competencies. Universities are not only producers of human capital but also complex organisations actively managing human capital capacity, quality, focus, and ability to adapt to global technological and institutional changes.

(5) The contemporary stage of human capital capacity management in universities in the context of sustainable development and green skills

The contemporary stage of human capital evolution is characterised by an orientation toward sustainable development, the green transition, the formation of green skills, and the development of the concept of the "green university." Universities act as institutional intermediaries in the transition toward sustainable economic development, serving as key centres for the formation of green human capital [61]. The innovation climate and resource endowments of universities become important catalysts for regional sustainable growth [62]. At the same time, the university educational environment forms environmentally oriented values and social attitudes: according to Chaberek and Ziolkowska, students interpret the activities of city authorities in the field of sustainable development through the prism of their own educational experience, which emphasises the role of universities in training environmentally conscious citizens [63]. The growth in the number of doctoral students and the development of innovative human capital increase regions' green total factor productivity [64]. Thus, the development of higher education itself becomes an instrument for promoting green growth. According to Hrebenciuc et al., sustainability must be integrated into both educational and corporate strategies [65]. Environmental training and recruiting employees with environmental skills, as green enterprises drive innovation, are significant for business [66,67]. In modern conditions, the management of universities' human capital capacity takes on a strategic nature and includes developing mechanisms to foster green competencies, environmental culture, sustainable behaviour, and the adaptation of academic staff and students to the requirements of the green economy.

At the same time, certain contradictions exist in students' perceptions of sustainability: even within well-developed educational environments, they may demonstrate inconsistent environmental behaviour [68]. Accordingly, universities need to develop educational practices and curricula that foster sustainability-oriented competencies. In addition, student involvement in practical environmental initiatives, such as waste management, promotes environmental literacy and the development of sustainable professional behaviours [69]. The involvement of students reinforces the importance of management mechanisms that ensure the integration of sustainable development principles into educational programs, motivation systems, extracurricular activities, and universities' institutional culture.

According to Menon and Suresh, the following directions for advancing sustainability in universities can be identified: (1) integration of sustainability into curricula; (2) development of sustainability-oriented pedagogical approaches; (3) incorporation of sustainability into academic research; (4) implementation of sustainable campus practices; and (5) development of outreach programs involving external communities [70]. Accordingly, the management of human capital capacity

now encompasses not only the training of specialists but also the coordination of educational, research, and organisational processes that ensure the institutional sustainability of universities.

According to Al-Filali et al., campus environmental initiatives improve universities' financial sustainability [71]. Moreover, according to Wen et al., implementing the green campus concept reduces noise levels and enhances students' environmental comfort and well-being [72]. However, a green campus does not automatically form green human and intellectual capital. The green exchange of knowledge and the development of green innovations, through which environmental initiatives are transformed into the university's structural capital, play a crucial role [73]. As a result, the role of knowledge management and green innovation mechanisms is increasing, with the aim of transforming environmental initiatives into the university's long-term intellectual and structural capital.

Green human capital contributes to the development of digital solutions and the creation of conditions for environmentally sustainable entrepreneurial activity [74]. As a result, human capital requirements have transformed amid the green transition and sustainable development, necessitating a new definition of green-oriented human capital. Decarbonization, digitalisation, the introduction of ESG standards and the transition to resource-efficient production systems have transformed environmental competencies from an auxiliary component into a mandatory element of professional training.

Within the author's interpretation, *green-oriented human capital in universities* refers to the accumulated knowledge, professional skills, interdisciplinary competencies, environmental values and behavioural capabilities of students, academic staff, researchers and administrative personnel that enable them to contribute to a sustainable, low-carbon and resource-efficient economy. Unlike traditional forms of human capital, green-oriented human capital encompasses not only cognitive and professional skills but also environmental values and behavioural orientations aimed at minimising negative environmental impacts.

At the same time, a green university is defined as a higher education institution that integrates principles of environmental sustainability into its strategy, organisational processes, infrastructure, educational programs, and engagement with society, thereby transforming sustainability from an external attribute into an internal intellectual and structural capital of the organisation. In this sense, the green university functions as an institutional system that creates the conditions for the reproduction of green-oriented human capital. Thus, the management of human capital capacity at a green university takes an integrated form, combining strategic human capital management, the development of sustainable competencies, the greening of organisational processes, and the support of green innovations.

Within the framework of the proposed model, the university serves as an institutional platform where strategic management decisions, research activities, campus greening, educational practices, and social interaction constitute a complex of green competencies that ensure the region's sustainable development. Figure 3 systematises the key mechanisms for the formation of green-oriented human capital within universities.

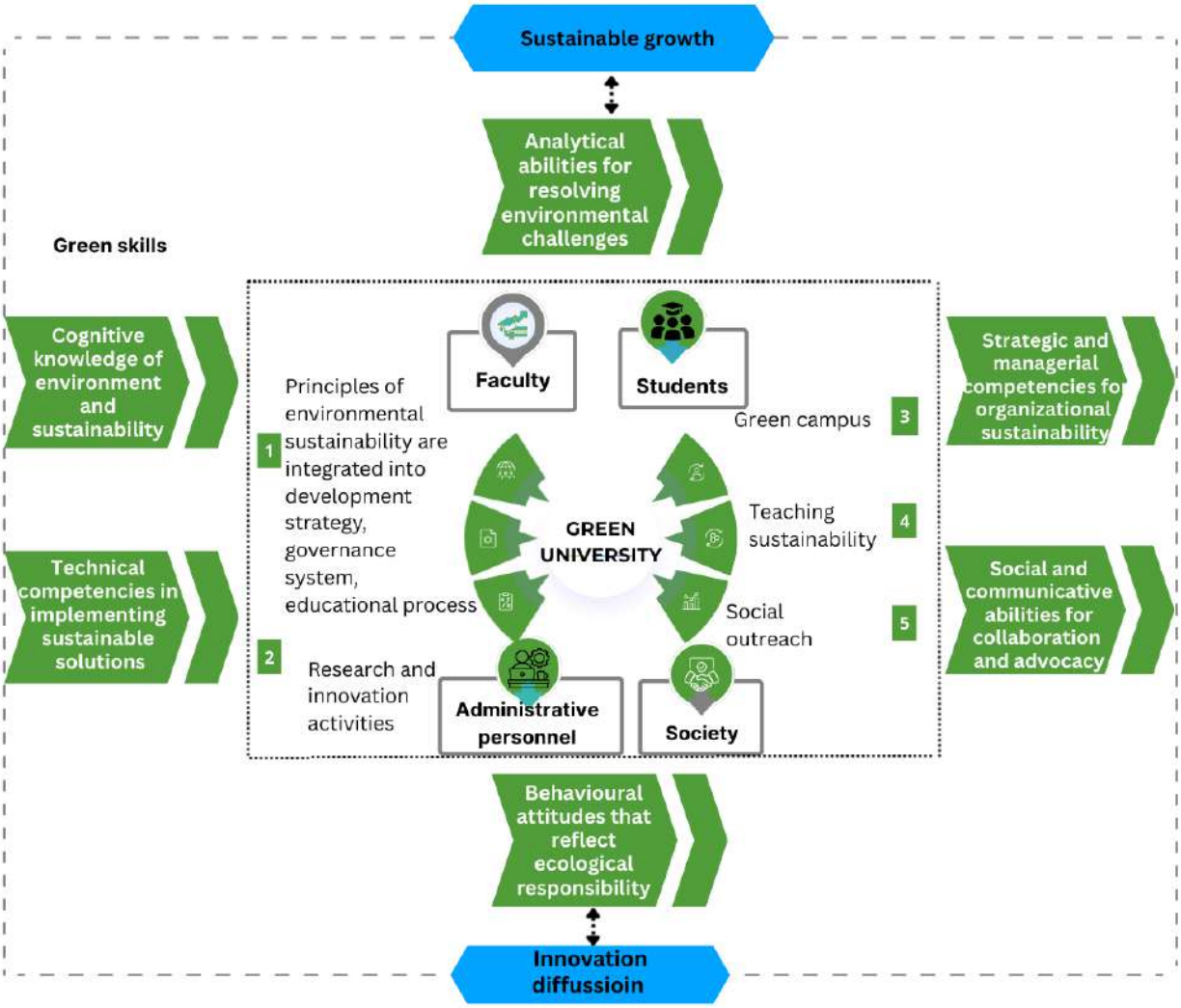

Figure 3 - Conceptual framework of the green university model for developing green-oriented human capital and supporting sustainable growth

Note - compiled by the author based on the literature review

The scheme visualises an integrative model for the formation of green-oriented human capital within the framework of a green university, emphasising the interconnections among the educational environment, students' and staff's competencies, institutional practices, and outcomes in sustainable development. The systemic nature of the transition toward sustainability demonstrates how the university ecosystem becomes a determining factor in the development of green skills and environmentally oriented behaviour. According to the author's interpretation, green skills are a set of professional and interdisciplinary competencies required for advancing a sustainable, low-carbon, and resource-efficient economy. Green skills cover the ability to make environmentally responsible decisions, manage natural resources, develop and implement green technologies, assess environmental impacts, and integrate sustainable practices into production, research, and management processes. The presented model also reflects the relationship between management mechanisms for human capital capacity and

sustainable development outcomes, demonstrating universities' role in reproducing environmentally oriented human capital.

The contemporary stage is characterised by a transition from viewing human capital as an economic factor to interpreting it as a complex, environmentally oriented resource that shapes the parameters of sustainable development and green growth. Thus, universities function as institutional mechanisms for the reproduction of green-oriented human capital, transforming sustainable strategies into educational, research, infrastructural and social practices. As a result, the current stage of human capital evolution is shaping a new paradigm in which environmental competencies are no longer an additional component but the structural core of professional training and innovative development. Green-oriented human capital capacity is a key resource for sustainable growth, and the effectiveness of its management mechanisms determines the competitiveness of universities, regions, and national economies in the context of a green transition.

The stages discussed above demonstrate the evolution of perspectives on human capital capacity management in higher education. To summarise the identified transformations and systematise the key characteristics of each period, Table 1 presents a consolidated overview of the evolution of the concept of human capital capacity management in the higher education system.

Table 1 - The evolution of the concept of human capital capacity management in the higher education system (1940 to present)

No.	Stage of development	Period	Key features	Main implications for higher education
1	2	3	4	5
1	Classical stage	1940–1980	Formation of the economic interpretation of human capital as a factor of economic growth. Development of theories of investment in education and professional training	Universities are viewed as producers of human capital; emphasis on the economic efficiency of education and the preparation of qualified specialists
2	Institutional stage	1980–2000	Integration of human capital theory with organizational and managerial sciences. Development of concepts of organizational learning, knowledge creation, intellectual capital and Human Resource Management (HRM). Human capital is beginning to be seen as a dynamic organizational ability based on collective learning, knowledge sharing, and innovation	Universities are recognized as learning organizations; emphasis on knowledge management and the development of academic potential
3	Innovation stage	2000–2010	Emphasis on human capital as a source of innovation and technological change. Emergence of the concepts of the “knowledge economy” and the “innovative university”	Universities become centers of innovation, establish technology parks, and strengthen cooperation with industry
4	Stage of adaptive competencies	2010–2020	Development of lifelong learning models and expansion of digital and adaptive competencies. Growing importance of soft skills and transversal competencies	Universities integrate digital technologies into educational processes and develop competencies required for flexible labour markets

Continuation of Table 1

1	2	3	4	5
5	Contemporary stage	2020–present	Transition toward the concept of sustainable human capital. Integration of ESG principles, green skills, and social responsibility into university strategies	Higher education focuses on developing environmentally and socially responsible human capital; expansion of sustainable campuses and green competencies
Note - compiled by the author				

The table summarises the evolutionary dynamics of theoretical and practical approaches to managing the human capital capacity in the higher education system. The concept has continually evolved: from viewing human capital as an individual economic resource to understanding it as a multi-level institutional category comprising inventive, digital, and sustainable components. Each of the highlighted stages captures a qualitative change in universities' functions and strategic priorities, driven by transformations in the global social and economic environment, technological progress, and evolving labour market requirements. The contemporary stage demonstrates the integration of ESG principles, environmental responsibility, and green skills into universities' strategic and educational processes, indicating a transition toward the formation of sustainable human capital as a key determinant of long-term development, innovation dynamics, and social sustainability.

The aforementioned research concludes that, in today's higher education system, the concept of human capital has evolved from a narrow economic interpretation to a comprehensive understanding of it as a strategic resource for universities. Human capital is now seen as a dynamic system of competences that includes intellectual, digital, environmental, and entrepreneurial traits rather than only the outcome of educational activity. This transformation has necessitated the development of institutional and organisational management mechanisms for human capital capacity, including research and green competencies, continuous professional development systems, academic mobility mechanisms, the stimulation of innovation, knowledge management, and the integration of sustainability into educational and university management processes. Modern universities increasingly serve as centres for developing adaptive competencies that ensure resilience to innovation, global competitiveness, and alignment with the requirements of the green and digital transitions. Consequently, the management of human capital capacity becomes a key element of the strategic development of higher education and the formation of a national innovation system.

1.2 Global experience in managing higher education systems in the context of the green transition

The higher education system experienced major changes associated with the expansion of digitalisation, the transition toward sustainable development, and the emergence of a green economy. In this regard, the role of universities needs to be rethought. HEIs should become active stakeholders in environmental and public

education. Accordingly, political, economic, and institutional transformations are shaping a new management model for the higher education system.

According to global evidence, the green transition cannot be realised without the active involvement of universities, which play a central role in developing human capital by involving green skills and competencies in curricula, scientific research, infrastructure, and management processes. Universities possess significant potential to test and apply innovative solutions to develop human capital equipped with green competencies, particularly when supported by national governments and international organisations that provide institutional frameworks for the sustainable development of higher education.

This section includes four analytical blocks. First, a bibliometric analysis is conducted to identify key countries and conceptual nodes in the existing scientific literature. It provides a theoretical and empirical basis for subsequent analysis. Second, a country case analysis is conducted to identify differences in institutional contexts, policy priorities, and implementation practices across various national higher education systems. Third, a typology of models is being developed to systematise existing approaches, identify their characteristics, prerequisites, and mechanisms of operation, and distinguish their similarities and differences. Fourth, the typology is being adapted to Kazakhstan's conditions. At this stage, the applicability of the identified models to the national context is considered, taking into account the specifics of educational policy, the organisational structure of universities, resource capabilities and strategic guidelines for the development of higher education in the country.

From a management perspective, international experience shows that the management of green universities is based on a set of interrelated mechanisms for human capital capacity management. To systematise them and identify the most common areas of management, a bibliometric analysis of international publications on the development of higher education in the context of the green transition was conducted. The results of the analysis allowed us to identify the main directions of the formation and development of human capital, which were subsequently grouped into several key categories: (1) Strategic mechanisms (integration of the principles of sustainable development into university strategies and management systems); (2) Human capital management mechanisms; (3) Educational mechanisms; (4) Research mechanisms; (5) Infrastructural mechanisms; (6) Mechanisms for stakeholder engagement and international cooperation.

To identify global experience in managing higher education systems during the green transition, a bibliometric method was used to highlight the countries most actively involved in developing and governing green universities. Figure 4 shows the publication selection process for the bibliometric analysis.

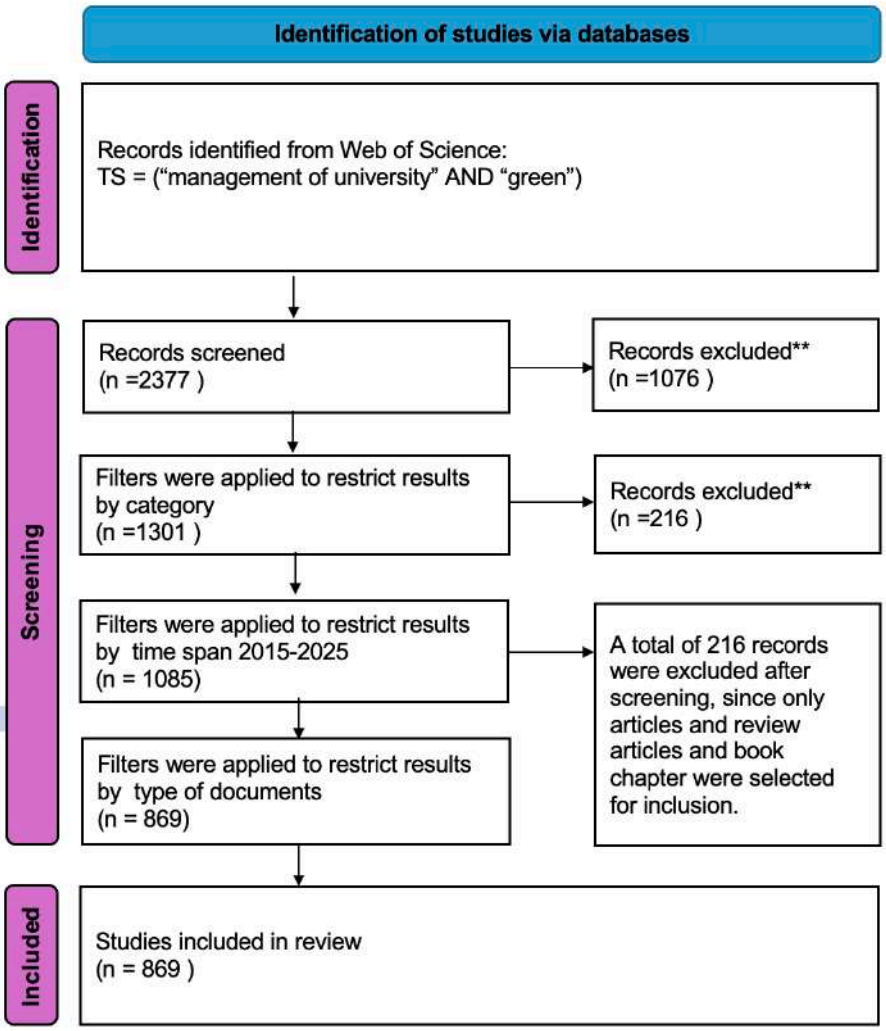

Figure 4 - PRISMA flow diagram

The PRISMA flow diagram shows that the Web of Science Core Collection database was used to search for publications using the keywords "HIGHER EDUCATION MANAGEMENT" and "GREEN" (October 18, 2025) and 2,377 publications were identified (1,823 articles, 100 review articles, 50 book chapters, 30 early access, 374 proceedings papers, etc., all available in all languages). To ensure relevance, results were filtered by subject categories: Management, Education, Political Science, Public Administration, Environmental Studies, Green & Sustainable Science and Technology, Engineering, and Multidisciplinary Sciences. Consequently, 1,301 publications on university management in sustainable and green development were selected.

At the next stage, the time range 2015-2025 was set, allowing for focus on the most relevant research reflecting current trends in digitalisation, sustainable development, and the introduction of environmental principles into the higher education system. After applying this restriction, the sample was narrowed down to 1085 publications. The conference proceedings were then removed from the resulting data set, leaving 869 publications for analysis.

VOSviewer was used for bibliometric analysis. The network was based on keyword co-occurrence. To improve reliability and reduce noise, keywords with at

least 5 occurrences were included. Total Link Strength (TLS) measures relationship strength by the cumulative intensity of co-occurrence links. Clustering used the VOS algorithm to identify thematic structures in the research domain.

The results of the bibliometric analysis are presented in Figure 5, which visualises the dynamics of scientific interest in green university management and identifies the main centres of scientific production.

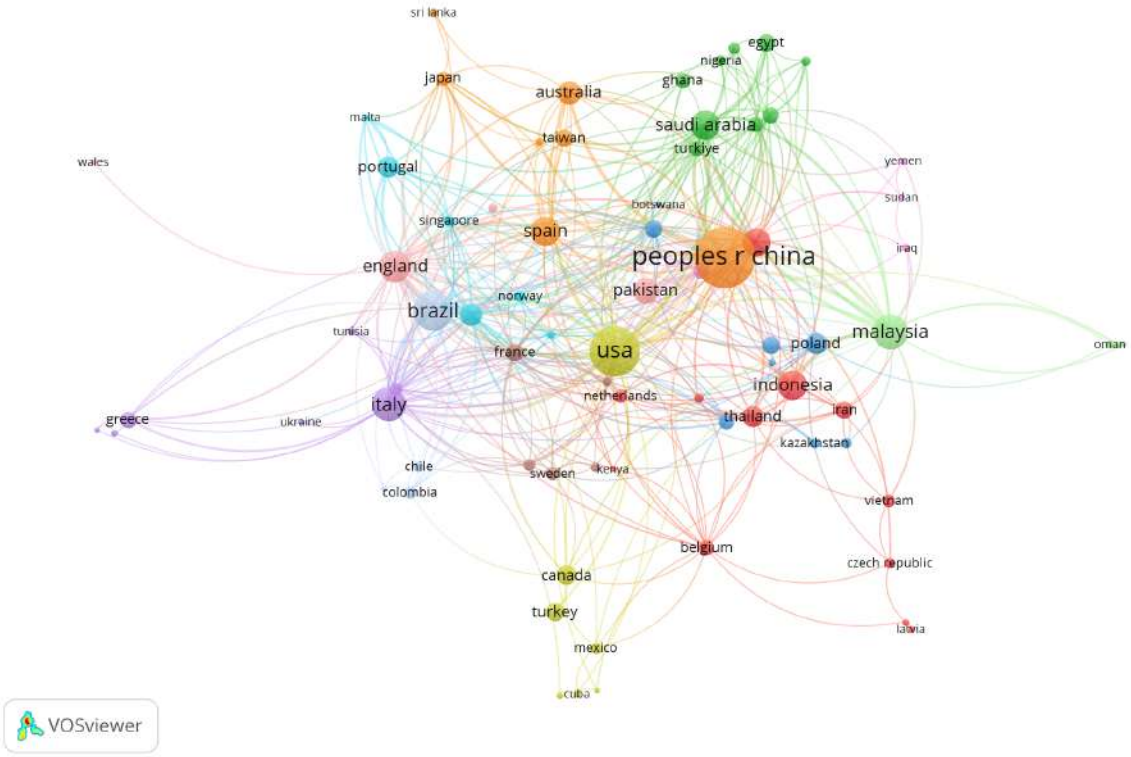

Figure 5 - Leading countries and clusters of scientific collaboration in the field of green higher education

Note - Visualization created in VOSviewer based on bibliometric data

Thus, based on the bibliometric analysis conducted, the countries with the largest number of publications and the highest intensity of international scientific relations in the field of university management in the context of the green transition were identified. The leading countries include the USA, China, Malaysia, England, Australia and the countries of the European Union. The dominance of these countries is due to the high level of development of research infrastructure, active government policy on sustainable development, significant investments in higher education and research, and the integration of ESG and sustainability approaches into university management. An additional factor is the high level of international publication activity and a well-developed system of global academic partnerships, which strengthen these states' central position in international research networks.

The bibliometric analysis demonstrates that the most effective models are based not on individual environmental initiatives but on integrating sustainability into the university's management system, including the development of green competencies, research potential, international cooperation, academic mobility, and institutional mechanisms to support green innovation. This approach confirms the need to

develop a systematic model of university human capital management that focuses on sustainable development and green skills.

The following section examines the governance models of green universities in these countries in greater detail. Countries are developing distinct green governance models based on national priorities, their level of digitalisation, government support, and academic engagement. Table 2 provides a comparative overview of governance directions and characteristic initiatives supporting green universities.

Table 2 - Characteristics of green university governance in different countries

Country	Main directions of managing green universities	Key features / initiatives
United States	Institutional and strategic governance of university sustainability	Implementation of Green Campus programs; Development of energy-efficient campuses; Participation in sustainability rankings (Sustainability Tracking, Assessment & Rating System — STARS); Integration of ESG principles into university strategies
United Kingdom	Strategic governance and corporate social responsibility in universities	Sustainability principles incorporated into strategic documents (HEFCE, Advance HE); Emphasis on decarbonization and sustainable resource management
Australia	Comprehensive integration of sustainability into governance, research, and education	Sustainable Campus Initiatives programs; cooperation with the Green Building Council; Establishment of educational centers for sustainable development and climate change
Selected EU member states	Governance based on European sustainability standards	Participation of universities in the European sustainability charter (EAUC); Development of green campuses and integration into environmental education systems
China	State strategy of green modernization and low-carbon development	Support from the Ministry of Education of China; Green University Network of China programs; Implementation of environmental standards and smart energy systems
Malaysia	Regional leadership in Green Campus Initiatives	National participation in the UI GreenMetric program; Integration of sustainability principles into campus management and curricula; Development of environmental indicator systems
Note - Compiled by the author		

The data indicate that although there is a general trend toward integrating sustainable development principles into higher education management, the implementation of green strategies varies considerably across national contexts, economic development, and government policies on education and the environment. In countries with advanced governance systems and high university autonomy, such as the United States, the United Kingdom, and Australia, institutions prioritise self-regulation, a corporate culture of sustainability, and partnerships with businesses or local communities. In contrast, in China and Malaysia, green universities are

developed within government-led strategies, in which centralised planning, national programs, and regulatory oversight predominate. European Union countries focus on harmonising educational and environmental policies with European standards for sustainable development and ESG approaches.

The following sections examine the specific features of green university governance in each identified country, with particular attention to institutional models, human resource policies, and mechanisms for human capital development in the context of the green transition.

United States

The USA's experience in sustainable development and the greening of higher education is of considerable interest for the development of human capital capacity management mechanisms in the context of the green transition. In the American model, universities are considered not only as educational institutions but also as key institutional centres for the development of environmentally oriented competencies, innovations, and sustainable management practices. The human capital capacity management system at universities is integrated into the sustainable development strategy and covers personnel policy, educational programs, research and infrastructure development on university campuses [75,76]. As a result, universities are creating an institutional environment conducive to training specialists and generating the knowledge necessary to develop a green economy. In the context of the green transition, the American model focuses on building human capital capacity, ensuring the development of decarbonization, sustainable innovation, and environmentally oriented economic growth.

One key area of human capital capacity management is greening university infrastructure and campuses. University territories are considered as experimental sites for the introduction of energy-efficient technologies, ecological construction and sustainable resource management models. Therefore, the study of the environmental strategies used in the development of the Bastyr University student campus has demonstrated the feasibility of integrating sustainable construction and energy-efficiency principles into the university's infrastructure [77]. Similar findings are reported in a study by Taleghani et al. (2014) evaluating strategies to reduce heat stress and improve climate resilience on the Portland State University campus [78]. An additional tool for sustainable management is the monitoring system for the environmental impact of university activities. In particular, Thurston and Eckelman propose a methodology for estimating greenhouse gas emissions associated with university procurement [79]. At the same time, Yang and Gao consider using the STARS rating system to estimate the carbon footprint of university campuses [80]. Complementing this perspective are studies of ecosystem services at university sites, which show that campuses can play an important role in biodiversity conservation and sustainable land use [81]. Such practices allow universities to use their campuses as tools for training personnel and testing solutions needed to implement the green transition.

An important element of human capital capacity management is integrating sustainable development principles into educational programs. At American universities, sustainable development is gradually becoming a part of business

education and management programs. An analysis of the content of the training courses shows an increase in the integration of environmental issues into the educational process and the formation of new competencies related to sustainable development and environmental management [82]. Research also shows that the university environment has a significant impact on students' environmental attitudes and attitudes towards sustainable technologies and infrastructure [83]. At the same time, Vallée notes that despite the expansion of educational initiatives, many US universities struggle to systematically integrate environmental literacy into their programs [84]. In the context of the green transition, integrating sustainability competencies into educational programs is becoming a necessary means of training specialists for a low-carbon economy.

An important feature of the American human capital capacity management model is the active involvement of students in sustainable university initiatives. Students participate in developing environmental projects, campus initiatives, and innovative solutions. Programs that develop sustainable leadership and environmental responsibility foster the managerial and entrepreneurial competencies necessary for a green economy [85]. In addition, universities create the institutional conditions for sustainable entrepreneurship and innovation. In particular, Fichter and Tiemann show that universities play a key role in shaping ecosystems to support sustainable entrepreneurship through educational programs, research centres, and business engagement [86]. The development of green markets and environmental technologies stimulates the formation of new competencies and the development of human capital focused on sustainable innovation [87]. The development of sustainable entrepreneurship contributes to the formation of human capital capacity, with a focus on green technologies, the circular economy, and environmental innovations.

The participation of universities in innovation ecosystems and regional development is a significant driver of human capital development. Research shows that universities act as intermediaries between scientific knowledge, technological innovation and economic development of territories. Trencher et al. emphasise the importance of intersectoral collaboration between universities, businesses, and government institutions in implementing sustainable urban transformations [88]. Similarly, McCauley and Stephens consider the development of energy clusters as a mechanism for the formation of sustainable regional innovation systems, in which universities serve as knowledge-generating and training centres [89]. As part of the green transition, universities serve as regional centres for staff training and the dissemination of sustainable technological solutions.

Sustainability research indicates that the transition to a green economy involves integrating human capital, innovation, and institutional changes. Specifically, Amin et al. argue that the decarbonization of the U.S. economy is related to the development of renewable energy, innovation, and human capital [90]. Similarly, Cole et al. show that environmental policy and institutional conditions can significantly influence the structure of economic development and specialisation of countries [91]. The institutional aspects of the United States' innovative development are also considered in Polyakov et al., which emphasises the role of

scientific organisations and universities in the formation of an innovative economy [92]. An additional factor for sustainable development is the involvement of organisations' management structures in stimulating green technological innovation [93]. The American experience shows that successfully implementing the green transition requires integrating human capital management mechanisms, innovation policy, and sustainable university development.

A separate area of research concerns the social aspects of sustainable development and the well-being of the population. In particular, Mitchell et al. show that interaction with the natural environment and the development of social capital have a significant impact on the sustainable development of urban areas [94]. These factors also form the value and behavioural foundations of human capital for sustainable development. In turn, Bash et al. emphasise the importance of ethical principles of sustainable development and their integration into engineering and technological systems, which strengthens the role of universities as institutions of value-based environmental responsibility [95]. The development of green-oriented human capital is becoming an important condition for long-term sustainability and social adaptation amid the economy's green transformation.

Thus, the US experience demonstrates a comprehensive model for human capital capacity management in the higher education system in the context of a green transition. The greening of university infrastructure, the integration of sustainable development into educational programs, the participation of universities in innovative ecosystems and the support of sustainable entrepreneurship form an institutional environment for the development of environmentally oriented competencies. The above-mentioned practices confirm that universities can play a crucial role in the green transition, providing the training and development of the knowledge necessary to implement it and to achieve sustainable social and economic development.

United Kingdom

The United Kingdom is one of the global leaders in developing the green university concept, in which the management of human capital and institutional resources is integrated with Corporate Social Responsibility (CSR) and the Environmental, Social, and Governance (ESG) approach. The governance model of sustainable development in British universities is characterised by a high degree of academic autonomy, transparency, and an orientation toward public accountability, which positions universities not only as educational institutions but also as active actors in social and environmental policy [96]. The formation of a sustainable university sector is based on key initiatives such as the Higher Education Funding Council for England (HEFCE), Advance HE and UK Research and Innovation (UKRI), as well as strategic documents — Sustainable Development in Higher Education Strategy (2005-2010) and Education for Sustainable Development (ESD) Framework (2014-2024) [97,98]. These frameworks established the foundation for integrating sustainability principles into human resource policies, educational programs, research activities, and infrastructure development. Consequently, sustainability in British higher education is viewed not only as an environmental issue but also as a managerial category linked to human capital development,

leadership, and organisational culture [99]. In the context of the green transition, the British model focuses on integrating ESG and CSR approaches into the human capital capacity management system and providing training for a low-carbon, sustainable economy.

According to Jenkins, the transition toward a sustainable university requires a new type of academic leadership oriented toward the strategic management of human capital. Leaders of British universities cultivate an institutional culture in which sustainability becomes part of staff's professional identity and a criterion for evaluating institutional performance. Ranking systems such as the *People & Planet Green League* and the *Times Higher Education Impact Rankings* encourage universities to implement human resource practices that support the development of sustainability competencies, staff participation in environmental initiatives, and increased accountability [96]. However, as Jones notes, the pursuit of high positions in sustainability rankings may, in some cases, lead to green image building, in which sustainability becomes a marketing instrument rather than an internal transformation of organisational culture [99]. Such mechanisms contribute to the formation of an institutional environment in which the development of green competencies becomes part of universities' strategic management in the context of a green transition.

Leading universities—including the University of Cambridge, the University of Oxford, the University of Leeds, and the University of Exeter—have introduced programs such as *Sustainability Leadership* and *Climate Governance* to develop managerial and climate-related competencies [100,101,102,103]. These programs cover ethical leadership, corporate responsibility, and strategic planning. Participation in them is considered an element of career growth, and staff involvement in sustainable projects is incorporated into the performance appraisal system. Consequently, leadership in sustainable universities takes on a human-centred character, emphasising the development of competencies, ethical responsibility, and collective participation. In the context of the green transition, these programs aim to train academic and managerial personnel capable of implementing climate strategies and managing sustainable transformations at universities.

The British model of the sustainable university is based on a *whole-institution approach*, developed by HEFCE and supported by Advance HE, in which sustainable development is treated as a cross-cutting governance principle encompassing staff recruitment and training, financial planning, infrastructure management, and research activities [104]. The integration of ESG and CSR approaches enhances strategic accountability. In other words, carbon disclosure and social initiatives shape universities' reputations for corporate responsibility and institutionalise sustainability as a management function that encompasses human resources, finance, and educational policies [105]. This approach contributes to the development of a comprehensive governance system in which sustainability underpins human capital strategies and organisational learning. The implementation of the whole-institution approach allows British universities to integrate green transition mechanisms into all levels of management, from personnel policy to infrastructure and financial planning.

The development of human capital in the context of sustainable development in British universities is not limited to educational activities. Universities focus on adaptive human capital to address the challenges of the green economy by embedding green skills [104, 106]. Universities integrate sustainability topics into professional development programs, administrative staff training, and professional development frameworks for academic personnel. These measures create systems of continuous competency renewal, in which every employee becomes involved in organisational learning and strategic planning processes. Human resource policy thus becomes an element of knowledge governance aimed at developing a new form of professional identity that includes climate awareness and ethical responsibility. As a result, the development of green skills is seen as a key element in adapting human capital capacity to the demands of decarbonization and the green economy.

The formation of a sustainable organisational culture is impossible without employee involvement and the development of horizontal interaction structures. According to Jones, mutual responsibility, empathy, and collective action are the foundation for an "environmentally friendly" university [107]. Through innovative forms of engagement that combine professional identity with environmental mission, some colleges aim to encourage staff members to become more environmentally conscious [108]. Thus, effective human capital capacity management in green universities is achieved not through administrative control, but through a culture of collaboration and meaning-building. Similarly, Jerome, within the framework of the community-scale green infrastructure concept, emphasises the importance of horizontal structures, such as Sustainability Committees and Green Impact Programs, in which employees and students jointly implement projects to reduce the carbon footprint, improve waste management, and conserve biodiversity [109]. Thus, the British model of human capital capacity management is based on the principles of participation, engagement and co-management, which distinguishes it from centralised bureaucratic systems. Such forms of co-management enhance the involvement of staff and students in implementing the goals of the green transition and in developing a sustainable organisational culture.

Students play a crucial role in promoting the principles of sustainable development by actively participating in sustainability initiatives. According to Thompson et al., universities support student organisations that promote campaigns on decarbonisation, climate justice, and ethical investment [110]. It shapes generations of climate-responsible leaders, strengthens universities' social capital, and provides a link between learning, research, and practice. In addition, studies by Thompson et al. confirm that access to campus green spaces helps strengthen students' sense of belonging to the university community and increases their involvement in sustainable initiatives[110]. In the context of the green transition, student initiatives are becoming an important mechanism for disseminating environmental values and developing climate-responsible human capital.

British universities also prioritise infrastructure development for the green transition. The application of the BREEAM (Building Research Establishment Environmental Assessment Method) standards ensures energy efficiency in campus buildings and enhances staff well-being and motivation [111]. The Zero Carbon

Oxford University by 2035 and Cambridge Sustainability Framework programs include digitalising energy management, using renewable energy sources, and employee training in environmental management principles [112,113]. The Cambridge and Oxford campuses have become examples of the synthesis of digital technologies, biophilic design, and strategic human resource management. Leading universities are creating research centres that combine science, management and policy: the Grantham Institute for Climate Change and the Environment (Imperial College London), the Cambridge Institute for Sustainability Leadership (CISL), the Tyndall Centre for Climate Change Research, and the Centre for Environment, Energy and Natural Resource Governance (University of Cambridge)[114,115,116,117]. These centres function as organisational hubs for knowledge transfer and professional competence development, linking academic science, business, and government agencies. These infrastructure and research initiatives provide institutional support for the green transition by integrating technology development, sustainable management, and training for green-oriented human capital.

Despite the high level of institutionalisation of sustainable development, the British model faces several contradictions. O'Neill and Sinden note that the neoliberal logic of university management leads to the commercialisation of sustainability when environmental policy is used as a branding and marketing tool, thereby weakening its value and educational potential [118]. There is fragmentation between environmental and human resource strategies, as Saha et al. observe[105]. This has implication for the consistency of the reforms. Pritchard and Kelly observe that, despite many universities across the world adopting the BREEAM standard, many lack sufficient competence in asset management [119]. As a result, some campuses are green on paper but not in practice, underscoring the need to further develop managerial and technical skills. These contradictions demonstrate that the success of the green transition depends not only on the implementation of environmental standards but also on the effectiveness of human capital capacity management mechanisms and organisational changes.

The British Green University model is an integrated human capital and sustainable development management system based on the principles of CSR and ESG, academic autonomy and transparent accountability. Unlike many countries, the UK has moved further towards institutionalising sustainability in human capital management: certification standards, engagement schemes, and evaluation systems have been developed that foster a culture of participation and responsibility. The experience of British universities shows that sustainable development is not just something they say; it is also a part of their corporate identity and educational mission. Universities are creating an effective sustainability ecosystem that focuses on developing human capital and transforming society through a mix of ESG standards, strategic leadership, and student involvement. Thus, the UK serves as an example of how sustainability principles can be deeply integrated into higher education management systems, turning universities into sources of climate responsibility, green innovation and the implementation of green transition strategies.

Australia

Australia occupies a leading position in the Asia-Pacific region in developing the green university concept and systematically integrating sustainable development principles into higher education. The governance of human capital, infrastructure, and research in Australian universities is structured around the national agenda defined by *Australia's National Sustainability Framework for Higher Education* and the *Sustainable Development Goals (SDGs) in the Higher Education* program coordinated by Universities Australia and the Australian Department of Education [120]. These initiatives have established strategic guidelines for universities to develop human resources capable of driving a green transition, reducing carbon footprints, and advancing social sustainability. In the context of the green transition, the Australian model focuses on building human capital capacity, ensuring the development of a low-carbon economy, climate sustainability, and green innovation.

Australian universities are engaged in international associations and ratings, including the QS Sustainability Rankings, the UI GreenMetric, the Global Universities Partnership on Environment for Sustainability (GUPES), and the Green Building Council of Australia (GBCA), which facilitate the sharing of best practices and university improvement. Leading universities — the University of Melbourne, the Australian National University (ANU), the University of Queensland, Monash University and the University of New South Wales (UNSW) — have developed their own Sustainability Frameworks and People & Planet Strategies, where sustainability is considered as a key principle of strategic management and human capital development [121,122,123,124,125]. Participation in international sustainability initiatives allows universities to integrate green transition mechanisms into strategic management, educational policy, and human capital development.

Baer and Gallois note that institutional commitment to sustainable development increasingly serves as an indicator of the quality of university management and social responsibility [126]. However, declarations of sustainability are not always supported by corresponding human capital and organisational mechanisms, leading to symbolic rather than substantive sustainability. This situation reflects a broader challenge for governance systems: the need to move beyond declaratory commitments toward transformative change in university organisational culture. Such challenges demonstrate that the successful implementation of the green transition requires not only the formal adoption of sustainability strategies but also a deep transformation of human capital capacity management mechanisms.

The sustainable development of universities is impossible without the formation of a new type of human capital — leaders capable of managing environmental and social changes. Davison et al. propose the concept of distributed leadership, in which sustainability is achieved through horizontal management that involves faculty and researchers in decision-making [127]. Choy emphasises that integrating learning and practice through universities' interactions with employers is becoming a mechanism for training specialists capable of implementing sustainable solutions in the real sector [128]. In the context of the green transition, distributed leadership promotes training human capital who can manage environmental and social transformations across various sectors of the economy.

Professional development for teaching and administrative staff is organised through the Sustainability Leadership and Climate Governance programs, which aim to develop competencies in sustainable management, climate solutions, green engineering, and social impact. Universities are implementing staff performance assessment systems that include indicators of participation in sustainability projects, sustainability-related publication activity, and innovation in the educational process [129]. The development of such programs ensures the formation of green skills and the adaptation of universities' human capital to the challenges of decarbonization and sustainable development.

Baer and Gallois emphasise that the HR policy of Australian universities should shape not only professional competencies but also value leadership, with sustainability becoming part of professional identity [126]. Faculty act not just as translators of knowledge but also as facilitators of cultural change that shapes students' stable worldview. The formation of environmentally oriented values and climate responsibility is becoming an important mechanism for preparing human capital capacity for a green transition.

Effective human capital capacity management at universities in Australia is based on an inclusive model, which includes participation, engagement, and co-management. Figueredo and Tsarenko note that students' participation in sustainable development initiatives depends on a combination of personal values and institutional support [130]. Butt, More, and Avery further elaborate on this idea, stating that the myth of the green student does not reflect reality, as environmental motivation is not an automatic process but rather an outcome of a system of leadership, communication, and mentoring [129]. In response to these challenges, universities are implementing programs such as Student Sustainability Leaders, Green Impact, Enviro Collective, and Sustainable Campus Champions, in which students implement projects to reduce their carbon footprint, promote social responsibility, and foster environmental entrepreneurship. Involving students in Sustainability Committees and Governance Boards gives them a voice in shaping strategy and infrastructure decisions.

Walshe and Law show that at the University of Melbourne and Griffith University, students not only participate in developing green initiatives but also integrate them into campus spatial planning [131]. Malone and Young associate this with a new pedagogical paradigm of sustainability based on empathy, participation, and an understanding of the interdependence of man and nature [132]. Thus, the Australian human capital capacity management model is based on an expanded understanding of participation, from administrative involvement to cultural collaboration at a sustainable university. The involvement of students in co-management processes strengthens institutional support for the green transition and promotes the development of climate-responsible human capital.

The physical infrastructure of Australian universities is not only a material base but also a tool for developing human capital. Most campuses are certified under Green Star and NABERS (National Australian Built Environment Rating System) standards, which ensure energy efficiency, rational water use, and waste minimisation. The University of Queensland operates the university's largest solar

power plant, and Monash University became the first university in the country to receive carbon-neutral certified status.

Li et al. note that the development of green buildings is motivated not only by economic but also by social factors such as reputation, innovative leadership, and staff well-being [133]. Rasekh and McCarthy emphasise that the successful implementation of sustainable projects requires highly qualified employees and interdisciplinary coordination [134]. Campus spaces are designed using biophilic design principles that promote engagement, productivity, and stress reduction [135]. Such an infrastructure policy enables the use of campuses as tools for implementing a green transition and developing sustainable models of professional behaviour.

Modern universities are developing concepts of living buildings and living labs. In other words, universities are turning their campuses into experimental spaces for sustainability. Udawatta et al. and Martek et al. emphasise that such spaces promote collaborative research and learning, in which students, faculty, and technical staff co-create innovative solutions [136,137]. Living labs and living buildings form a practice-oriented training environment necessary for the development and implementation of green technologies.

Knowledge management is becoming an integral element of sustainable university management. Mamtora, Bradshaw, and Lemberget propose the concept of green open access as a means of sustainable knowledge dissemination and increased transparency in academic communication [138]. In addition, Chou et al. demonstrate that the use of big data enhances the potential of strategic management and sustainable marketing, forming the basis for evidence-based HRM and the integration of intellectual capital into a sustainable management system [139]. The use of digital technologies and knowledge governance systems enhances universities' ability to adapt human capital to the demands of a green transition and a sustainable economy.

The research activities of Australian universities are integrated into the national programs of the Research Support Program, the Australian Research Council (ARC) and the Cooperative Research Centres (CRC), aimed at developing interdisciplinary research in the fields of climate, biodiversity, renewable energy and social justice [140,141,142]. The leading research centres, such as Monash Sustainable Development Institute (MSDI), ANU Climate Change Institute, and the University of Sydney Institute for Sustainable Futures (ISF), serve as platforms for integrating science, management, and education. The integration of scientific research, management, and education contributes to the development of innovative human capital necessary for implementing national climate and sustainability strategies.

Through the Sustainable Built Environment National Research Centre (SBEnrc) and Clean Energy Finance Corporation (CEFC) programs, universities are developing partnerships with business and government, providing technology transfer and commercialisation of sustainable solutions [143,144]. These interactions form an innovation ecosystem in which human capital, infrastructure, and science mutually enhance one another. Such partnerships provide the institutional framework for a green transition by combining training, technology transfer, and the development of sustainable innovation.

Despite the high level of institutional integration of sustainable development, research reveals several contradictions. Figueredo, Tsarenko and Butt et al. note the need to develop mechanisms to recognise and motivate staff and students so that sustainability is perceived as a collective mission rather than a formal obligation[129, 130]. Baer and Gallois add that neoliberal management logic and ratings orientation sometimes weaken the value base of sustainability, turning it into a branding tool [126]. Rasekh and McCarthy (2016) and Martek et al. emphasise that even innovative projects risk remaining fragmented without systematic human capital support and coordination [134, 137]. The identified limitations show that the effectiveness of the green transition largely depends on the consistency of universities' human, organisational, and infrastructural management mechanisms.

Thus, the Australian green university model is an integrated system in which the management of human capital, infrastructure, science, and the culture of participation form an interconnected ecosystem of sustainability. The Australian approach combines academic autonomy, market flexibility, and social responsibility. Human capital becomes the core of this system: employees, students, and researchers act as agents of change, ensuring the implementation of national and global SDGs and the green transition. Australian universities are not only forming educational and research centres but also new models of socially responsible leadership that provide training to build human capital capacity to realise a green transition and a sustainable future.

Selected EU member states/ the European Union policy framework

The European Union (EU) is transforming its economy and society in response to the European Green Deal, the EU Climate Law, and the 2030 Agenda for Sustainable Development [145,146,147]. Higher education has a system-forming role. EU universities are becoming platforms for institutional experiments in which sustainability is integrated into management, science, and learning [148,149]. Human capital capacity management within the framework of the green transition is an integrated strategy that combines education, innovation, employment policy, and corporate social responsibility. In the context of the green transition, the European model focuses on building human capital capacity to ensure the achievement of climate neutrality, sustainable economic growth, and social inclusion.

According to EU regulatory documents, including the European Skills Agenda for Sustainable Competitiveness, the Pact for Skills, and the Green Competence Framework (GreenComp), human capital is crucial to the green transition [150,151,152]. The knowledge, skills, values, and managerial competencies of human capital are needed to build a sustainable, digital, and inclusive Europe. The European Commission stresses that universities should become "competence hubs", providing continuous learning and skills transfer between education, business and society. Erasmus+, Horizon Europe, Marie Skłodowska-Curie Actions, and the European University Alliances promote institutional cooperation and mobility of human capital [153,154,155,156]. Within the European Education Area, there is a requirement to integrate sustainable development and ESG approaches into universities' strategic management. The implementation of these initiatives aims to

train human capital and develop the green competencies necessary for the functioning of the EU economy amid decarbonization and digital transformation.

In European universities, an ESG-oriented model of corporate governance is gaining strength, combining transparency, accountability, and social mission. De Oliveira, Leitão, and Alves show that corporate governance in higher education institutions is increasingly serving as a mechanism for integrating sustainability into human resource policy and strategic planning [157]. Universities are creating internal structures, such as Sustainability Offices, Green Committees, and Pro-Rectors for Sustainability, to coordinate actions and prepare ESG-related reporting. Such corporate governance mechanisms provide institutional support for the green transition by integrating sustainability principles into universities' human capital, education, and research policies.

Modern EU universities are seen as systems that combine education, management, and infrastructure to develop sustainability competencies. European universities are increasingly involving students in sustainability management processes. Student councils for sustainable development, Student Green Offices initiatives, and volunteer programs form horizontal links between the administration and students. Administrations with students strengthen universities' social capital and foster a culture of participation in achieving climate and social objectives [158]. The involvement of students in co-management processes contributes to the development of climate-responsible human capital and a culture of participation in implementing the goals of the green transition.

Student movements (Italy, the Netherlands) demonstrate how students become agents of change by combining academic knowledge with public initiatives that align with the principles of lifelong learning and citizenship for sustainability. Cantalejo et al. demonstrate that green pedagogies and service-learning are becoming a tool for transferring sustainable development competencies [149]. The training develops students' leadership, collaboration, and civic responsibility skills. Green pedagogies and service-learning are becoming important tools for training human capital who can adapt to the demands of the green and digital economy.

Human capital capacity management is based on the principle of the learning organisation: the professional development of academic staff and managers is linked to the goals of energy efficiency, inclusion, and digitalisation. For example, many universities have introduced programs such as *Leadership for Green Transition* and *Sustainability Management Training*, in which the development of professional competencies is assessed alongside environmental and social contributions. Such programs ensure the development of the human capital necessary to implement ESG strategies, decarbonisation, and sustainable organisational management.

The green transition in EU university governance includes not only educational and human resource strategies but also spatial strategies. Tagliabue et al. demonstrate the use of digital twin technology to assess the sustainability of university buildings and to train students to analyse energy consumption data [159]. In Finland, the University of Turku has implemented a *circular food system* model on its campus, in which students manage closed-loop systems for food provision and recycling [160]. Campuses become living labs, i.e., laboratories for learning through

participation in sustainable projects [161]. Using the example of schools and universities involved in the New European Bauhaus initiative, this paper shows that the design and use of spaces directly affect students' development of systems-thinking and collective-responsibility skills. The use of living labs and digital technologies allows universities to integrate green transition mechanisms into educational and research activities.

Gawel et al. emphasise the importance of stakeholder-centred governance: universities, together with employers and government agencies, design courses focused on the green and digital transformation of small and medium-sized businesses [148]. As a result, the relationship between personnel training and the labour market's needs is strengthened, ensuring the implementation of the employability principle for sustainability. Hrebenciuc et al. develop this logic by introducing the concept of the "triple employment dilemma"—the need to balance the interests of academia, industry, and sustainability, as the successful integration of universities into the green economy requires strategic management of human capital in conjunction with industrial and social policies [65]. In the context of the green transition, such interaction strengthens the link between the personnel training system and the needs of a sustainable economy and labour market.

Research activity oriented toward sustainability also plays a major role in human capital governance. Programs such as *Horizon Europe* and the *Green Deal Calls* stimulate the formation of research consortia that bring together universities, businesses, and public authorities (e.g. *the Climate Change Risk and Resilience Lab* (Polytechnic University of Milan and etc). These centres create platforms for knowledge transfer and innovation, fostering the development of intellectual capital, that is, universities' ability to produce and disseminate knowledge for sustainable development. Research consortia and sustainability centres constitute the innovative human capital capacity that ensures the development and dissemination of green technologies and sustainable solutions.

According to Fissi et al., European universities develop six interrelated mechanisms of sustainable governance: governance, operations, teaching, research, community engagement, and reporting. At the University of Florence, for example, the position of Pro-Rector for Sustainability has been established, along with programs in energy efficiency, waste recycling, and sustainable mobility, as well as public lecture initiatives such as *Encounters with the Town* [162]. The comprehensive implementation of these mechanisms allows universities to integrate the goals of the green transition into the strategic and operational management system.

Nevertheless, despite institutionalisation, issues such as funding and staff shortages, as well as insufficient stakeholder engagement, remain. These are issues characteristic of the European environment, where the success of the green transition depends on integrating local initiatives into the European policy framework. The existing constraints show that the success of the green transition depends on the consistency of human capital capacity management mechanisms, financial support and institutional coordination at the pan-European level.

The experience of the European Union shows that human capital capacity management in the context of the green transition is based on four dimensions:

1) Strategic — the development of Europe-wide policies (Green Deal, Skills Agenda, GreenComp) and EU-funded programs.

2) Institutional — the implementation of ESG-oriented corporate governance and network structures of sustainable universities (RUS, EAUC, Copernicus Alliance).

3) Pedagogical — the formation of green competencies through service-learning, project-based methods, and digital technologies.

4) Cultural — the development of values of responsibility, inclusion, and cooperation through student participation and social partnership.

These elements form an ecosystem in which human capital is recognised as a primary driver of innovation-led development, social justice, and climate neutrality. Taken together, these measurements form the institutional basis for building human capital capacity to implement the green transition across the European Union.

The European experience confirms that the green transition is, first and foremost, a transition in thinking, management, professional culture, and mechanisms for developing green competencies. EU universities demonstrate the ability to integrate environmental, digital, and social principles into a human capital capacity management system. Italy, Finland, the Netherlands, Germany, and Spain represent different models, yet all converge on the understanding that sustainability is a competence. Within this logic, human capital capacity management becomes the core of university strategy, ensuring the training of personnel and the development of competencies necessary to implement the green transition, achieve EU climate goals, and strengthen Europe’s intellectual and social potential in the global context.

China

In China, human capital capacity management in the higher education system is institutionally embedded in a centralised state strategy for sustainable development and the transition to a low-carbon model of economic growth. Unlike many Western models, in which the greening of universities primarily occurs through initiatives at individual campuses or within network associations, the Chinese approach is characterised by a high degree of strategic coordination and vertical integration. The concept of a green university is considered a structural element of a macro-level policy of environmental modernisation, correlated with the doctrine of Ecological Civilisation and the "Made in China 2025" program [163]. In this logic, higher education is a tool for achieving national goals of decarbonisation, technological modernisation, and innovation. In the context of the green transition, the Chinese model focuses on building human capital capacity to ensure the implementation of national goals of decarbonization, technological sovereignty, and sustainable industrial development.

As McBeath et al. emphasise, the formation of the green university in China reflects a systemic institutional shift of the entire postsecondary education system toward the principles of resource efficiency, environmental regulation, and social responsibility. State priorities are translated into university strategic plans, campus construction standards, educational programs, and performance evaluation

mechanisms [164]. Universities provide both human and scientific resources for the green transformation of the economy, forming a new type of human capital—interdisciplinary, environmentally oriented, and capable of developing low-carbon technological solutions. This approach makes it possible to integrate the mechanisms of the green transition into the system of personnel training, scientific research, and state strategic management at universities.

In the context of the global environmental crisis and the growing climate agenda, human capital capacity management is gaining strategic importance, as it is the faculty, researchers and administrative staff who ensure the integration of sustainability principles into curricula, research projects and the campus management system [165,166]. The Chinese model presupposes not fragmented but institutionally embedded integration of sustainability into academic activities. As a result, human capital capacity management is becoming a key instrument for the institutional implementation of the green transition in China's higher education system.

The green university is understood as a model of institutional development aimed at reducing resource pressure, fostering an environmental culture, and creating an environment for sustainable innovation [167]. The campus is considered a *living lab*, within which students and staff develop and test solutions for energy conservation, waste management, sustainable design, and greening spaces [168,169]. In this context, human capital capacity management is directly linked to campus architecture, the organisation of work processes, and the digital infrastructure for resource monitoring [170]. The use of campuses as living labs supports the practical training of human capital and the development of competencies necessary to implement green technologies and sustainable solutions.

Institutional transformation is accompanied by the development of sustainability assessment tools. Chen et al. propose an integrated campus assessment system that includes energy efficiency, resource management, environmental governance, and educational engagement [171]. Zhu et al., analysing the experience of Zhejiang University, show that energy-saving programs are implemented as part of centralised strategies and are accompanied by the development of environmental audit procedures, managerial reporting, and staff incentive mechanisms [172]. The development of environmental audit and management reporting systems strengthens universities' institutional capacity to support the goals of the green transition at the operational level.

The infrastructural dimension of green transformation in the Chinese context also has a systemic character. Wu et al. demonstrate that the benefits of green buildings materialise over the long term and depend on the structure of the regional energy balance and on construction technology standards [173]. Decisions in campus infrastructure require parallel training of specialists capable of conducting integrated carbon analyses and life-cycle assessments of buildings. Wang et al. emphasise that universities in China's cold regions need adaptive carbon accounting strategies that account for the region's climatic characteristics [174]. In this way, human capital capacity management is integrated with building maintenance, climate adaptation, and digital analytics. In the context of the green transition, such

infrastructure projects require training in climate analytics, resource management, and low-carbon engineering.

The educational component of the green transformation is characterised by a combination of regulatory mechanisms and behavioural mechanisms. The inclusion of environmental modules in the training of teaching staff contributes to the formation of a professional identity focused on social responsibility and long-term planning of decision outcomes [175]. Sustainable education centres, interdisciplinary departments, and retraining programs for employees involved in building maintenance and resource analytics are being created [176]. The development of green competencies is linked not only to the content of learning, but also to the formation of an organisational culture that supports the values of sustainability, collaboration and innovation [176]. The development of ecological culture and green competencies is considered a necessary condition for adapting human capital to the challenges of sustainable and low-carbon development.

Without including environmental indicators in HEIs' KPIs, sustainability remains secondary [177]. In response, the Green HRM approach is being developed, which involves integrating green competencies into recruitment and certification procedures, encouraging employee participation in eco-projects, and supporting interdisciplinary collaboration [178]. As a result, green innovations are considered not only as technological, but also as social innovations implemented through changes in motivational mechanisms and collective practices. Tao et al. additionally show that digital transformation enhances the ability of organisations to implement environmental innovations, which highlights the need to synchronise the human resources and digital policies of universities [179]. The integration of Green HRM and digital technologies allows universities to synchronise their HR policies with national priorities for green transition and environmental modernisation.

Despite the reform, a gap persists between strategic declarations and the actual practice of campus greening [170,177]. The extent of faculty engagement can vary, and efforts to sustain it may be seen as an administrative requirement rather than a direct link to career advancement. If sustainability is not sufficiently embedded in the system of professional incentives, environmental practices may be limited to reporting. The identified contradictions show that the success of the green transition depends not only on centralised strategies but also on the involvement of human capital capacity in the processes of sustainable transformation of universities.

In general, the Chinese green university model represents an institutionally coordinated human capital capacity management system in which government strategy, university governance, infrastructural modernisation, and educational transformation form a unified architecture. The green university is not a collection of individual environmental projects, but a mechanism for the structural restructuring of human capital, embedded in the national trajectory of green transition, low-carbon development and technological modernisation.

Malaysia

Malaysia holds a leading position in Southeast Asia in developing green universities and institutionalising sustainable development principles within the higher education system. Human capital capacity management is based on *Vision*

2030, the *Malaysia Green Technology Master Plan (2017–2030)*, and the *Malaysia Education Development Plan 2015-2025,* all of which prioritise sustainability as a state policy priority in education and innovation [180, 181]. The greening of higher education is regarded as a strategic instrument for enhancing university competitiveness and achieving SDGs [182]. The conceptual foundations of eco-masterplanning and bioclimatic design, which underpin the development of sustainable campuses, align with the principles of green infrastructure integration and systemic environmental planning [183]. In the context of the green transition, the Malaysian model focuses on building human capital capacity and on developing a low-carbon economy, green technologies, and sustainable innovations.

Unlike other management approaches, the Malaysian model complements government intervention with institutional autonomy. The Ministry of Higher Education is responsible for developing a framework for transition into sustainable development models, while universities focus on developing implementation tools. The multi-criteria analysis of sustainable development confirms that institutional flexibility is an important factor in the effective implementation of green development strategies [184]. At the same time, studies of barriers to green campus operations reveal institutional, financial, and cultural constraints to sustainable transformation that require strategic management and cross-functional coordination [185]. This approach makes it possible to adapt the mechanisms of green transition to the institutional, social and cultural characteristics of universities, while maintaining a balance between government regulation and university autonomy.

The key focus is the institutionalisation of green HRM practices. Empirical studies demonstrate that the introduction of green learning, the formation of environmental commitment, management support and the development of an organisational culture of sustainability positively affect the environmental behaviour of employees and the environmental performance of universities [186,187,188,189]. The sustainability of universities is determined by the quality of human capital capacity management and the integration of environmental competencies into personnel policy [190]. Additional data indicate that personal moral standards, environmental knowledge, and transformational leadership shape academic staff's environmental behaviour [191,192,193]. The integration of green HRM contributes to the formation of human capital capacity, capable of supporting the environmental modernisation of universities and the implementation of green transition strategies.

The student environment is considered the basis for the formation of green human capital. Students' intentions and behaviour depend on environmental literacy and sustainable attitudes [194]. Student involvement in eco-campus initiatives fosters sustainable practices and an institutional culture of sustainability [195]. Additionally, the inclusion of sustainable components in the educational curriculum and the institutional setting will influence the development of green entrepreneurial intentions [196,197,198]. The formation of environmental awareness and green mindfulness is considered an important behavioural mechanism for the sustainable transformation of the university environment [199]. Additionally, the role of ecological awareness and perceived consumer effectiveness in shaping students' green consumer behaviour has been identified [200,201]. In the context of the green

transition, the development of environmental literacy and green entrepreneurship is becoming an important mechanism for training personnel for a sustainable economy.

The infrastructural development of universities is carried out in accordance with the principles of eco-campus and smart-campus, combining the greening of spaces and the digitalisation of management. The results of the quality of the interior building environment, microclimate, energy efficiency, and carbon footprint will help to attain sustainable performance [202,203,204]. Psychological studies show that incorporating green space into university campus design would help restore cognitive resources, thereby improving students' mental well-being [205]. The proportion of green spaces would affect microclimatic parameters, such as tree condition [206]. Built environment factors are also related to the sustainability of mobility and walkability on campuses [207]. The development of low-carbon campuses requires an integrated approach that includes management mechanisms, technological solutions, and behavioural change [208]. Such infrastructure solutions enable enablers to use their campuses as tools to implement and develop the green transition and develop sustainable models of professional and behavioural interaction. Behavioural aspects of sustainable mobility and waste management are additional elements of campus sustainability [209,210]. The formation of environmentally responsible behaviour is considered an important element in adapting human capital capacity to the challenges of sustainable development and decarbonization.

Research activities strengthen the institutional capacity for sustainability. Research in environmental behaviour confirms that universities serve as catalysts for social transformation [211]. The formation of green intellectual capital is recognised as an important component of the sustainable development strategy, consisting of human, structural, and relational aspects [212]. The growth of green innovation research indicates the expansion of the technological base of sustainable development [213]. From a broader social perspective, the extent of green infrastructure and urban ecosystems is associated with achieving the SDGs [214]. The development of green intellectual capital provides training for human capital capacity, with a focus on the development and implementation of environmental innovations.

The uniqueness of the Malaysian model lies in its integration of the cultural and normative foundations of sustainable development, endowing environmental policy with a value dimension and enhancing the educational potential of higher education. The integration of cultural and value aspects of sustainability contributes to the formation of long-term social support for the green transition in the higher education system. As a whole, the Malaysian model is an integrative system encompassing government strategy, autonomy, green HR practices, behavioural mechanisms, infrastructural solutions, and the formation of green intellectual capital. Universities act as centres of social transformation, developing human capital capable of integrating environmental knowledge, managerial competencies, and the values of sustainable development, all of which are necessary to implement the green transition.

Comparative analysis of the United States, the United Kingdom, Australia, the selected European Union countries, China, and Malaysia demonstrates that, despite differences in social and economic contexts and governance models, these countries are converging on a similar logic of the green university as an integrated system for human capital development. In addition, sustainability is most effective when integrated across all levels of university governance. This includes strategic planning, personnel policies, curricula, research activities, physical infrastructures, and student participation. In all the countries considered, the green transition is accompanied by a transformation of human capital management mechanisms to develop green competencies and sustainable leadership, and to adapt universities to the requirements of a low-carbon economy.

The difference between the models is the level of state coordination. For instance, in the United States, the United Kingdom, Australia, and selected European countries, university autonomy, public accountability, and partnerships play an important role. However, in China and Malaysia, the green transition is coordinated at the national level. Despite these differences, a common challenge in all cases remains the gap between declarative goals and actual outcomes—the "performance gap"—which can be overcome not only through technological solutions but, above all, through the development of human competencies, adequate motivation, and a sustainable organisational culture. Differences in management models determine the specifics of implementing the green transition: decentralised systems emphasise academic autonomy and partnerships, while centralised models ensure tighter coordination of sustainability strategies and personnel policy.

In all the countries considered, human capital capacity management is becoming the principal instrument of institutional change: universities implement professional development strategies, evaluate staff environmental engagement, stimulate innovative thinking, and cultivate sustainable leadership. Students move from learners to co-governors, participating in the design and implementation of environmental initiatives, while campus infrastructure becomes not only a learning space but also an educational laboratory where sustainability is practised through architecture, energy conservation, and digital management. In the context of the green transition, human capital capacity management is becoming a key mechanism for universities' institutional adaptation to environmental, technological, and social changes.

In all countries, research activity performs an integrative function, linking academic science, policy, and society. Universities become centres of knowledge transfer and innovation for developing green technologies, climate solutions, and circular-economy models. International and national research networks facilitate the dissemination of best practices and the development of common approaches to the governance of sustainable development. Research activities contribute to the development of human capital, focusing on green technologies, climate solutions, and models of sustainable development.

In summary, the green university serves as an intellectual and cultural centre for sustainable development, shaping future human capital, supporting ecological modernisation of the economy, and reinforcing global values of responsibility and

justice. Although the objectives are similar, the implementation mechanisms differ according to the degree of centralisation, cultural context, and institutional governance models.

The generalisation of international experience suggests that the governance of the green transition in the higher education system has a multi-level structure, in which strategic decisions are made at the national and supranational levels, while implementation occurs through institutional and individual mechanisms within universities, as illustrated in Figure 6.

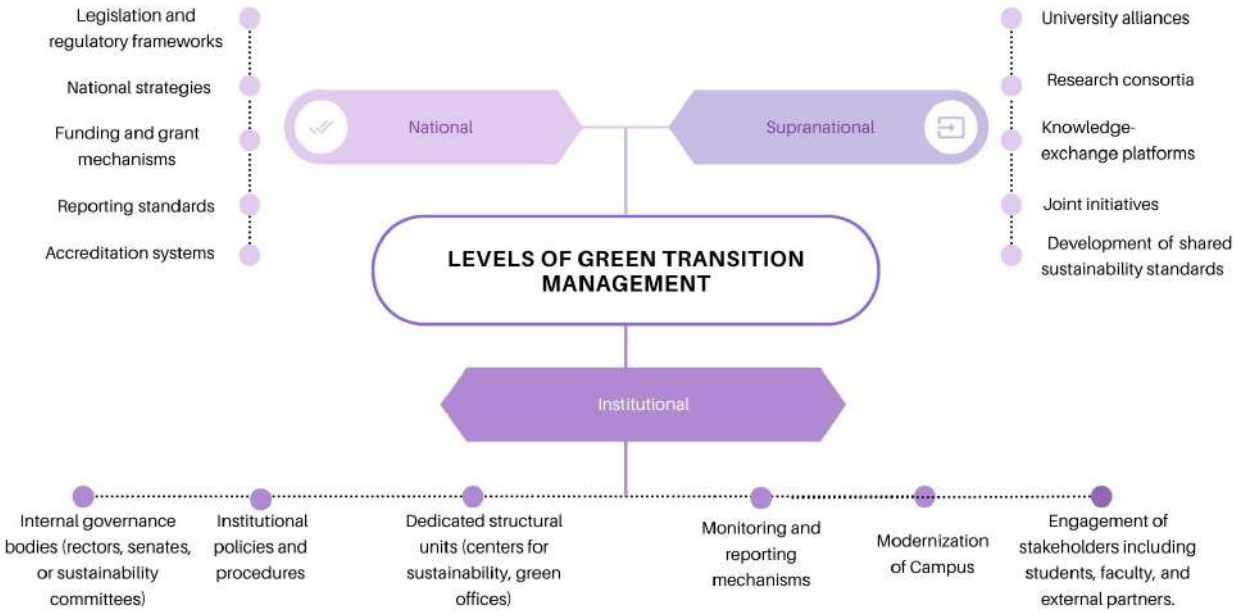

Figure 6 - Multi-level framework shaping human capital capacity management in the green transition of higher education of universities

Note - Compiled by the author

The scheme reflects the multilevel management structure of human capital capacity in the context of universities' green transition, including supranational, national, and institutional levels. Each level performs its own functions in the development of competencies, organisational training, professional development and the formation of a sustainable organisational culture.

At the supranational level, university alliances, international research consortia, knowledge exchange platforms, and joint initiatives adopt unified approaches to developing green skills and sustainability competencies. International networks create opportunities for academic mobility, collaborative research, the exchange of best practices, and professional training, contributing to the development of research competencies and the expansion of universities' human capital capacity. The development of common standards for sustainable development ensures consistency of requirements for environmental and managerial competencies of academic staff and students.

At the national level, legislative and regulatory frameworks, government strategies, financing and grant support mechanisms, reporting and accreditation

systems form the institutional conditions for managing human capital capacity. National policy influences the content of educational programs, the development of green competencies, the training of personnel for a low-carbon economy, and the implementation of sustainability principles in universities' personnel policy. Grant schemes and government support mechanisms stimulate staff development, scientific research, and the introduction of innovative educational practices.

The human capital of universities is directly managed at the institutional level. Internal management bodies (rectorates, senates, sustainability committees), institutional policies, and specialised sustainable development units (green offices, sustainability centres) ensure the organisation of professional development, training, and advanced training programmes for teaching and administrative staff. Monitoring and reporting systems enable assessment of competency development, employee participation in sustainability initiatives, and the outcomes of environmental programs. The modernisation of campuses and the involvement of stakeholders create an organisational learning environment in which students and staff acquire practical skills in sustainable behaviour and in implementing the goals of the green transition.

Thus, the green transition of universities is realised through the interconnection of strategic, institutional and organisational management mechanisms of human capital capacity, where regulation forms competence requirements, international networks create opportunities for learning and knowledge exchange, and the institutional level ensures staff development, motivation and the integration of sustainability into the daily activities of universities.

Table 3 summarises the main types of governance models for the green transition identified from an analysis of international experience from universities in the United States, the United Kingdom, Australia, selected EU countries, China, and Malaysia.

Table 3 - Types of models and main practices of foreign countries recommended for adaptation to the conditions of Kazakhstan

Type of governance model	Key practices recommended for adaptation in Kazakhstan	Expected effect of adaptation
1	2	3
Autonomous-network model (United States, United Kingdom, Australia, selected EU universities)	– Establishment of a Sustainability Office / Centre for Sustainable Development in each university with a dedicated budget and authority; – Inclusion of green competencies and participation in sustainability initiatives in the KPI systems of academic and administrative staff; Development of student leadership programs such as Green Ambassadors, Eco-Reps, and Student Green Offices; –Transformation of the campus into a living lab: energy audits, waste management, and resource monitoring as educational and	– Increased engagement of faculty and students in sustainable development; – Formation of a sustainable organizational culture rather than mere reporting compliance; – Enhanced competitiveness of universities on international ranking platforms such as UI GreenMetric, QS Sustainability, and THE Impact Rankings;

Continuation of Table 3

1	2	3
	research case studies; Partnerships with business and local communities for joint environmental projects	Improved quality and practical orientation of education
Centralized development model (China)	–Establishment of a national coordination platform for green universities; –Development of unified national standards for green campuses and a series of model methodological guidelines; –Large-scale retraining programs for faculty and operational staff focused on climate issues, energy management, and sustainable design; –Inclusion of green outcomes in institutional university KPIs, not only in the evaluation of individual staff members; –Digital monitoring of campus resource consumption through BIM/IoT systems	– Rapid scaling of green practices at the national level; – Reduced resource intensity of campuses and lower operational costs; – Improved technical competence of operational staff; – Greater trust in reforms through uniform rules and transparent reporting
Hybrid cultural-value model (Malaysia)	– Reliance on community values and university identity, including environmental awareness, volunteering, and social participation; – Creation of Green Campus Clubs and student eco-cooperatives; – Support for local “here and now” initiatives such as greening university spaces, waste separation, and micro-projects on waste reduction; – Integration of sustainability into non-formal education through project weeks, festivals, and campaigns; – Support for “small wins” and low-threshold initiatives in order to involve broad groups of students and faculty	– Strengthening of the social capital of universities; – Expanded engagement of students and young faculty members; – Greater sustainability of change through its consolidation in everyday practices; – Formation of value-based motivation rather than solely administrative compliance
Note - compiled by the author		

Based on the comparison of different models of green university governance, the following conclusions can be drawn. First, human capital is a key factor in the green transition: in all countries, the success of greening universities is determined less by technological solutions than by the levels of competence, motivation, and involvement among teachers, staff, and students. For Kazakhstan's higher education system, this means moving from a predominantly infrastructural understanding of sustainability to a focus on developing human capital, including green skills, environmental leadership, and mechanisms for the continuous professional development of teaching and administrative staff.

Second, the degree of management centralisation sets the development trajectory. In China and Malaysia, the transformation of universities is being

implemented through a government strategy and scaled through national programs and standards. In the USA, Great Britain, Australia and the selected EU contries, university autonomy, corporate culture and partnerships play a leading role. A mixed model seems most applicable to Kazakhstan, combining state coordination and strategic guidelines with the expansion of universities' institutional autonomy to implement sustainability initiatives and develop their own human capital capacity management mechanisms.

Third, sustainable development models are most effective when anchored in HR policies, such as integrating green competencies into teaching staff training programs, incorporating environmental indicators into KPIs and certification processes, and developing recognition systems and career paths for sustainable leadership. For universities in Kazakhstan, this indicates the need to modernise personnel policy, introduce elements of Green HRM, and integrate sustainability indicators into performance assessment systems for academic and administrative staff.

Fourth, the campus, as a "living laboratory," is a tool for implementing the green transition and allows you to combine learning, research, and the practice of environmentally oriented behaviour. For Kazakhstan, the development of living labs can serve as a mechanism to integrate universities' educational, scientific, and practical activities, particularly in energy efficiency, sustainable infrastructure, and environmental monitoring.

Fifth, student participation is a critical condition for sustainable transformation, as student engagement increases the sustainability of organisational change and strengthens a culture of responsibility. In Kazakhstan, this implies developing student co-management mechanisms, environmental initiatives, Green Offices, and Sustainability Committees to foster environmentally responsible human capital.

Thus, international experience shows that effective management of green universities requires a systematic integration of human capital, educational, and infrastructure policies, as well as the formation of an organisational culture in which sustainability is not an external requirement but part of the professional identity and daily activities of the academic community. For Kazakhstan's higher education system, adopting these mechanisms can serve as a basis for modernising human capital capacity in the context of a green transition, ensuring the development of green competencies, sustainable management practices, and the institutional readiness of universities for environmental and technological transformation.

1.3 Methodological aspects of human capital capacity management in the higher education system of Kazakhstan

The modern transformation of higher education in Kazakhstan is part of the country's shift toward sustainable, low-carbon development. This shift is outlined in the National Strategy “Kazakhstan-2050”, the Concept of transition to a green economy and updated strategies for science and higher education [215,216]. In these circumstances, managing human capital at universities becomes especially important. Faculty, researchers, administrative staff, and students act as key agents

of change. The ability of universities to achieve the green transition, create innovative ecosystems, and ensure sustainable change depends on their competencies, values, and participation.

Human capital capacity management needs a methodological rethink due to the changing role of the university in society, increasing demands for scientific productivity, the development of digital technologies, and global environmental challenges that require integrating sustainable development into educational, human resources, and infrastructure policies in higher education institutions [217]. As Kazakhstan's higher education system modernises, the importance of scientifically based methods grows. Global competition for talent, faster digitalisation, and the green transition all heighten this need. Solid methodologies provide a holistic view of the formation, development, and use of human capital. This section presents methodological foundations, explains the levels of analysis of human capital, and reviews the methods and tools for assessing university human capital capacity management.

The structuring of the theoretical and methodological foundations of human capital capacity management research in the higher education system is presented in Figure 7, which summarises the key approaches and their corresponding theoretical concepts.

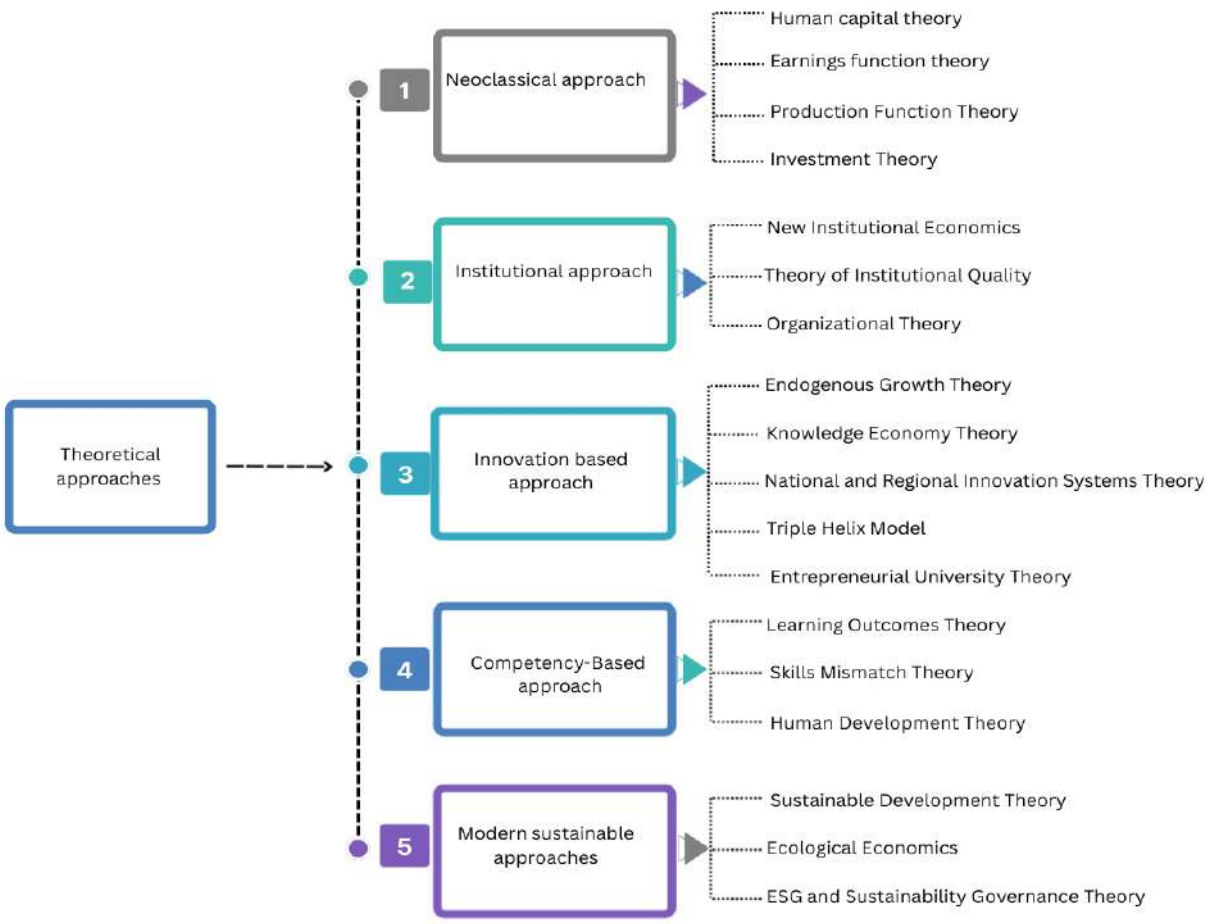

Figure 7 - Theoretical approaches to the analysis and management of human capital in the higher education system

Note - compiled by the author

The methodological basis of the research is informed by the evolution of scientific ideas about human capital in the higher education system and by integrating five theoretical approaches that reflect the key areas of analysis. According to the neoclassical approach, higher education is an investment process that creates human capital and increases graduates' productivity and income. It is also used to measure the economic impact of educational programs and the efficiency of resource allocation at the university. The institutional approach emphasises the roles of formal and informal institutions, management quality, and organisational mechanisms in the formation of human capital, with a focus on the needs of the knowledge economy. The innovation-oriented approach views universities as key elements of innovation systems that generate knowledge, develop research competencies, and facilitate technology transfer, while recognising human capital as a source of innovative growth. The competence approach focuses on the quality of educational outcomes and on the alignment of the competencies developed with the requirements of the labour market, including the development of universal and professional skills. The modern sustainable approach is based on the concept of sustainable and green human capital, integrating environmental, social, and managerial aspects into the management of higher education development. Next, each theoretical approach will be considered in detail.

The neoclassical approach

In the case of higher education institutions, the measurement of human capital by the neoclassical theory is based on income levels of the graduates, the return on investment in terms of education, the production functions of the university where human capital is an important product, and the efficiency of investments in the university's human capital. The university is also considered an economic agent that rationally uses limited resources to achieve educational and scientific results. Its activity is interpreted as a production process in which labour, capital and knowledge are combined in order to form human capital and increase social productivity. Application of production functions, in particular the Cobb–Douglas function adapted to the conditions of higher education, allows us to formalize the relationship between resource costs and the results of university activities, quantify the contribution of human capital of students, faculty and researchers, as well as compare its impact with the contribution of material and financial resources [218,219]. This creates an analytical framework for assessing the economic effectiveness of universities and justifying management decisions.

Universities use investment analysis methods to assess the economic effectiveness of investments in the formation and development of human capital. Educational programs, human capital training, and scientific activities are considered long-term investment projects that require comparing costs and expected benefits over time. The main tool for such an evaluation is the Internal Rate of Return (IRR), which assesses the profitability of an educational program by comparing graduates' future income with total tuition costs [220]. A complementary investment analysis tool is the Net Present Value (NPV) indicator, which reflects the total discounted effect of investments in human capital [221]. A positive NPV indicates

that the economic benefits of implementing the educational program exceed the costs incurred and, accordingly, confirms the economic justification of the investment. The combined use of IRR and NPV indicators provides a quantitative basis for substantiating management decisions in resource allocation, optimising the portfolio of educational programs, and increasing the effectiveness of university investments in human capital.

Thus, in the context of the neoclassical economic theory, the human capital of higher education institutions is quantitatively assessed by analysing the economic impact of education, the productive efficiency of universities, and the effectiveness of investments in human development. Together, the methodological tools form an integral methodological basis for the neoclassical assessment of human capital in higher education institutions, focusing on measuring its contribution to economic efficiency, competitiveness, and performance.

The institutional approach

The assessment of human capital within the institutional approach is based on the interpretation of it as the result of the functioning of a system of formal and informal institutions that determine the conditions for its formation, development, and use. Within the framework of this approach, the analytical focus is shifted to the quality of the institutional environment, the set of management mechanisms and regulatory rules is an important factor in the formation, development and effective use of human capital in universities, determining the conditions for the reproduction of competencies, motivation and innovation potential. Human capital is assessed by analysing the effectiveness of institutional conditions in ensuring its sustainable reproduction and development.

The analysis of regulatory requirements for educational programs, accreditation procedures, and internal quality assurance, as well as the degree of consistency between educational standards, labour-market needs, and the priorities of social and economic development, is an important component of assessing the institutional effectiveness of the higher education system. Additionally, the internal management practices of universities are analysed, including personnel policy, faculty selection and promotion systems, mechanisms for motivating and stimulating scientific and pedagogical activities, and institutes for advanced training and academic development. Effective internal management practices lead to the accumulation and retention of human capital within the university environment. Moreover, the analysis of the aggregated results of higher education institutions (the quality of students' educational achievements, the sustainability of graduates' professional trajectories, scientific productivity and the level of international academic integration of universities) reflect the ability of the institutional system to create conditions for the development of human capital [222,223,224].

Thus, within the institutional approach, human capital in the higher education system is assessed by analysing the quality of the institutional environment, management mechanisms, and university performance. This approach enables the identification of systemic factors that determine the sustainability and reproducibility of human capital, as well as the formulation of scientifically sound recommendations to improve the management of higher education.

Innovation-oriented approach

The assessment of human capital within the framework of the innovation-oriented approach is based on the understanding of human capital as a source of knowledge generation, dissemination, and commercialisation, as well as the main driver of innovative development and technological progress. The innovation-oriented approach focuses on the human capital capacity to generate new knowledge, technologies, and solutions in the face of uncertainty and rapid environmental change. In the context of higher education, human capital is assessed primarily by the innovative potential of students, faculty, and researchers, as evidenced by their ability to conduct research, engage in interdisciplinary collaboration, pursue entrepreneurship, and participate in innovative ecosystems.

The theoretical basis of the innovation-oriented approach comprises the theory of endogenous economic growth, the concept of knowledge economics, the theory of national and regional innovation systems, the triple helix model, and the concept of an entrepreneurial university. Within these theories, universities are considered key participants in innovation, ensuring not only the reproduction of knowledge but also its transformation into economically and socially significant innovations.

Innovation theory also highlights the role of universities in building entrepreneurial and innovative skills. In this regard, the availability and effectiveness of educational programs in innovation management, technological entrepreneurship, and the commercialisation of research, as well as the functioning of incubators, accelerators, and technology transfer centres, are evaluated. The theory of endogenous economic growth considers human capital, knowledge and innovation as internal sources of sustainable economic development. Universities are institutions that form human capital capable of generating innovation and ensuring long-term economic growth [8,9].

The concept of the knowledge economy emphasises the leading role of knowledge, intellectual resources and human capital in the modern economy. Higher education is considered not only a mechanism for training human capital, but also a space for the creation, dissemination, and use of knowledge. Human capital is assessed through its ability to learn, create new knowledge, and participate in innovation processes [225].

The theory of national and regional innovation systems views innovation as the result of interaction among universities, businesses, and the state within sustainable institutional and network structures. The human capital of universities is a system-forming element of the innovation system, providing scientific research, technology transfer, and human capital training for high-tech sectors of the economy [226].

The "triple helix" model (university–industry–government) specifies the mechanisms of interaction between key actors of innovative development. Within this model, universities act not only as educational institutions but also as entrepreneurial structures actively involved in the commercialisation of knowledge, joint research, and the development of innovative ecosystems. Human capital is considered a carrier of intersectoral competencies and an intermediary between science, business and the state [14].

The concept of an entrepreneurial university complements the innovation-oriented approach by focusing on transforming universities into active participants in economic development. In this concept, special emphasis is placed on developing entrepreneurial, innovative, and managerial competencies within human capital, as well as on creating infrastructure to support innovation activities, including incubators, accelerators, and technology transfer centres [227].

As a result, human capital capacity is assessed by analysing universities' research and innovation performance. For example, the volume and quality of scientific publications, patent activity, participation in applied research, creation of start-ups and spin-off companies, and the level of technology transfer. The involvement of human capital in innovation networks and ecosystems (the degree of university participation in national and international research projects, the level of collaboration with business, industry and the public sector, as well as the intensity of interdisciplinary interactions) is an important criterion for analysis.

Thus, within an innovation-oriented framework, the assessment of human capital in the higher education system is conducted by analysing its ability to generate and disseminate knowledge, participate in innovation processes, and foster sustainable innovation ecosystems. This approach allows us to consider human capital not only as a resource but also as an active factor in transforming the economy and society, shaping the long-term competitiveness of universities and national innovation systems.

Competence-based approach

The assessment of human capital within the competence approach is based on the view that it comprises competencies that equip individuals to perform professional, research, and social functions effectively. In the higher education system, human capital is assessed by the level of development of professional, universal, and end-to-end competencies among students and graduates, as well as by the teaching staff's competence potential. The key objective of the assessment is the learning outcome, defined as a measurable level of competence development in accordance with educational standards, professional requirements, and qualifications frameworks.

Within this approach, the degree of alignment between the developed competencies and labour-market requirements is analysed, enabling the identification of gaps between educational outcomes and the economy's needs [228]. Accordingly, the competence-based approach provides a methodological basis for the assessment and management of human capital, focusing on the practical applicability of skills and on improving the quality of higher education. To quantify the degree of discrepancy between the competencies developed in the higher education system and the requirements of the labour market, the skills mismatch indicator is used within the competence approach to compare supply and demand for competencies [228].

The competence-based approach to assessing human capital in the higher education system focuses on analysing the level of development of professional, universal, and end-to-end competencies among students and teaching staff. The analysis of the alignment of the developed competencies with labour-market

requirements identifies gaps between educational outcomes and the economy's needs. The use of the skills mismatch indicator enables the quantification of the effectiveness of human capital training and the development of a practice-oriented management framework to improve the quality and relevance of higher education.

Modern sustainable approach

The modern sustainable approach considers human capital as a set of knowledge, skills, values, and behaviours that aim to ensure environmental sustainability, resource efficiency, and economic growth. In the higher education system, green human capital is formed through educational programs, scientific research and institutional practices focused on sustainable development.

The figure 8 shows that quantitative, qualitative, and mixed analyses are used to assess human capital capacity management in universities. These methods provide the empirical basis for the research and enable us to obtain reproducible, comparable assessments of the effectiveness of educational and managerial decisions.

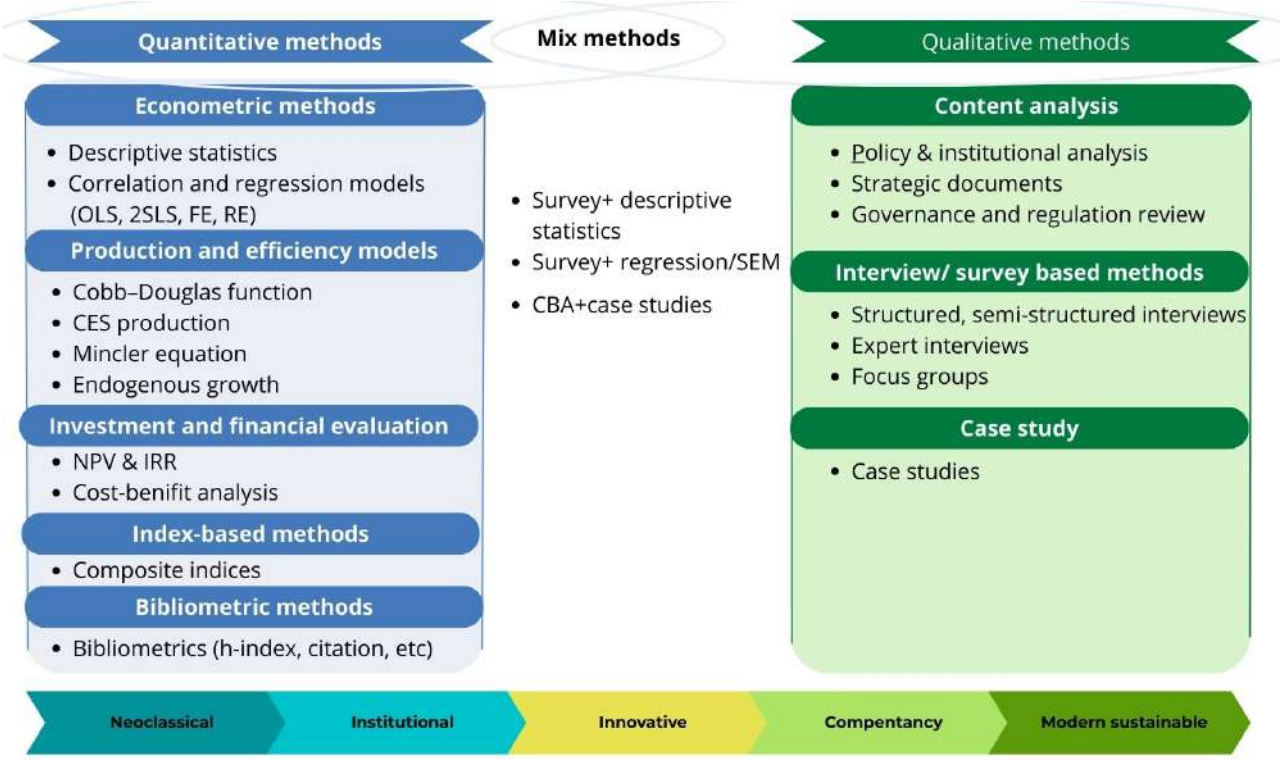

Figure 8 - Methods of human capital assessment and management at universities

Note - compiled by the author

Quantitative methods for human capital assessment and management in the higher education system focus on measuring, modelling, and statistically verifying relationships among human capital characteristics, institutional conditions, and university performance. Econometric methods occupy a central place in the quantitative assessment of human capital and are used to analyse the economic impact of education and to assess the effectiveness of management decisions in the higher education system. The use of econometric methods enables the identification

and statistical confirmation of cause-and-effect relationships among indicators of human capital, university institutional parameters, social, and economic outcomes.

Regression analysis using the least squares method (OLS) is widely used to assess the effects of education and human capital indicators on the performance of graduates, universities, and organisations. This approach is used to analyse graduates' incomes, employment indicators, and labour productivity, and to conduct an initial assessment of the impact of educational and managerial factors [229]. OLS models provide a basic interpretation of relationships, but their application is limited by possible endogeneity and unobserved heterogeneity.

To overcome these limitations, panel data-based research uses fixed-effects (FE) and random-effects (RE) models that account for the time-invariant characteristics of universities, regions, and individuals. FE models control for unobservable individual effects, whereas RE models assume they are random; the choice between them is based on the Hausman test. The use of these models is especially relevant when analysing the dynamics of human capital formation and assessing the impact of changes in educational policy and the institutional environment over time, and also to evaluate the effectiveness of changes in the management mechanisms of human capital capacity of universities [230]. Shaikh et al. (2024) used a quantitative micro-level approach, in which they administered questionnaires, conducted factor analysis, applied multiple regression (OLS), and analysed media to study the relationships among sustainable management practices, human capital, and organisational change [231].

An advanced example of panel econometric analysis is presented in the study by Yu, Majeed and Liu [230]. The authors employ cross-dependency tests, slope heterogeneity tests, panel unit root and cointegration tests, long-run estimators (Cup-FM, Cup-BC), and the dynamic seemingly unrelated cointegration regression (DSUR) model. The authors examine the interactions between foreign investment and human capital and test the ecological Kuznets curve hypothesis using a quadratic form of GDP. This approach enables assessment of the impact of institutional and managerial factors on the development of human capital in the context of a sustainable transformation of the economy and higher education.

The neoclassical approach uses the Mincer equation to assess the economic impact of human capital and an economic growth model to determine its role in economic development. The authors apply structural modelling approaches, including SEM and PLS-SEM, to examine complex cause-and-effect relationships and latent variables [232,233,234,235].

The instrumental variables approach and the two-stage least squares (2SLS) method are employed to examine the effectiveness of educational policy and staff training mechanisms, as well as universities' contribution to the development of regional human capital [21,236]. The authors apply OLS regression, economic models, and panel data to examine the regional effects of universities and human capital accumulation [37,237,238].

The Cobb–Douglas and CES production functions are used to analyse universities as specific production systems that transform resources into educational and scientific outcomes [239]. A similar quantitative approach is used in studies of

regional development and the decomposition of economic growth to assess the effectiveness of resource management, academic staff, and educational and research activities at universities [240].

Investment and financial methods are used to evaluate the effectiveness of educational programs and human resource management at universities, including IRR, NPV, and cost-benefit analyses. These methods enable comparisons of the economic costs and expected outcomes of investments in human capital and are used to assess the effectiveness of investments in developing universities' human capital capacity [241].

Scientometric and bibliometric methods are used to assess the research human capital of universities and include analysis of publication activity, citations, h-index, patent activity and indicators of innovation productivity. These approaches are used both to analyse international differences in academic productivity and to study the mechanisms of diffusion of scientific ideas, and also to evaluate the effectiveness of the management of research human capital of universities [212,242,243,244].

At the micro level, quantitative methods are used to analyse innovation and patent activity using computational data models (e.g., Poisson and Negative Binomial) and logistic regression. This makes it possible to evaluate the effectiveness of mechanisms for stimulating innovation and research activity of human capital management [46,245]. A number of papers use quasi-experimental designs and panel data to assess the causal impact of educational policies, including the impact of meritocratic scholarships on graduate career trajectories [246].

In research on the disclosure of intellectual capital, content analysis of online resources is used, followed by the operationalisation of indicators as indices. In particular, Gao et al. analyse the quality of disclosure of human, structural, and relational capital on the websites of leading universities, and Ramírez et al. and Ramírez et al. use regression models to assess the impact of corporate governance and institutional factors on intellectual capital disclosure practices[247,248,249]. In general, the reviewed studies demonstrate that a combination of econometric, production-economic, investment-financial, scientometric and index methods forms a reliable empirical basis for assessing the impact of higher education and the effectiveness of human capital capacity management, as well as for justifying managerial and strategic decisions in the field of university development.

Qualitative methods

A separate group in the study of human capital and the role of universities comprises qualitative research focused on analysing human capital capacity management mechanisms, sustainable management practices, and institutional conditions for the formation of human capital. A number of studies on sustainable development and human resource management use case studies, analyses of sustainable personnel management practices, expert interpretations, and descriptive analyses of organisational mechanisms. In the work of Blok et al., a qualitative applied approach is used to conceptualise sustainable competencies and build green human capital at the organisational level [250]. Similarly, Bueno et al. rely on qualitative and applied valuation methods, including case study and cost-benefit analysis, and do not use classical econometric models [251].

In the paper by Albats et al., the qualitative research design is used, including multiple case studies and semi-structured interviews. The paper uses thematic and content analysis of the data to identify the microfoundations of companies' human capital that drive the effectiveness of university-industrial partnerships [252]. A similar qualitative approach is used in university-industry interaction studies that analyse human, structural, and relational capital.

Adilkhanov et al. assess the scientific potential of Kazakhstan's regions using an integral index methodology based on official statistical indicators and comparative regional analysis. The study relies on multidimensional assessment techniques rather than econometric modelling [253]. Jonbekova et al. investigate university–industry partnerships in Kazakhstan through qualitative analysis based on interviews with university and industry representatives. The study identifies institutional motivations, barriers and benefits of collaboration through thematic interpretation [254]. Berdykulova et al. examine the digital transformation of Kazakhstani universities using survey data and institutional analysis. Their methodology combines descriptive statistical analysis with expert interpretation to identify key trends in university digitalisation [255]. Kozhabaeva et al. analyse human development in Kazakhstan using official statistical data and comparative analytical methods. The research applies a system-based approach to evaluate the determinants of human capital development without relying on advanced econometric modelling [256].

Thienphut et al. use the case study method to explore strategic human capital capacity management at a new university. The research is based on interviews with management personnel, analysis of strategic documents and qualitative content analysis [257]. Rinkinen et al. examine multiple cases and semi-structured interviews and explore the role of the university as a "space of opportunity" in the regional entrepreneurial ecosystem [258]. The use of thematic and institutional analysis allows us to reveal the functions of universities that are not fixed by quantitative economic indicators.

Roncancio-Marín et al. use an exploratory qualitative design in which, through a series of case studies and semi-structured interviews, the mechanisms underlying the formation of the social orientation of academic entrepreneurship are analysed [259]. A sociological and institutional qualitative approach is applied in the work of Zborovsky and Ambarova, which analyses the transition of educational communities from unsuccessful to successful models of human capital transfer [260]. A similar institutional analysis underlies the study by Lo and Stark, which examines libraries' role as institutions in developing human capital in the knowledge economy [261]. Sagadiyev adopts a conceptual and analytical approach to examine the role of human capital in Kazakhstan's innovation-driven development. The study is based on the interpretation of national development priorities, institutional reforms, and strategic policy documents without the application of formal quantitative modelling [262].

Mixed Methods

A significant number of modern research studies on human capital and sustainable development in the university environment rely on a mixed-methods design that combines quantitative and qualitative approaches. Mixed methods allow

for simultaneous consideration of measurable outcomes (behaviour, economic effects, employment indicators) and the institutional, social, and behavioural context of their formation. A quantitative dominant mixed design is used in research where the empirical analysis is based on survey data and statistical methods, supplemented by qualitative interpretation. Mixed methods are particularly in demand when evaluating the effectiveness of human capital capacity management mechanisms, as they allow simultaneous analysis of quantitative results and the institutional mechanisms that shape them.

For example, the study by Al-Zohbi and Pilotti is based on an online student survey and includes descriptive statistics, Spearman's correlation analysis, univariate analysis of variance (ANOVA), and a 2-sample t-test. Content analysis is used to interpret open issues, and the role of universities in shaping sustainable practices is assessed through institutional benchmarking using the SAQ for Colleges and Universities tool [68]. A similar approach is used in the comparative analysis of university human capital planning, where quantitative methods (descriptive statistics, ANOVA) are complemented by a qualitative interpretation of management practices [263].

The study by Nunfam et al. employs a mixed-methods design: student survey data are analysed using descriptive statistics and factor analysis, and the quantitative results are then integrated with a qualitative analysis of open responses to identify institutional barriers and constraints to human capital development [264]. A quantitative dominant mixed design is also used in the work of Decker-Lange et al., where data from surveys of students and graduates, as well as a regression analysis of the impact of entrepreneurial education on employability, are complemented by high-quality interviews that reveal the mechanisms underlying the formation of skills and career expectations [265].

The research also combines qualitative analysis of educational and institutional effects with economic assessments. For example**,** Rakhimzhanova et al. employ quantitative economic analysis to evaluate the quality of human capital in Kazakhstan using official statistical indicators and comparative assessment methods. The methodology focuses on measuring the economic characteristics of human capital and identifying the key factors affecting its development rather than applying advanced econometric techniques [266]. Quantitative assessments of investments and expected benefits are complemented by case studies and comparative analyses of educational practices, which allow for the comparison of financial effects with qualitative learning outcomes.

A similar principle of integrating quantitative indicators with institutional analysis is used to evaluate national science and technology programs. In the study by Hung et al., quantitative indicators of human capital and relational assets are combined with expert and institutional interpretations to provide a comprehensive assessment of the effectiveness of scientific policy [267].

A qualitatively dominant mixed-methods design is used in research, in which the interpretation of social, institutional, and behavioural mechanisms plays a key role, while quantitative data serves an auxiliary function. Thus, in the study by Christie et al., quantitative data from student surveys and descriptive statistics are

supplemented by qualitative analysis of interviews and reflective materials to assess the impact of various forms of peer learning on the development of graduate employability [268]. A mixed but qualitatively dominant approach is adopted in the work of Kurt and Fidan, combining questionnaire data and descriptive statistics with analysis of students' open responses to compare university expectations with the actual contribution of higher education to career development [269]. Similarly, in a study by Hannon et al., case studies and interviews aimed at analysing models of the development of students' social and cultural capital from socially disadvantaged groups are complemented by descriptive statistics, which enable linking institutional practices with empirical observations [270].

Spankulova et al. apply quantitative statistical analysis to examine the influence of innovative activity, human capital, and knowledge spillovers on regional economic growth in Kazakhstan. The methodology is based on the analysis of regional statistical indicators and assessment of relationships between innovation factors and economic performance, allowing the authors to identify the contribution of human capital to regional development [271]. Quantitative indicators, combined with qualitative analysis of demographic and organisational changes, are also used in research on gender and the institutional aspects of scientific development [255].

Methodological tools for the assessment and management of human capital in the higher education system are selected depending on the research task, data structure and level of analysis (micro–meso–macro). Descriptive analysis, descriptive statistics, correlation and comparative analysis are used to describe the characteristics of human capital, educational processes and institutional parameters. Regression models and the least squares method (OLS) are used to identify statistical relationships between variables. When analysing the dynamic changes of universities, regions, and countries over time, panel models with fixed and random effects (FE/RE) are used to account for unobservable heterogeneity among research units. Structural modelling methods (SEM, PLS-SEM) are used to study complex cause-and-effect relationships, latent constructs, and indirect effects. Under conditions of endogeneity and inverse causality, instrumental variables and the two-step least squares method (2SLS, IV) are used. Resource efficiency and human capital effectiveness are assessed through the Cobb–Douglas and CES production functions. The Poisson and Negative Binomial models are used to analyse publication, innovation, and patent activity, presented as calculated data. The institutional, organisational, and behavioural mechanisms of human capital formation are explored using qualitative methods, including case study, expert interviews, content, thematic, and institutional analysis.

Thus, the assessment and management of human capital in the higher education system are based on a combination of quantitative, qualitative, and mixed-methods analysis, the choice of which is determined by the research's theoretical focus, the level of analysis, and the object of evaluation. Quantitative methods provide a reproducible assessment of the economic impact of education, the effectiveness of universities, and the causal effects of human capital; qualitative approaches reveal the institutional, social, and organisational mechanisms of its formation; and mixed designs integrate measurable results with contextual interpretation. Collectively,

these methodological approaches form a multi-level analytical framework that enables universities to be considered simultaneously as economic actors, institutional systems, knowledge-generation centres, competence-building spaces, and institutions of sustainable development. The systematisation of these approaches, their theoretical focus and applied methods are presented in Table 4.

Table 4 - Approaches and methods of human capital analysis in higher education

Approach	Theoretical Focus	Method	Level of Analysis	Interpretation for Universities
Neoclassical	Human capital as an investment generating economic returns	Mincer equation; OLS regressions; panel models (FE/RE); IRR, NPV, cost– benefit analysis (CBA)	Micro / Meso / Macro	The university is assessed in terms of the economic efficiency of educational programs and the labor market returns to education
Institutional	Human capital as a product of the institutional environment and governance mechanisms	Institutional analysis; Index and aggregated indicators; Content analysis of strategic and online documents; Comparative analysis	Meso / Macro	The university is considered as a mechanism for the reproduction of human capital
Innovation	Human capital as a source of knowledge, innovation, and technological growth	Regression analysis of innovation activity; Structural equation modeling (SEM)	Meso / Macro	The university is interpreted as a center for knowledge generation, transfer, and commercialization
Competency-based	Human capital as a set of professional and transversal competencies	Survey questionnaires; factor analysis; SEM / PLS-SEM; regression models; Mixed methods (surveys + interviews, content analysis)	Micro / Meso	The university is evaluated based on the quality and relevance of the competencies developed
Contemporary sustainability-oriented	Human capital as a resource for sustainable development	Surveys; Descriptive statistics; ANOVA; Correlation analysis; Content analysis; institutional benchmarking; index modeling	Micro / Meso	The university functions as an institution for the formation of green human capital
Note - compiled by the author				

The table presented demonstrates that the assessment of human capital management in the higher education system is based on theoretical approaches and methodological tools that reflect its multilevel nature. The neoclassical approach focuses on the economic benefits of education and the effectiveness of investments, the institutional approach focuses on the role of the managerial and regulatory environment, the innovative approach focuses on the ability of universities to generate and commercialize knowledge, the competence approach focuses on the quality and relevance of skills, and the sustainable approach focuses on the contribution of universities to the formation of green human capital. Thus, the table confirms that a comprehensive assessment of human capital in universities is impossible within the framework of a single analytical approach and requires the integration of quantitative, qualitative and mixed methods of analysis, which creates a methodological basis for further empirical research and the development of management solutions in the field of higher education development.

Based on the above, it can be concluded that the transformation of Kazakhstan's higher education in the context of the green transition and digitalisation strengthens the role of universities as key producers and accumulators of human capital that determines the sustainability and competitiveness of the economy. The management of human capital capacity in universities requires a methodological rethink in light of the expansion of universities' functions, which now encompass being an economic actor, an institutional system, a centre for knowledge generation and innovation, a space for competence formation, and an institute for sustainable development. The theoretical and methodological basis of the research integrates neoclassical, institutional, innovative, competence-based, and sustainable approaches, enabling it to cover various dimensions of human capital and avoid one-sided interpretations. The neoclassical approach provides a quantitative assessment of the economic impact of education, production efficiency and the effectiveness of investments in human capital, the institutional approach emphasizes the influence of the regulatory environment, personnel policy and human capital management mechanisms on the reproduction and retention of human capital, and the innovation-oriented approach considers the university as an element of the innovation system, assessing research and innovation performance through publications, patents, startups and interaction with the industry. The competence-based approach focuses on matching learning outcomes to labour market requirements and identifying gaps between graduate training and the structure of skill demand, while the sustainable approach broadens the scope of analysis to encompass environmental knowledge, skills, values, and ESG-oriented institutional practices within universities. The systematization of methods shows that the assessment and management of human capital in the higher education system are based on a combination of quantitative, qualitative and mixed methods of analysis, and the choice of specific tools is determined by the theoretical focus of research, data structure and level of analysis . Taken together, this confirms that a comprehensive assessment of universities' human capital capacity is impossible within a single methodological framework and requires integrating multiple analytical tools to provide a basis for subsequent empirical research and the development of management solutions in Kazakhstan's higher education system.

2 Analysis and evaluation of human capital capacity management of Kazakhstan's higher education system in the context of the green transition

2.1 Analysis of the current state and level of development of Kazakhstan's higher education system

The higher education system of Kazakhstan plays a vital role in training qualified specialists, developing human capital, and advancing the country's scientific capacity. The Message of the President of the Republic of Kazakhstan, K. Tokayev, dated September 8, 2025, “Kazakhstan in the era of artificial intelligence: current challenges and their solutions through digital transformation”, emphasises that the development of human capital is a key factor for competitiveness and sustainable growth[272]. In the context of the transition to eco-friendly development and the introduction of green economy principles, the training of human capital with competencies in environmentally sound technologies, energy efficiency, and environmental management is particularly important. Higher education is becoming an important tool for guaranteeing balanced economic growth and for developing cutting-edge solutions in ecology, industry, and natural resource management.

Due to the transition from the centralised Soviet model to a market-oriented economy, considerable institutional and structural changes have taken place in the higher education system. The Law of the Republic of Kazakhstan "On Education" consolidated the principles of academic freedom and opened up opportunities for the creation of private higher education institutions [273]. During the same period, universities began to adopt new financing mechanisms, including government educational grants and a paid-tuition system.

In 2010, Kazakhstan joined the Bologna process, which became an important stage in the modernisation of the higher education system [274]. As a result, a three–level model of higher education (bachelor's degree, Master's degree, and PhD) was introduced and harmonised with international standards. This reform has expanded opportunities for student and faculty academic mobility and introduced a requirement for a national accreditation and quality assurance system in education, thereby increasing the competitiveness of Kazakhstani universities on the international stage and improving the quality of education.

In 2018, the Law on University Autonomy was adopted, which allowed universities to be more flexible with the content of educational programs, which, together with the introduction of digital technologies into the educational process, made it possible to increase the availability of higher education and adapt educational programs to new labour market requirements [275]. In addition, universities are focused on developing scientific potential, as reflected in increased scientific publications, increased grant funding, and expanded cooperation with international universities.

In Kazakhstan, universities are funded by several sources, including the state budget, enterprise funds, and tuition fees. In recent decades, the funding structure has seen marked changes due to the general modernisation of the higher education system and its focus on international standards. One main indicator of the state's

priority in higher education development is the share of education expenditures in gross domestic product (GDP).

Figure 9 shows the share of higher education expenditures in Kazakhstan's GDP from 2000 to 2024.

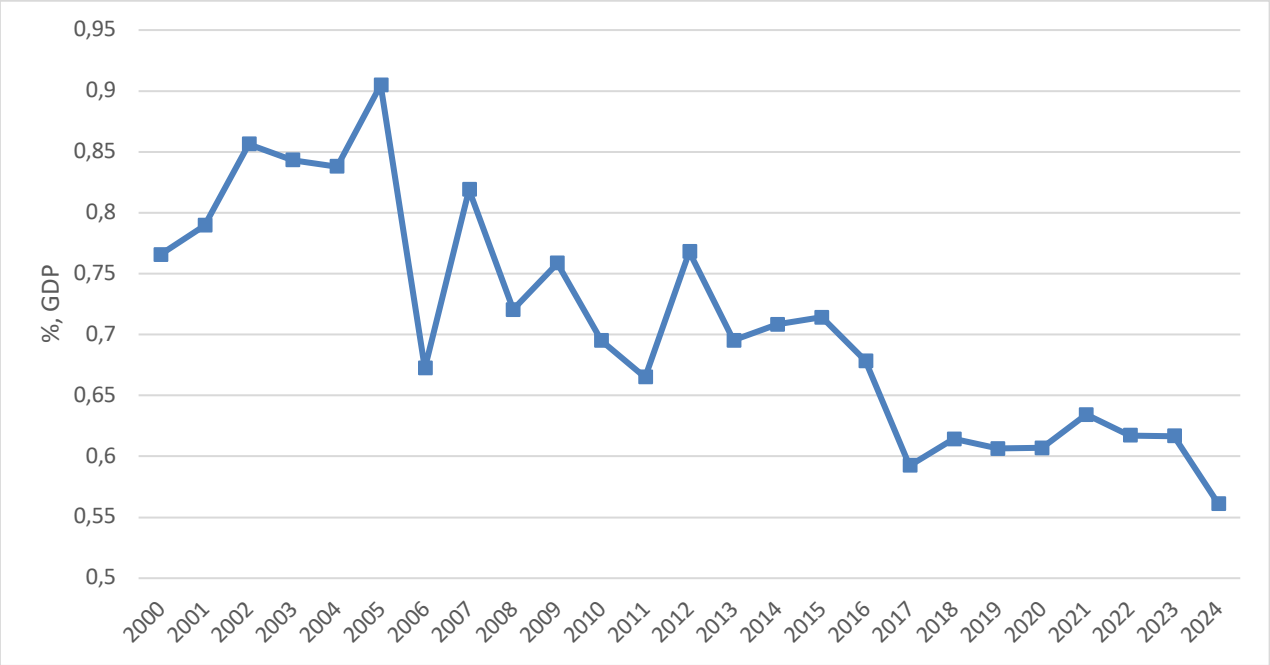

Figure 9 - The share of higher education expenditures in GDP for 2000-2024, in %

Note - compiled by the author based on the Bureau of National Statistics data

According to data for 2000-2024, government spending on higher education as a share of GDP in Kazakhstan has been declining. At the beginning of the period under review, the indicator was about 0.75% of GDP and gradually increased, reaching a maximum of more than 0.90% of GDP in 2005. However, since 2006, the share of expenditures has begun to decline, possibly due to a reallocation of budget priorities, changes in the financing system for higher education, and the growth of the private sector in education. In subsequent years, the decline was undulating, which may indicate the implementation of a policy to optimise budget expenditures and increase the role of market mechanisms in higher education. A particularly clear decline occurred in 2018, when the share of expenditures reached its lowest level during the period under review. In our opinion, this may be due to budget optimisation, changes in the structure of educational expenses, and increased university autonomy, which was accompanied by increased non-governmental sources of financing.

The dynamics of higher education funding can also be considered in absolute terms. It is important to take into account not only the share of higher education expenditures in GDP but also their actual volume, which enables a more detailed analysis of how government spending has changed amid the transformation of educational policy. Figure 10 shows the dynamics of higher education spending over the period from 2000 to 2024.

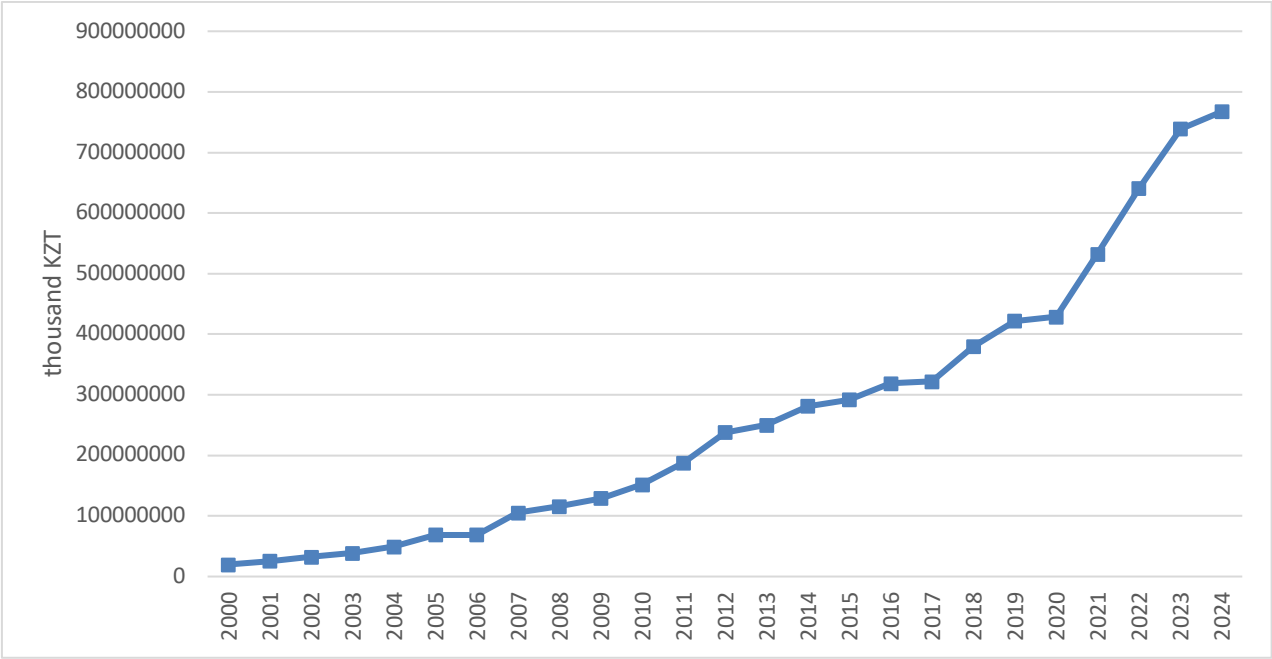

Figure 10 - The dynamics of higher education expenditures for 2000-2024, in thousands of tenge

Note - compiled by the author based on the Bureau of National Statistics data

During the analysed period of 2000-2024, state financing of higher education in Kazakhstan has steadily increased. Thus, from 2000 to 2007, the growth rate remained moderate, as the priority tasks were the transition to a market-based financing model and the adaptation of universities to new conditions. In 2008, there was a temporary decline, likely related to the effects of the global economic crisis. Since 2009, higher education financing has been recovering and showing steady positive dynamics. This period is characterised by the implementation of key reforms, including strengthening universities' autonomy, developing a three-tier education system within the framework of the Bologna process, and expanding government grant-financing programs.

After 2010, the dynamics of financing are characterised by a significant acceleration of growth. Moreover, during this period, public investment in the higher education sector has increased substantially due to the implementation of university modernisation programs, the expansion of grants, and the requirement to strengthen the international competitiveness of Kazakhstan's higher education system. Since 2020, funding for the higher education system has sharply increased. In our opinion, this is due to the strengthening of higher education's role in implementing government priorities, notably in the context of digitalisation, human capital development, and the transition to a knowledge economy. An additional factor could be the desire to mitigate the effects of the COVID-19 pandemic, which exposed vulnerabilities in the education system and necessitated additional investments in digital infrastructure, training, and the adaptation of educational processes to new conditions. In addition, increased funding may reflect efforts to achieve the goals

outlined in strategic documents, such the Concept of Development of Higher Education and Science of the Republic of Kazakhstan for 2023-2029 [276].

For example, spending has increased gradually since 2000, and the growth rate has accelerated since 2010. A particularly sharp increase in funding is noted after 2020, which may be due to the expansion of educational programs, increased scholarships and salaries, modernisation of universities and an increase in government orders for training.

Thus, there is a contradictory trend: current expenditures on higher education, even if they have increased in monetary terms, have decreased as a share of the GDP, which may signal increased private financing, demographic changes, and fiscal policy transformations. One of the key factors influencing resource utilisation and the strategy for higher education development is changes in the number of higher education institutions.

From a managerial point of view, the revealed dynamics point to a gradual transition from a predominantly state-funded model to a mixed model, in which the role of extra-budgetary sources and the institutional autonomy of universities are increasing. This reinforces the need to implement strategic monetary management of human capital, including improving the efficiency of asset allocation, developing project financing mechanisms and linking investments to the effectiveness of educational and scientific activities.

Modernisation, reforms and integration with international standards are causing major changes to Kazakhstan's higher education system, which has also affected the number of universities. Table 5 presents the dynamics of the number of higher education institutions for 2000, 2005, 2010, 2015, 2020, and 2024.

Table 5 - Dynamics of the number of universities in Kazakhstan in 2000, 2005, 2010, 2015, 2020, 2024

Year	Number of HEIs	Growth, %
2000	170	-
2005	181	6.471
2010	149	-17.680
2015	127	-14.765
2020	125	-1.575
2024	116	-7.200

An analysis of the data shows that in the early 2000s, there was a slight increase in the number of universities, but since 2010, the number has declined. The sharpest decline occurred in 2010-2015, due to the processes of optimising the educational system, including the introduction of new accreditation standards and increased quality control of educational services. In the following years, the rate of decline in the number of higher education institutions gradually slowed. However, there is a trend toward fewer higher education institutions. Consequently, the number of universities was reduced to 116 in 2024. This could mean the government is focusing on university effectiveness rather than increasing their number. The introduction of mandatory institutional and programmatic accreditation, increased licensing requirements, and increased competition between universities have contributed to

the closure of underperforming universities. This process may continue in the future, requiring an analysis of its impact on the availability of higher education and on the development of human capital.

In fact, higher education institutions play an important role in developing high-quality human resources. This is because these institutions ensure that students are well prepared to meet the challenges of the contemporary labour market. For instance, universities should seek to understand global trends to design their learning programs in line with current economic needs. From a managerial perspective, the reduction in the number of universities reflects the transition of the higher education system from extensive expansion to a model of institutional selection and quality control. This process reinforces the relevance of strategic management mechanisms, accreditation, personnel policy, and university competitiveness as factors of sustainable human capital development.

Figure 11 shows the dynamics of changes in the total number of university students in Kazakhstan from 2000 to 2024.

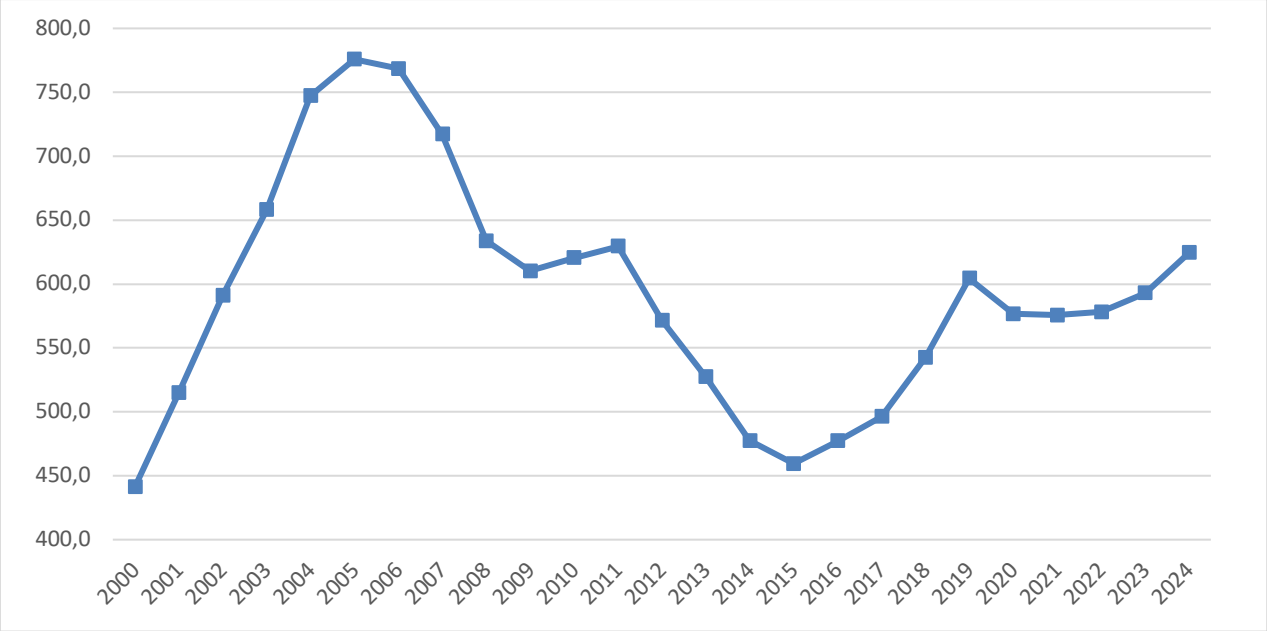

Figure 11 - Dynamics of the number of students in 2000-2024, in thousands

Note - compiled by the author based on the Bureau of National Statistics data

Over the analysed period 2000-2024, the dynamics of the number of students in higher education institutions in Kazakhstan reflect complex changes in the higher education system driven by demographic factors, educational policy reforms, and the transformation of the higher education structure. In the early 2000s, there was a sharp increase in the number of students, driven by greater access to higher education and favourable economic conditions. Since 2006, the number of students has decreased, likely due to demographic decline and stricter admission requirements, particularly the introduction of the Unified National Testing (UNT) in the 2003-2004 academic year. However, there has been a steady decline in the number of students since 2006, possibly due to several factors. Firstly, there was a demographic correction in this period, as the birth rate declined in the 1990s. Secondly, an active

phase of reforming the higher education system has begun, including the introduction of mandatory institutional and programmatic accreditation, which has led to the closure or merger of several universities and to stricter requirements for applicants. Together, these factors led to a decrease in the number of students, which reached a minimum level in 2015-2016.

However, since 2018, the number of students has stabilised and shown moderate growth. Recent years (2019-2024) show a stable trend, and several factors may explain this, including the adaptation of the higher education system to new conditions, government funding, the expansion of grant programs, and the development of digital technologies in the educational process.

The change in the number of university students reflects not only general trends in the higher education system but also the transformation in the structure of human capital training. In addition to the dynamics of the total student population, the development of master's and doctoral studies, which have become key elements in the modernisation of higher education, is of particular interest. The development of master's and doctoral programs is also related to strengthening universities' scientific capacity, improving research quality, and training highly qualified human capital. For the higher education management system, the identified changes require more flexible forecasting of demand for educational programs and adaptation of mechanisms for distributing government orders. The growth or decrease in the student body directly affects the personnel burden, the financial stability of universities and the need to modernise the educational infrastructure.

Figure 12 shows the dynamics of the number of students studying for Master's and doctoral degrees in 2000-2024.

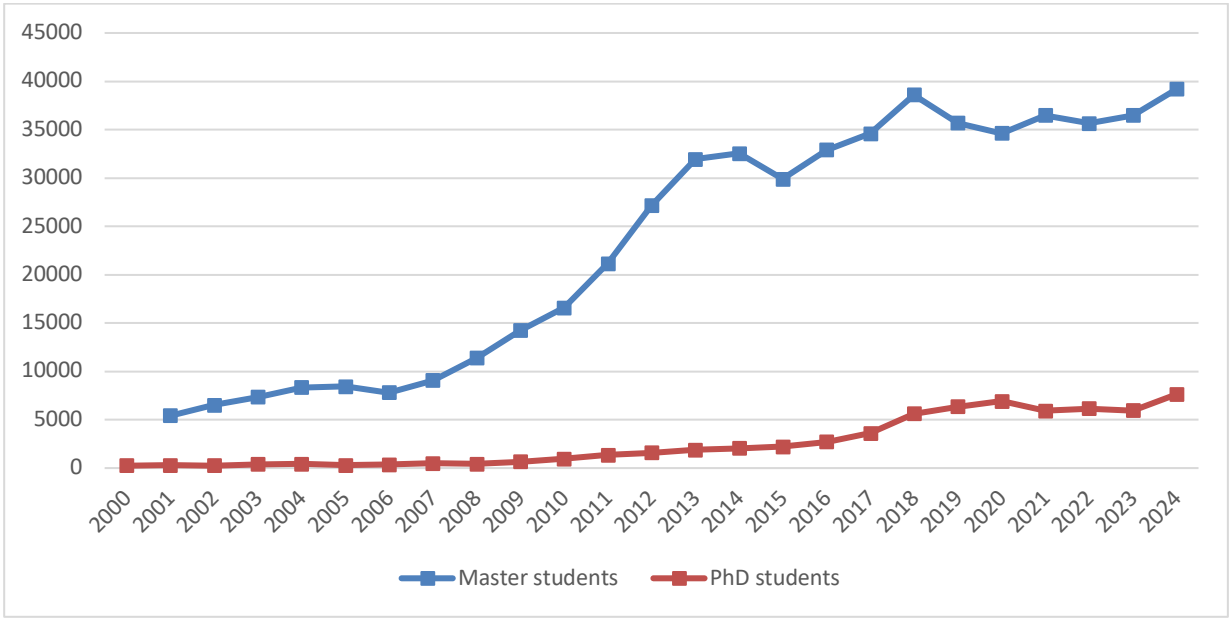

Figure 12 - Number of students in master's and doctoral studies in 2000-2024, people

Note - compiled by the author based on the Bureau of National Statistics data

The number of undergraduates shows a steady upward trend over the period under review, particularly after 2010. While the number of undergraduates was below 10 000 in the early 2000s, it was about 39 000 in 2024. This growth is also driven by Kazakhstan's integration into the Bologna process, increased government funding for master's degree programs, and the labour market's growing demand for higher levels of human capital.

Doctoral studies, by contrast, remained less popular for a long time, with enrollment numbers low until 2010. However, after 2011, growth gradually accelerated, becoming especially noticeable after 2015. This trend is associated with the introduction of the PhD-doctoral system, which replaced the Soviet postgraduate school, as well as with an increase in the number of government grants, the possibility of paid tuition and increasing demands on the academic careers of faculty and researchers.

Thus, the presented data indicate active development of postgraduate education in Kazakhstan, a positive trend in equipping universities with qualified scientific human capital, and the implementation of initiatives targeted at rejuvenating and renewing the teaching staff.

Next, Table 6 shows the dynamics of doctoral students' graduations and defences.

Table 6 - Dynamics of doctoral students' graduation and dissertation defence in 2000, 2005, 2010, 2015, 2020, 2024

Year	Doctoral graduates	Graduation with defense	Defense rate (%)
2000	78	15	19.2
2005	127	17	13.4
2010	168	136	81.0
2015	533	175	32.8
2020	1446	483	33.4
2024	1422	278	19.5

The dynamics of doctoral graduate numbers and dissertation defence levels in Kazakhstan for 2000, 2005, 2010, 2015, 2020, and 2024 reflect key changes in the system for training highly qualified scientific human capital. However, the period saw the number of doctoral graduates rise significantly from 78 in 2000 to 1,422 in 2024. The most significant growth in the number of graduates was recorded between 2010 and 2020, when it rose from 168 to 1,446, stimulated by increased grants, the introduction of a fee-based department, and the popularity of pursuing a PhD.

Along with the growth in the number of graduates, there is considerable variability in the coefficient of successful dissertation defence. In 2000, this indicator was 19.2%; by 2005, it had decreased to 13.4%, but by 2010 it had increased sharply to 81.0%. This period is likely associated with the changes in the system of defending theses in the context of Kazakhstan's integration into the Bologna Process, which was accompanied by a significant increase in the number of defences. However, since 2015, this indicator has declined: 32.8% in 2015, 33.4% in 2020, and only 19.5% in 2024.

The reasons for the reduction in the share of defended doctoral students may be associated with the following factors: the increase in the quality of dissertation research, including the publication of the results in international peer-reviewed journals, may require more time for preparation; the increase in the number of defended doctoral students may have led to a situation where the competition for academic positions affects the motivation for further research; the increase in the number of doctoral students who do not complete their defence in due time may be associated with the reduction in the level of academic training or changes in the preferences of graduates.

Thus, despite the positive trend in the number of doctoral graduates, the proportion of successful defences has decreased, underscoring the need to review mechanisms that support doctoral students, improve the system of scientific guidance, and develop new tools to promote the timely completion of dissertation research. From the perspective of human capital management, the growth of postgraduate education reflects universities' increased orientation towards research and innovation. At the same time, the decrease in the proportion of successful defences indicates the need to improve the mechanisms for scientific guidance, academic support, and the stimulation of doctoral students' research productivity. Consideration of the dynamics of student numbers across fields of study enables the identification of key trends in tertiary education, the tracking of changes in demand for individual specialities, and the assessment of the impact of educational policy on human capital. Appendix A presents the number of students in the main areas of study for 2000-2024, allowing us to trace the dynamics of higher education development in the context of labour market needs and social and economic changes.

In the early 2000s, the number of students in faculty education increased significantly, more than doubling by 2005. During the same period, there was a significant increase in interest in business and law, likely due to the development of a market economy and growing demand for specialists in these fields. A significant increase in the number of students was also recorded in the field of information and communication technologies (ICT), which may be due to the onset of digitalisation and the expansion of the market for IT specialities.

However, after 2005, the number of students began to decline across many areas. This was especially noticeable in business and law, where by 2015 the number of students had more than halved. This tendency may indicate labour market saturation with specialists in this field, a decline in the attractiveness of legal and economic education, and a shift in applicants' educational priorities. A similar trend was observed in engineering and technical specialities, likely due to the lack of funding for technical training at the time. In the field of ICT, there was also a temporary decline in the number of students; this could be explained by the restructuring of training in specialised fields and by the shortage of qualified faculty in ICT.

Since 2015, structural trends have increased enrollment in certain fields. Thus, there is a considerable increase in the number of students in faculty training; this could be explained by the government's increased support for faculty. Another field that has experienced considerable growth is medicine; this is probably linked to

healthcare reforms and the increased demand for medical specialists. The most rapidly growing field is information technology, where the number of students has increased more than twofold since 2020.

The analysis of student numbers across fields of study shows considerable shifts in higher education priorities, reflecting labour market requirements and strategic guidelines for economic development. In recent years, there has been an increase in interest in teaching, medical and IT specialities, while engineering, technical and economic areas show a downward trend. However, the situation with environmental professions requires special attention, as they play a key role in the transition to sustainable development and a green economy.

The identified structural changes require adjustments to educational policy and training human capital management mechanisms to align with the economy's long-term priorities. For the human capital management system, this means the need for closer coordination among universities, employers, and the state to shape the educational order and forecast competency needs. In the context of increasing environmental issues, including climate change, environmental pollution and the need for the rational use of natural resources, the training of qualified specialists in this field is of particular importance.

The modern labour market calls for not only specialists in traditional sectors of the economy, but also highly qualified professionals in ecology. Table 7 shows the dynamics of the number of students studying in environmental specialities for the period 2000, 2005, 2010, 2015, 2020, and 2024.

Table 7 - Dynamics of graduation of students in environmental specialities in Kazakhstan (2000, 2005, 2010, 2015, 2020, 2024)

Year	Ecology (Growth, %)	Life Safety and environment (Growth, %)	Water Resources (Growth, %)	Land Management (Growth, %)	Forestry (Growth, %)
2000	165	487	164	138	105
2005	212 (28.5%)	1558 (220.0%)	727 (343.3%)	1094 (692.8%)	568 (441.9%)
2010	1479 (597.6%)	663 (-57.4%)	253 (-65.2%)	298 (-72.7%)	105 (-81.5%)
2015	1352 (-8.6%)	746 (12.5%)	271 (7.1%)	375 (25.8%)	161 (53.3%)
2020	897 (-33.7%)	1483 (98.8%)	275 (1.5%)	235 (-37.3%)	290 (80.1%)
2024	0 (-100.0%)	1152 (-22.3%)	113 (-58.9%)	0 (-100.0%)	599 (106.6%)

The pattern of student graduation in the fields of ecology, life safety and environment, water resources, land management, and forestry in Kazakhstan for 2000, 2005, 2010, 2015, 2020, and 2024 shows a fluctuating trend, influenced by educational reforms, the need for specialists, and the government’s priorities in training human capital.

In the early 2000s, there was a significant increase in the number of students in all areas. From 2000 to 2005, the number of students in the field of life safety and the environment increased by more than threefold (220%), suggesting growing attention to environmental safety and man-made risks. Significant growth was recorded in land management, with a 692.8% increase. This could be attributed to the regulation of land relations and the need to train qualified specialists in this field. Another field that recorded high growth was forestry, which rose by 441.9%. This

could be attributed to the active programs for the restoration and management of forest resources.

After 2005, there was a sharp decline in student enrollment across most areas. In 2010, the largest reductions were in forestry (-81.5%), land management (-72.7%), and water resources (-65.2%), which may indicate a decrease in demand for specialists in these areas or a redistribution of educational programs. The exception was ecology, where the number of students increased by 597.6%, possibly due to the strengthening of international initiatives in sustainable development and environmental regulation.

The period 2010-2020 is characterised by attempts to stabilise student numbers across several areas. In 2015, there was moderate growth in the fields of water resources (7.1%) and forestry (53.3%), which may indicate the emergence of new educational programs and state-level support for these specialities. In 2020, there was a significant increase in the number of students in the fields of life safety (98.8%) and forestry (80.1%), which could be due to the actualisation of environmental protection issues, climate change, and the need to train specialists in natural risk management.

However, after 2020, there has been a sharp decline in the number of students in most areas. In 2024, training in human capital in ecology (0 graduates) and land management (0 graduates) was discontinued. There is also a significant decrease in life safety and environment (-22.3%) and water resources (-58.9%). This trend may be related to changes in state financing of higher education, optimisation of educational programs, and a decrease in demand for specialists in these industries, which may result in a shortage of qualified human capital.

Therefore, modern-day problems such as climate change, depletion of natural resources, and environmental pollution require training specialists who can implement sustainable technologies and develop environmentally focused strategies. However, an analysis of student numbers shows a decrease in interest in environmental and environmental specialities, which could lead to a shortage of human capital in key sectors of the green economy.

In addition, according to the World Economic Forum, almost half of employers (47%) plan to transform business models in the context of a green transition, and about 39% of existing skills will require significant updating by 2030 [277]. From a managerial point of view, a decrease in training for environmental specialists poses a risk of a shortage of human capital to implement green transition tasks. This indicates the need to develop targeted mechanisms to support environmental education programs, including grant financing, employer demand stimulation, and the integration of green competencies across a wider range of specialities.

To complement the quantitative analysis, the study employed semi-structured expert interviews with 12 representatives of the administrative and managerial staff (AMS) of Kazakhstani universities who combine managerial and teaching responsibilities. The interviews were conducted using the questionnaire presented in Appendix B and served to examine the green dimension of human capital transformation in higher education. Specifically, the expert questionnaire assessed the significance of decarbonisation for university development, the integration of

sustainability principles into curricula, the availability of green educational programmes, employer demand for green skills, institutional sustainability practices, and the role of universities in regional sustainable development.

The selection of experts was carried out using a purposive (purposive sampling) method, taking into account their professional involvement in strategic management, the development of educational programs, and the introduction of elements of sustainable development and ESG approaches into universities' activities. The sample size was determined by the principle of analytical saturation, in which subsequent interviews yielded no significantly new substantive categories or managerial interpretations. This category of experts is of particular analytical interest, as it combines managerial and academic perspectives to evaluate the processes of integrating the green agenda into university activities and educational programs. The demographic and professional structure of the experts is presented in Table 8.

Table 8 - Demographic and professional characteristics of experts

University	Number of Participants	Gender		Position			Age group		
		male	female	faculty	management	faculty and management	Up to 40	41-49	50+
Atyrau University of Oil and Gas	7	3	4	1	5	1	2	2	3
Korkyt Ata Kyzylorda University	1	-	1	-	1	-	1	-	-
Kozybayev University	1	1	-	-	1	-	1	-	-
Zhangir khan University	3	1	2	-	3	-	-	2	1

Regarding the expert panel, there are representatives from four Kazakhstani universities, with a strong presence from Atyrau University of Oil and Gas (7 experts), given its industry-specific expertise and active engagement in the ESG agenda. The gender composition of the sample is characterised by a relative balance with a slight predominance of men. Most respondents combine managerial and teaching functions, accordingly enhancing the analytical value of the interview by combining strategic and academic experience. The age structure covers all key professional cohorts, with a predominance of experts aged 41 and above, indicating a high level of institutional and managerial experience. The purposive expert sample provides exploratory insights into institutional practices but is not statistically representative of Kazakhstan’s entire higher education system

The study was conducted between December 2023 and April 2024. The experts were representatives of Kazakhstani universities, including heads of higher education institutions, administrative and managerial staff, faculty, and researchers directly involved in the development of educational programs, research and implementation of initiatives in the field of sustainable development and ESG. The average length of an interview was about 60 minutes. The interviews were conducted remotely via Microsoft Teams. Before the interview, each expert was informed of

the purpose of the study, the procedure for the use of the information received, and the confidentiality guarantees. All interviews were recorded with the consent of the participants. In accordance with the principles of research ethics, the participation of experts was completely voluntary. All personal data has been anonymised. During processing, each interview was assigned a unique code (E1, E2, E3, etc.).

The initial transcription of the interview was generated automatically via the Microsoft Teams, after which each transcript was manually checked and edited. At this stage, automatic speech recognition errors were eliminated, and professional terms, names of educational programs, organisations, and regulatory documents were clarified. The prepared transcripts were used as the source material for qualitative analysis.

The qualitative analysis of the interview transcripts was conducted in NVivo 14 using thematic analysis. The analysis followed an iterative coding process. Initially, meaningful text segments were assigned initial codes. Subsequently, conceptually related codes were grouped into broader analytical categories, which were then synthesised into higher-order themes reflecting the key dimensions of human capital capacity management in Kazakhstan's higher education system in the context of the green transition. The resulting thematic framework is presented in Table 9.

Table 9 - Thematic framework of expert interview analysis based on NVivo coding

Theme	Subtheme	Representative codes
1	2	3
Institutional policies and governance	Green transition policies	Green economy policy; national regulatory framework; environmental legislation; institutional sustainability strategy; university governance; green economy initiatives
	Sustainable campus management	Energy efficiency; renewable energy; resource management; waste management; water conservation; campus greening; green buildings; carbon neutrality; eco-zones; recycling; thermal insulation; solar panels; infrastructure modernisation
Curriculum transformation and green competencies	Integration of sustainability into curricula	Sustainable development courses; environmental education; curriculum redesign; ecology modules; green economy; circular economy; alternative energy; waste management; environmental legislation; interdisciplinary programmes
	Teaching and learning approaches	Problem-based learning; interactive learning; interdisciplinary teaching; case studies; field research; experiential learning
	Academic staff development	Professional development; continuous training; Erasmus+ projects; sustainability training centres; international cooperation
	Green competencies	Environmental literacy; energy literacy; ESG knowledge; systems thinking; critical thinking; interdisciplinary competencies; environmental decision-making; collaborative problem solving; knowledge of environmental regulations

Continuation of Table 9

1	2	3
Societal engagement and labour market	University–society interaction	Partnerships with business; collaboration with schools; cooperation with local authorities; environmental organisations; farmer engagement; sustainability events; community outreach; commercialisation projects; regional partnerships
	Regional development	Adaptation to regional needs; local sustainability challenges; regional innovation; stakeholder engagement
	Labour market alignment	Employer demand; green skills; graduate employability; demand for sustainability specialists; sustainable project management; green qualifications

During the thematic analysis, NVivo generated 3 main themes, 8 subtopics, and more than 60 primary codes. The most frequently repeated codes related to the issues of universities' institutional policy in the field of sustainable development, greening campuses, integrating the principles of sustainable development into educational programs, developing students' green competencies, universities' interaction with employers and local communities, as well as creating demand for specialists with green skills.

Qualitative data collection continued until theoretical saturation was achieved. At the final stage of the study, new interviews did not yield any new codes or analytical categories. The subsequent responses mostly confirmed the already identified topics related to the greening of educational programs, the development of green competencies, the improvement of institutional governance and the interaction of universities with external stakeholders. This allowed us to conclude that the collected empirical material is sufficient to solve the set research tasks.

The results of expert interviews with representatives of Kazakhstani universities indicate that the integration of green elements into educational programs is undertaken in the context of the formation of institutional demand for greening higher education, yet in practice, it remains fragmented and unsystematic. In most cases, sustainable development and green transition do not operate as independent logics for designing educational programs, but are integrated into the educational process through separate disciplines, modules, or thematic blocks embedded within traditional professional training trajectories. This finding is reflected in the opinion of one expert, who noted:

"The green transition requires not only the introduction of individual courses, but also a comprehensive transformation of educational programmes so that graduates acquire competencies necessary for sustainable development." (Expert E4)

According to expert estimates, the most common form of integration of the green agenda is the inclusion of basic environmental education disciplines such as "Ecology", "Ecology and Sustainable Development", and "Environmental Science and Society", which cover a wide range of students and form a common level of environmental awareness. At the same time, these disciplines, focus on the formation of general knowledge, values, and attitudes, and, to a lesser extent, on the

development of applied green competencies relevant to graduates' future professional activities. One respondent explained:

"Most educational programmes integrate sustainability through courses such as Ecology, Sustainable Development or Industrial Ecology, while comprehensive green programmes remain limited." (Expert E11)

More in-depth integration of green elements is typical for engineering, energy, oil and gas, and agricultural and technical educational programs. Within these areas, environmental issues are addressed through specialised disciplines such as industrial ecology, life safety, green engineering, energy efficiency, and renewable energy sources. However, even in these programs, sustainable development is more often seen as a factor in minimising environmental risks and optimising production processes, rather than as a systemic transition to new models of economic and technological development.

Expert interviews also point to the practice of partially modernising the content of traditional disciplines, with courses in economics, management, engineering, or design including separate topics on decarbonisation, ESG approaches, waste management, and the rational use of resources. At the same time, such changes are selective, depend on the initiative of individual departments or faculty, and are not supported by uniform methodological requirements and measurable learning outcomes.

A significant role in embedding green elements is played by design- and practice-oriented learning formats, including the completion of final qualification work on environmental topics and student participation in applied research and international educational projects. Nevertheless, coverage of students in such formats remains limited, and the practices themselves are not always institutionalised inside educational programmes. The importance of practice-oriented learning was repeatedly emphasised during the interviews:

"The most effective approaches are practice-oriented learning formats based on cooperation between students and enterprises implementing environmental projects." (Expert E9)

This finding highlights the growing importance of experiential and project-based learning for developing practical green competencies.

An important conclusion of the expert analysis is the lack of end-to-end competence models at Kazakhstani universities that focus on developing green skills as a key learning outcome. Experts consistently identified environmental literacy and systems thinking as the core competencies required for future graduates:

"Environmental literacy, systems thinking and interdisciplinary problem-solving are becoming essential competencies regardless of students' specialisation." (Expert E3)

This confirms that experts view green competencies as cross-cutting learning outcomes rather than discipline-specific knowledge.

Green elements are more often used as a contextual supplement to professional training than as clearly defined and evaluable learning outcomes. An additional limitation is the weak and heterogeneous demand from regional employers for formalised green competencies, which reduces universities' motivation to transform their educational programs in depth. Although employer demand remains uneven

across sectors and regions, several experts noted that expectations regarding sustainability competencies are gradually increasing.

"Employers increasingly expect graduates to understand environmental management, resource efficiency and sustainability standards when entering the labour market." (Expert E8)

This observation suggests that although employer demand for formalised green competencies remains uneven, expectations regarding sustainability-related knowledge and environmental management skills are gradually increasing across several sectors of the economy. Experts also stressed that cooperation with external stakeholders remains an important mechanism for developing green competencies:

"Universities strengthen cooperation with local communities through joint projects with businesses, local authorities and environmental organisations." (Expert E12)

These findings demonstrate that cooperation with external stakeholders provides universities with practical opportunities to strengthen students' green competencies through real-world sustainability projects.

In general, based on expert interviews, it can be concluded that the educational programs at Kazakhstani universities are in the initial stages of adapting to the requirements of the green transition. The presence of separate green elements indicates the formation of an institutional and substantive basis for greening higher education, but their fragmented nature stresses the need to move from point-based inclusion of environmental issues to a systematic, competence-based model for developing green human capital in Kazakhstan's higher education system.

The development of a green economy requires embedding environmental principles across all sectors, from energy and agriculture to industry and urban planning. Such an approach requires modernising the content and structure of educational programs to develop competencies in green technologies and sustainable development. State policy in higher education should take these changes into account, thereby stimulating growth in the number of students in strategically important areas of ecology and sustainable development.

Thus, the change in human capital in the context of the transition to a green economy requires not only the modernisation of educational programs, but also an increase in the accessibility and attractiveness of professions focused on environmentally sound technologies and principles of sustainable development. The implementation of these changes will ensure the training of human capital capable of effectively tackling modern environmental issues and of developing an economic model aimed at long-term environmental safety and the rational use of resources.

Overall, the interview findings demonstrate that the integration of the green agenda in Kazakhstani universities still depends largely on the initiatives of individual departments and academic staff rather than on coherent institutional governance mechanisms. This highlights the need to move towards a centralised competency-based management model in which sustainability learning outcomes, green competencies, performance indicators, and monitoring mechanisms are systematically embedded into universities' educational policies.

The qualitative findings obtained from expert interviews are further complemented by an analysis of statistical indicators characterising the development of Kazakhstan's higher education system. The analysis of student numbers, especially in environmental specialities, discloses notable shifts in educational priorities and labour market needs. At the same time, the teaching staff fulfils an important role in guaranteeing the quality of specialist training, which is a key factor in the development of the academic environment, scientific research, and educational programs. The number of teaching staff is one of the key indicators of the state of the higher education system, reflecting staffing levels at universities and their ability to maintain the quality of the educational process. Table 10 shows the changes in the number of teaching staff for 2000, 2005, 2010, 2015, 2020, and 2024.

Table 10 - Dynamics of the number of teaching staff in 2000, 2005, 2010, 2015, 2020, 2024

Year	Number of faculty	Growth, %
2000	29577	-
2005	43382	46.67
2010	39 600	-8.71
2015	38 087	-3.82
2020	36 307	-4.67
2024	37 599	3.55

The number of teaching staff in Kazakhstan has fluctuated for 2000, 2005, 2010, 2015, 2020, and 2024 due to various factors, including higher education reforms, demographic trends, and student numbers. Looking at the number of teaching staff in the early 2000s, it is evident that it was significantly higher. This could be because of the increase in the number of higher education institutions. In 2005, the number of faculty was 43 382, which is 46.7% more than in 2000. However, after 2010, there has been a downward trend in the number of faculty, which coincides with the optimisation of universities, increased accreditation requirements, and changes to the structure of higher education funding.

After 2010, the number of teaching staff decreased to 39 600, a 8.7% decrease from 2005. This decline continued in 2015, when the number of faculty decreased to 38 087 (-3.8%). This trend is due to university restructuring and a reduction in student numbers.

In 2020, the number of teaching staff decreased to 36 307 (-4.7% compared to 2015), which may be due to further optimisation of universities' human capital structures, the digitalisation of education, and increased faculty workload. However, as early as 2024, the number of teaching staff increased slightly to 37,599 (3.56%), which may indicate stabilisation of universities' personnel policies and a possible increase in the need for faculty due to rising student numbers in certain areas of study.

For the human capital management system, the revealed dynamics underscore the need to prioritise academic workload management and the development of mechanisms to attract and retain teaching staff. In the context of digitalisation and the green transition, the development of teacher training programs and the

acquisition of new competencies in sustainable development and digital technologies are of particular importance.

The ratio of teaching staff to students is an important indicator of the quality of higher education. This indicator reflects the level of academic workload for faculty, the possibility of an individual approach to students, and the general state of personnel policy at universities. The dynamics of the teaching staff-to-student ratio for 2000-2024 are shown in Figure 13.

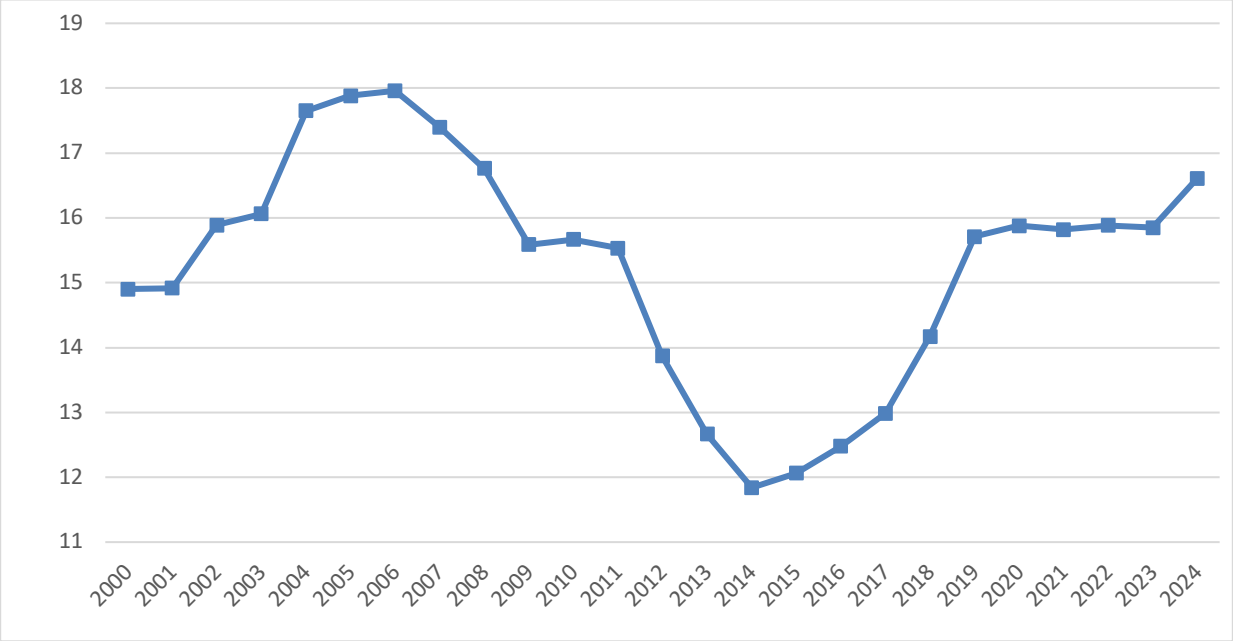

Figure 13 - Dynamics of the ratio of students and teaching staff in higher education in Kazakhstan in 2000-2024

Note - compiled by the author based on the Bureau of National Statistics data

The student-to-faculty ratio at higher education institutions in Kazakhstan from 2000 to 2024 reveals structural changes in the system. It is a significant factor in evaluating teaching quality, as faculty academic workload and the level of attention they can give students depend on it.

In the early 2000s, the ratio remained relatively stable, averaging 14 students per teaching staff. However, by 2005-2006, it reached its maximum value, likely due to an increase in the number of students from low-resource backgrounds. During this period, the number of university applicants increased, leading to greater faculty workload and larger study groups.

However, after 2006, there was a gradual trend toward reducing the student-to-faculty ratio, which could be due to a variety of factors. Firstly, it could be attributed to a reduction in the number of students in Kazakhstan, which was undergoing a demographic downturn, as well as to efforts to tighten university and study program requirements. Secondly, state policy in higher education began to turn towards improving teaching quality, thereby reducing the burden on teaching staff. In 2012-2014, the coefficient reached its minimum value – about 10 students per faculty, which could indicate a balanced personnel policy in the higher education system.

However, since 2015, the student-to-faculty ratio has been increasing. During this period, the number of students has increased, likely because higher education has become more accessible. In 2019, the ratio again reached 14 students per faculty member, denoting a shift in universities' approaches to human capital capacity management.

In recent years (2020-2024), this indicator has stabilised, showing slight fluctuations. This dynamic may be due to the higher education system reaching a balance between student and faculty numbers. The dynamics of the student-faculty ratio will depend on factors such as increases in student numbers, measures to attract new teaching staff, and the introduction of digital technologies, which may affect the structure of the educational process and the burden on faculty.

From a managerial perspective, the student-to-faculty ratio does not reflect only university staffing but also the effectiveness of human capital deployment within the higher education system. Preserving a balanced ratio is an important condition for ensuring the quality of education, reducing professional burnout among teaching staff, and increasing the sustainability of university management.

As a result of the analysis, it was possible to characterise the current state and structural dynamics of Kazakhstan's higher education system in the context of institutional reforms, resource provision, and compliance with the objectives of the green transition. In general, modernisation (transition to market mechanisms, joining the Bologna Process, introduction of a three-tier model, university autonomy) was accompanied by a simultaneous increase in absolute spending on higher education and a decrease in their share in GDP, which indicates a contradictory configuration of priorities: an increase in nominal support with a relative weakening of the role of the state in the economy. Additionally, it was revealed that optimising the university network is a long-term process (as reflected in reductions in the number of universities after 2010) and marks the transition from quantitative expansion to institutional quality control through accreditation and increased efficiency requirements.

It should be concluded that a structural shift has been identified in the training of human capital in areas of study: with the stabilization of the total number of students, the concentration of demand for IT, medicine and pedagogy increases, while environmental and natural resource specialties show a sharp drop in graduation by 2024, creating the risk of a shortage of human capital capacity for the implementation of a green economy. At the postgraduate level, the number of doctoral graduates has increased, while the proportion of defences has decreased, indicating a gap between the scaling of the PhD trajectory and the effectiveness of dissertation completion, likely related to stricter publication requirements and an insufficient support system for doctoral students. The system's personnel outline shows that the number of teaching staff after the reduction phase is stabilising, and the overall student/faculty ratio has reached more balanced levels, but remains sensitive to demographic waves and management decisions.

As a supplement to the quantitative findings, the expert interviews produced a qualitatively new result: the incorporation of the green agenda in educational programs takes place mainly in fragments, i.e., via individual disciplines and

modules, but not via a competence approach with measurable learning outcomes. This shows the institutional need to green higher education, with insufficient methodological and organisational integration of green competencies in the curriculum and the employer requirements system. Overall, the results provide a basis for making adjustments in the policies regarding the funding of green tracks, the organisation of the curriculum in terms of the competency-based system, the development of PhD completion, and levelling the human resource level so that the higher education system becomes a real driver of green human capital formation.

2.2 Assessment of the structure and development trends of the human capital capacity of the higher education system of Kazakhstan

Higher education institutions play a key role in developing human capital and guaranteeing sustainable social and economic progress. They perform not only an educational, but also a scientific and research function, contributing to the formation of knowledge and advancements. In the context of educational system transformation and changes in government policy, universities face new challenges, including improving the quality of education, allocating resources optimally, and adapting to the requirements of the modern labour market. One of the key factors determining the success of universities is their teaching staff, qualifications, research activity, and competence to adapt to higher education reform.

The Government has initiated a program to provide annual scientific internships to 500 Kazakhstani researchers at leading foreign scientific centres and universities. The aim of this program is to improve the professional qualifications of domestic scientific and technical personnel, expand access to international best practices, and ensure the transfer of modern scientific technologies and knowledge to the national research environment [276].

The requirements for teaching staff are growing, and universities are interested in human capital that publishes articles, has a high citation rate, and has an academic degree. Most of them face several problems, including insufficient English proficiency, limited integration of teaching staff into international research projects, and high academic workload. These limitations significantly affect the ability of teaching staff to realise their scientific potential and meet international standards for publication activity, which play an important role in university ratings (for example, QS and THE). From the perspective of human capital capacity management, this indicates the need to develop systems to support research activities, reduce excessive academic workload, and expand academic mobility and language training programs. In the context of the green transition, these measures are becoming particularly important, since the development of international research competencies and interdisciplinary cooperation is a prerequisite for training personnel for sustainable development.

Figure 14 shows the dynamics of the Kazakhstani universities' development in international rankings from 2010 to 2024.

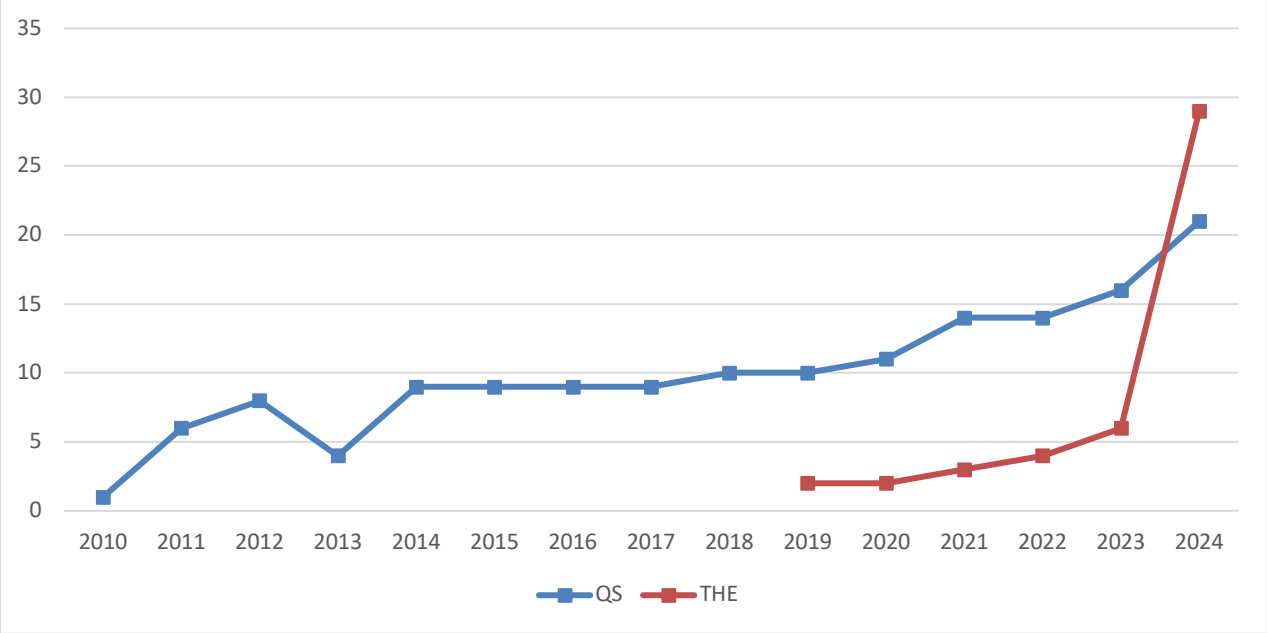

Figure 14 - Representation of Kazakhstani HEIs in the international rankings from 2010 to 2024

Note - compiled by the author based on the Bureau of National Statistics data

The data reveal a steady, rising trend in the number of Kazakhstani universities included in the world's leading rankings, denoting a significant increase in the international competitiveness and recognition of the Kazakhstani higher education system. Since 2010, the number of universities in the QS ranking list has increased from 2 to 16, which is evidence of the effectiveness of measures to raise research activity (the proportion of faculty with academic degrees and the citation index), international cooperation, and academic reputation. An especially pronounced increase has been observed since 2019, driven by intensified government policy measures to support scientific research and improve teaching staff skills.

The THE rating, which has been available since 2019, also shows positive dynamics, noting an increase in the number of universities in Kazakhstan from 1 university in 2019 to 29 in 2024. This trend indicates a gradual strengthening of universities' position in scientific research, an increase in citation counts, and the acceptance of advanced curricular standards.

Thus, the presented dynamics testify to the effectiveness of state policy and management decisions of Kazakhstani universities aimed at inclusion into the international scientific and educational space, as well as the gradual formation of competitive human capital in the country. From the perspective of human capital capacity management, this means strengthening universities' orientation towards developing the research competencies of teaching staff, international publication activity, and increasing academic reputation as principal factors in institutional competitiveness. In the context of the green transition, the growth of international university integration creates prerequisites for the inclusion of Kazakhstani universities in global ESG and sustainability initiatives.

Next, we will consider the quantitative composition of the teaching staff by academic degree, as shown in Figure 15.

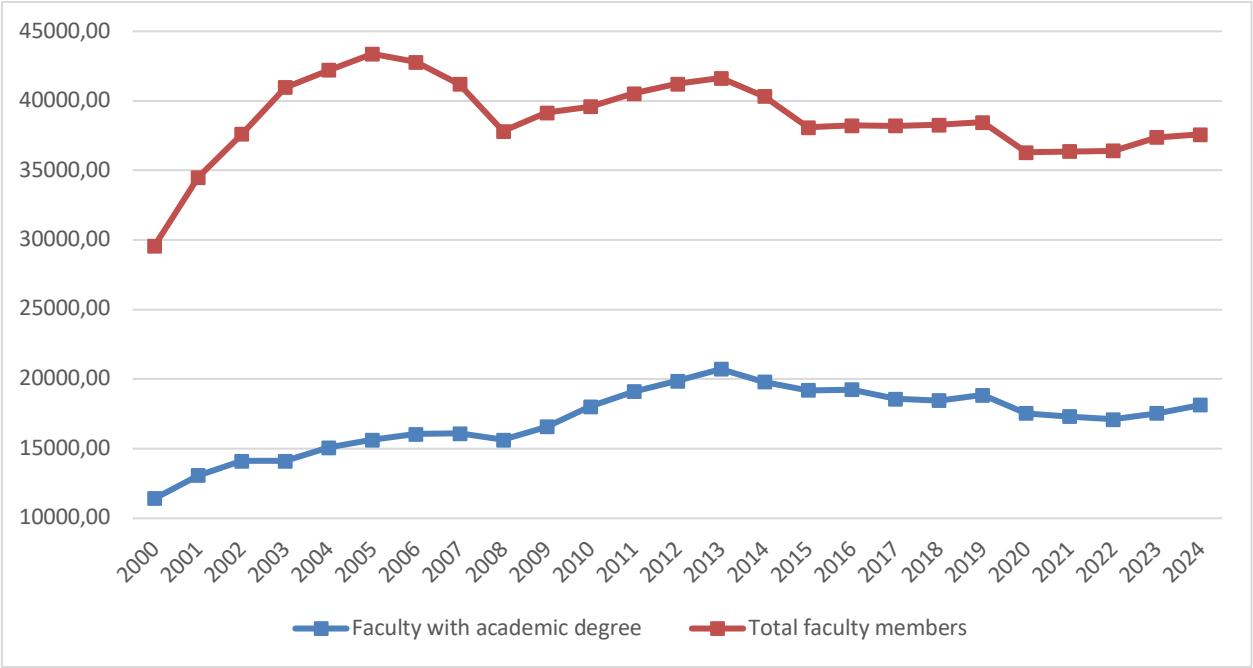

Figure 15 - Dynamics of the number of teaching staff with an academic degree from 2000 to 2024

Note - compiled by the author based on the Bureau of National Statistics data

During the period 2000–2024, the dynamics of academic staff in Kazakhstan's higher education system exhibited several distinct stages. Between 2000 and 2005, the total number of faculty members increased significantly from approximately 29.4 thousand to 43.4 thousand, reflecting the expansion of the higher education system and growing demand for academic staff. From 2006 to 2008, the total number of faculty members declined to approximately 37.8 thousand, after which a moderate recovery was observed during 2009–2013, reaching about 41.7 thousand. Since 2014, the total number of faculty members has gradually decreased and stabilised at approximately 36–37 thousand in recent years.

The number of faculty members holding academic degrees followed a broadly similar trajectory. It increased steadily from approximately 11.4 thousand in 2000 to a peak of more than 20.5 thousand in 2013. After 2013, this indicator gradually declined, reaching approximately 17 thousand in 2022, before recovering slightly to around 18 thousand in 2024. The observed dynamics may reflect demographic changes within the academic workforce, including the retirement of senior academics and the gradual transition from the traditional Candidate and Doctor of Sciences system to the PhD qualification model.

Overall, the figure demonstrates that the expansion of Kazakhstan's academic workforce during the first half of the analysed period was accompanied by a substantial increase in the number of highly qualified faculty members. However, after 2013 both indicators exhibited a downward trend, followed by relative stabilisation in recent years. These changes indicate the need to strengthen human capital capacity management mechanisms aimed at attracting, retaining, and developing highly qualified academic staff, thereby ensuring the long-term

sustainability and competitiveness of the higher education system in the context of the green transition.

From the perspective of human capital capacity management, the identified trends indicate the need to develop a long-term personnel strategy focused on the reproduction of scientific and pedagogical staff and on supporting young researchers. The development of a PhD training system, academic mentoring, and retention mechanisms for qualified personnel are significant. In the context of the green transition, these measures become critically important, since sustainable development requires highly qualified teaching staff who can develop green competencies and conduct interdisciplinary research.

Next, Table 11 presents the gender distributions of faculty.

Table 11 - Percentage of female faculty with academic degrees

Academic degree	2000	2005	2010	2015	2020	2024
Doctor of Science, %	15.1	21.1	32.6	38.6	42.6	49.4
Candidate of Science, %	43.0	50.7	57.3	60.1	62.4	64.6
PhD, %	-	-	46.4	52.6	57.0	60.9

According to the data presented for 2000, 2005, 2010, 2015, 2020, and 2024, the percentage of female faculty holding academic degrees increases over time. In 2000, the percentage of female doctors of sciences was 15.1%, while the percentage of female candidates of sciences was 43%. It is worth noting that the percentage of female doctor of sciences holders in 2024, i.e., 49.4%, has tripled from 2000, when it was 15.1%. Regarding candidates in the sciences, the proportion of women increased from 43.0% in 2000 to 64.6% in 2024.

In our opinion, this demonstrates a considerable improvement in women's opportunities to reach the highest stage of a scientific career, as well as a gradual reduction in the gender gap in the scientific community. However, it should be borne in mind that the awarding of the degrees of doctor of sciences and candidate of sciences in Kazakhstan was discontinued in 2010 as part of the reform of the higher education system. In this regard, the observed increase in the proportion of female doctors of science may reflect not only patterns of academic career growth but also the influence of demographic factors, including the duration of professional activity and the life cycle of researchers.

In 2010, 46.4% were women, and by 2024, this figure had increased to 60.9%. This trend demonstrates the success of integrating women into a new degree program in the Kazakh educational system and indicates the attractiveness of PhD programs to women scientists. From the perspective of human capital capacity management, the results show the gradual formation of a steadily inclusive scholarly environment and the expansion of career opportunities for women in science and higher education. This requires further development of academic career support mechanisms, leadership programs, and a balance of professional and family employment. In the context of the green transition, gender inclusivity takes on additional importance, as sustainable development entails increasing the

participation of diverse social groups in forming the country's research and scientific potential.

Table 12 shows the number of teaching staff by region in Kazakhstan for 2000, 2005, 2010, 2015, 2020, and 2024.

Table 12 - Dynamics of the number of teaching staff with an academic degree by region for 2000, 2005, 2010, 2015, 2020, 2024

Region	2000	2005	2010	2015	2020	2024	Growth (basis)
Kazakhstan	11323	15642	18037	19204	17545	18 147	60.3
Abay	-	-	-	-	-	571	-
Akmola	183	276	400	361	326	318	73.8
Aktobe	424	657	665	789	611	499	17.7
Almaty	130	152	206	345	244	109	−16.2
Atyrau	198	254	143	301	223	189	−4.5
West Kazakhstan	252	430	466	613	534	474	88.1
Zhambyl	534	541	563	553	448	440	−17.6
Zhetysu	-	-	-	-	-	131	-
Karaganda	1277	1452	1479	1558	1372	1 330	4.2
Kostanay	282	454	534	524	478	420	48.9
Kyzylorda	312	362	393	389	362	389	24.7
Mangystau	76	159	178	186	30	149	96.1
Pavlodar	284	533	589	579	557	505	77.8
North Kazakhstan	139	197	193	177	149	146	5.0
Turkistan	1215	1796	2153	2267	548	458	−62.3
Ulytau	-	-	-	-	-	36	-
East Kazakstan	860	1012	1198	1147	943	345	−59.9
Astana city	625	1051	1915	2712	2703	2 969	375.0
Almaty city	4532	6316	6962	6703	6305	6 981	54.0
Shymkent city	-	-	-	-	1712	1 688	-

During the period under review, there has been an overall positive long-term trend in the indicator for Kazakhstan as a whole: its value has increased from 11 323 in 2000 to 18 147 in 2024. The most intensive growth occurred in 2000-2015, when the indicator consistently increased from 11 323 to 19 204. In 2020, there was a temporary decrease to 17 545, indicating the impact of unfavourable social and economic aspects and administrative and territorial transformations. Nevertheless, the 2024 value remained below the peak recorded in 2015, indicating that the long-term upward trajectory was accompanied by noticeable fluctuations in the later period.

Almaty city remained the leading city, with the indicator increasing from 4 532 in 2000 to 6981 in 2024. Astana became the second most dynamic centre, rising from 625 to 2969, which represents the largest relative growth among all regions (375%). Mangystau region also increased significantly, from 76 to 149, while West Kazakhstan region demonstrated substantial long-term growth despite a decline after 2015. A comparison of regional patterns shows significant heterogeneity in

development. The highest growth rates over the entire period were observed in Astana (375%), Mangystau (96.1%), West Kazakhstan (88.1%), Pavlodar (77.8%) and Akmola (73.8%) regions. These territories are characterised by a steady rise in indicators of economic activity, urbanisation, and investment attractiveness.

At the same time, some regions were characterised by stagnation or contraction. Thus, in the Almaty region, the indicator decreased by 16.2% relative to the base period, in the Karaganda region, it practically did not change (4.2%), and the most significant decrease was observed in the Turkestan (-62.3%) and East Kazakhstan (-59.9%) regions. It should be borne in mind that a significant part of the decrease is due to the administrative and territorial reform, as a result of which new regions of Abai, Zhetysu and Ulytau were formed, as well as the city of Shymkent, which was previously allocated to a separate administrative unit, which led to the redistribution of statistical indicators between the regions.

The changes after 2020 are particularly noticeable. At the national level, the indicator increased moderately from 17 545 in 2020 to 18 147 in 2024. However, regional dynamics were mixed. The most significant absolute increase was observed in Almaty city (+676 compared to 2020), Astana (+266), and Mangystau (+119) regions. At the same time, several regions, including Turkestan, East Kazakhstan, and Almaty, maintained relatively low values due to changes in administrative boundaries. Overall, the findings show a continued strengthening of territorial differentiation. The main increase in the indicator is driven by the largest urban agglomerations, Almaty and Astana, as well as some industrially developed regions, whereas some regions show more moderate growth rates or declines due to both structural economic differences and administrative and territorial transformations in recent years.

In addition, regional inequalities in the number of teaching staff with academic degrees can negatively affect the quality of education and research activities in less developed areas. The scarcity of qualified professionals also hinders universities in those areas from conducting large-scale research projects, securing international grants, and participating in international scientific communication. This, in turn, influences the academic reputation and competitiveness of the universities in question.

To eliminate the identified imbalances and increase the research potential of new and less developed regions, it is necessary to ensure the implementation of a targeted government policy. It may include creating conditions for the professional and career growth of faculty, developing infrastructure for scientific research, supporting academic mobility, and attracting young professionals through incentive mechanisms and providing social guarantees. From the perspective of human capital management, regional differences indicate the need for a differentiated personnel policy and for developing mechanisms to align academic potential across territories. This involves strengthening support for regional universities, creating incentives to consolidate scientific staff, and developing interregional research networks. In the context of the green transition, reducing regional inequalities is especially important, as environmental modernisation and the development of a green economy require

qualified personnel not only in megacities but also in the country's industrial and resource regions.

Figure 16 shows the level of human capital capacity management in the higher education system.

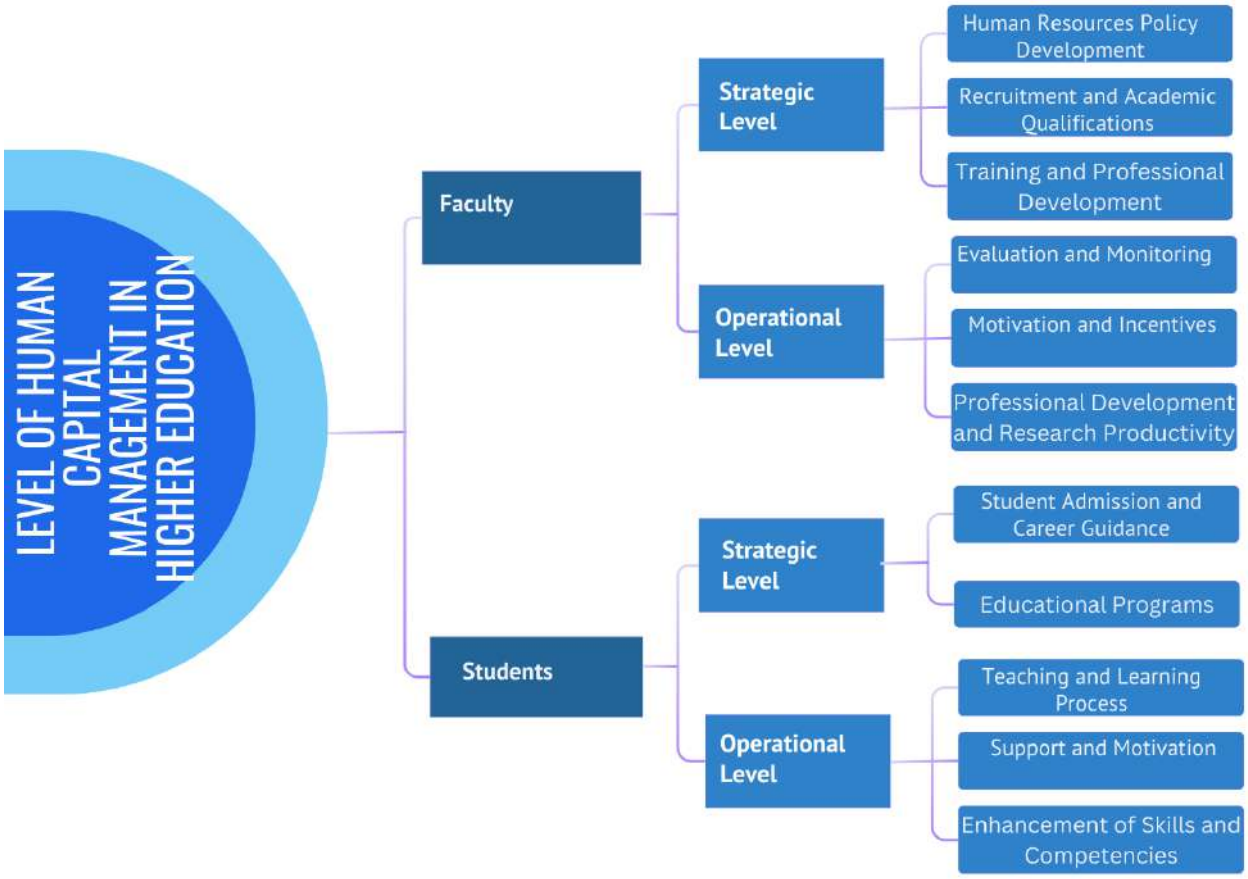

Figure 16 - The levels of human capital capacity management

Note - compiled by the author

Effective human capital capacity management in the higher education system entails creating a favourable scholarly setting that encourages faculty to engage in continuous vocational development and to develop research competencies. In this regard, the mechanisms of motivation, evaluation and career advancement of teaching staff are of particular importance. From a scientific perspective, the human capital capacity management scheme in the higher education system, divided into teaching and student components, enables clear identification of the key areas and mechanisms for implementing personnel and educational policies in universities.

Human capital capacity management for teaching staff provides an effective approach to developing a long-term personnel policy and fostering academic capacity by selecting qualified personnel and stimulating their career development. The operational management level includes continuous assessment and monitoring of faculty's activities, professional development mechanisms (internships, academic mobility, study programs), and various tangible and intangible incentives that increase scientific productivity and strengthen universities' international reputation.

At the same time, student human capital capacity management is also divided into strategic and operational areas. Strategic management includes the selection and recruitment of applicants, as well as career guidance and marketing, to build a stable student body. Operational management focuses on the direct implementation of the educational process, monitoring academic achievement, and providing social and financial support (scholarships and grants). All this is aimed at improving the quality of education and developing the skills and competencies of graduates who are in demand by the labour market.

Thus, integrated and balanced human capital capacity management of both faculty and students is an essential condition for the sustainable development of universities. The consistency and interconnection of these management areas ensure that universities achieve a competitive advantage at national and international levels, enhancing their reputation and capacity to adapt to the challenges of the modern educational and scientific environment. In the context of the green transition, this management system should be complemented by mechanisms to develop ESG competencies, stimulate sustainable leadership, and integrate sustainability principles into educational management processes.

The quantitative analysis presented in this section does not directly measure green competencies or the environmental performance of universities. Its purpose is to assess the current human capital and institutional capacity of the higher education system, including qualifications, research performance, professional experience, motivation, and incentive mechanisms. These characteristics form the organisational foundation upon which green-oriented competencies and sustainable university practices can subsequently be developed. Accordingly, the quantitative findings are interpreted as a diagnostic baseline for assessing the capacity of universities to implement new strategic priorities associated with the green transition.

Next, the faculty survey carried out across 14 regions and 3 cities of national significance in 2024 is considered (Appendix C). The study involved 958 faculty members, of whom 730 were women, a significant proportion of the sample. 32 universities were represented in the survey, which provides representative data on the current state of academic human capital in the country.

The respondents' age range is 25 to 65 years and older, allowing consideration of faculty professional development across several career stages. In particular, among the respondents, 165 are aged 25-34, 286 are aged 35-45, 273 are aged 46-55, 183 are aged 56-65, and 51 are aged 65+. In addition, 507 respondents (53%) hold academic degrees, showing a high level of qualification among university academic staff.

Since a significant proportion of the variables were measured on ordinal scales, Spearman's rank correlation coefficient was used to assess the relationships among the indicators. This method allows us to identify monotonous relationships between variables without requiring a normal distribution of data. The analysis includes demographic, educational, and professional characteristics of academic staff, as well as indicators indicating the research, innovation, and qualification potential of human resources in the higher education system. The results are presented in Table 13.

Table 13 - Spearman's Correlation Analysis

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	2	3	4	5	6	7	8	9	10	11	12	13
GEN	1	0.004	-0.097	0.015	0.112	0.079	-0.111	0.017	0.054	0.040	0.030	0.032
AGE	0.004	1	0.550	-0.487	-0.086	-0.278	0.250	-0.038	-0.075	-0.043	-0.080	-0.012
AQ	-0.097	0.550	1	-0.559	-0.402	-0.199	0.476	0.052	-0.026	0.010	-0.056	-0.007
PD	0.015	-0.487	-0.559	1	0.188	0.240	-0.280	0.022	0.053	0.046	0.086	-0.005
AP	0.112	-0.086	-0.402	0.188	1	0.072	-0.217	-0.063	-0.042	-0.056	-0.023	-0.011
ELP	0.079	-0.278	-0.199	0.240	0.072	1	0.064	0.006	0.016	-0.011	-0.011	-0.094
PA	-0.111	0.250	0.476	-0.280	-0.217	0.064	1	0.099	0.057	0.047	0.021	-0.004
RP	0.017	-0.038	0.052	0.022	-0.063	0.006	0.099	1	0.764	0.729	0.718	0.448
RI	0.054	-0.075	-0.026	0.053	-0.042	0.016	0.057	0.764	1	0.696	0.749	0.433
GE	0.040	-0.043	0.010	0.046	-0.056	-0.011	0.047	0.729	0.696	1	0.689	0.444
PIP	0.030	-0.080	-0.056	0.086	-0.023	-0.011	0.021	0.718	0.749	0.689	1	0.445
ASQ	0.032	-0.012	-0.007	-0.005	-0.011	-0.094	-0.004	0.448	0.433	0.444	0.445	1

(1) GEN – Gender
(2) AGE – Age
(3) AQ – Academic qualification
(4) PD - Period of Degree Award
(5) AP - Academic Position
(6) ELP - English Language Proficiency
(7) PA - Publication Activity
(8) RP - Research Productivity
(9) RI - Research Income
(10) GE – Employability
(11) PIP - Patents and Intellectual Property
(12) ASQ - Academic Staff Qualification

The Spearman correlation analysis revealed several meaningful associations between the characteristics of academic staff and the indicators reflecting the human capital capacity of Kazakhstan's higher education system.

Among the individual characteristics of academic staff, the strongest positive association was observed between age and academic qualification ($\rho = 0.550$), suggesting that older respondents are more likely to possess higher academic qualifications. A moderate negative correlation was identified between academic qualification and the period of degree award ($\rho = –0.559$), indicating that respondents who obtained their highest academic degree earlier generally hold higher academic qualifications. Academic qualification also demonstrated a moderate positive relationship with publication activity ($\rho = 0.476$), suggesting that higher-qualified academic staff tend to be more actively involved in research.

Age showed a weak positive association with publication activity ($\rho = 0.250$), whereas English language proficiency exhibited only weak relationships with publication activity ($\rho = 0.064$) and research productivity ($\rho = 0.006$). These coefficients indicate that English proficiency alone is only weakly associated with research performance within the analysed sample.

The strongest correlations were observed among the institutional performance indicators. Research productivity demonstrated strong positive relationships with research income ($\rho = 0.764$), graduate employability ($\rho = 0.729$), and patents and

intellectual property (ρ = 0.718). Similarly, research income was strongly associated with patents and intellectual property (ρ = 0.749) and graduate employability (ρ = 0.696). These findings suggest that universities with stronger research performance also tend to demonstrate better innovation outcomes and graduate employment performance.

Moderate positive correlations were also identified between research productivity and academic staff qualification (ρ = 0.448), research income and academic staff qualification (ρ = 0.433), graduate employability and academic staff qualification (ρ = 0.444), and patents and intellectual property and academic staff qualification (ρ = 0.445). These relationships indicate that institutions with more highly qualified academic staff generally demonstrate stronger research and educational outcomes.

Overall, the correlation matrix suggests that institutional indicators of human capital capacity are more closely associated with academic qualifications and research-related characteristics than with demographic variables such as gender and age. The strongest relationships are concentrated among research productivity, research income, graduate employability, patents and intellectual property, and academic staff qualification, highlighting the interconnected nature of research capacity, educational quality, and human capital development within higher education institutions.

An additional sample assessment of the impact of financial incentives on the scientific productivity of the teaching staff was conducted (Appendix D). 93 academic staff from Kazakhstani universities participated in the survey, 58 of whom were women. The analysis of respondents by academic qualifications shows that the sample included 4 doctors of science, 14 holders of PhD degrees, 24 candidates of science, and 33 master's degree holders, providing an idea of the various levels of academic status and professional maturity of the teaching staff. The purpose of this stage of the study was to identify the relationships between the level of financial incentives and academic activity (measured by the number of attached and confirmed key performance indicators (KPIs), publication activity, and the number of awards received. Table 14 shows Spearman's correlation analysis based on the collected data.

Table 14 - Correlation analysis

Variables	(1)	(2)	(3)	(4)	(5)	(6)
ACAD. DEG.	1.000	0.040	0.143	0.113	0.216	0.378
ACT. MIN.	0.040	1.000	0.718	0.659	0.631	0.506
AT KPI	0.143	0.718	1.000	0.891	0.617	0.308
APPR KPI	0.113	0.659	0.891	1.000	0.397	0.557
KPI BONUS	0.216	0.631	0.617	0.397	1.000	0.664
BONUS	0.378	0.506	0.308	0.557	0.664	1.000

(1)	ACAD. DEG.	Academic degree
(2)	ACT. MIN.	Activity minutes
(3)	AT KPI	Attached KPI
(4)	APPR KPI	Approved KPI
(5)	KPI BONUS	KPI Bonus
(6)	BONUS	Bonus paid

Based on the correlation matrix, the following conclusions are drawn:

Academic degree (ACAD. DEG.) demonstrates only weak positive correlations with most performance indicators. The strongest association is observed with the final bonus paid (BONUS; ρ = 0.378), followed by the preliminary KPI bonus (KPI BONUS; ρ = 0.216). Weak positive correlations are also found with the number of attached KPIs (ρ = 0.143), approved KPIs (ρ = 0.113), and activity minutes (ρ = 0.040). These results suggest that academic degree is only modestly associated with research and incentive performance.

Activity minutes (ACT. MIN.) exhibit strong positive correlations with the number of attached KPIs (ρ = 0.718), approved KPIs (ρ = 0.659), and the preliminary KPI bonus (ρ = 0.631). Moderate positive relationships are also observed with the final bonus paid (ρ = 0.506). These findings indicate that higher levels of academic activity are generally accompanied by greater participation in the KPI system and higher financial rewards.

The strongest relationship in the matrix is observed between attached KPIs (AT KPI) and approved KPIs (APPR KPI) (ρ = 0.891), indicating a high level of consistency between submitted and subsequently approved performance indicators. Attached KPIs are also positively associated with the preliminary KPI bonus (ρ = 0.617), whereas their relationship with the final bonus paid is comparatively weaker (ρ = 0.308).

The preliminary KPI bonus (KPI BONUS) demonstrates a strong positive correlation with the final bonus paid (BONUS) (ρ = 0.664), suggesting that the initial incentive allocation is largely reflected in the final financial reward following the evaluation process. In addition, the approved KPI is moderately associated with both the preliminary KPI bonus (ρ = 0.397) and the final bonus paid (ρ = 0.557), indicating that KPI approval contributes to the determination of financial incentives.

The correlation analysis indicates that financial incentives are more closely associated with academic performance indicators than with academic degree. Strong positive relationships were identified among activity minutes, attached KPIs, approved KPIs, preliminary KPI bonuses, and final bonus payments, suggesting that research activity and KPI performance constitute the core elements of the university incentive system. In contrast, academic degree demonstrates only weak positive associations with most performance indicators, indicating that academic qualifications alone are not a primary determinant of financial rewards. From the perspective of human capital capacity management, these findings suggest that universities increasingly rely on measurable performance indicators when allocating incentives and evaluating academic staff. In the context of the green transition, this performance-based management framework provides opportunities to incorporate sustainability-related indicators into university KPI systems, including participation in green research projects, environmental innovation, and sustainable development initiatives.

The findings demonstrate that universities' capacity for further green-oriented transformation depends on the quality of the existing human capital management system. Academic qualifications, research capacity, international experience,

institutional support, and transparent incentive mechanisms constitute enabling conditions for the subsequent development of green-oriented human capital.

However, these indicators should not be interpreted as direct measures of green competencies. Rather, they reflect the general organisational and human capital capacity of higher education institutions to implement sustainability-oriented educational programmes, green research initiatives, ESG-based management practices, and continuous professional development.

The assessment of the structure and trends in the development of the human resources potential of Kazakhstan's higher education system has shown that over the past two decades, there have been significant qualitative and quantitative changes in academic human capital. It has been established that the state policy aimed at improving the quality of higher education, supporting scientific research and internationalising universities has contributed to strengthening the positions of Kazakhstani universities in international rankings, increasing research activity and improving the skills of the teaching staff.

The analysis of the human capital structure revealed a steady increase in the number of teachers with academic degrees, an increase in the proportion of women in academic science, and a gradual renewal of the system of training scientific personnel through PhD programs. At the same time, problems in the reproduction of academic staff have been identified due to generational change among researchers, the insufficient pace of training new specialists, and persistent regional imbalances in the distribution of teaching staff with academic degrees. This indicates the need to develop a long-term personnel policy to develop the scientific potential of regional universities and ensure a balanced distribution of highly qualified personnel.

The results of the sociological survey and correlation analysis suggest that human capital capacity management in higher education is more closely associated with academic qualifications, publication activity, and research productivity than with demographic characteristics. Strong positive correlations were identified among research productivity, research income, patent activity, and graduate employability, indicating that these dimensions of university performance are closely interconnected. Overall, the findings emphasise the systemic nature of human capital capacity, where research excellence, knowledge commercialisation, and educational outcomes mutually reinforce one another.

An additional analysis of financial incentive mechanisms has shown that the effectiveness of scientific activity is more determined by the effectiveness assessment system and the results achieved than by the formal characteristics of academic status. This confirms the expediency of further developing human capital management models based on an objective assessment of faculty's research productivity, publication activity, academic mobility, and professional development.

In general, the results of the study indicate that increasing the competitiveness of Kazakhstan's higher education system requires a transition to an integrated human resource management model that combines mechanisms for strategic personnel planning, development of research competencies, support for young scientists, international academic integration and promotion of scientific performance. In the context of the transition to a green economy, this model should be complemented by

tools for the formation of ESG competencies, the development of interdisciplinary research and the integration of sustainable development principles into the personnel policy of universities, which will ensure the training of human capital capable of effectively responding to modern technological, environmental, social and economic challenges.

2.3 Prospects for the transformation of human capital capacity management in higher education in the context of the green transition

The current stage of higher education development is characterised by the growing influence of global trends in sustainable development, digitalisation, and the green economy, which are placing universities under pressure to fundamentally revise traditional approaches to human capital capacity management. From the perspective of the global green transition, the university is taking on the role of a key actor in developing environmentally literate and socially responsible human capital capable of functioning effectively in the new reality.

In Kazakhstan, the transition to a green economy is part of the long-term state strategy for sustainable development, reflected in such documents as the Strategy "Kazakhstan-2050", the Concept for the Transition of the Republic of Kazakhstan to a Green Economy and the Strategy for Achieving Carbon Neutrality of the Republic of Kazakhstan until 2060 [215, 216,278]. Within the framework of these documents, the state's desire to form a low-carbon, resource-saving, and environmentally sound development model is declared, with a special role assigned to the higher education system. Universities act as strategic actors in implementing the climate and environmental agenda by providing training for qualified human capital, fostering an environmental culture, conducting applied and fundamental research in sustainable development, and implementing innovative management solutions. Nevertheless, the practical implementation of the climate and environmental agenda is constrained by several institutional and resource limitations. Among the important limitations are the lack of institutional readiness to effectively implement green strategies, including the absence of sustainable management systems, the limited incorporation of sustainable development into universities' strategic plans, and insufficient infrastructure. In addition, the scarcity of educational programs and the human capital capacity for sustainable development are important limitations. The absence of faculty members competent in this area, as well as the "piecemeal" incorporation of ecology, ESG, and climate sustainability into educational programs, affects the effectiveness of education for green economy specialists.

Management of human capital should not only focus on workers' education and skills development, but also on promoting sustainable thinking, developing the green skills of students and workers, and fostering the ability to learn and adapt to environmental challenges. Thus, it is necessary to transform both the substantive, organisational, and managerial components of the university's activities, including creating a favourable environment for the development of green competencies and

fostering a corporate culture focused on sustainability and environmental responsibility.

In the context of the global sustainable development agenda, the higher education system must transform the educational environment in accordance with ESG principles. These changes affect not only the content of educational programs but also approaches to human capital management as a key factor in the institutional development of universities. The modern quality assurance system of higher education is a multi-level mechanism that combines government regulation, external assessment and internal self-assessment procedures aimed at continuously improving the quality of educational services. Accordingly, the quality assurance system should expand its focus beyond academic standards to include the assessment of institutional capacity, staff competencies, and governance practices supporting ESG implementation.

The quality assurance system should include mechanisms to evaluate and validate the competencies of teachers and graduates in ESG. This includes: (1) improving HR policy by updating qualification requirements and including ESG criteria in personnel selection, evaluation and professional development procedures; (2) training specialists with interdisciplinary environmental, social and managerial competencies that are in demand in a low-carbon economy and sustainable development; (3) development of accreditation mechanisms providing for the integration of ESG competencies into educational standards and external quality assessment procedures. Figure 17 shows the main directions for integrating ESG principles into the quality assurance system in higher education.

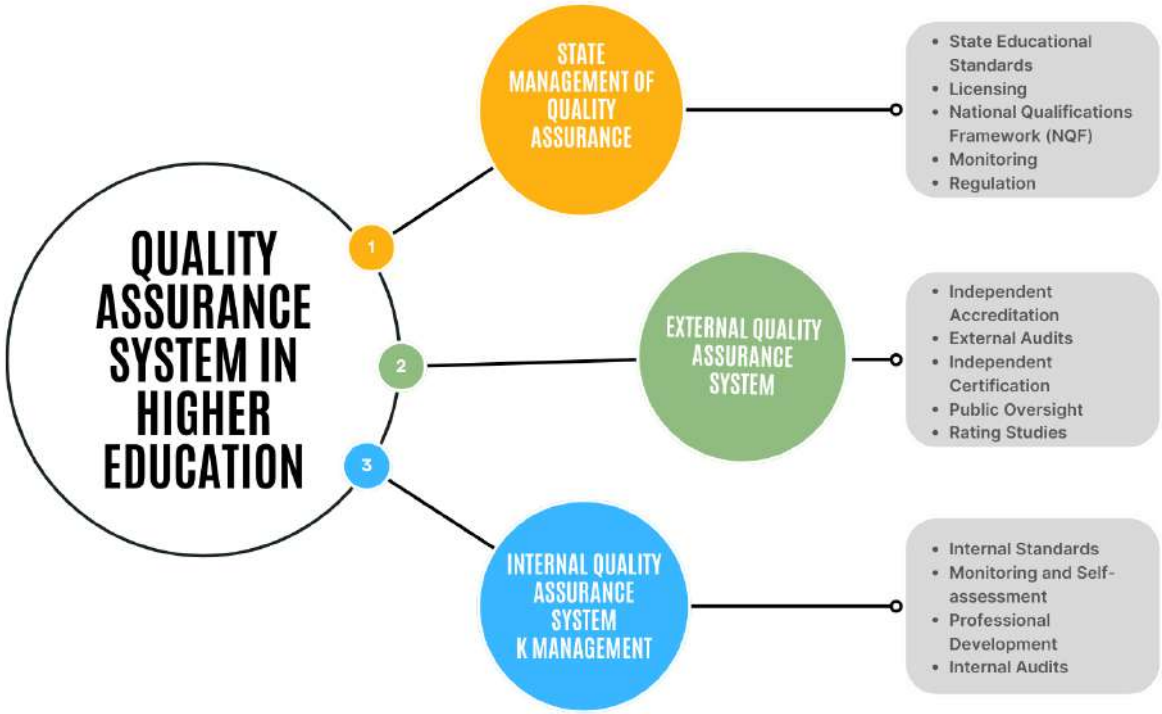

Figure 17 - Quality assurance system in higher education

Note - compiled by the author

Based on the figure, the quality assurance system in higher education consists of three interrelated levels. The first level, state management, uses government mechanisms such as State Education Standards (SES), licensing, the National Qualifications Framework (NQF), monitoring, and regulation to ensure that educational activities comply with national and international standards. SES set minimum requirements for educational programs and outcomes, licensing controls entry into the educational market, and the qualifications framework aligns levels with labour market needs. Monitoring ensures rapid responses to issues and timely adjustments to policies and regulations, providing a basis for accreditation and certification procedures.

The second level, the external quality assurance system, is mainly represented by mechanisms for independent evaluation of educational activities and accreditation of educational programs and institutions. At this level, there are accreditation agencies, professional associations and other independent organisations that regularly check the compliance of educational programs and services with established standards and quality criteria. External assessment includes external audits, examinations, and certification procedures, conducted by independent experts to objectively assess quality and provide recommendations for the further development of educational organisations. An important role in the external quality assurance system is played by public control, carried out through public information and independent rating research, which increases transparency in the educational system and trust in it among society and employers.

In Kazakhstan, the Independent Agency for Quality Assurance in Education (IAQAE) and the Independent Accreditation and Rating Agency (IAAR) are key actors, regularly conducting accreditation, audits, certification, and forming national university rankings. Universities also participate in international rankings such as QS, THE, and the UI GreenMetric ranking. Domestic and international experts ensure assessments are objective, comprehensive, and aligned with standards, and offer development recommendations.

In addition to national accreditation agencies, universities are actively undergoing international accreditation of educational programs. For example, in economics, law, humanities, and social Sciences, the Foundation for International Business Administration Accreditation (FIBAA), for MBA and other business programs, the Association of MBAs (AMBA), for technical specialities and engineering, the Accreditation Board for Engineering and Technology (ABET), and others. The accreditation of educational institutions and programs also boosts their competitiveness, as it indicates compliance with international and national quality standards, thereby affecting universities' attractiveness to prospective students and employers. Accreditation also opens up opportunities for active international cooperation, facilitates academic mobility for students and faculty, and enhances universities' reputations at the national and international levels. Graduates of accredited programs receive a significant advantage, as their diplomas and qualifications are highly trusted by employers, which makes them more in demand and competitive in the labour market.

The third level, the internal quality assurance system, is formed directly within educational organisations. This level is based on the development and implementation of its own policies, procedures, and standards to continuously improve the quality of the educational process. Key elements of the internal system include monitoring and self-assessment of educational quality, regular internal audits of educational programs, advanced training for teaching staff, and the introduction of a feedback system involving students and other stakeholders. Internal quality mechanisms are based on the principles of self-organisation, responsibility, and autonomy of educational institutions, which enable them to quickly identify and eliminate deficiencies and adapt educational programs to changing conditions and labour-market needs.

Digitalisation (digital transformation) is one of the key tools of the internal education quality assurance system. The use of digital technologies can significantly improve the processes of monitoring, evaluation and quality control of educational activities within universities. Digitalisation helps automate and simplify processes such as collecting and analysing data on student learning outcomes, conducting online surveys and collecting feedback, and quickly adjusting curricula and teaching materials. In addition, the digitalisation of the internal quality system ensures transparency and accessibility of information for all participants in the educational process, thereby contributing to increased management efficiency, data-based decision-making, and, as a result, an increase in the overall quality of education at the university.

To conclude that the three levels, which include the public administration of the quality assurance system and the external and internal quality assurance systems, are all interrelated and complement each other as part of the quality management system in education. The interaction of these levels is an important prerequisite for achieving sustainable development and increasing the competitiveness of the educational sector.

Quality assurance systems play an important role in the successful integration of ESG principles into university activities. By implementing quality assurance systems, universities can effectively monitor progress, identify gaps, and implement new approaches to ensure innovative solutions that conform to international sustainability standards. In this regard, quality assurance is a fundamental tool for ensuring the application of ESG principles, thereby supporting the sustainable development of universities.

To assess the factors influencing the possibilities and effectiveness of transformation, this paper proposes using the PEST analysis presented in Table 15.

Table 15 - PEST- analysis of external factors affecting the development of human capital in the higher education system of Kazakhstan

Management implications	External factors affecting Kazakhstan's universities	Opportunity	Threat
1	2	3	4
P – Political	- National strategies (Green Economy–2050,	- Government support for ESG	- Dependence on public funding;

Continuation of Table 15

1	2	3	4
	Zhasyl Kazakhstan); - Higher education reforms and increased university autonomy; - International climate commitments (Paris Agreement, SDGs)	integration in higher education; - International cooperation and funding opportunities; - Greater institutional autonomy.	- Regulatory uncertainty and administrative constraints
E – Economic	- Expansion of green industries and renewable energy investments; - Economic diversification and demand for new competencies; - Development of innovation ecosystems	- Growth of research funding; - Industry–university collaboration; - Attraction of international students and external financing	- Budget constraints; - Brain drain; - Skills mismatch with labour market needs
S – Social	- Increasing environmental awareness among students; - Demographic and regional disparities; - Growing societal demand for sustainable education	- Development of sustainability competencies; - Strengthening universities' social responsibility; - Expansion of lifelong learning	- Regional inequality in educational opportunities; - Resistance to organisational change; - Unequal access to quality higher education
T – Technological	- Digital transformation of higher education; - Smart campus initiatives; - Rapid development of EdTech and green technologies	- Digital learning and hybrid education; Integration of smart and green campus technologies; Cooperation with innovation ecosystems	- Digital divide between universities; - Shortage of specialists in digital and sustainability fields; - Cybersecurity risks
Note - compiled by the author			

The analysis of political, economic, social, and technological factors shows that the development of human capital in Kazakhstan's higher education system and the integration of ESG principles are shaped by a complex of interrelated external factors. Key opportunities include government support for the modernisation of higher education, the expansion of universities' academic autonomy, increased investment in research and innovation, the development of digital educational infrastructure, and the growing demand for competencies in sustainable development. At the same time, significant constraints remain, including universities' dependence on government funding, regional differences in access to digital infrastructure, a shortage of specialists with digital and ESG competencies,

insufficient interaction with business, and increased competition for highly qualified academic staff.

Under these conditions, it is advisable to use a scenario approach, which enables assessment of the possible trajectories of university human capital development in response to changes in the external environment and the effectiveness of implemented management decisions. Scenario analysis not only identifies potential areas for developing the higher education system but also serves as a strategic planning tool, providing a basis for recommendations to improve personnel policy, enhance research potential, and increase the competitiveness of universities in Kazakhstan.

Table 16 below presents three key development scenarios (inertial, adaptive, and progressive), each reflecting a different degree of institutional readiness to implement the principles of sustainable development.

Table 16 - Scenarios for the development of universities

Criterion	Inertial scenario	Adaptive scenario	Progressive scenario
1	2	3	4
Goal	Absence of a strategically oriented sustainability policy; formal implementation of isolated green initiatives	Introduction of elective courses on environmental topics; partial professional development of academic staff; occasional participation in environmental projects	Integration of the ESG approach into HRM practices; institutional support for academic and professional development in sustainability; development and implementation of green educational strategies
Managerial actions	Maintenance of traditional disciplinary approaches; absence of development of environmental and digital competencies	Development of basic knowledge of sustainable development; enhancement of digital and flexible skills among selected groups of students and faculty	Development of systems thinking in the context of sustainable development; training of ESG leaders and change agents
Competency development	Passive observer of ongoing economic and societal transformations	Limited participant in selected sustainability initiatives	Active actor and driver of sustainable development at both regional and national levels
Role of the university	Short-term resource savings through avoidance of investments in transformation	Increased attractiveness of selected educational programs; sustainability of certain structural units	Growth of institutional prestige; preparation of human resources for the green economy; access to international grants, partnerships, and networks
Potential benefits	Strengthening of structural and human capital lag; loss of competitiveness and declining interest among prospective students	Fragmented changes and limited impact without systemic institutional and governmental support	Transformation into a center for training specialists in sustainable development and a generator of scientific and technological innovation

Continuation of Table 16

1	2	3	4
Risks	Loss of positions in the educational and professional market	Partial modernization with limited long-term impact	Resistance to change from part of the academic community; need for significant organizational and financial investments
Final outcome	Absence of a strategically oriented sustainability policy; formal implementation of isolated green initiatives	Introduction of elective courses on environmental topics; partial professional development of academic staff; occasional participation in environmental projects	Development and implementation of green educational strategies
Note - compiled by the author			

The presented scenario analysis shows that the further development of universities in Kazakhstan can take different trajectories, depending on the depth of integration of ESG principles into the human capital management system. The inertial scenario is characterised by the preservation of existing management approaches, which poses the risk of increasing technological lag, reducing the international competitiveness of universities, and limiting their contribution to the country's innovative development. The adaptive scenario assumes partial implementation of individual initiatives to develop competencies in sustainable development; without comprehensive institutional changes, its impact on improving the quality of human capital will be limited.

The most promising scenario for Kazakhstan's higher education system is the progressive scenario, which provides for the systematic integration of ESG principles into universities' personnel, educational, and research activities. The implementation of this scenario will enable the development of a modern human capital management model focused on research competencies, academic leadership, digital skills, and interdisciplinary interaction. This will create the prerequisites for improving the quality of specialist training, expanding universities' participation in international research projects, attracting external funding, and strengthening Kazakhstan's position in the global educational and scientific space.

For Kazakhstan, the transition to a progressive scenario is of strategic importance, as it supports the training of personnel in demand amid the technological modernisation of the economy, the development of low-carbon industries, and the implementation of national priorities in sustainable development. Under these conditions, the integration of ESG principles should be considered not as an independent goal, but as a tool for improving the efficiency of human capital management, ensuring the long-term competitiveness of universities and the sustainable development of the national higher education system.

Despite the advantages of transitioning to transformational models in higher education, implementing them entails several risks and barriers. Let's highlight the main problematic factors: (1) institutional resistance to change, (2) limited resources and low motivation of teachers, (3) insufficient intersectoral cooperation.

Institutional resistance to change

One of the main barriers to university transformation is resistance to change within existing structures and the academic community. Universities are organisations with long–standing traditions and established cultures, so any innovations may be perceived with caution by some members of management or teaching staff. There is often little interest among the university administration and some academic community representatives in the sustainable development agenda. In other words, not all managers and faculty members share the belief in the need for green reforms or social initiatives, considering them as an external imposition or a temporary fashion. The reasons for this resistance can be diverse: from a lack of understanding of the essence of sustainable development and fears of job complexity to fatigue from constant reforms in the education system. Institutional resistance manifests itself in a formal approach to new requirements or open criticism of changes. In addition, bureaucracy and hierarchy slow down the innovation process: it can take a long time to agree on new programs or strategies. As a result, promising initiatives (for example, the integration of new sustainability courses, the creation of interdisciplinary centres, or the redevelopment of the campus to green standards) may be delayed or not fully implemented. This barrier is compounded if top management provides insufficient support for the change agenda. The presence of stable university leaders who are convinced of the value of sustainable development can quell resistance and inspire human capital. Overcoming institutional resistance requires a change in organisational culture – through education, dialogue, and demonstration of the benefits of transformation (for example, increased reputation, new sources of funding, and improved working and learning conditions). Otherwise, there is a risk that the implementation of transformational models will remain declarative, with no real changes in the university's practice.

Limited resources and the motivation of the faculty

Another significant barrier is the lack of resources – financial, material, and human – to carry out transformations, as well as the associated low motivation of some employees. However, implementing new training programs, developing infrastructure, and conducting research on the identified sustainability issues require investment. Budget constraints remain a significant challenge for many universities, especially amid increased competition. The university management is caught between the need to fund traditional areas, such as the development of laboratory infrastructure to support ongoing research projects, and the need to fund new initiatives in sustainable development. Such initiatives include the creation of interdisciplinary centres, the introduction of advanced training programs in ESG competencies, the modernisation of infrastructure, and other structural transformations. In these circumstances, the existence of strategic declarations proclaiming a commitment to the principles of sustainable development remains formal unless accompanied by real investments. Thus, institutional transformation is impossible without financial support to sustain innovations. For example, a university may announce a commitment to reduce its carbon footprint but lack the funds to install solar panels or upgrade heating systems.

Faculty's low motivation is closely related to resource constraints. If teaching staff and researchers do not see clear incentives to be included in the new agenda — whether due to time constraints, lack of additional payments or institutional recognition for the increased workload, as well as insufficient support from management - their motivation to integrate sustainable development topics into training courses or participate in social initiatives remains low. As Brahm and Kuhner stated, faculty motivation is a critical factor in the successful integration of sustainable development into education. Without the faculty's motivation, it is believed that reform initiatives will remain only in declarations [279]. Many faculty members are already overloaded with existing responsibilities, including academic workload, implementation of research plans and participation in administrative work. Also, in the absence of appropriate infrastructural support, including methodological support, access to educational materials and the possibility of professional retraining, it is difficult to expect high-quality integration of sustainability principles into training courses. Accordingly, teaching staff will formally support the SDGs, but will not initiate their own actions to implement them.

Insufficient intersectoral cooperation

Transformational change in higher education requires active intersectoral cooperation – a partnership among universities, businesses, government agencies, and non-profit organisations. Without such cooperation, universities' efforts to implement sustainable practices may be isolated and less effective.

Firstly, a lack of strong interaction with industry and employers can create a gap between the content of educational programs and the real needs of the green economy. The development of new competencies at universities, such as sustainable leadership, environmental thinking, and digital skills, without relying on regular consultations with representatives of the labour market, risks inconsistency between the content of educational programs and employers' real needs. In such circumstances, graduates may face limited employment opportunities or difficulties applying their acquired knowledge and skills in practice. Effective partnership with the business community — implemented, in particular, through joint educational initiatives, internship programs, and employer participation in expert councils — ensures the relevance of emerging competencies and promotes faster integration of graduates into the professional environment, including in sectors focused on sustainable development. On the contrary, with weak interaction with the labour market, educational initiatives aimed at developing sustainable competencies may be perceived by companies as detached from reality, and graduates themselves may be found insufficiently prepared for practical challenges. As a result, students are less motivated to study these topics because they do not see clear career prospects in this field.

Secondly, limited interaction with authorities reduces universities' influence at the systemic level. Universities do not always have sufficient resources or political influence to promote systemic change at the public policy level or to secure the institutional support for their initiatives. For example, even if there is an innovative educational program focused on green urban planning, implementing and applying it may be difficult without active engagement with local authorities. Coordination

with government agencies at both the regional and national levels creates opportunities to scale successful university practices. Such a partnership makes it possible to integrate university initiatives into broader government programs, for example, to adapt and disseminate the green campus model in other educational institutions, and also opens up access to additional sources of funding and institutional support. With insufficient interaction with the authorities, the university risks remaining only a local actor with limited influence, and its contribution to sustainable development will be confined to the campus, without moving into the sphere of socially significant changes.

Thirdly, the lack of partnership with non-profit organisations and local communities deprives universities of a valuable feedback channel and social support. University projects on social innovation and environmental education for the population are much more effective when public organisations participate, as they understand local problems and enjoy the population's trust. When a university acts aloof, initiatives may not reach a wide audience or account for the community's specifics. For example, a program to train residents in energy efficiency will have a greater effect if implemented jointly with urban NGOs than independently by the university.

Coordination and partnership mechanisms are needed to overcome this barrier. Interaction platforms are being created in many countries – regional clusters of sustainable development, consortia of universities and companies on specific SDGs, and joint grant programs. When intersectoral cooperation mechanisms function effectively, synergy can be achieved: universities, working in partnership with government agencies, businesses, and civil society, implement large-scale initiatives such as urban "living laboratories" to test sustainable technologies. These projects not only aid in integrating knowledge into practice but also serve as catalysts for actual change in the physical landscape and the collective mind. Indeed, transformational initiatives may be nothing more than local experiments in the absence of adequate sectoral coordination. In conditions of fragmentation, innovative practices persist only as separate "islands" of stability, failing to reach the critical mass necessary for systemic impact and large-scale institutionalisation.

Next, Figure 18 presents the possibilities of integrating ESG principles in universities.

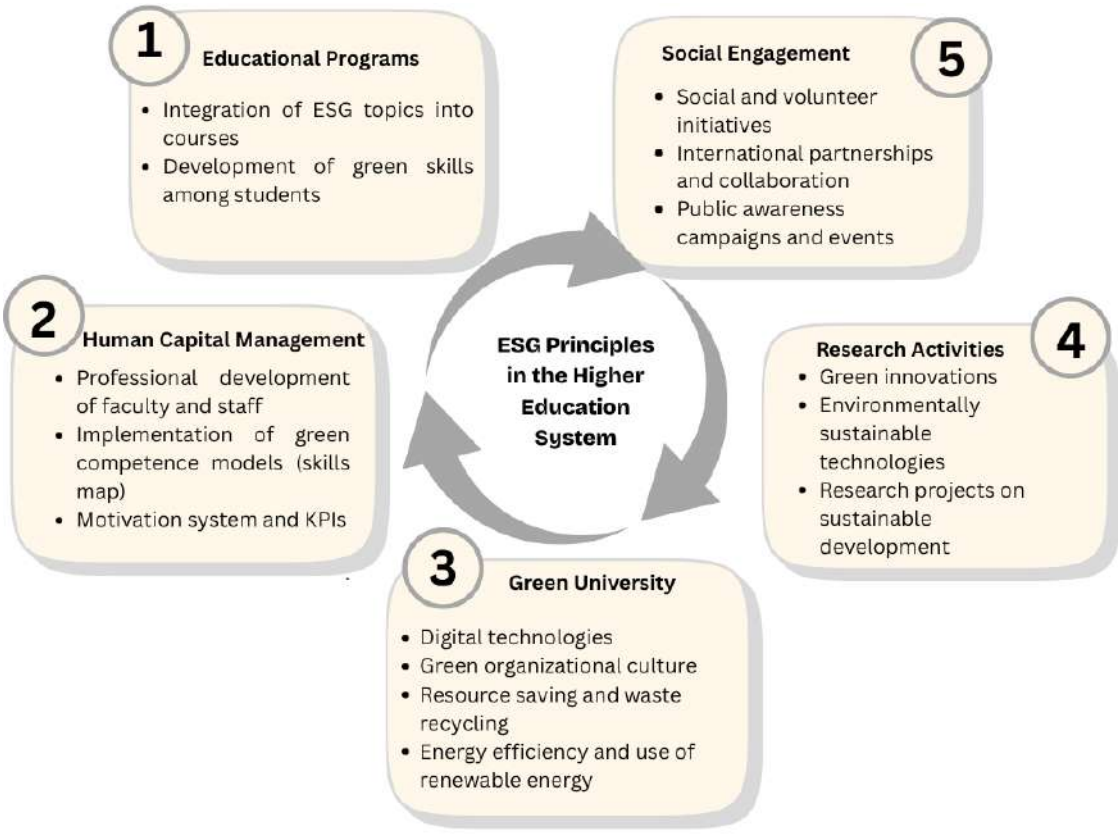

Figure 18 - Integration of ESG principles into the higher education system

Note - compiled by the author

ESG principles can be integrated into the higher education system through (1) Transformation of educational programs and training courses; (2) Improvement of human capital capacity management; (3) Development of green infrastructure and campus environment; (4) Development of scientific research in the field of sustainable development; (5) Interaction with external stakeholders.

(1) Transformations of educational programs and training courses

Modern trends in sustainable development and the transition to a green economy pose fundamentally new challenges for the higher education system, including the training of specialists capable of working effectively in a green economy. In this context, the development and implementation of new educational programs specifically focused on the formation of students' necessary knowledge, skills and competencies related to the green economy and environmentally sustainable technologies is of particular importance.

These programs should include components such as environmental management, sustainable resource management, renewable energy economics, and fundamentals of the circular economy and low-carbon development. An important aspect is not only the creation of specialised programs, but also the systemic integration of ESG principles (Environmental, Social, Governance) and sustainable development into existing disciplines and training areas, regardless of their profile and level of education. It should be noted that integration requires an interdisciplinary approach to ensure an understanding of the interrelationships among economic, environmental, and social processes, and to develop practical

skills in applying ESG principles in professional activities among students. Accordingly, it is necessary to revise traditional approaches to the content and structure of training courses, and to supplement them with modules and topics related to the social, environmental, and managerial aspects of sustainable development.

(2) Improving human capital capacity management

The introduction of ESG principles into the HR policy of universities involves a revision of approaches to human capital capacity management and the introduction of new criteria for the selection, evaluation and professional development of staff and teachers. An important factor in the successful implementation of the concept of sustainable development in universities is the targeted development of green competencies of staff and teaching staff. In the context of the global green transition, universities need to actively develop their staff's knowledge and skills to effectively address environmental sustainability and socially responsible management challenges. The creation of specialised professional development and retraining programs focused on the acquisition and development of green skills and competencies will enable teachers and staff to better understand the challenges of the green transition and integrate the knowledge they acquire into their teaching, scientific, and administrative activities.

In addition, the introduction of continuous learning approaches for staff and faculty members is particularly important, enabling them to adapt promptly to the constantly changing conditions and requirements of the green economy. In this case, universities can use training formats such as regular training, seminars, webinars, practical workshops, and short-term internships to continuously update staff competencies.

An important direction is to integrate environmental and social factors into the system of motivation and encouragement for staff, to develop professional competence and employee engagement in solving sustainable development problems. In our opinion, the inclusion of environmental and social factors in the system of internal motivation and stimulation of teaching staff contributes to the formation of a sustainably oriented academic environment in which not only pedagogical and scientific effectiveness, but also contribution to the promotion of sustainable development values become priorities. This approach allows expanding the criteria for evaluating the effectiveness of teaching staff, taking into account their participation in initiatives related to environmental education, the development and implementation of ESG training courses, and projects aimed at the sustainable development of university infrastructure.

The integration of these factors into the motivation system enables the development of a more holistic model of staff development, in which academic freedom is combined with social responsibility, and pedagogical activity is combined with the development of green and transversal competencies among students. In the long term, this enhances universities' institutional sustainability and their ability to adapt to the demands of the green economy.

(3) Development of green infrastructure and campus environment

The concept of a green university presupposes the development of a university environment grounded in environmental sustainability, social responsibility, and effective management. A university that adheres to these principles becomes not only an educational institution but also a model of a sustainable community that demonstrates commitment to ESG values in practice.

One of the key areas of implementation of this concept is the introduction of resource-saving and energy-efficient technologies, the organisation of environmentally friendly waste management, and the development of sustainable transport and information infrastructure. However, technical and infrastructural changes are impossible without corresponding changes in the cultural and behavioural levels of all participants in the educational process.

The formation of an institutional culture of sustainability requires systematic work to strengthen the values of environmental and social responsibility. The institutional culture includes awareness of the importance of sustainable behaviour, support for initiatives aimed at the rational use of resources, compliance with environmental standards and the development of social justice. Such values are consolidated through the development of ethical codes, awareness-raising activities, and through the participation of students and staff in sustainable practices of daily campus life.

Intra-university communities such as student clubs, faculty initiative groups, environmental associations, and volunteer movements play an important role in strengthening this culture. These associations not only support the practical implementation of the principles of sustainable development but also foster a culture of trust, cooperation, and shared responsibility for the university's future.

At the same time, universities' digital transformation is becoming an important tool for achieving sustainability. The effective use of digital technologies enables significant reductions in environmental impact by eliminating paper-based document management and reducing transport loads and energy consumption. Online courses, distance learning systems, electronic document management and digital platforms make educational and administrative processes more environmentally friendly, transparent and accessible.

Along with technological solutions, special attention should be paid to the development of digital competencies among faculty members, administrative staff and students. A modern university requires skills in working with online platforms, analytical abilities in environmental monitoring, and the ability to design and implement sustainable initiatives using digital tools. These competencies should be developed through formal training, professional development, and continuing professional development programs.

Thus, the concept of green university and digital transformation represent complementary strategies aimed at creating an environmentally responsible, social and innovative educational environment. Their implementation contributes not only to achieving the SDGs but also to strengthening the university's position as an active participant in the global green transition.

(4) Development of scientific research in the field of sustainable development

Scientific research plays an important role in implementing ESG principles in higher education, contributing to the creation and dissemination of new knowledge necessary for transitioning to sustainable development models. The research activities of universities contribute not only to scientific understanding of global environmental and social challenges but also to the development of practical solutions adapted to national and regional contexts. In the context of the actualisation of the climate agenda and the growing social responsibility of higher education institutions, the development of research in sustainable development is becoming an integral part of universities' strategies to contribute to the implementation of the UN SDGs and national priorities.

(5) Interactions with external stakeholders.

Effective implementation of ESG principles involves the active involvement of external stakeholders in higher education institutions' activities. The development of partnerships with employers, local communities, authorities, international organisations, and associations will ensure the exchange of experience and joint implementation of initiatives in the field of sustainable development. Regular interaction with stakeholders enables the determination of labour market requirements, the improvement of educational programs, and increased transparency and accountability of universities to society.

In the context of globalisation and the green transition, international cooperation is becoming an integral part of universities' strategies for sustainable development, acting as an important factor in improving the quality of education and human capital capacity management. Active cooperation with international partners allows universities not only to share experiences but also to integrate the best global management and learning practices focused on sustainability and ESG principles.

One of the key areas of international partnership is the development and implementation of online educational programs in cooperation with leading foreign universities and international organisations that are already actively using green standards and technologies. Such programs can be aimed at training specialists with a comprehensive understanding of sustainable development, capable of solving environmental and social problems at the international level. Joint educational projects, student and faculty academic mobility, and participation in international environmental initiatives contribute to developing a global perspective on sustainability issues and enhancing participants' intercultural and professional competencies.

An equally important aspect is the attraction of international experience in human capital capacity management and the exchange of best practices in sustainable management. Cooperation with leading foreign universities and international organisations enables us to adopt successful approaches to integrating ESG principles into recruitment, evaluation, motivation, and employee professional development. Participation in international conferences, seminars, and internships provides an opportunity to study and adapt the experience of foreign colleagues and introduce the most effective methods and technologies, thereby significantly increasing the effectiveness of human capital capacity management in conditions of sustainable development.

Thus, the prospects for transforming human capital capacity management in higher education in the context of the green transition encompass a comprehensive restructuring of university activities. These prospects include reorienting educational programs towards sustainable development, developing green competencies among teachers and staff, strengthening the institutional culture of sustainability, improving personnel management based on ESG principles, digital transformation of educational and administrative processes, and active international partnerships and the exchange of experience.

Further, Table 17 presents the key factors of the green transition, examples of their adaptive implementation in the higher education system, and the goals of such transformations.

Table 17 - Key factors and directions of adaptation of human capital capacity management of universities to the conditions of green transition

Green transition factor	Required adaptation	Expected outcome
Development of green competencies among faculty and staff	Strengthening sustainability-related knowledge and competencies	Improved environmental awareness and professional readiness of academic staff
Green HRM practices	Alignment of human resource policies with sustainability objectives	Greater consistency between personnel development and institutional priorities
Integration of ESG into educational programmes	Updating curricula and learning outcomes	Graduates equipped with sustainability-related competencies
Development of students' green skills	Expanding practice-oriented and interdisciplinary learning	Improved readiness for employment in the green economy
Green organisational culture	Promoting environmentally responsible behaviour within universities	Stronger institutional culture of sustainability
Energy efficiency and renewable energy	Increasing resource efficiency in campus operations	Reduced environmental impact of university activities
Green innovation and digital technologies	Adoption of innovative and digital solutions supporting sustainability	Higher institutional adaptability and innovation capacity
Social engagement	Expanding cooperation with local communities and stakeholders	Stronger civic engagement and social responsibility
ESG communication	Increasing awareness of sustainability initiatives	Greater stakeholder participation and institutional visibility
ESG-oriented performance assessment	Incorporating sustainability indicators into institutional evaluation	Better monitoring of sustainability performance
Digital transformation	Expanding digital infrastructure and digital competencies	More efficient educational and administrative processes
Note - compiled by the author		

Thus, the identified areas of adaptation reflect the key conditions for transforming human capital capacity management in Kazakhstan's higher education system in the context of the transition to a sustainable development model. Their implementation will allow universities not only to integrate ESG principles into educational, scientific, and human resources activities, but also to improve the quality of training for specialists capable of effectively solving modern environmental, technological, social, and economic problems. This is of strategic importance for Kazakhstan, as it contributes to the development of human capital in demand in priority sectors of the economy, increases universities' research potential, and strengthens their contribution to achieving national SDGs.

The comprehensive implementation of these areas will lay the foundation for modernising the university's personnel policy, developing the research competencies of the teaching staff, expanding international academic cooperation, and increasing the competitiveness of Kazakhstani universities in the global educational space. At the same time, this will help reduce regional disparities in the development of academic potential, strengthen university cooperation with government and business, as well as train highly qualified human capital who can ensure the country's innovative development, accelerate the technological modernisation of the economy and support the implementation of Kazakhstan's long-term priorities in the field of sustainable development and achieving carbon neutrality.

The analysis showed that the transformation of human capital capacity management in Kazakhstan's higher education system is a necessary condition for increasing universities' competitiveness in the context of the technological modernisation of the economy, digital transformation, and the transition to sustainable development principles. It has been established that effective adaptation of universities requires comprehensive changes covering educational, scientific, personnel, organisational, and managerial activities. At the same time, the development of human capital should be considered not only as a professional development of the teaching staff, but also as the formation of new professional, research, digital and ESG competencies that meet the modern requirements of the labour market and the state policy of Kazakhstan.

It is shown that the existing system of quality assurance in higher education has the necessary institutional potential to integrate ESG principles, but requires expanding evaluation criteria to include indicators of human capital development, research effectiveness, digital maturity, and university sustainability. The PEST analysis identified key external factors influencing the development of human capital, and the scenario analysis demonstrated that achieving long-term goals is possible only through a progressive scenario that integrates ESG principles into university management processes.

At the same time, the main barriers to transformation were identified, including institutional resistance to change, limited financial and human resources, insufficient motivation among the teaching staff, and weak intersectoral cooperation. Overcoming these limitations requires a transition from fragmented initiatives to a comprehensive human capital management model that integrates to develop human

capital, advance digital transformation, foster international cooperation, improve educational programs, and advance activities.

The practical significance of the results obtained for Kazakhstan lies in the formation of scientifically sound directions for the modernisation of the human capital management system of universities, aimed at improving the quality of training specialists, strengthening research potential, reducing regional disparities and expanding the integration of Kazakhstani universities into the international educational and scientific space. The implementation of the proposed directions will contribute to training personnel for priority sectors of the economy, developing the country's innovation potential, and achieving strategic national goals in sustainable development and carbon neutrality.

The results provide a theoretical and methodological basis for developing a comprehensive model for managing universities' human capital potential in Kazakhstan, which is presented in the next section of the dissertation research.

3 Mechanisms for managing human capital capacity management in the higher education system in the context of the green transition

3.1 An integrated approach to human capital capacity management in higher education

The modern higher education system faces the need for constant updating and adaptation to the new challenges of the globalised world, digital transformation, and the green transition, which is becoming a key context for social, economic, and institutional transformation. In the context of increasing international competition and the growing demand for high-quality human capital training, the key direction of state educational policy is not only the modernisation of the system as a whole but also the development of effective management mechanisms and governance models. In addition, traditional management models of higher education institutions are proving insufficiently flexible to respond to the challenges posed by the decarbonisation of the economy, digitalisation, and the transformation of the labour market. In this regard, there is growing interest in concepts that promote a systematic, step-by-step reform of the educational environment through the integration of HR systems, decision-making mechanisms, ESG approaches and sustainable governance. One of these conceptual frameworks is a three-stage modernisation model, which involves the sequential progression through stages of institutionalisation, practice transformation, and sustainable development, each of which should be linked to the tasks of training, using, and reproducing human capital.

The integrated model enables not only to ensure the strategic orientation of reforms but also to establish sustainable management mechanisms focused on the long-term development of universities' human capital. The application of the integrated approach contributes to the development of students' and teachers' competencies, strengthens academic autonomy, improves HR systems, and improves the quality of decision-making, which improves the quality of the educational process, stimulates research activity, and creates conditions for expanding universities' contributions to the country's social and economic development by fostering competitive human capital. Thus, the main purpose of this study is to identify and analyse the mechanisms of modernisation of the higher education system through an integrated approach to managing human capital, as well as to define the conditions for the effective implementation of governance models and HR systems in the context of the green transition.

At the same time, Kazakhstan's higher education system faces several problems that directly affect the quality of human capital formation and reproduction. Firstly, insufficient funding limits the development of human resources and the universities' research capacity. Secondly, the limited effectiveness of institutional reforms that fail to establish a clear link between structural changes and human capital development. Thirdly, there remains an imbalance in the structure of human capital training, including a reduction in specialist training in environmental areas. Fourth, the lack of systematic integration of green competencies into educational programs

is evident in their fragmented inclusion across separate disciplines and modules, without the development of end-to-end competence models, clearly defined learning outcomes, and assessment mechanisms, thereby reducing the contribution of educational programs to the development of green human capital.

Next, let's take a closer look at each of the above problems.

(1) Insufficient funding

Despite a gradual increase in government spending on higher education in absolute terms, its relative share of GDP is decreasing. So, if in 2006 this share was 0,76%, then by 2019, it had dropped to 0,60%. Such a decrease indicates that financing growth does not keep pace with the country's overall economic development and that insufficient priority is given to higher education in the state budget policy. In the context of growing demands for the quality of educational services, digital transformation, and the need to train personnel for a new green economy, the current level of funding is becoming a limiting factor in the system's development.

In addition, it should be noted that the low level of investment in higher education institutions affects their competitiveness at the international level; namely, it is difficult for them to attract highly qualified teachers, improve their material and technical equipment, and participate in international research projects. For this reason, talented students and scientists emigrate abroad. Weak financing also hinders the implementation of innovative programs, the development of science and the commercialisation of research, which is critically important in the context of the transition to a knowledge economy. Thus, chronic underfunding not only slows the development of the educational system but also undermines the country's long-term social and economic growth goals.

Insufficient investment in higher education directly impacts universities' human resource capacity. Limited financial resources reduce their ability to attract and retain highly qualified teachers, upgrade their material and technical base, and integrate into the international academic space. All this leads to an increased outflow of talented students and young researchers abroad, forming the problem of "brain drain". Moreover, weak financing hinders the introduction of innovative educational programs, the development of research activities and the commercialisation of scientific results, processes that are crucial for the accumulation and reproduction of human capital in the context of the transition to a knowledge economy. Insufficient funding limits universities' ability to build long-term HR systems focused on the development, retention, and reproduction of academic human capital. As a result, management mechanisms at universities are becoming increasingly short-term and administrative, while investments in developing research, digital, and green competencies remain limited. Thus, chronic underfunding not only slows the development of the educational system but also limits long-term opportunities to build competitive human capital, undermining the country's strategic goals for social and economic growth.

(2) Limited impact of institutional reforms

Over the last two decades, considerable institutional reforms have been undertaken in the Kazakhstani higher education system, such as the optimisation of

the university structure and participation in international educational initiatives. However, despite the formal renewal of institutional mechanisms, the reforms remain ineffective at developing universities' human capital, particularly in academic, research, and managerial capacities.

One of the main factors contributing to the limited effectiveness of reforms is the fragmented nature of institutional changes, in which new mechanisms and tools are introduced without a stable link with the reproduction and qualitative development of human capital. Thus, the formal participation of universities in international rankings and accreditation procedures is not accompanied by a deep integration of teachers and researchers into the global academic community, does not lead to a steady increase in research and teaching competencies, and often comes down to meeting formal requirements [280,281].

A significant limitation remains the discrepancy between the declared institutional autonomy and universities' actual capacity to develop their own human capital. Despite the legal consolidation of autonomy, universities continue to operate under conditions of high regulatory and financial dependence on centralised solutions, which limit their ability to develop flexible personnel strategies, invest in the professional development of teachers and researchers, and build sustainable academic career paths. As a result, universities face limitations in forming effective personnel policies, implementing adaptive incentive mechanisms, and making long-term decisions on human capital development.

An additional factor is that institutional reforms are implemented within the framework of a vertically oriented management model, in which the academic community is, to a limited extent, involved in the processes of development, adaptation, and monitoring of changes. Such a governance model reduces the flexibility of institutional management mechanisms and limits the academic community's participation in shaping green transition strategies. This undermines the credibility of reforms in the minds of faculty members and researchers and undermines their effectiveness as key carriers and agents of human capital development, thus emphasising that reforms are externally imposed management decisions [282].

An important systemic limitation is that the reforms are not accompanied by the creation of comprehensive conditions for developing human capital, including increasing managerial and pedagogical capacity, developing scientific and digital infrastructure, and improving financing mechanisms. In the absence of these supporting factors, even institutionally progressive reforms lose their transformative potential and fail to lead to sustainable improvements in the quality of education and research.

In addition, the emphasis in the reform assessment system continues to shift towards quantitative indicators, such as the number of publications, the proportion of teacing staff with academic degrees, or the coverage of academic mobility programs. At the same time, such qualitative parameters of human capital development as the sustainability of research teams, the effectiveness of doctoral training, the attractiveness of academic careers, and the reproduction of scientific

schools remain poorly measurable and, as a result, are not sufficiently taken into account in management decisions [280].

Finally, institutional reforms do not eliminate but, in some cases, increase regional disparities in the development of human capital at universities. Universities operating in resource-scarce regions face far fewer opportunities to attract, retain, and develop qualified staff, thereby creating greater stratification and reducing the system's overall human capital.

Taken together, the above points point to the need to reorient institutional reforms from formal changes in management and regulatory mechanisms to the systemic development of universities' human capital, which is considered a key factor in improving the quality of higher education, academic sustainability, and long-term innovative development.

(3) An imbalance in the structure of human capital training and a reduction in the training of specialists in environmental areas

In 2015-2024, Kazakhstan has seen a transformation of educational priorities. The stabilisation of student numbers after a period of decline was accompanied by a change in the structure of demand for educational directions. There is also increasing interest in the fields of IT, medicine, and pedagogy, whereas engineering and economics are becoming less popular. One of the most alarming trends is the declining number of specialists in ecology, which may lead to a critical shortage of human capital to implement the green transition strategy. Such a disparity in the structure of specialist training threatens the formation of sustainable human capital capacity in key industries for the future.

One of the reasons for this disparity is the lack of connection between the higher education system and long-term forecasts of labour market needs. The lack of flexible instruments to align educational programs with national industrial and environmental goals creates a structural mismatch between university graduates and national economic needs. Besides, career guidance services in schools and colleges are underdeveloped, hindering applicants from making informed choices about their careers. The situation is aggravated by the uneven distribution of grants and educational subsidies, which means applicants' choices are determined less by strategic development challenges than by short-term benefits or the level of information accessibility. The results obtained indicate a weak integration of strategic planning mechanisms and management tools into the processes of adapting educational policy to the priorities of sustainable and green development. As a result, HR systems of higher education do not ensure the timely formation of green human capital for a low-carbon economy. As a result, there is a shortage of human capital in industries critical to sustainable development, such as renewable energy, natural resource management, and environmental engineering.

(4) Insufficient systematic integration of green competencies into educational programs

The transition to a low-carbon, sustainable economy requires a review of the content and focus of educational programs. However, existing university curricula and modules do not fully address the training needs of specialists with competencies in renewable energy sources, resource conservation, and the sustainable

management of natural resources. Lagging behind can lead to a mismatch between graduates and the requirements of the green labour market. As a result, higher education risks losing its role as a factor of sustainable development and modernisation of the economy.

In addition, interdisciplinary approaches are underdeveloped, a necessary foundation for systemic thinking, which is especially important for solving environmental and social challenges. Most programs remain focused on traditional disciplinary frameworks and do not include the key elements of education for sustainable development recommended by international organisations [283,284]. The lack of emphasis on ESG principles (environmental, social, and corporate responsibility) and green skills limits graduates' ability to adapt to new sectors of the economy, and the introduction of greenness into educational programs is poorly represented, which limits graduates' opportunities to work in new sectors of the green economy [285]. The existing curriculum governance mechanisms do not systematically integrate green competencies into educational trajectories. To overcome this challenge, it is necessary to systematically transform educational trajectories in collaboration with employers, environmental experts, and international partners.

Thus, the identified limitations indicate that the existing management mechanisms and governance models in Kazakhstan's higher education system are insufficiently adapted to the challenges of digital and green transformation. The need to transform existing approaches to human capital management arises from the introduction of an integrated model grounded in the principles of strategic HR management, ESG transformation, and multilevel management.

Managing the development of human capital in the higher education system is a strategic task aimed at creating a sustainable, inclusive and competitive educational environment. In the context of digitalisation, the accelerated transformation of the labour market, and global challenges of sustainable development, there is a need to build a model that ensures not only the accumulation of knowledge but also the development of the ability to apply it in scientific, technological, and entrepreneurial fields.

The integrated approach to managing human capital development in the higher education system is a multi-level governance model that combines strategic, institutional, operational and external management mechanisms into a single decision-making system. Unlike traditional administrative regulation, the integrated approach focuses on developing HR systems that ensure the formation, reproduction, and retention of academic human capital in the context of digital transformation, the ESG agenda, and the green transition. The main goal of the approach is to create a sustainable human capital management system that ensures universities' adaptability to technological, environmental, and institutional changes.

Thus, Table 18 shows the difference between traditional and integral approaches in key parameters.

Table 18 - Comparison of traditional and integral approaches to human capital capacity management

Feature	Traditional approach	Integrated approach
Focus	Administrative regulation and control over formal indicators	Management of human capital development as a strategic resource
Instruments	Accreditation, norm-based funding, quantitative metrics	ESG principles, digitalization, individualized learning trajectories, multilevel governance
Role of the university	Executor of state policy	Active participant integrating education, research, and innovation
Interaction	Vertical (state – universities)	Horizontal and network-based (universities – industry – international partners)
Outcome	Formal compliance with standards	Competitive and sustainable human capital
Note - compiled by the author		

Table systematises the key differences between traditional and integral approaches to managing human capital development in higher education. In particular, traditional models rely primarily on administrative regulation, regulatory oversight, and quantitative metrics, thereby limiting universities' flexibility and reducing their ability to develop strategically. At the same time, the integrated approach is based on the systemic interaction of all participants in the educational ecosystem (i.e. key participants in the process), the inclusion of ESG principles, digitalisation, and internationalisation, which allows us to consider human capital as a strategic resource and form sustainable mechanisms for its reproduction. As a result, the integrated approach ensures the transition from fragmented, quantity-oriented reforms to qualitative modernisation, where the focus is not on the management structure as such, but on the development of human capital as a key factor in social and economic progress.

If the table reflects conceptual differences, then Figure 19 shows exactly how the integrated approach is implemented in practice through successive stages of modernisation and the participation of key participants in the process.

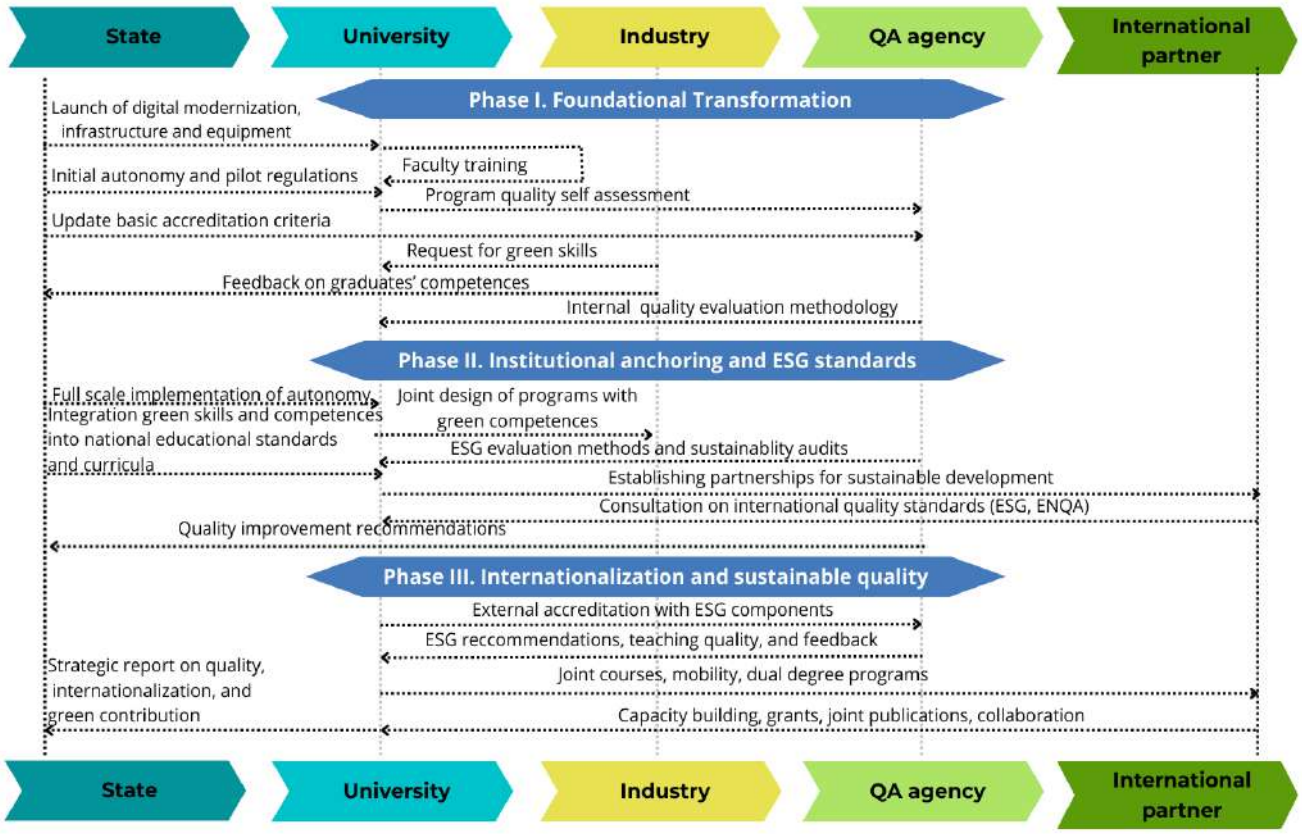

Figure 19 - The integral model of human capital capacity management in the higher education system for green transition

Note - compiled by the author

The presented scheme illustrates an integrated model for modernising the higher education system in Kazakhstan, in which universities' human capital is the central object and outcome of institutional transformations. The model's logic reflects a step-by-step mechanism of reforms aimed at the formation, development, and reproduction of academic, research, and managerial human capital in the context of digitalisation, the introduction of green skills, ESG, and internationalisation. The major actors in this change process are the government, universities, employers, quality assurance bodies, and international partners, and their interaction is said to shape the quality and sustainability of human capital accumulation at various stages.

The basic transformation stage is focused on creating institutional and infrastructural conditions for the development of human capital at universities. The government is initiating digital modernisation and investments in educational and research infrastructure, laying the foundation for increased productivity in teaching and research. During this period, universities are focusing on developing internal quality assurance mechanisms and improving their teaching staff's skills in digital, green, and inclusive competencies. Employers are involved in formulating requests for relevant skills from graduates, thereby enabling the correlation of the content of educational programs with the requirements of the labour market and increasing the applied value of the generated human capital. In this context, universities act as institutional actors adapting their personnel and educational practices to changes in

the regulatory and economic environment, which correlates with the logic of institutional change [286].

The second stage is characterised by the transition to systematic management of human capital capacity. The expansion of academic and administrative autonomy enables universities to develop long-term staff development strategies, integrate green and ESG competencies into educational standards and curricula, and strengthen the linkages among learning, research, and management. QA agencies play an important role in fostering a culture of responsibility and accountability by implementing ESG-based assessment methodologies that capture not only formal indicators but also the quality of human capital development. International cooperation promotes knowledge transfer, the development of managerial and academic competencies, and universities' institutional capacity to sustainably reproduce human resources. Theoretically, this stage correlates with the concept of capacity building, in which human capital is considered a key resource for sustainability and quality [287].

The third stage refers to the phase of institutionalisation of human capital, where it is integrated into the global academic space. This is done through external accreditation procedures, in which ESG elements are integrated into the evaluation of the quality of education, research, and management potential at universities. This enhances the expansion of human capital development for employees and students by advancing double-degree programs, academic mobility, and educational and research partnerships. This has been made easier by external partners' contributions to human capital development, including grants, publications, and research partnerships. This has made universities answerable to the global academic space, not only to their countries, as evidenced by the strategic reports prepared, which include contributions to human capital, the quality of education, scientific productivity, and the achievement of sustainable development objectives.

The proposed model differs fundamentally from the traditional higher education system by focusing not only on the organisation of the educational process but also on the strategic management of human capital at universities. In the previous model, the main focus was on administrative control, quantitative indicators of the contingent, compliance with standards and centralised allocation of resources. Human capital was considered primarily as the system's human resources, whereas in the new model, it becomes a key factor in innovative, digital, and sustainable development. The university is interpreted as a multifunctional ecosystem that unites education, science, innovation and interaction with society. The novelty of the model also lies in integrating ESG principles, green competencies, and digital skills into HR policy, educational programs, KPIs, and quality assessment mechanisms. Compared to the previous approach, which was mainly focused on training specialists, the new model emphasises continuous competency development, international mobility, research potential, and institutions' ability to adapt to environmental and technological changes.

An additional difference of the model is the transition from linear, centralised management to a multi-level system of interaction among the state, universities, employers, QA agencies, and international partners. Previously, employers and

international networks played a limited role, but now they are becoming full-fledged participants in the development of competencies, quality assessment, and research on human capital. Additionally, the new model introduces mechanisms for measurability and strategic accountability: in addition to quantitative educational indicators, publication activity, the development of digital and green competencies, international integration, participation in ESG projects, and the capacity for innovation are all used to evaluate the efficacy of universities. In addition, the model is based on a step-by-step logic of transformation, from basic modernisation of infrastructure and human resources to systemic management of human capital and its integration into the global academic space. This allows us to consider the modernisation of Kazakhstan's higher education as a long-term strategy for the formation of a sustainable, competitive and adaptive university system.

Thus, the presented model demonstrates the transition from institutional and technological reforms to a human-centred trajectory of higher education modernisation, in which the development of universities' human capital is considered a key condition for the sustainability, competitiveness, and international integration of Kazakhstan's higher education system. To develop the described integral model and facilitate its practical use, Table 19 presents recommendations based on this model, focusing on the development of human capital in universities within the higher education system.

Table 19 - Recommendations for the modernisation of higher education based on an integrated approach

Level	Identified Problems	Recommendations	Expected effect
1	2	3	4
Strategic level (state policy and regulatory environment)	1. Insufficient funding; 2. Limited university autonomy; 3. Low effectiveness of reforms	- Introduction of performance-based and funding per capita; - Expansion of institutional autonomy; - Integration of ESG and SDGs into strategic policy documents	- Financial sustainability of universities; - Stimulation of innovation and institutional flexibility; - Sustainable and results-oriented regulation; - Alignment of education policy with national priorities
Institutional level (university governance and human capital capacity management policy)	1. Weak internal quality assurance mechanisms; 2. Insufficient human and research capacity; 3. Gap between academic and applied content	- Development of strategic governance and HR strategies; - Implementation of internal quality assurance systems and ESG monitoring; - Modernization of curricula to include green, digital, and soft skills; - Integration of dual and project-based learning;	- Effective management of human resources; - Improvement of academic reputation; - Updating of educational content; - Attraction and retention of qualified specialists; - Digitalization and improved accessibility

Continuation of Table 19

1	2	3	4
		- Investment in digital and research infrastructure	
Operational level (faculty, students, researchers)	1. Lack of digital and sustainability competencies; 2. Limited opportunities for professional development; 3. Low student motivation and engagement	- Professional development programs for faculty (ESG, EdTech); - Individual learning trajectories and academic mobility for students; - Development of research and project-based activities; - Support for startups, research clubs, and mentorship programs	- Growth of personal and professional capacity; - Increased motivation and engagement; - Development of sustainable and flexible skills; - Preparation of graduates for the digital and green economy
External environment (industry, research, international partners)	1. Weak linkage between universities and the labor market; 2. Limited participation in international projects; 3. Weak integration of science, education, and business	- Development of the "university–industry–science" model; - Joint educational programs and R&D projects; - Participation in international rankings and networks; - Partnerships within transnational consortia (ESG, SDG, Horizon); - Collaboration with business and regional stakeholders	- Increased relevance of education to labor market needs; - Development of applied research and innovation; - Global competitiveness; - Increased trust in university degrees; - Stronger connection between education, economy, and sustainability
Note - compiled by the author			

The presented recommendations focus on the phased development of universities' human capital and reflect the integral nature of the modernisation of the higher education system. Their logic is structured to link changes in public policy, institutional management, and the educational process with the formation, development, and reproduction of academic, research, and managerial human capital.

From a strategic perspective, the focus is on establishing conditions that enable the accumulation of human capital, including sufficient financial support, university autonomy, and the incorporation of ESG principles into educational policy. The development of these measures helps create an institutional environment in which human capital is not an auxiliary resource but a key factor in the sustainability and competitiveness of the higher education system.

The institutional level focuses on human capital capacity management within universities. The recommendations are aimed at developing strategic and personnel management, strengthening research capacity, updating the content of educational programs and implementing internal quality systems. Human capital is the

foundation of universities' academic reputation and their ability to attract and retain qualified faculty and researchers.

At the operational level, there is a focus on human capital development, including teacher professional development, the development of sustainable and digital competencies among students, and the expansion of academic mobility and research opportunities. Implementing these measures increases professional capacity and enhances the motivation and involvement of key participants in the educational process.

Interaction with the external environment is considered an additional channel for developing human capital through partnerships with industry, science, and international organisations. Such connections strengthen the applied focus of human capital training, promote knowledge transfer, and enhance universities' global competitiveness.

In general, the recommendations demonstrate a holistic approach to the modernisation of higher education, in which the development of universities' human capital is a central mechanism for improving the quality of education, the innovation potential, and the sustainability of Kazakhstan's higher education system. Further development of the formulated recommendations implies their refinement, taking into account the temporal logic of transformations, which makes it possible to correlate the development of human capital of universities with the stages of long-term transformation of the higher education system. Among the key measures aimed at modernising higher education, the following areas should be highlighted, broken down into three periods: 2026-2030, 2030-2035, and 2036-2040. (Table 20).

Table 20 - Policy on modernisation of the higher education system based on an integrated approach

No.	Implementation period	Policy on modernisation of the higher education	KPI / Indicators	Responsible Actors
1	2	3	4	5
1	2026–2029 (short-term)	*Direction 1. Financial and managerial sustainability* – Increasing transparency of the mechanisms of allocation of funds within the framework of per capita financing; – Implementation of quality indicators in the effective financing system; – Development of internal management institutions; – Implementation of professional development programs for university administrative staff; – Implementation of ESG reporting; – Support for student and faculty initiatives in the field of sustainable development *Objective:* to ensure financial stability and development of managerial	– The share of universities that have implemented ESG reporting (%); – The number of APS that have completed advanced training; – The share of funding allocated by KPIs (%); – Number of green projects and startups; – Transparency Index of university management	MSHE RK; universities; supervisory boards; professional development centers.

Continuation of Table 20

1	2	3	4	5
		competencies of universities' human capital		
		Direction 2. Digitalization of the educational process and administration – Development of LMS and digital infrastructure; – Improvement of digital literacy of teaching staff; – Digital upskilling/reskilling programs; – Development of dual and project-based learning Objective: to develop digital human capital and adapt teaching staff and students to the demands of the digital economy	– Percentage of teaching staff who completed digital training (%); – The level of digital literacy of teaching staff; – The number of online courses and blended programs; – The share of disciplines with project-based learning (%); – LMS usage level	MSHE RK; universities; IT departments; employers
		Direction 3. Quality improvement and international integration – Updating programs in accordance with the SDGs; – Development of academic mobility; – Harmonization of accreditation with international standards *Objective:* to develop internationally competitive academic human capital	– Number of international partnerships; – Share of teaching staff and students in academic mobility (%); – Number of programs with ESG/SDG component; – University positions in QS/THE; – Number of Scopus/WoS publications	MSHE RK; universities; accreditation agencies
		Direction 4. Updating the content and standards of education – Revision of educational programs; – Implementation of the competence approach; – Creation of a personnel demand forecasting system *Objective:* to develop competencies that meet the requirements of the labor market and the green economy	– Percentage of updated educational programs (%); – The level of employment of graduates; – The index of matching skills to the labor market; – The share of programs with green skills; – The level of satisfaction of employers	MSHE RK; universities; employers; industry associations
2	2030–2035 (medium-term)	*Direction 1. Large-scale digital transformation* – Implementing AI in administration and analytics; – integration with employer and internship platforms *Objective:* to form a data-driven human capital management system.	– The share of automated HR processes (%); – the number of AI-based services; – the level of employment through digital platforms; – the speed of academic data processing	MSHE RK; universities; IT companies; employers
		Direction 2. Formation of the green infrastructure of universities and integration of sustainable practices – Energy-efficient campuses; – Creation of green laboratories and research hubs; – Implementation of green operating standards	– Number of green campuses; – Reduction of energy and water consumption (%); – Number of green laboratories; – Proportion of students involved in sustainability projects;	MSHE RK; universities; MENR RK; business partners

Continuation of Table 20

1	2	*3*	4	5
		Objective: to develop green human capital and practical competencies for sustainable development	- Number of climate/green skills programs	
3	2036–2040 (long-term)	*Direction 1. Global positioning and sustainability* – Transition to ecosystem management of universities; – Strengthening the role of universities in the sustainable development of regions; – Integration into global academic networks *Objective:* to create a sustainable innovation ecosystem and globally competitive human capital	– Number of international research networks; – Share of foreign teachers and students (%); – Positions in global sustainability rankings; – The level of regional innovation contribution of universities; – Number of green patents/startups	MSHE RK; universities; international organizations; regional authorities
Note - compiled by the author				

Formulating policy directions for modernising the higher education system should be considered the initial stage in building an integrated, human-centred approach to its development in Kazakhstan. In this context, the key objective of the proposed measures is to create conditions for the formation, development, and sustainable reproduction of human capital at universities, as well as to increase the adaptability of faculty, management staff, and students to digital, environmental, and institutional transformations. Implementing these directions involves the participation of a wide range of actors, including government agencies, universities, employers, international organisations, and professional communities.

The successful implementation of the higher education modernisation policy requires the phased implementation of short-, medium- and long-term measures, each of which is focused on the development of human capital, strengthening the institutional stability of universities and the formation of a system of measurable results reflecting the quality of educational, research and management activities.

Measures to ensure financial and managerial sustainability

In conditions of limited funding and universities' high dependence on centralised solutions, strengthening institutional autonomy as a basic condition for effective human capital management is becoming a priority. The introduction of per capita and effective financing, along with quality indicators, into the resource allocation system creates incentives to increase research activity, improve teaching quality, and enhance the professional development of teaching staff. The development of internal management mechanisms — academic and supervisory boards, internal monitoring systems, and ESG reporting — to ensure increased transparency and manageability of universities is becoming essential. An additional area is implementing professional development programs for administrative staff to build managerial and analytical competencies. Metrics such as the percentage of faculty enrolled in professional development programs, the level of funding transparency, the adoption of ESG reporting, and increases in teaching staff and student involvement in sustainable development initiatives can be used to assess the success of these initiatives.

Measures to modernise the digital infrastructure

The development of basic digital infrastructure is a key factor in improving the quality and productivity of universities' human capital. The modern higher education system requires the introduction of LMS platforms, cloud services, and digital learning management tools that provide access to educational and research resources. The elimination of the digital divide between universities, especially in regional contexts, is seen as a condition for equalising professional development opportunities for teachers and students. Improving faculty digital literacy and implementing advanced training programs in digital technologies contribute to developing digital human capital and renewing pedagogical practices. In the medium term, digital transformation entails integrating universities with employers and internship platforms, as well as incorporating artificial intelligence and data-driven management into administrative and analytical procedures. The effectiveness of these measures can be assessed by the level of digital competencies among teaching staff, the proportion of disciplines that use digital technologies, the degree of implementation of AI tools, and indicators of student engagement in digital educational formats.

Measures to improve the quality of higher education and international integration

Improving the quality of higher education in the context of Kazakhstan's integration into the global educational space is directly related to the development of universities' human capital. Focusing on international quality standards, academic reputation, and sustainable development requires updating educational programs to align with the SDGs and to develop competencies in demand in the green and digital economy. The development of soft skills, critical thinking, digital and communication skills contributes to the formation of adaptive human capital capable of effectively responding to structural changes in the labour market. An important area is the internationalisation of higher education, including academic mobility, international cooperation and participation in global academic networks. The harmonisation of accreditation procedures with international standards and ESG approaches enhances the culture of quality and contributes to the international competitiveness of Kazakhstani universities. Indicators of academic mobility, the proportion of educational programs with an ESG component, institutions' standing in worldwide rankings, the degree of graduate employment, and the number of international research projects can all be used to gauge the effectiveness of these initiatives.

Measures to update the content and standards of education

The revision of educational programs, taking into account labour market requirements and the principles of the competence approach, aims to develop human capital that meets the needs of the modern economy. The introduction of flexible educational trajectories, the development of soft skills, and the creation of a demand-forecasting system for personnel make it possible to increase the practice orientation of specialist training and reduce the gap between the higher education system and the labour market. To ensure students are integrated into actual manufacturing and research processes, the development of project-based and dual education is crucial.

The percentages of programs with project-based learning, employer satisfaction levels, graduate employment rates, and the extent to which educational outcomes meet professional standards can all be used to assess the efficacy of policy initiatives.

Measures to create a green university infrastructure and integrate sustainable practices

The development of green university infrastructure and the introduction of sustainable practices are considered key areas of human capital development in the context of the green transition. Universities are becoming platforms for the formation of environmental knowledge, green skills, and values that provide training for the green economy. A culture of sustainable behaviour among students and staff is encouraged by incorporating sustainable development principles into campus infrastructure, including waste management, water and energy conservation systems, and energy-efficient buildings. The creation of green laboratories, research centres, and demonstration sites expands the possibilities of practice-oriented learning and interdisciplinary research. At the same time, the development of ESG reporting, environmental monitoring and green regulations strengthens institutional mechanisms for sustainability management. Indicators such as lower energy consumption, the number of green campuses, the number of publications and projects on sustainable development, faculty and student participation in green initiatives, and universities' participation in international sustainability ratings can be used to assess the efficacy of initiatives.

Thus, the set of measures presented forms a multi-level trajectory for modernising Kazakhstan's higher education system, in which human capital is considered a key resource for sustainable development, innovative transformation, and increased international competitiveness of universities. The implementation of these directions requires coordination among the state, universities, business, and society, as well as the establishment of a system of measurable indicators to assess the effectiveness of higher education modernisation policies in the context of the digital and green transition.

The analysis showed that the existing higher education management system in Kazakhstan faces systemic constraints that hinder the effective development of human capital at universities. The key ones are insufficient funding, limited effectiveness of institutional reforms, an imbalance in the structure of personnel training, and insufficient integration of environmental and ESG competencies into educational programs. These problems reduce the higher education system's ability to respond in a timely manner to the challenges of digital transformation, decarbonization of the economy, and the development of human resources for sustainable development.

The necessity of transitioning from the traditional administration-oriented management model to an integrated approach that considers human capital a strategic resource for the modernisation of higher education is substantiated. The proposed integrated model combines the mechanisms of strategic HR management, ESG transformation, digitalisation, internationalisation, and multilevel interaction of key stakeholders. Unlike existing practices, this model focuses not only on

regulating the educational process but also on the formation, development, retention, and reproduction of academic, research, and managerial human capital.

The developed three-stage modernisation model provides for a consistent transition from the creation of institutional and infrastructural conditions to the systematic management of human capital and its further integration into the global academic space. The implementation of this model contributes to strengthening the research potential of universities, developing digital and green competencies, improving the quality of education and expanding international cooperation.

The proposed recommendations and directions of modernisation policy for the period up to 2040 constitute an integrated system of measures covering financial stability, the development of digital infrastructure, the improvement of educational content, internationalisation, and the implementation of the principles of sustainable development. Their implementation will increase universities' adaptability to technological and environmental changes, provide training for the green economy, and create conditions for the sustainable reproduction of human capital.

Thus, an integrated approach to human capital development management serves as the conceptual basis for the modernisation of Kazakhstan's higher education system and ensures the transition to a university model focused on sustainable development, innovation, international competitiveness, and effective participation in implementing the national agenda for digital and green transition.

3.2 Institutional and motivational mechanisms for academic human capital management

In subsection 3.1, an integral approach to managing the development of human capital in the higher education system was presented, in which universities are considered as the main institutional platforms for the formation and reproduction of academic, research and managerial human capital. The integral model showed the interrelationships among strategic guidelines, the institutional environment, educational and scientific practices, and interactions with external stakeholders in the development of universities' human capital. At the same time, the practical implementation of the integrated model at the university level requires a transition from conceptual provisions to instrumental support. In this regard, this section moves from the concept to the mechanisms through which universities can improve the quality of human capital. The mechanisms ensure the practical implementation of an integrated approach, acting as a link between strategic priorities and institutional transformations, and translating them into sustainable changes in universities' personnel policy, research effectiveness, and educational activities. The need to consider mechanisms stems from the assessment of human capital capacity management in Kazakhstan's higher education system, presented in section 2.2, which revealed persistent structural and institutional constraints that hinder the improvement of the quality and reproduction of human capital in universities.

Firstly, there are still limitations on the academic and research competitiveness of teaching staff in the international academic space. Despite the growing number of Kazakhstani universities on the QS and THE ranking lists, it is evident that the

new requirements for publication activity and citation rates reveal systemic barriers, including low levels of English proficiency and limited faculty engagement in international research. As a result, the capacity of academic staff is being realised unevenly, and the internationalisation of universities' human capital is partially institutionalised.

Secondly, the high academic and administrative burden on teaching staff creates conditions that are not conducive to sustainable research productivity. The increasing demands for scientific publications and participation in scientific projects are creating time and resource constraints, limiting faculty's ability to systematically develop their research competencies, establish long-term publication strategies, and pursue competitive grants and collaborative scientific initiatives.

Thirdly, there are imbalances in the teaching staff structure, manifested in a quantitative increase in the proportion of employees with academic degrees, while risks associated with ensuring the sustainable and continuous development of universities' research potential remain. On the one hand, an increase in the share of teaching staff with an academic degree is a positive indicator of the quality of human capital. On the other hand, the number of teachers with academic degrees has decreased since 2014 and insufficient replenishment of the outflow through PhD programs poses threats to the sustainable development of scientific schools in universities.

Fourth, there are still pronounced regional disparities in the distribution of teaching staff with academic degrees. The concentration of qualified personnel in the largest academic centres is accompanied by shortages in a number of regions, which limits the research potential and quality of the academic environment of regional universities, reduces their participation in major research projects and international grants, and, as a result, affects the competitiveness of universities outside megacities.

Fifth, insufficient consistency in motivational mechanisms and significant heterogeneity in incentive practices across universities have been revealed. Despite the fact that proven performance indicators (KPIs) are closely related to the amount of financial rewards and can be considered as an effective tool for increasing the activity of teaching staff, significant differences remain between faculties at universities both in terms of performance and bonus practice, as well as a limited dependence of the amount of remuneration on the level of academic qualifications of employees. This situation increases the risk of motivation focusing on formally measurable activities and necessitates adjustments to incentive systems that account for the specifics of academic roles, including research, teaching, scientific leadership, and international cooperation.

Sixth, the scientific productivity of teaching staff shows a pronounced institutional dependence on career status and academic integration. The number of publications is most closely related to the position held, the presence of an academic degree and the level of English proficiency. In the absence of mechanisms focused on the targeted development of research and language competencies in the early stages of academic careers, universities face the risk of consolidating a hierarchical model of scientific productivity, in which increased publication activity is provided

primarily by employees in senior academic positions, rather than through the systematic formation and development of human capital.

The totality of the identified problems indicates that improving the quality of human capital at universities requires not only systemic reforms but also the introduction of coordinated university-level mechanisms focused on developing research and language competencies among teaching staff, optimising academic workload, levelling regional imbalances, and improving motivational tools.

Mechanisms to improve the quality of human capital are important given the identified limitations and deficits in the human capital capacity management system. Table 21 presents mechanisms for improving the quality of human capital in Kazakhstan's higher education system, grouped by the main areas of management impact and focused on developing academic, research, and management capacity among teaching staff.

Table 21 - Mechanisms for improving the quality of human capital in the higher education system in Kazakhstan

No.	Mechanism	Form of implementation in universities	Innovative element
1	2	3	4
1	HR policy	– Local regulatory documents (faculty regulations, position standards, evaluation procedures); – Selection and evaluation committees with participation of external experts; – Electronic individual faculty dossiers (teaching load, achievements, publications, feedback)	– Integration of digital portfolios with LMS and HR systems; – Analytics of career dynamics (data-informed promotion); – Competency frameworks and individual career tracks
2	Professional development and competency enhancement of faculty	– Centers for academic development and teaching excellence; – Certification programs (EdTech, Academic Writing, AI in Education, UDL); – Individual learning pathways and mandatory CPD approaches	– Modular and hybrid formats (blended learning, MOOC-oriented courses); – Learning analytics and digital competency passports; – Internal online academies and peer-to-peer learning
3	Internal research funding and research support	– Mini-grants and internal research competitions; – Seed funding for early-career researchers; – Support for APCs, translations, and interdisciplinary projects	– Electronic platforms for application submission and monitoring; – Internal research accelerators and mentorship programs; – Focus on knowledge transfer and regional development
4	Financial incentives and KPI mechanisms	– Multilevel evaluation system (research, teaching, project activity); – Differentiated incentives based on publication quality; – Consideration of individual and collective results	– Integration of KPIs with career and research objectives; – Automated calculation and visualization of KPIs; – Team-based KPIs and flexible bonuses considering project complexity
5	Mentorship and academic community development	– Mentorship programs for early-career faculty and researchers; – Interfaculty interest groups;	– Intergenerational communities of practice; – Mentorship programs with regular feedback;

Continuation of Table 21

1	2	3	4
		– Clubs for pedagogical and research innovation	– Internal research hubs and coworking spaces
6	Digital and infrastructure support	– Development of cloud services and institutional repositories; – Integration of learning management systems with educational data analytics tools; – Development of digital educational resources and virtual laboratories	– Use of data analytics to assess teaching and research performance; – Development of open-access platforms and academic peer-review mechanisms; – Support for hybrid and online learning formats
7	Internationalization of faculty human capital	– Assessment of English language proficiency; – English for Research / Teaching programs; – Support for joint publications and visiting scholar programs	– Digital language profiles for faculty; – AI-supported academic writing tools; – Automated matching with international partners
8	Academic workload management and faculty career tracks	– Differentiated workload models (teaching / research / hybrid tracks); – Teaching load reduction for grant-funded and publication projects; – Optimization of administrative reporting	– Workload analytics and algorithm-based workload distribution; – Integration of workload management with KPIs and career trajectories; – AI-driven automation of routine processes
9	Regional balancing and distributed development of human capital	– Inter-university distributed departments and research groups; – National academic mobility for faculty; – Joint educational and research programs	– Virtual research laboratories; – Regional career accelerators (fast-track promotion); – Geo-analytics of human capital distribution
	Note - compiled by the author		

HR policy

The personnel policy and the certification system for teaching staff play a key role in shaping and improving the quality of human capital in the higher education system. In the context of the transition of Kazakhstani universities to a research university model and the strengthening of academic competitiveness, personnel strategies are becoming particularly important, as they determine the criteria for hiring, promoting, and developing teachers and set institutional guidelines for academic productivity.

Modern challenges related to the regional imbalance in the distribution of qualified personnel, the ageing of academic staff, and increasing international requirements require universities to move from formalised procedures to more flexible, transparent and results-oriented human capital capacity management systems. As part of the implementation of the personnel policy, it is essential to develop and implement local regulations governing position requirements, procedures for competitive selection, and the certification of teaching staff. The functioning of attestation and competition commissions, including the participation of external experts, is aimed at improving the objectivity of assessments and

equalising quality standards for human capital within universities. These procedures lay the institutional foundations for transparent, predictable academic career paths.

Keeping electronic individual dossiers for teachers, collecting information on workload, scientific and pedagogical achievements, participation in projects, and feedback results, allows us to systematise information about the university's human capital. The use of such tools facilitates a transition from a fragmentary assessment of individual indicators to a comprehensive analysis of the professional profiles of teaching staff and their dynamics over time.

An essential element of improving the quality of human capital is the introduction of competency models that form common guidelines for the professional development of teachers at various stages of their academic careers. The competence-based approach enables alignment of teaching staff requirements with universities' institutional priorities and the use of certification results to plan individual professional growth and career advancement.

Thus, personnel policy and certification mechanisms serve not only as instruments of administrative control but also as the most important factors in institutional development. When properly configured, they can create a motivational environment focused on professional growth, quality teaching, and a sustainable academic career. This requires the systemic integration of digital solutions, the transition to competency-based models, and the institutionalisation of the principles of equity and academic recognition. The clarity of career requirements, the openness of assessment processes, and the connection between faculty members' professional growth and certification all influence the effectiveness of the personnel policy. This helps institutions manage their academic personnel more steadily and enhances the calibre of their research and instructional endeavours. This method enables the incorporation of environmental and ESG capabilities into academic requirements and teaching staff professional development in the context of the green transition.

Professional development and competency enhancement of faculty

Professional development of the teaching staff is one of the key mechanisms for the sustainable development of human capital in the higher education system. In the context of rapid digitalisation, the internationalisation of universities, and the increasing complexity of the educational environment, the teacher finds himself in a position requiring continuous professional growth and adaptation to new formats of study, academic communication, and scientific work.

In the conventional perspective, professional development was viewed as short courses, often formal. However, from a contemporary perspective, professional development is grounded in the philosophy of Continuous Professional Development (CPD), which is a step-by-step, purposeful, and self-directed development of knowledge, skills, and teaching strategies. CPD is integrated into universities' strategic and institutional frameworks and becomes an obligatory element of their personnel policy.

One of the most effective organisational formats in universities in Kazakhstan is the academic development centre (Teaching and Learning Centre), which offers certification and modular programmes in key areas such as higher education pedagogy, digital learning (EdTech), academic writing, inclusive education, and

project management. These programs are developed with the needs of teaching staff and institutional priorities in mind, and their completion is included in individual teacher development plans.

An innovative element is the introduction of hybrid and adaptive learning formats (blended learning, self-paced modules), which enable teachers to integrate work and learning and to choose an individual pace and trajectory for content development. Additionally, gamification elements (digital badges, ratings, challenges) are used to increase participants' engagement and visualise their progress.

Formats of internal horizontal learning, such as peer-to-peer support, mentor schools, academic hubs, and interdepartmental teaching practice laboratories, are being developed. These not only enhance cooperation between universities but also cultivate a culture of mutual learning and reflection.

Special attention is paid to international professional development opportunities, including participation in online programs offered by leading foreign universities (Coursera, edX, FutureLearn), online seminars, internships, and exchange programs. Some Kazakhstani universities are developing their own online academies that provide access to courses adapted to the local context and based on best international practices.

The introduction of digital teacher competence passports, integrated with the university's LMS and HR systems, is emerging as a promising area. Such solutions enable visualisation of the professional development paths of teaching staff, planning training based on competence deficits, and automatic generation of recommendations for further development.

Thus, professional development ceases to be a one-time administrative procedure and becomes a strategic mechanism embedded in the university's management model. It provides increased flexibility, professional sustainability, and innovative teaching activities for teaching staff, while contributing to universities' achievement of the goals of quality, accreditation, and international competitiveness. The effectiveness of professional development programs depends on their practical applicability, regularity and compliance with modern educational and technological changes. For universities, this ensures the development of flexible professional competencies and increases the faculty's ability to adapt to new learning and research formats. In the context of the green transition, the mechanism promotes training for teachers to integrate the principles of sustainable development into the educational process.

Internal research funding and research support

The development of sustainable research human capital in universities requires systematic, targeted support for the teaching staff's scientific activities. Internal scientific grants serve as an institutional mechanism for the accumulation and development of research competencies among teaching staff, as well as a tool for ensuring the reproduction of universities' scientific potential.

In the context of limited access to external grant resources, especially at regional universities, internal grant programs are becoming an important factor in equalising the quality of human capital and reducing territorial disparities. Such

tools allow universities to create conditions for realising teachers' research potential, launching pilot projects, and forming research areas that contribute to the long-term strengthening of the academic environment.

The practice of allocating mini-grants and seed financing plays an important role in building a pool of researchers. Encouraging young scientists would facilitate their involvement in scientific activities, prevent demotivation in their professional lives, and foster long-term scientific development. Mentoring and methodological assistance in scientific projects would help to develop scientific research skills and sustain scientific development.

Financing publication activities, including publication fees, scientific translation, and conference participation, contributes to the development of academic writing skills, international communication, and project interaction. The implementation of these measures enhances the individual research potential of the faculty and expands their participation in international scientific networks, thereby increasing the competitiveness of universities' human capital.

The development of inter-faculty and inter-university research consortia enhances the collective nature of human capital accumulation, forms interdisciplinary competencies and contributes to the strengthening of scientific schools. Projects focused on solving regionally significant tasks expand the social significance of research activities and strengthen the connection of university human capital with the social and economic development of territories. Moreover, the electronic support for project submission and management is transparent and helps reduce bureaucracy, creating more appropriate conditions for the concentration of teaching staff's capacity on research.

In this manner, the role of internal scientific grants is not only to provide financial support for research, but also to serve as a mechanism for developing research potential among university staff. Its effectiveness depends on the level of integration with personnel policy, the motivation system, and the strategic guidelines for university development, aimed at strengthening scientific potential. The growth of research activities, assistance for new scientists, and increasing participation of teaching personnel in research initiatives are all indicators of the success of internal grant funding. Universities can improve the research environment and, as a result, develop long-term scientific potential. Internal funds promote research on ESG practices, sustainable development, and environmental technology in the framework of the green transition.

Financial incentives and KPI mechanisms

Financial incentives in the higher education system are an important tool for managing human capital development at universities, as they provide economic incentives to increase the scientific and pedagogical activity of teaching staff. The award model based on key performance indicators (KPIs) has become widespread in Kazakhstani universities and covers parameters such as publication activity, participation in grants and research projects, management of students' scientific work, the introduction of innovative educational practices, and international cooperation.

This is because KPI mechanisms enable a link between individual teacher performance and the university's overall goals. This would ensure the manageability of human capital accumulation and development processes. Empirical data indicate a stable positive relationship between the performance levels of established indicators and the amount of financial rewards, confirming the stimulating effect of financial incentives on increasing research productivity and the professional involvement of teaching staff. At the same time, it is through KPIs that limitations in the existing incentive model's performance are noted. A difference in the effectiveness of bonus payments is observed among faculties and between qualification levels and teachers' remuneration.

Improving financial mechanisms involves transitioning to more differentiated assessment models that account for disciplinary specifics, the stage of an academic career, and the variety of teachers' professional roles. More attention to collective results, contributions to the construction of scientific schools, and interdisciplinary tasks is a step towards strengthening research potential and sustaining academic development.

Alignment of the KPI system with individual professional growth trajectories is a key to transforming financial incentives from an administrative control tool into a strategic human capital capacity management tool. In this case, bonus payments serve not only to encourage achieved results but also as an element of a long-term policy to foster sustainable academic careers and increase universities' competitiveness.

Thus, financial incentives based on KPIs represent an institutionally significant mechanism for developing human capital, the effectiveness of which depends on the transparency of evaluation criteria, the fairness of remuneration distribution, and their integration into the university's overall strategic management system. The effectiveness of the incentive system depends on the objectivity of the indicators and the consistency of the KPIs with the actual results of the teachers' activities. For universities, this allows them to strengthen the motivation of teaching staff and direct the development of human capital in line with their strategic priorities. In the context of the green transition, the inclusion of environmental and sustainability indicators in the KPI system supports the development of green educational and research initiatives.

Mentorship and academic community development

The development of human capital in universities includes creating a stable professional environment that supports knowledge transfer, professional development, and the strengthening of research and teaching competencies. In this regard, mentoring and academic communities are considered as institutional mechanisms in the accumulation and reproduction of academic capacity.

Mentoring helps young teachers adapt, develop their research and teaching skills, and reduce the risks of professional isolation. Regular interaction with more experienced colleagues allows you to develop your own career trajectory, strengthen your publication activity, and increase your involvement in research projects. Thus, mentoring serves to transfer professional experience and ensure the continuity of scientific and pedagogical practices.

The systematic organisation of mentoring programs, including mentor reinforcement, joint professional growth planning and regular feedback, contributes to the sustainable development of the university's talent pool. The mechanism is of the greatest practical importance in regional universities, where limited external academic contacts increase the need for internal support and the development of human capital.

Inter-faculty groups, scientific seminars, and internal research associations foster the collective exchange of knowledge and the development of interdisciplinary competencies. Forms of this type of interaction contribute to creating an environment of collective responsibility for the quality of educational and scientific activities.

The interaction of teachers from different generations ensures institutional continuity, the preservation of scientific traditions and the simultaneous introduction of innovative approaches. Discussion of professional cases, collaboration on publications and projects enhance the collective nature of human capital development. The use of digital interaction tools expands the possibilities for communication and collaboration, but their role is auxiliary to the main task of strengthening the academic environment and developing teachers' professional competencies.

Thus, mentoring and academic community function as tools for strengthening human capital in universities, ensuring its qualitative renewal, reducing staff turnover, and promoting a sustainable academic culture. The effectiveness of these mechanisms is determined by their institutional consolidation, resource support, and recognition of their contribution to colleagues' development as an important element of professional activity. The effectiveness of mentoring is determined by the level of professional interaction and the stability of academic ties within the university. For universities, this helps to strengthen the research culture, transfer experience and develop human resources. In the context of the green transition, academic communities are accelerating the dissemination of environmental knowledge and the development of interdisciplinary approaches to sustainable development.

Digital and infrastructural support

Higher education institutions require a stable digital and infrastructural environment that supports the development of professional competencies among teaching staff. The digitalisation of the educational process and the expansion of hybrid forms of education increase the need for technological security in universities, as the effectiveness of realising the academic and research potential of teaching staff directly depends on the quality of the infrastructure.

The integration of learning management systems with educational data analysis tools creates conditions for improving pedagogical practices, increasing teaching adaptability and developing teachers' digital competencies. The use of analytical tools allows teachers to make more informed decisions in organising the educational process, thereby improving the quality of educational activities.

The development of cloud infrastructure and secure digital resources ensures access to scientific materials, facilitates project collaboration, and enables effective communication within the university community. Such an environment reduces the

transaction costs of professional activity, expands the possibilities of research interaction and strengthens the institutional stability of human capital.

The creation of digital laboratories, studios, and resources for developing online courses contributes to the development of new pedagogical competencies and to the expansion of teachers' academic mobility. Support for the development of online programs enhances the competitiveness of university human capital in the context of internationalisation of education.

The use of automation and data mining tools enables the optimisation of routine processes, reducing the administrative burden on teachers and freeing up resources for scientific and methodological work. Such solutions increase labour productivity and contribute to more effective use of the professional capacity of teaching staff.

The development of open educational resources and mechanisms for academic interaction expands teachers' involvement in professional networks and promotes the dissemination of best practices, thereby strengthening the collective nature of human capital accumulation. Digital and infrastructural support is an institutional condition for the sustainable development of universities' human capital. The effectiveness of the mechanism is determined by its integration into the university's development strategy, systematic investment in infrastructure, and improvements in teaching staff's digital literacy. The extent to which digital support is incorporated into the university's teaching and research procedures determines its effectiveness. This guarantees higher teacher productivity, the growth of digital skills, and less administrative work for universities. Digital solutions help create sustainable university management models and better utilise resources in the context of the green transition.

Internationalisation of faculty human capital

Internationalisation is a mechanism for the qualitative development of universities' human capital by expanding the academic, research, and language competencies of the teaching staff. The involvement of teaching staff in the international scientific community enhances research culture, builds skills in multinational teams, and improves publication effectiveness.

An audit of English language proficiency enables the assessment of academic staff's linguistic potential and the identification of areas for professional growth. The implementation of the English for research and English for teaching programs aims to develop academic writing skills, prepare grant applications, and teach in a foreign language, thereby directly enhancing universities' competitiveness in human capital.

The support of joint publications and academic mobility programs contributes to the accumulation of international research experience, the expansion of scientific networks and the formation of stable professional relationships. The formation of digital language profiles of teachers and the use of intellectual support for academic writing improve the quality of scientific texts and reduce barriers to inclusion in the global academic community. Thus, the development of this mechanism strengthens the international integration of universities' human capital, increases its mobility and contributes to the formation of sustainable research potential. The effectiveness of internationalisation is evident in the expansion of international cooperation, increased publication activity, and the development of academic mobility among

teachers. For universities, this enhances integration into the global educational and research space. In the context of the green transition, international academic relations facilitate the transfer of best practices for sustainable development and green innovation.

Academic workload management and faculty career tracks

The rational distribution of academic workload is a prerequisite for sustainable human capital development at a university. The workload in teaching and administration impedes opportunities for scientific activity and the development of teaching staff, which, in turn, lowers the efficiency of reproducing research potential.

The introduction of differentiated role trajectories (mainly pedagogical, research, or combined) allows you to take into account individual professional priorities and to develop sustainable career strategies. Exemption from part of the academic load during the implementation of grants and publication projects creates institutional conditions for concentrating on research.

The use of analytical load-balancing tools ensures a balance between the teacher's educational and scientific functions, and integrating the load with the results assessment system enables the alignment of individual development with the university's goals. Automation of routine processes reduces the time costs of academic work and frees up resources for intellectual activity. Workload management in this format helps to reduce professional burnout, increase research productivity, and form sustainable career paths within the university system. The effectiveness of workload management is determined by the ability to balance teaching, research and organisational activities of teaching staff. For universities, this creates conditions for sustainable professional development and improving the scientific effectiveness of teachers. In the context of the green transition, flexible role models enable more active involvement of teaching staff in ESG-oriented projects and interdisciplinary research.

Regional balancing and distributed development of human capital

The uneven distribution of qualified personnel between regions limits the overall potential of the higher education system. The concentration of teaching staff with academic degrees in large academic centres is accompanied by a weakening of the research environment at many regional universities, which affects the quality of training and scientific activity.

The mechanisms of distributed development are designed to enhance universities' human capital outside megacities by creating network-type research centres, interuniversity departments, and joint educational programs. Academic mobility at the national level helps to transfer knowledge and experience.

The creation of virtual research laboratories expands access to scientific infrastructure regardless of geographical location, and analytical monitoring tools for personnel allocation enable us to make informed decisions in personnel policy. The implementation of this mechanism ensures a more even development of academic and research potential, strengthens the sustainability of the university system and forms a balanced model of human capital reproduction at the national level. The effectiveness of regional development mechanisms is manifested in

reducing staff disparities and expanding the capabilities of regional universities. For the higher education system, this contributes to a more even distribution of academic and research potential across the country. In the context of the green transition, developing human capital capacity in regions ensures the training of specialists to support the sustainable development of territories and the implementation of environmental initiatives at the local level.

Sustainable and systematic improvement in the quality of teaching staff in universities requires coordination among the academic community, administrative structures, and external partners. Changes in academic work requirements, increased international competition, and the digitalisation of the educational environment require a phased, institutionalised implementation of human capital development mechanisms. In this regard, it seems necessary to formalise an algorithm for distributing functions and responsibilities among the participants in the process. Figure 20 demonstrates the multilevel logic of interactions at the stages of design, testing and institutionalisation of human capital development mechanisms.

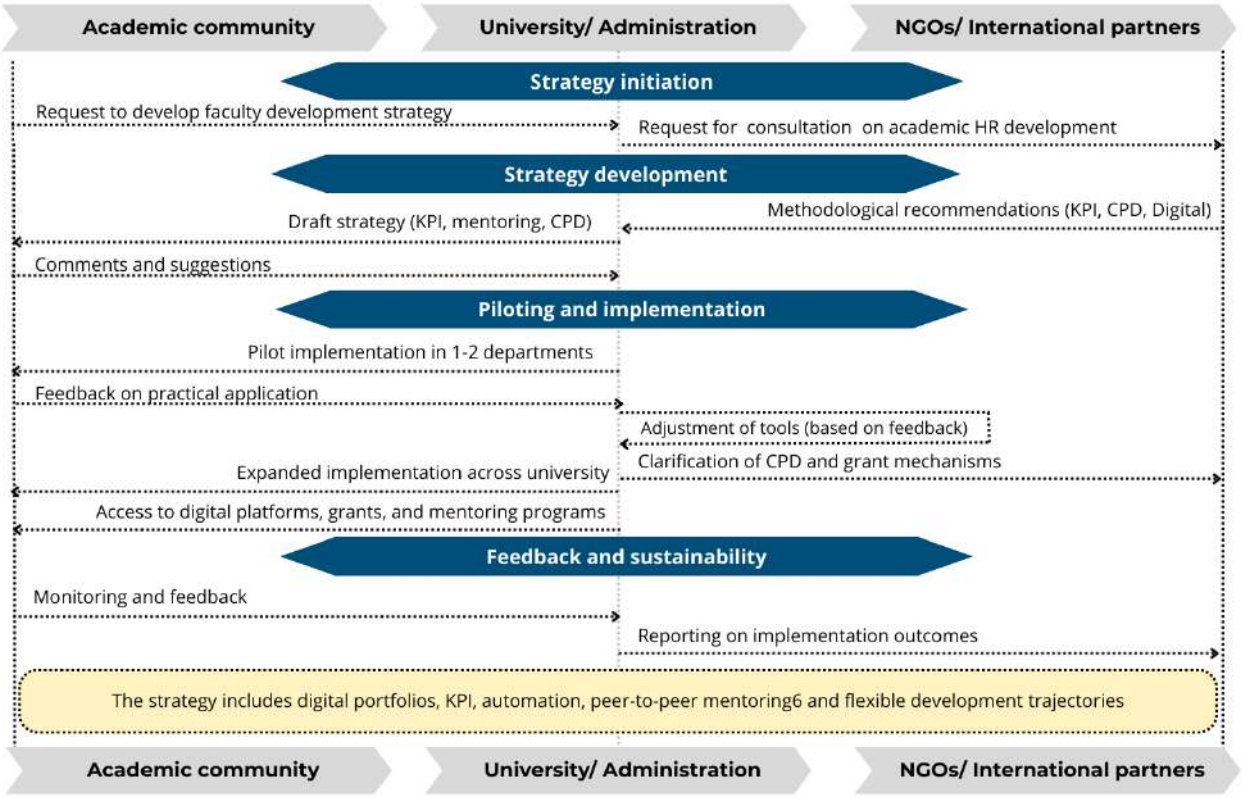

Figure 20 - Multilevel model of interaction in the implementation of human capital development mechanisms

Note - compiled by the author

The model depicts a system of management mechanisms that coordinate university human capital development processes. The proposed model forms a multi-level governance system that unites the academic community, university management and external partners into a single strategic management cycle. The managerial value of the model lies in its view of human capital development as a

continuous decision-making process informed by feedback, performance monitoring, and the adaptation of HR systems to changing conditions. Universities can transition from disjointed personnel administration to systematic management of academic and research capacity by utilising technology such as KPIs, digital portfolios, CPD programs, mentorship, grant mechanisms, and peer-to-peer learning. This model is relevant for Kazakhstan because it mitigates the consequences of high centralisation of management, limited institutional autonomy, and regional imbalances in human resource development by introducing more flexible, adaptive mechanisms for managing human capital.

The model's additional analytical value is evident in the context of the green transition, as it integrates human capital development with the objectives of sustainable development and the ESG transformation of universities. In the presented logic, the green transition is not an external complement but a key context for modernising HR systems and governance approaches in higher education. The mechanisms of CPD, digital monitoring, academic mentoring, and international cooperation enable students to develop green competencies, sustainable management skills, interdisciplinary interaction, and environmentally oriented decision-making. Piloting and subsequent institutionalisation of these tools create conditions for the long-term reproduction of green human capital within universities. As a result, the model demonstrates that the sustainability of the higher education system is determined not only by the amount of resources, but also by universities' ability to build adaptive human capital management mechanisms that train for a low-carbon, sustainable economy in Kazakhstan.

Therefore, the proposed mechanisms for improving the quality of teaching staff's human capital within the university demonstrate a transition from fragmented, formal approaches to a strategically verified model for developing human capital. The introduction of digital tools, individual career paths, feedback mechanisms, scientific accelerators, and academic hubs not only enhances teachers' professional competence but also makes the university a sustainable, innovative, and competitive institution.

In conclusion, the system-forming condition for the sustainable development of the university is improving the quality of the teaching staff's human capital. The implementation of an integrated approach to human capital development requires not only strategic thinking but also the introduction of coordinated university-level mechanisms to build competencies, enhance research capacity, and renew academic capacity.

The set of mechanisms that has emerged reflects the transition from fragmented management decisions to an institutionally structured model of human capital development. Their consistent integration into personnel policy, the motivation system, and the scientific and educational activities of universities provides a basis for strengthening the competitiveness of higher education and for the formation of a sustainable model for the reproduction of academic and research human capital.

3.3 Implementation framework for green-oriented human capital capacity management: stakeholder matrix and roadmap

In the context of the global environmental crisis and the transition to sustainable development, the development of human capital is becoming a strategic priority for the higher education system. Universities serve not only to reproduce knowledge but also to form environmentally responsible, socially oriented, and professionally adaptive subjects of the economy. A sustainable transition requires not only adjustments to educational programs but also a comprehensive institutional transformation encompassing all levels of human capital capacity management.

In the previous section, institutional mechanisms to improve universities' human capital quality in the context of the green transition were considered, including the regulatory consolidation of ESG principles, the integration of sustainability into strategic documents, and the establishment of a management infrastructure. However, the institutionalisation of the relevant mechanisms represents only the initial level of transformation. Further development requires a transition from normative design to a long-term, phased implementation of an integrated approach that ensures sustainable reproduction and qualitative complication of human capital.

The systemic mechanisms for implementing the green approach are considered as a strategy for managing the development of human capital at universities. The main focus is less on the description of organisational changes than on the purposeful development of competencies, values, professional adaptability, and the transformational potential of students, teaching staff, and administrative staff. Management, in this context, serves as a tool for the structural transformation of the qualitative characteristics of human capital in line with the requirements of sustainable development and the green economy.

The evolutionary model reflects a consistent transition from the initial implementation of ESG principles to their scaling and subsequent institutionalisation as a mandatory element of the quality system of higher education. As the integrated approach is implemented, the structure of human capital becomes more complex: from the development of basic environmental and digital literacy to the formation of professional sustainable competencies, managerial maturity, and the ability to initiate systemic changes. Thus, the system mechanisms for implementing the green approach are interpreted as tools for the long-term strategic management of human capital development, which determine universities' competitiveness and their contribution to Kazakhstan's sustainable development.

In this regard, there is a need to systematise the mechanisms that foster the development of green human capital across levels of university management. The systematisation of these mechanisms is presented in Table 22, which summarises the key areas and tools for developing human capital in the context of the green transition.

Table 22 - Systemic mechanisms for strengthening human capital in higher education within the context of the green transition

Mechanism	Main directions and instruments	Tools	Responsible actor	Expected effect
1	2	3	4	5
Institutional mechanisms	– Integration of ESG principles into university strategy and KPI systems; – Participation in international initiatives (UI GreenMetric, SDSN); – Inclusion of sustainability criteria in the evaluation of institutional units *Goal:* institutionalization of sustainable development principles in the university's strategic management system and integration of environmental and social competencies into the human capital development model	ESG reporting; sustainability KPIs; Internal quality assurance systems; Strategic planning instruments; Sustainability audits; Institutional benchmarking	Ministry of Science and Higher Education; university administration; QA agencies; Sustainability offices	Institutionalization of environmental competencies; Formation of value-based foundations for sustainable behaviour; Enhancement of the international competitiveness of human capital
Educational mechanisms	– Introduction of courses on sustainable development, climate policy, and the circular economy; – integration of sustainability topics into existing disciplines; – development of 21st-century skills; – CPD programs for faculty members *Goal:* development of a set of green, interdisciplinary, and digital competencies among students and faculty that ensure adaptability and competitiveness in the context of the sustainable transformation of the economy	Curriculum redesign; Micro-credentials; LMS platforms; Interdisciplinary modules; CPD programs; Competency-based learning models	Universities; Faculty members; Curriculum committees; Employers; Accreditation agencies	Development of green and interdisciplinary competencies; Increased professional flexibility and competitiveness of graduates and academic staff
Managerial mechanisms	– Grants and awards for projects in the field of sustainable development; – individual digital development trajectories; – establishment of sustainability-oriented structures; – engagement of staff in green initiatives Goal: creation of a motivational and organizational environment that stimulates the development of professional, project-based, and innovative competencies of university human capital	KPI systems; HR analytics; grant mechanisms; Mentoring programs; Digital portfolios; Performance evaluation systems	University management; HR departments; Research offices; Faculty development centers	Increased motivation to implement sustainable practices; Accumulation of project and managerial competencies; Greater engagement of academic staff

Continuation of Table 22

1	2	3	4	5
Infrastructure and digital mechanisms	– Development of energy-efficient and resource-saving infrastructure; – Digitalization of human capital capacity management processes; – Online training in ESG-related fields *Goal:* creation of a technologically and environmentally supportive environment ensuring the effective development, accumulation, and utilization of the university's human capital	Smart campus technologies; LMS and HRM systems; AI-based analytics; Digital monitoring platforms; Virtual laboratories	University administration; IT departments; Infrastructure units; Government support programs	Formation of environmentally responsible behavior; Development of digital competencies; Increased institutional sustainability of human capital
Social engagement and student initiatives	– Student environmental clubs and volunteer initiatives; – Student participation in sustainability strategic planning; – Collaboration with local communities *Goal:* development of students' social, civic, and leadership potential as a component of the university's extended human capital	Volunteer programs; Participatory governance mechanisms; Student project funding; Community partnerships; Leadership platforms	Student organizations; Universities; Local authorities; NGOs; Community partners	Development of social and civic capital; Formation of leadership and project competencies; Strengthening the connection between the university and regional development
Note - compiled by the author				

The systematisation of key mechanisms to strengthen human capital within the higher education system in the context of the green transition reflects the complexity of the university's transformation. The transformation of higher education in the context of sustainable development and green transition is carried out by the following mechanisms: (1) Institutional, (2) Educational, (3) Managerial, (4) Infrastructural and digital, (5) Social engagement and student initiatives. For Kazakhstan, the development of these mechanisms is becoming strategically important in the context of implementing a policy to decarbonise the economy, achieve carbon neutrality by 2060, digitalise public administration, and train personnel for new sectors of the green economy. Unlike in many developed countries, Kazakhstan's higher education system continues to face high centralisation of management, regional disparities in the distribution of scientific and pedagogical staff, and limited integration of ESG approaches into universities' institutional governance and HR systems. In this regard, the modernisation of human capital management mechanisms is becoming not only an educational, but also a strategic task of national development.

(1) Institutional arrangements

Institutional mechanisms in the context of green transition should be viewed not as a series of administrative procedures, but as a single strategy for managing human capital development at the university. Their key function is to create a

regulatory and managerial environment in which the development of environmental, social and managerial competencies becomes a systematic, reproducible and strategically oriented process. In this context, the institutionalisation of ESG principles entails the shift of sustainable development from declarations to management decisions that affect the qualitative characteristics of human capital. For Kazakhstan, this mechanism is especially important given universities' continued dependence on centralised decision-making and the insufficient integration of ESG principles into their strategic management systems. The inclusion of sustainability indicators in universities' governance mechanisms enables the shift from formal compliance with regulatory requirements to human capital management aligned with long-term strategic priorities.

The integration of ESG principles into the university's mission and strategy, as well as the inclusion of green indicators in management's KPI system, internal audit procedures, and budget planning, constitute the strategic focus of human resource development. Sustainability becomes a criterion for effectiveness alongside academic results. As a result, management and academic staff develop strategic, long-term thinking, the ability to account for environmental and social risks when making decisions, and a sense of responsibility for sustainable outcomes. Thus, the strategic component of human capital is developing, ensuring the university's ability to adapt to climatic and economic uncertainty. The applied effectiveness of the mechanism can be assessed using indicators such as the university's participation in international sustainability ratings, the percentage of educational programs with ESG components, the availability of sustainability KPIs in the unit evaluation system, and the participation of teaching staff in ESG-oriented CPD programs.

The inclusion of green competencies in HR policy, through requirements for recruitment, certification, and career advancement, as well as through ESG continuous professional development programs, ensures the targeted formation of professionally adaptive capital. Teaching staff and researchers develop the ability to integrate the ESG approach into their own subject areas, engage in interdisciplinary thinking, and be ready for continuous learning and adaptation to the requirements of the green economy. Thus, human capital acquires the quality of professional flexibility and competitiveness in the context of sustainable transformation.

The strategic alignment of educational programs (curriculum alignment) plays a significant role and involves revising curricula to include courses on sustainable development, using problem-based and service-learning methods, and monitoring students' development of green competencies. As a result, students develop systematic environmental thinking, the ability to solve complex sustainable tasks, skills in the practical application of the principles of the circular economy and social responsibility. Teachers, in turn, develop the methodological competence to integrate ESG topics into disciplines and design interdisciplinary educational trajectories. This strengthens the cognitive and practical component of the university's human capital.

The institutionalisation of sustainable development in research policy contributes to the formation of innovative and scientific capital. Researchers are developing competencies in generating applied solutions to climate and social

problems, knowledge transfer, and innovative and entrepreneurial thinking. This process enhances the university's ability to act not only as an educational institution but also as a technological driver of the green economy.

International integration is an important element of the human capital development management strategy. Participation in global initiatives such as the UI GreenMetric and the Sustainable Development Solutions Network enables universities to compare their results against international standards and implement best practices for sustainable development. Participation in international initiatives contributes to the development of staff skills in benchmarking, strategic positioning, working in global academic networks, and implementing academic mobility, thereby strengthening the international and network components of universities' human capital. Participating in international ESG initiatives helps Kazakhstani universities become more visible internationally, enhance their academic reputation, and integrate into the global educational landscape—all of which are crucial amid growing global competition for human capital.

An additional tool for strategic development is the triple helix partnership, which unites the state, business and the non-profit sector. Interaction with external stakeholders builds staff and students' intersectoral communication skills, understanding of the regulatory and market environment of the green economy, and the ability to work in public-private partnerships and implement social impact projects. As a result, the social and institutional adaptability of human capital is developing.

Thus, institutional mechanisms, as a strategy for managing human capital development, ensure the formation of a multi-level structure of green human capital, including strategic management competence, professional ESG competencies, methodological maturity, innovation potential, international competitiveness, and intersectoral adaptability. Their systematic implementation creates conditions for the sustainable reproduction of a qualitatively new type of human capital capable of ensuring the university's long-term transformation and strengthening Kazakhstan's competitiveness in the context of a green transition.

(2) Educational mechanisms

Educational mechanisms in the context of the green transition should be considered a strategy for managing human capital development, aimed at fostering sustainable competencies, values, and professional qualities that meet the requirements of the green economy. The transformation of educational programs goes beyond the formal adjustment of curricula and involves a comprehensive transformation of the educational process aimed at the consistent formation of a qualitatively new type of human capital, characterised by environmental orientation, interdisciplinary integration, digital competence and the ability to innovate. For Kazakhstan, educational mechanisms are particularly important given a shortage of personnel in renewable energy, environmental management, ESG analytics, and sustainable management of natural resources. The current personnel training structure does not yet adequately meet the needs of the economy's green transformation.

In the first stage, the educational strategy focuses on developing a cognitive and value-based foundation for sustainable development. The inclusion of climate policy, circular economy, bioethics, social justice, and digital sustainability topics in educational programs develops students' basic ESG literacy, understanding of the interrelationships among economic, environmental, and social processes, and a value orientation toward responsible professional behaviour. At this stage, the foundation of ecological and social consciousness is being laid, providing internal motivation to participate in sustainable transformations.

The next stage concerns the methodological transformation of the educational process and the development of analytical and digital competencies. The use of problem-based learning, service-based learning, and interdisciplinary projects shifts the focus from knowledge transfer to developing the ability to solve complex, sustainable tasks. Students develop critical and systematic thinking skills in analysing climate risks, the ability to work with data and digital tools, and the ability to engage in interdisciplinary interaction. Thus, the analytical and digital components of human capital are developing, ensuring their adaptability to technological and environmental changes.

The next stage of the educational strategy involves the professionalisation of green competencies by integrating ESG principles directly into specialised disciplines. The topics of sustainable development and the circular economy are integrated across engineering, economics, management, and humanitarian fields of study, enabling students to master the mechanisms for applying sustainability principles in specific professional activities. They develop the ability to design sustainable solutions, assess the environmental and social effects of professional actions, and make responsible managerial and technological decisions. In this way, professional green capital is being developed, thereby increasing graduates' competitiveness in the labour market. This reduces the structural gap between the higher education system and the demands of the Kazakh labour market, especially in the sectors of energy, industrial decarbonization, water resources and environmental regulation.

The last phase in the educational strategy is the development of transformational competencies and leadership potential. Students learn to manage projects, think entrepreneurially, and engage in institutional practices by taking part in initiatives, teams, and social practices. Leadership, communication, and the willingness to initiate sustainable change in organisations and regions are being developed. At this level, transformational human capital is being formed, capable not only of adapting to the conditions of the green economy but also of driving it. In Kazakhstan, the development of this type of human capital is becoming a factor in increasing national competitiveness and economic resilience to climate and technological change.

Thus, educational mechanisms, as a strategy for managing human capital development, ensure the consistent development of cognitive ESG literacy, analytical and digital competencies, professional green skills, and leadership potential. Their systematic implementation creates a sustainable model for reproducing a new generation of human capital, capable of ensuring the long-term

competitiveness of universities and contributing to the sustainable development of Kazakhstan's economy.

(3) Management mechanisms

Management mechanisms in the context of the green transition should be considered a strategy for developing human capital, aimed at fostering sustainable professional, leadership, and organisational competencies within the university community. Their task is not only to coordinate ESG initiatives but also to create a management environment in which the development of green skills, responsibility, and innovation potential becomes part of individual and collective professional trajectories.

At the first stage, the management strategy assumes the institutional consolidation of sustainable development through the creation of a specialised unit (office or department of sustainable development) with the authority to coordinate the regulatory framework, monitor ESG indicators and integrate sustainability principles into the management system. This step builds strategic management competence, the ability to work with ESG metrics, system planning skills, and a sense of responsibility for long-term results among managers and administrative staff. At the same time, institutional maturity and readiness to manage complex transformational processes are developing. For most Kazakhstani universities, such governance structures are still in their early stages of development, and ESG functions are often fragmented and not integrated into the strategic decision-making process.

At the second stage, the strategy focuses on personalising human capital development by digitalising individual trajectories. The introduction of an e-portfolio and individual professional growth plans that reflect the contributions of staff and students to achieving the university's environmental and social goals enables the integration of sustainability criteria into certification and career development procedures. As a result, competencies in self-development, reflexive management of one's professional trajectory, digital literacy, and the ability to correlate personal achievements with the institutional goals of sustainable development are developed. Human capital acquires the quality of conscious professional responsibility. The digitalisation of HR systems enables Kazakhstani universities to increase transparency in personnel policy, reduce subjectivity in certification procedures, and strengthen the analytical basis for managerial decision-making.

The third stage of the management strategy involves introducing motivational tools, including grants, bonuses, and ESG-oriented KPIs for departments and individual employees. Incentive schemes provide a stable source of intrinsic motivation to participate in green initiatives, strengthen result orientation, and promote the development of project and leadership potential. Employees develop skills in project development and implementation, teamwork, strategic planning, and assessing the social and environmental effects of their activities. There is a culture of recognising contributions to sustainable development as an element of professional success. The effectiveness of these mechanisms can be assessed using indicators of publication activity, teaching staff participation in green projects,

international collaboration, and employee involvement in sustainable development programs.

At the final stage, the management strategy assumes active staff involvement in interdisciplinary green projects — initiatives in energy efficiency, waste management, renewable energy development, and digital environmental solutions. Participation in such projects contributes to the development of innovative thinking, the ability to work in cross-functional teams, intersectoral interaction skills, and managerial adaptability. The transformational component of human capital is being formed — the willingness not only to perform regulated tasks, but also to initiate sustainable changes within the organisation.

Thus, management mechanisms, as a strategy for human capital development, ensure the gradual development of strategic management competence, digital and reflective maturity, project and leadership skills, and the innovative and transformational potential of personnel. Together, they create an integrated management architecture in which sustainable development is anchored not as an external agenda but as an internally accepted value and professional norm that ensures the university's long-term institutional sustainability.

(4) Infrastructural and digital mechanisms

It is advisable to consider infrastructural and digital mechanisms in the context of the green transition as a strategy for managing the development of human capital, since they form not only the material and technological basis for sustainability, but also create an environment in which the competencies, values and professional qualities of the university community develop systematically and continuously. In this context, infrastructure and digital solutions serve as tools for the targeted development of environmental, digital, and innovative components of human capital.

The development of the green campus concept involves introducing energy-efficient buildings, using renewable energy sources, implementing intelligent monitoring systems for resource consumption, separating waste collection, and implementing environmentally friendly transport infrastructure. Such an environment is not just technologically significant but also educationally significant, where students and staff learn to be resource-efficient and environmentally responsible, and to understand their carbon footprint and their responsibility for reducing it. Daily interaction with the "smart" infrastructure contributes to the development of ecological thinking, sustainable behavioural attitudes, and the ability to apply the principles of rational resource use in professional activities. This strengthens the behavioural and value component of green human capital. In Kazakhstan, the development of green university infrastructure is also linked to the need to improve building energy efficiency, especially given the country's high energy intensity and regional climate.

Digitalisation of human capital capacity management through the introduction of an e-portfolio and individual development trajectories ensures the personalisation of professional growth and the integration of ESG indicators into the results assessment system. Recording academic achievements, research work, and involvement in sustainable initiatives helps students and employees build skills in

self-evaluation, strategic career planning, and self-development. The application of educational data analytics helps build the skills of management staff in data-informed decision-making, forecasting, and resource allocation. As a result, digital and managerial capital are developing, ensuring the university's adaptability to technological and climatic changes. This is particularly crucial for Kazakhstan, as disparities in university digital maturity and access to contemporary research infrastructure persist. In the context of regional inequality, digital tools are becoming an important mechanism for equalising access to educational and research opportunities between the universities of Almaty, Astana and regional centres.

The introduction of online ESG training formats and microqualifications expands access to continuing education and contributes to the systematic updating of competencies. Modular courses on sustainable development, climate policy and circular economy, complemented by interactive simulations and cases based on smart campus data, form applied ESG competencies, the ability to analyse the environmental and social effects of decisions, as well as skills to integrate sustainable principles into professional practice. At the same time, the quality of learning and flexibility (learning agility) is being developed, enabling human capital to adapt quickly to the changing requirements of the green economy.

The combined functioning of green infrastructure, digital management tools, and online education creates an integrated ecosystem of human capital development. The process develops a foundation in environmental stewardship, digital literacy, analytical and design skills, innovative thinking, and the ability to collaborate across disciplines. Infrastructure is turned into a "laboratory of sustainability," data becomes a "strategic management tool," and educational platforms a "means of competence accumulation." Thus, the principles of sustainable development are consolidated as a daily professional norm, ensuring the long-term reproduction of the university's green human capital.

(5) Social engagement and student initiatives

Social engagement and student initiatives in the context of the green transition should be considered a strategy for managing human capital development, with a focus on building students' social, civic, and leadership potential. Their role is not only to expand extracurricular activities but also to systematically develop the qualities that enable graduates to act as agents of sustainable change in the economy and society. In Kazakhstan, the development of students' social engagement is particularly important for strengthening civic responsibility, environmental culture, and regional sustainability.

Institutionally anchored green and socially oriented clubs foster the practical application of sustainable development principles. The development of students' environmental responsibility, teamwork skills, and the ability to implement initiatives in resource-limited settings through their participation in separate waste collection programs, volunteer projects in reducing the carbon footprint, and environmental education. The competencies in teamwork, communication, and social interaction are being developed, thereby strengthening the social capital of human resources.

Service learning, integrated into major disciplines, strengthens the link between academic knowledge and public practice. The inclusion of socially useful tasks in the educational process forms students' ability to apply theoretical knowledge to solving real social and environmental problems, and develops analytical thinking and professional responsibility. At the same time, reflexive competence is being developed, as participation outcomes are recorded in electronic portfolios and taken into account during internal certification, thereby increasing awareness of personal contributions to sustainable development. For Kazakhstani universities, such practices enable them to strengthen the link between higher education and local environmental and social problems in the regions.

Support for student social entrepreneurship through acceleration centres fosters entrepreneurial and innovative potential. Mentoring and financial support for projects with social and ecological effects develops students' skills in project management, strategic planning, social impact assessment and resource mobilisation. Thus, an entrepreneurial component of human capital is being formed, focused on creating sustainable business models and social innovations.

Mentoring programs that bring together undergraduates, graduate students, and freshmen contribute to the formation of leadership skills, empathy, and the ability to interact horizontally. Involving students in sustainable projects from the early stages of their studies strengthens their sense of belonging to institutional goals and develops organisational coordination skills. A culture of responsibility and mutual support is taking shape as part of corporate human capital.

The implementation of the "living labs" concept extends the campus boundaries to the urban ecosystem and involves students in testing energy-efficient infrastructure and inclusive design alongside local communities. Participation in such projects develops competencies in intersectoral cooperation, skills in working in public-private partnerships, and the ability to consider the interests of various stakeholders and analyse the social and environmental consequences of decisions. The experience gained in intersectoral cooperation enhances the flexibility of human capital in the institutional environment and its resilience to social transformations. In Kazakhstan, living labs can serve as tools for testing solutions in energy efficiency, waste management, and sustainable urban development, taking into account the specific characteristics of regional territories.

The involvement of corporate partners through CSR programs provides financial support for initiatives and, at the same time, shapes students' understanding of the mechanisms of interaction between business and society. Communication skills with external partners are being developed, as is the ability to work under grant-financing conditions and to evaluate the social effectiveness of projects. Special attention to inclusive initiatives promotes the values of equal access, social justice and respect for diversity, strengthening the ethical component of human capital.

The system of non-material and financial motivation, such as awards for social impact, Student-eco-Leader grants, and the recognition of volunteer activity in the diploma supplement, creates a stable internal motivation to participate in socially significant projects. The formed practices strengthen skills in self-organisation,

managerial leadership, and a sustainable focus on social and environmental responsibility.

Collectively, social engagement and student initiatives, as strategies for managing human capital development, foster environmental responsibility, civic engagement, leadership skills, entrepreneurial thinking, and intersectoral competence. The university community becomes an active subject of social and ecological modernisation, and graduates acquire the qualities necessary to implement sustainable transformations at the organisational, regional, and national levels.

Thus, the systemic transformation of human capital capacity management in universities is possible only with the simultaneous and coordinated functioning of institutional, educational, managerial, infrastructural, digital and social mechanisms. Their integration ensures the transition from fragmented initiatives to a holistic model for reproducing green human capital. The presence of strategic leadership, institutional will, a developed organisational culture, and sustainable partnerships enables the university not only to adapt to the requirements of the green transition but also to act as an active participant in shaping a sustainable economy. For Kazakhstan, implementing this model is of strategic importance, as it enables the development of a new type of human capital capable of ensuring sustainable economic modernisation, developing low-carbon industries, and increasing the international competitiveness of the national higher education system.

At the same time, the effectiveness of implementing these mechanisms is largely determined by the quality of the university's interactions with various stakeholder groups. The degree of their influence and interest in transformational processes determines the priority of management decisions, the nature of communication and the allocation of resources. In this regard, it seems advisable to analyse the stakeholder structure for implementing green initiatives in human capital capacity management.

Figure 21 shows a stakeholder matrix, reflecting the distribution of key actors by level of influence and degree of interest in the university's sustainable transformation processes.

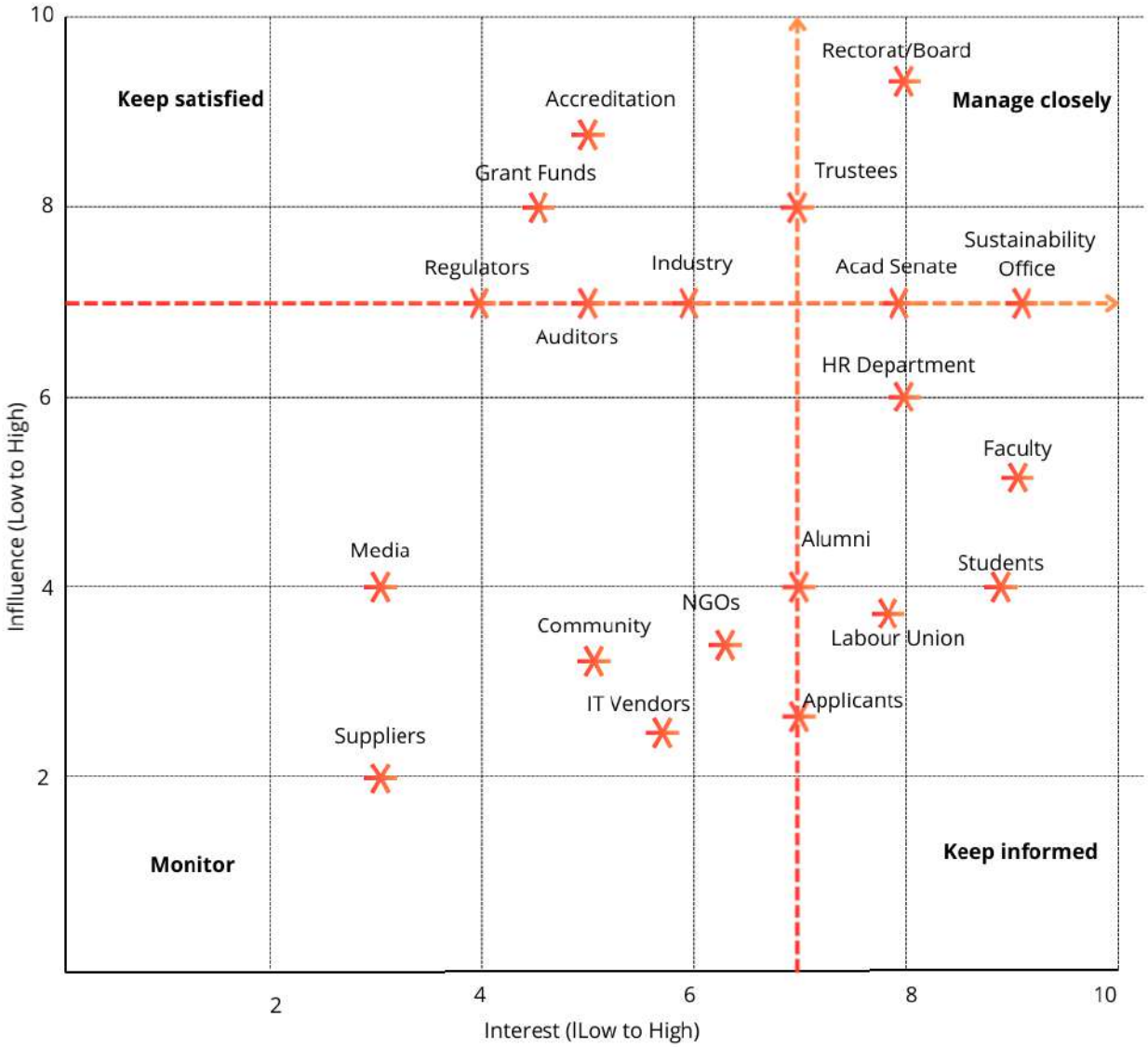

Figure 21 - Stakeholder matrix of green initiatives in human capital capacity management in higher education institutions

Note – compiled by the author

The figure shows the stakeholder matrix, reflecting the distribution of key actors by their level of influence on the processes of green transformation in higher education and their degree of interest in developing green human capital. In Kazakhstan, the change is mostly state-initiated and administratively coordinated, in contrast to many foreign university systems, where the ESG agenda is primarily started by universities and the academic community. This suggests that whereas students, instructors, and public organisations have a comparatively smaller influence on strategic decision-making, regulators, the rector's office, trustee structures, and accreditation agencies have a greater concentration of influence. This specificity reflects the continuing vertical governance model in Kazakhstan's higher education system, in which key management mechanisms are formed from the top down through government policy, regulatory requirements, and institutional KPIs.

The peculiarity of the Kazakh context is also that the green transition in universities is still at the stage of institutional implementation, whereas in many European universities, ESG and sustainability governance are already integrated into the operational model of university management. In Kazakhstan, sustainable development is more often implemented through individual projects, international initiatives and accreditation requirements, rather than through a fully institutionalised decision-making and HR systems. That is why external actors, such as regulators, grant funds, international partners, and accreditation structures, which drive the implementation of ESG practices and green competencies, have a strong influence on the figure. At the same time, the relatively high positions of the Sustainability Office and the HR Department reflect universities' gradual transition toward more systematic human capital management in the context of green transformation.

The Manage closely quadrant includes key strategic actors: the Rector's Office, the Board of Directors, the Trustees, the Academic Senate, the Sustainability Office, the HR Department, and industry representatives. In Kazakhstan, the administrative and managerial levels typically serve as the primary drivers of ESG integration and the modernisation of human capital management. Unlike the more decentralised models of university governance common in many Western countries, Kazakhstani universities are more dependent on centralised decision-making, financing mechanisms, and government priorities. Therefore, the management's capacity to incorporate ESG concepts into the university's strategy, KPIs, HR policy, and resource allocation system will determine the success of the green transformation.

The Keep satisfied zone includes accreditation bodies, Grant Funds, Regulators, Auditors, and industry representatives. For Kazakhstan, this segment is more significant than in many countries with high university autonomy, since external evaluation and financing mechanisms are often the key incentives for institutional change. International ratings, ESG-oriented accreditation standards, and grant programs serve as instruments of external pressure, enabling universities to adapt their governance models and human capital management mechanisms to the requirements of the green economy.

The Keep informed quadrant (high interest — relatively low impact) includes students, alumni, faculty, trade unions, and applicants. In the Kazakh context, this group shows growing interest in sustainable development and green competencies, but their participation in decision-making remains limited. This distinguishes Kazakhstan from the university systems of Northern Europe and several EU countries, where students and faculty participate significantly more in governance processes and in the development of sustainability strategies. At the same time, the gradual expansion of academic autonomy and the development of sustainability initiatives create the prerequisites for strengthening these groups' role in shaping a green university environment.

The Monitor (low interest — low impact) zone includes Suppliers, IT Vendors, media representatives, and part of the local community. Despite their peripheral position, their role in Kazakhstan is gradually increasing due to the digitalisation of universities and the expansion of the ESG agenda. In particular, IT vendors are

becoming key participants in implementing digital HR systems, ESG monitoring platforms, and analytical tools for human capital management. At the same time, NGOs, which occupy an intermediate position between the Monitor and Keep informed zones, have the potential to strengthen their influence by developing partnerships in sustainable development and implementing joint environmental and educational projects.

Thus, the presented matrix reflects the specifics of the Kazakh model of green transformation of higher education, which is characterised by the high role of the state and administrative governance, the dependence of universities on external regulatory and accreditation mechanisms, as well as the gradual transition from the formal introduction of ESG approaches to the systematic management of the development of green human capital. Unlike more mature foreign models of sustainability governance, the Kazakh system is at the stage of institutional formation, where the key factor in effectiveness is universities' ability to integrate human capital management mechanisms, ESG principles, and decision-making processes into a single sustainable development strategy.

However, the spatial distribution of stakeholders by level of influence and interest reveals only the structure of interaction. To understand the logic of the progressive development of human capital, it is necessary to consider the temporal dimension of transformation — how institutional solutions and partnership mechanisms are consistently transformed into sustainable competencies, managerial maturity and the transformational potential of universities.

The transitions between stages of the human capital management system are determined by the maturity of management mechanisms. In particular, the transition from the initial stage (2026-2029) to the stage of systemic development (2030-2035) is possible if ESG principles are integrated into educational programs and personnel policy, and if performance assessment systems, including KPIs and other performance indicators, are established. The transition to the stage of deep integration (2036-2040) is driven by the institutionalisation of sustainable development principles, the development of digital management systems, and the achievement of a high level of academic staff involvement in scientific and sustainable activities. In Kazakhstan, these transitions also depend on universities' institutional readiness, the specifics of government regulation, and regional differences in the development of higher education. In this regard, Table 23 systematises the stages of modernisation of university human capital capacity management in the context of the green transition and demonstrates how the integrated approach is implemented in the long term, ensuring the consistent accumulation of qualitatively new green human capital.

Table 23 - A roadmap for modernising university human capital capacity management in the context of a green transition

Period	Key mechanisms	Human capital characteristics formed	Transition conditions
1	2	3	4

Continuation of Table 23

1	2	3	4
2026–2029 Launch and integration	– Participation in international initiatives (UI GreenMetric, SDSN, UNEP-GUPES); –Integration of ESG principles into mission statements and KPIs; – Development of new courses on sustainable development; – Professional development of faculty (CPD, MOOCs, micro-credentials); – Student “green” clubs; – Waste separation campaigns	– Basic ESG literacy; – Environmental and social awareness; – Critical thinking; – Digital literacy; – Initial institutional adaptability; – Formation of value orientations toward sustainability	– Initial institutionalization of ESG principles in higher education governance; – Formation of regulatory and organizational foundations for green transition; – Growing demand for sustainability competencies in the labour market; – Expansion of international sustainability standards and rankings
2030–2035 Digital infrastructure and governance	– Development of green infrastructure; – Full digitalization of HR processes (e-portfolio, individual learning trajectories); – Large-scale online ESG education; – Establishment of Green Offices; – Internal hackathons and project grants; – Student participation in strategic governance	– Professional ESG competencies; – Project management skills; – Data-driven thinking; – Interdisciplinary integration; – Managerial and digital maturity; – Increased motivation for sustainability initiatives	– Transition from fragmented initiatives to systemic sustainability governance; – Expansion of digital ecosystems in universities; – Integration of ESG indicators into accreditation and quality assurance systems; – Strengthening links between universities, industry, and regional green economies
2036–2040 Deep integration and societal impact	– Inclusion of students in sustainability governance bodies; – Universities as regional centers of environmental education; – Living labs with cities and NGOs; – Support for startups and GreenTech initiatives; – Transition to carbon-negative campuses; – Use of AI analytics in governance	– Transformational and leadership competencies; – Entrepreneurial and innovative potential; – Capacity for cross-sectoral collaboration; – Institutional and social resilience; – Global competitiveness; – Ability to initiate systemic sustainable change	– Mature sustainability governance ecosystem; – Full integration of ESG principles into university management and human capital systems; – Strong alignment between higher education and green economic transformation; – Universities acting as drivers of regional and national sustainable development
Note - compiled by the author			

In light of Kazakhstan's institutional, social, and economic features, the roadmap shows that an integrated approach to managing human capital development in the context of a green transition entails a continuous transformation of universities' competence structures rather than one-time reforms. For the Kazakh higher education system, this model is particularly relevant because it must simultaneously address several tasks: modernising university management, reducing regional disparities, increasing universities' international competitiveness, and training personnel to implement the national strategy for carbon neutrality and a green economy. Unlike in many countries where the ESG agenda has already been institutionalised, the green transition in Kazakhstan is at an early stage, with regulatory, personnel, and infrastructural mechanisms still being developed, requiring a gradual, adaptive approach to building human capital.

The period 2026-2029 is characterised by the initial integration of ESG principles into universities' missions, strategies, and educational programs in Kazakhstan. At this stage, sustainable development is gaining status as a priority in state educational policy; however, it largely retains a programmatic character and relies on universities' participation in international projects and rankings (e.g., UI GreenMetric, SDSN). For Kazakhstan, this stage is especially important in the context of limited ESG competencies, insufficient integration of green skills into educational programs, and universities' high dependence on centralised management decisions. The main focus of the stage is developing basic ESG literacy, environmental and social awareness, digital competence, and critical thinking. Human capital is being built to acquire the cognitive and value basis for sustainable behaviour, and initial institutional adaptability to the requirements of the green economy and the new demands of the labour market in Kazakhstan is being developed.

The period 2030-2035 marks the transition of Kazakhstani universities from individual ESG initiatives to a sustainability governance system. The ESG approach goes beyond individual projects and becomes an integrated element of educational standards, HR systems, HR policy, and decision-making mechanisms. For Kazakhstan, this stage will be characterised by the development of digital infrastructure, the introduction of data-driven management, the expansion of university autonomy, and the strengthening of the relationship between the higher education system and the needs of regions' green economies. There is digitalisation of personnel development management processes, the introduction of competence-monitoring systems, and the development of green infrastructure as a practical learning environment. Professional ESG competencies, project management skills, data-driven thinking, interdisciplinary integration and managerial maturity are being formed. Human capital is moving from awareness to the professional, sustainable competence needed to implement Kazakhstan's climate and technological transformation.

The period 2036-2040 presupposes the full institutionalisation of ESG and sustainable development within Kazakhstan's higher education system. ESG becomes a mandatory element of the quality assurance system, accreditation standards and a criterion for evaluating the effectiveness of university governance.

For Kazakhstan, this stage means universities transitioning from being adaptation institutions to active drivers of the green transformation of the economy and regional development. The university functions as a centre for environmental education, innovation and intersectoral partnership, integrated into international academic and research networks. Transformational and leadership competencies, entrepreneurial and innovative potential, and the ability to initiate systemic changes and engage in intersectoral interaction are being developed. Human capital develops strategic stability, international mobility, and global competitiveness, which are especially important for enhancing Kazakhstan's position in the global knowledge economy and for sustainable development.

Thus, the evolution of the presented stages demonstrates the transition of the Kazakh higher education system from the fragmented implementation of ESG practices to their full institutionalisation in the human capital management system. The persistent challenge of the competence structure of human capital reflects not only the internal modernisation of universities but also Kazakhstan's adaptation to the long-term challenges of the green transition, digitalisation, and global competition.

Thus, the systemic mechanisms for implementing the green approach in higher education should be considered the basis for the long-term management of universities' human capital development. The analysis showed that the transition to a green economy requires not individual environmental initiatives, but a comprehensive transformation of institutional, educational, managerial, infrastructural and social mechanisms.

It is established that institutional mechanisms ensure the regulatory and strategic consolidation of ESG principles, creating conditions for the sustainable reproduction of green-oriented human capital. Educational mechanisms contribute to the development of environmental literacy, interdisciplinary thinking, digital skills and professional competencies necessary for new sectors of the economy. Management mechanisms make it possible to integrate ESG indicators into HR policy, motivation, career development and decision-making system.

Infrastructural and digital mechanisms are of particular importance, as they transform the university environment into a practical platform for fostering sustainable behaviour, digital maturity, and innovation potential. In turn, social engagement and student initiatives enhance civic responsibility, leadership skills, and students' ability to participate in implementing environmental and social change.

The proposed stakeholder matrix has shown that Kazakhstan is characterised by a high role for the state, regulatory authorities, and university management in promoting the green transformation. At the same time, the participation of students, teachers, NGOs, and local communities remains limited, underscoring the need to expand participatory governance mechanisms and enhance the role of the academic community in implementing the ESG agenda.

The developed roadmap for the modernisation of human capital management reflects a gradual transition from initial ESG integration in 2026-2029 to systemic development in 2030-2035, and to the full institutionalisation of sustainable development in 2036-2040. This logic allows us to consider the development of

green-oriented human capital as a continuous process of accumulating competencies, managerial maturity, innovation potential, and international competitiveness in universities.

In general, the implementation of systemic mechanisms of the green approach will enable Kazakhstani universities to move from fragmented environmental initiatives to a holistic model of human capital management focused on sustainable development, digital transformation, decarbonization of the economy, and training for the country's future needs.

CONCLUSION

Based on the dissertation research conducted, the following conclusions were drawn:

1. It has been established that scientific ideas about human capital capacity management in the higher education system have steadily evolved from the classic understanding of human capital as a result of investments in education and professional training to a modern concept including innovative, digital, adaptive and environmentally oriented competencies. It is shown that, initially, human capital was considered a factor in increasing labour productivity and economic growth, while universities were considered institutions for training qualified personnel. The development of institutional and organisational approaches has expanded the content of this concept to include knowledge management, academic staff development, organisational training, and the formation of intellectual capital at universities. It is well established that in the knowledge economy, human capital is becoming a key driver of scientific research, technological development, academic entrepreneurship, and regional competitiveness. It is well established that modern universities should ensure not only the development of professional knowledge and skills, but also the advancement of adaptive competencies that can effectively respond to digitalisation, global competition and the transformation of the labour market. It is established that the modern paradigm of human capital management is based on the concept of sustainable and green development, which entails integrating ESG competencies, environmental accountability, interdisciplinary interaction, and training for a low-carbon economy. As a result, it is evident that human capital capacity management in the higher education system is a strategic, multi-level, and dynamic process that ensures the competitiveness of universities, the development of the national innovation system, and the achievement of SDGs.

2. It has been established that the effective development of green universities is based on the integrated human capital capacity management, integrated into the strategy of sustainable development. The bibliometric analysis made it possible to identify the countries that are world leaders in this field (USA, Great Britain, Australia, European Union countries, China and Malaysia), as well as to systematise key management areas, including strategic, personnel, educational, research, infrastructure-related and international cooperation mechanisms. A comparative study has shown that, despite differences in government regulation models and levels of university autonomy, successful practices are united through integrating the principles of sustainable development into personnel policy, educational activities, research, university infrastructure management, and stakeholder interactions. Three management models of green universities are identified: autonomous—networked, centralised, and hybrid cultural-value, each with specific tools for the formation of green-oriented human capital. It is proven that for Kazakhstan, the most promising is the adaptation of a hybrid model combining state coordination with the expansion of institutional autonomy of universities, the introduction of Green HRM principles, the development of "living laboratories", environmental leadership, academic mobility, international cooperation and a

system of continuous development of green competencies. The results obtained from the scientific and methodological basis for improving human capital capacity management and modernising Kazakhstan's higher education system in the context of the transition to a green economy.

3. An integrated methodological structure for human capital capacity management of the higher education system has been developed, combining neoclassical, institutional, innovation-oriented, competence-based and sustainable approaches. It is established that each of these approaches discloses different aspects of the formation, development and use of human capital, while their integration delivers a comprehensive analysis of management mechanisms in the higher education system. It has been shown that the assessment of human capital capacity should be conducted at the micro, meso, and macro levels, using complementary quantitative, qualitative, and mixed research methods which account for the economic, institutional, innovation, competence, and environmental characteristics of universities. The author proposes a classification of methods for assessing and managing human capital capacity, including econometric, institutional, investment, scientometric, competence-based, and ESG-oriented analytical tools. It has been proven that, in the context of the transition to a green economy, established approaches to assessing human capital should be complemented by indicators of the development of green competencies, sustainable behaviour, environmental accountability, innovation activity, and the quality of universities' institutional environment. The developed methodological structure provides a scientific basis for a full assessment of the effectiveness of human capital capacity management and for developing practical solutions to advance it in Kazakhstan's higher education system, in accordance with the principles of sustainable development.

4. It is established that Kazakhstan's higher education system has undergone a large-scale institutional transformation, accompanied by the modernisation of management mechanisms, the development of university autonomy, and inclusion into the international educational space. The analysis showed contradictory trends in financing: while government spending increased steadily in absolute terms, the share of government spending in GDP tended to decrease, showing a greater role for a mixed financing model and extra-budgetary sources. It is revealed that the reduction in the number of universities reflects the transition from an extensive expansion of the system to institutional optimisation and increased requirements for the quality of educational activities. Structural changes in personnel training have been identified, manifested in increased demand for educational programs in information technology, medicine, and pedagogy, while reducing training for specialists in environmental and natural resource fields, which creates risks to staffing the green transition. It is shown that the development of postgraduate education is accompanied by an increase in the number of doctoral graduates; however, a decrease in the proportion of successfully defended dissertations indicates the need to improve the mechanisms of scientific guidance and academic support for doctoral students. It has been established that the human capital capacity of universities, after a period of decline, shows signs of stabilisation, and the student-to-teaching-staff ratio has approached a more balanced level. The results of the

expert study confirmed that the inclusion of sustainable development principles into educational programs is largely fragmented and not yet grounded in a systematic competence-based approach. In general, it has been proven that Kazakhstan's higher education system has the necessary institutional prerequisites for further modernisation, but achieving the goals of the green transition requires increased training in environmental areas, the development of doctoral studies, strengthening the human resources of universities and improving the interaction of the state, universities and the labour market.

5. It has been established that human capital capacity management of the teaching staff in the higher education system of Kazakhstan is determined by a combination of institutional, personnel, research and motivational factors. The analysis showed an increase in the international competitiveness of Kazakhstani universities, as reflected in greater representation in world rankings and increased scientific activity, while noting constraints related to high academic workload, insufficient English proficiency, limited participation of faculty members in international research projects, and regional disparities in scientific capacity. The findings suggest that publication activity and research productivity are primarily associated with academic qualifications, academic position, and research-related characteristics, whereas demographic variables demonstrate comparatively weak relationships. Strong positive correlations among research productivity, publication and patent activity, research income, and graduate employability emphasise the systemic role of research human capital in enhancing the overall performance and competitiveness of higher education institutions. It has been established that the current system of key performance indicators and financial incentives focuses primarily on the results of scientific activity, but does not provide a sufficient link between faculty members' academic qualifications and the financial incentive mechanisms. The results show the need to improve human capital management by developing research and language competencies, expanding academic mobility, supporting young scientists, reducing regional inequalities, and aligning the motivation system with the strategic priorities of sustainable development.

6. It has been established that human capital capacity management in the higher education system of Kazakhstan in the context of the transition to a green economy is limited by a combination of institutional, personnel, resource and organisational factors. It is revealed that one of the key obstacles is insufficient institutional embedding of sustainable development principles, as evidenced by the fragmented inclusion of ESG approaches and green competencies across university strategies, educational programs, and management mechanisms. It is evident that the development of human capital is constrained by the limited financial, infrastructural, and human resources necessary for the modernisation of the learning setting, digital transformation, and the training of specialists for the green economy. It has been found that a high academic workload, insufficient motivational and methodological support from the teaching staff, and a weak relationship between ESG initiatives and career development reduce the effectiveness of human capital formation and reproduction. It is also revealed that insufficient interaction among universities, businesses, government agencies, and other stakeholders limits the practical

orientation of educational programs and their correspondence with the needs of sustainable development. In general, the main limitation is the lack of a comprehensive human capital capacity management model which integrates personnel policy, competence development, research, digital transformation, motivation mechanisms, and intersectoral partnerships into a single university management system.

7. An integrated multilevel management model for the development of human capital in the higher education system of Kazakhstan in the context of a green transition is proposed, combining the strategic, institutional, operational and external levels of university management. Unlike the traditional administrative model, the developed approach focuses on the formation, development, and reproduction of academic human capital through integrating ESG principles, digital transformation, internationalisation, and strategic HR management. Within the framework of the model, a three-stage modernisation mechanism is proposed, providing a consistent transition from the formation of institutional conditions and the expansion of infrastructure for strategic human capital management to the incorporation of this management into the international academic space. The developed approach ensures alignment of personnel policy, educational, scientific, and innovative activities of universities with the goals of sustainable development and consolidates human capital development mechanisms into a single strategic management system. The results obtained substantiate the need to transition to a human-centred management model in higher education, in which human capital is considered a key strategic resource for innovative development, the international competitiveness of universities, and the development of human resources for the sustainable development of Kazakhstan.

8. A system of interrelated mechanisms for improving human capital capacity management of the higher education system of Kazakhstan in the context of a green transition has been developed and scientifically substantiated, guaranteeing the development of academic, research, digital and managerial potential of the teaching staff. It has been established that improving the effectiveness of human capital management requires the integrated implementation of HR policy mechanisms, professional development, internal research funding, financial incentives and KPIs, mentoring, digital and infrastructural support, internationalisation, academic workload management and regionally balanced human capital development. It has been proven that their integrated application guarantees the transition from fragmented personnel administration toward strategic human capital management in universities, promotes the development of research potential, the expansion of international cooperation, the strengthening of academic competitiveness, and the systemic integration of the principles of sustainable development into the educational, scientific, and managerial activities of universities. The implementation of the proposed system of mechanisms creates institutional conditions to increase the competitiveness of Kazakhstani universities, reduce regional inequalities, and guarantee the sustainable reproduction of human capital in the higher education system.

9. A conceptual model has been developed for the implementation of an integrated approach to university human capital management in the context of a green transition, guaranteeing the phased integration of ESG principles into the strategic, educational, human resources and infrastructural development of the higher education system. Five interrelated groups of implementation mechanisms are systematised: institutional, educational, managerial, infrastructural—digital, and social engagement mechanisms that ensure the formation of environmental, digital, research, managerial, and transformational competencies among students, faculty, and administrative staff. A stakeholder matrix and a roadmap for the modernisation of the human capital management system for the period up to 2050 have been developed, defining the implementation sequence of mechanisms and the distribution of responsibilities among key participants in the green transformation of higher education. It has been proven that implementing the proposed model ensures the transition from local initiatives to systemic, strategic human capital management based on digitalisation, international cooperation, the development of green infrastructure, continuous professional development of personnel, and the use of ESG performance indicators. The pragmatic implementation of the developed mechanisms lays the foundation for the development of competitive green-oriented human capital, increases universities' flexibility to technological and institutional changes, and strengthens the higher education system's contribution to achieving Kazakhstan's national goals of sustainable development and carbon neutrality.

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APPENDIX A

Human capital training by fields of study in higher education, 2000, 2005, 2010, 2015, 2020, 2024

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Field	Pedagogical	Art and humanities	Social science	Business and law	Natural sciences	ICT	Engineering and technical	Agricultural	Veterinary	Medicine	Services	National safety
2000	85556	113993		110640	18150	10039	73450	9286	2806	16456		
2005	183470	66561	73491	198175	27577	21699	135764	13093	4099	27512	16240	1830
2010	133133	31022	9043	235345	15939	24912	98683	8274	4034	28378	28501	1964
2015	116315	32004	10589	108748	13915	15158	83701	9827	5686	38363	17633	2177
2020	158 996	33133	14819	113378	18486	36625	104681	8211	6052	44356	26784	4009
2024	170 733	38 163	22 534	84 418	30 762	63 790	102 629	8 250	4 553	58 305	27 623	4 609
	Growth	Growth	Growth	Growth	Growth	Growth	Growth	Growth	Growth	Growth	Growth	Growth
Field	Pedagogical	Art and humanities	Social science	Business and law	Natural sciences	ICT	Engineering and technical	Agricultural	Veterinary	Medicine	Services	National safety
2005	114,4	-41,6		79,1	51,9	116,1	84,8	41,0	46,1	67,2		
2010	-27,4	-53,4	-87,7	18,8	-42,2	14,8	-27,3	-36,8	-1,6	3,1	75,5	7,3
2015	-12,6	3,2	17,1	-53,8	-12,7	-39,2	-15,2	18,8	41,0	35,2	-38,1	10,8
2020	36,7	3,5	39,9	4,3	32,8	141,6	25,1	-16,4	6,4	15,6	51,9	84,2
2024	7,4	15,2	52,1	-25,5	66,4	74,2	-2	0,5	-24,8	31,5	3,1	15

APPENDIX B

EXPERT INTERVIEW QUESTIONNAIRE

This questionnaire has been developed within the framework of the doctoral thesis on the management of human capital capacity in the higher education system of Kazakhstan in the context of the green transition.

Purpose of the interview: to obtain expert assessments of institutional, educational, social, and economic factors influencing the transformation of universities in the context of the green transition, as well as to identify key mechanisms for the development of green-oriented human capital and related competencies. The interview is anonymous, and all collected data will be used only in an aggregated form. Duration: 45–60 minutes.

Data collection methodology: Data were collected through semi-structured interviews with elements of a standardised questionnaire, conducted with experts representing higher education institutions, including academic staff, university management, and researchers involved in sustainability and ESG-related initiatives.

The survey was conducted online, leveraging digital platforms to ensure coverage of experts across different regions and enhance the representativeness of the sample.

The questionnaire structure includes thematic sections that assess institutional transformation of universities, integration of sustainability principles into educational programmes, development of green competencies, and the societal impact of universities. The collected data were used for both quantitative and qualitative analysis, as well as for comparison with secondary statistical sources. This approach ensures triangulation of quantitative findings and expert assessments.

SECTION A. EXPERT PROFILE	
1. Organization 2. Position 3. Years of experience in the sector:: 4. Category: 5. Field of teaching/research: 6. Publications on sustainability/green transition: 7. University (profile):	_____ _____ _____ ☐ Management ☐ Academic staff ☐ Researcher _____ ☐ Yes ☐ No _____
SECTION B. GREEN UNIVERSITY **Objective:** To assess the role of the green transition and decarbonisation in the strategic development of universities, the extent of integration of environmental and energy-efficient practices into institutional policies, and the implementation of campus-level sustainability initiatives. The section also aims to evaluate the regulatory and institutional context supporting the development of green skills and competencies within higher education systems.	
8. What is the significance of the green transition and decarbonisation for your university? ☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high 9. How important are environmental and energy-efficient measures within your university's overall institutional sustainability strategy? ☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high 10. What specific measures or initiatives are being implemented to transform your campus into a green and sustainable environment?	

11. Are there national or institutional regulatory requirements regarding the development of green skills and competencies among students?

☐ Yes , indicate _____

☐ No

☐ Partially

SECTION C. SECTION C. CURRICULUM AND GREEN COMPETENCIES

Objective: To assess the extent to which sustainability principles are embedded in academic programmes, the adaptation of curricula to the requirements of the green transition, and the development of green skills and competencies through educational and pedagogical practices.

12. To what extent are sustainability concepts integrated into academic curricula in your university?

☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high

13. To what extent are educational programmes aligned with the requirements of the green transition (across Bachelor's, Master's and PhD levels)?

☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high

14. To what extent are traditional disciplines adapted to address real-world sustainable development challenges?

☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high

15. How effective are the pedagogical approaches used for education for sustainable development (e.g., problem-based learning, interdisciplinary approaches)?

☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high

16. Which pedagogical approaches are most effective?

_____

_____

17. Which educational programmes or disciplines in your university are most closely associated with the green transition?

_____

_____

18. What key green skills and competencies should be developed among students?

_____

_____

SECTION D. SOCIETAL IMPACT

Objective: To assess the role of universities in sustainable development through societal engagement, regional integration, and labour market alignment.

19. To what extent do universities interact with society in the context of sustainable development?

☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high

20. To what extent is the "third mission" of universities implemented in your region?

☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high

21. To what extent are educational programmes adapted to local and regional needs related to the green transition?

☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high

22. To what extent do universities promote stakeholder and community engagement in sustainability initiatives?

☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high

23. To what extent do employers require green skills from graduates?
☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high
24. Please provide examples of how universities strengthen links with local communities in the context of sustainable development.

25. What mechanisms are used to implement the “third mission” of universities?

26. What green skills are most demanded by employers in your region?

_____
_____
_____
_____

The questionnaire is structured into thematic sections reflecting key dimensions of institutional transformation, curriculum development, and societal engagement in the context of the green transition in higher education. The objectives of these sections are to identify the mechanisms influencing the formation of green-oriented human capital, including the integration of sustainability principles into academic programmes, the development of green skills and competencies, and the role of universities in regional and societal development.

The results of the survey will be used to generate empirical evidence for the analysis of human capital capacity management in higher education under the green transition, as well as to develop policy recommendations and institutional strategies aimed at enhancing the capacity of universities to support sustainable development.

APPENDIX C

QUESTIONNAIRE FOR ACADEMIC STAFF (HEIs, KAZAKHSTAN)
This questionnaire has been developed within the framework of the doctoral thesis on the management of human capital capacity in the higher education system of Kazakhstan and

Purpose of the survey: to assess the characteristics of human capital and identify key factors influencing academic excellence in higher education institutions.
The survey is anonymous, and all collected data will be used only in an aggregated form.
Data collection methodology: Data are collected through a structured questionnaire with elements of standardised measurement scales (Likert-type), administered among academic staff of higher education institutions. The survey enables quantitative analysis of key indicators and comparative assessment across respondents.
The questionnaire is structured into thematic sections reflecting key dimensions of human capital, academic excellence, and institutional development. The collected data will be used for statistical analysis and the development of evidence-based recommendations.

SECTION A. RESPONDENT PROFILE	
1. University: 2. Region: 3. Gender: 4. Age group: 5. Academic degree: 6. Place where degree was obtained: 7. Position: 8. Combination of teaching and research: 9. Administrative role: 10. English proficiency: 11. Publications (Scopus/WoS): 12. International experience:	_____ _____ ☐ Male ☐ Female ☐ 25–34 ☐ 35–44 ☐ 45–54 ☐ 55–64 ☐ 65+ ☐ Master ☐ PhD ☐ Candidate of Sciences ☐ Doctor of Sciences ☐ Kazakhstan ☐ Abroad _____ ☐ Yes ☐ No ☐ Basic ☐ Intermediate ☐ Advanced ☐ 0 ☐ 1–5 ☐ 6–10 ☐ 11–20 ☐ 20+ ☐ Yes ☐ No
SECTION B. RESEARCH AND TEACHING PERFORMANCE OF ACADEMIC STAFF **Objective:** To evaluate the key dimensions of academic staff performance, including research output, teaching quality, and integration of research into educational activities.	
13. Academic staff demonstrate high publication productivity. ☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree 14. Research outputs have a high citation impact. ☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree 15. Academic staff actively participate in grant and funded research. ☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree 16. Academic staff are actively involved in international research collaboration. ☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree 17. Courses are practice-oriented and aligned with real-world needs. ☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree 18. Research results are effectively integrated into teaching. ☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree	
SECTION C. INSTITUTIONAL FACTORS AFFECTING ACADEMIC STAFF PERFORMANCE	

Objective: To assess institutional and organizational conditions influencing academic staff performance, including availability of research funding, workload distribution, infrastructure quality, incentive systems, and opportunities for international collaboration.

19. Sufficient research funding is available.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

20. The university provides strong institutional support for research activities.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

21. Incentive systems (KPIs, bonuses) effectively stimulate performance.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

22. Opportunities for international mobility are sufficient.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

SECTION D. DEVELOPMENT AND PERFORMANCE ENHANCEMENT

Objective: To identify key barriers and enabling factors affecting academic staff productivity, as well as to determine priority measures, management practices, and performance indicators (KPIs) that can enhance research and teaching effectiveness in higher education institutions.

23. What are the key factors limiting academic staff performance in your university?

24. What measures could improve research productivity?

25. What measures could improve teaching effectiveness?

26. What institutional changes are needed to enhance academic staff performance?

27. What key performance indicators (KPIs) should be used to evaluate academic staff?

_____

APPENDIX D

QUESTIONNAIRE ON FINANCIAL INCENTIVES AND ACADEMIC STAFF PERFORMANCE

This questionnaire has been developed within the framework of the doctoral thesis on the management of human capital capacity in the higher education system of Kazakhstan and

Purpose of the survey: to assess the relationship between financial incentives and academic staff performance, including research activity, KPI achievement, and bonus payments.
The survey is anonymous, and all collected data will be used only in an aggregated form.

SECTION A. RESPONDENT PROFILE	
1. University: 2. Gender: 3. Age group: 4. Academic degree: 5. Position: 6. Faculty/Department 7. Combination of teaching and research: 8. English proficiency:	_____ ☐ Male ☐ Female ☐ 25–34 ☐ 35–44 ☐ 45–54 ☐ 55–64 ☐ 65+ ☐ Master ☐ PhD ☐ Candidate of Sciences ☐ Doctor of Sciences _____ ☐ Yes ☐ No _____ ☐ Basic ☐ Intermediate ☐ Advanced
SECTION B. ACADEMIC ACTIVITY **Objective:** to assess the level of academic activity contributing to performance indicators..	
9. Number of academic activities (publications, projects, conferences): _____ 10. Time spent on research activities (hours/month): _____ 11. Number of publications (last 3 years):_____	
SECTION C. KPI SYSTEM **Objective:** To evaluate the formation and implementation of KPI indicators.	
12. Number of KPI indicators assigned _____ 13. Number of KPI indicators approved _____ 14. To what extent do assigned KPIs reflect actual academic activity? ☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high 15. To what extent do approved KPIs correspond to real performance outcomes? ☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high	
SECTION D. FINANCIAL INCENTIVES **Objective:** To assess the role of financial incentives in academic productivity.	
16. Planned KPI bonus (KPI Bonus, monthly, KZT): _____ 17. Actual bonus received (Bonus, monthly, KZT): _____ 18. To what extent do financial incentives motivate your research activity? ☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high 19. To what extent does bonus size depend on actual performance? ☐ Very low ☐ Low ☐ Medium ☐ High ☐ Very high	

SECTION E. PERCEIVED EFFECTIVENESS OF INCENTIVE SYSTEM

Objective: To assess perceived effectiveness of institutional incentive mechanisms.

20. Financial incentives increase publication activity.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

21. KPI system objectively evaluates academic performance.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

22. Bonus distribution is fair across departments.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

23. Academic degree influences performance evaluation.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

24. Institutional conditions support research productivity.

☐ Strongly disagree ☐ Disagree ☐ Neutral ☐ Agree ☐ Strongly agree

25. What factors most influence academic productivity in your university?

26. What improvements are needed in the KPI and incentive system?

27. How can financial incentives be better aligned with academic performance?

APPENDIX E

ЖШС «Кенжеғали Сағадиев атындағы Халықаралық Бизнес Университеті»
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№ 551 от 24 07.2026
на № ____ от ____

To the Dissertation Council
of Kenzhegali Sagadiyev University
of International Business

IMPLEMENTATION ACT
of the results of the dissertation research

This is to certify that the results of the dissertation research conducted by doctoral student Olzhebayeva Gulbakhyt Serikovna on the topic "Mechanisms of human capital capacity management of higher education system of Kazakhstan in the context of the green transition", completed under the educational programme 8D04101 – Management, were utilized in the implementation of research activities within the framework of the programme-targeted funding project of the Ministry of Science and Higher Education of the Republic of Kazakhstan for 2024–2026, IRN BR24992974, entitled "Modernization of the Higher Education Quality Assurance System in Kazakhstan Based on Digitalization: Development of Approaches, Mechanisms, and an Information Base."

In particular, the following results of the dissertation research have been implemented in the research and analytical activities of the project:

- methodological approaches to human capital capacity management at both the higher education system and university levels, taking into account the principles of sustainable development, ESG approaches, and digital transformation, which were used in developing scientific and methodological approaches to the modernization of higher education governance;
- scientific and practical recommendations for the modernization of the higher education system aimed at developing green competencies, strengthening research capacity, and enhancing the competitiveness of universities, which were taken into account in the preparation of analytical materials and project recommendations for the development and modernization of Kazakhstan's higher education system.

The implementation of these research results has provided additional scientific and methodological justification for approaches to the modernization of the higher education system, the development of university human capital capacity, the formation of green competencies, and the implementation of the principles of sustainable development in the context of digital transformation.

The results of the dissertation research conducted by Olzhebayeva Gulbakhyt Serikovna are of significant scientific and practical value and may be used in the further development of human capital capacity management mechanisms and in enhancing the competitiveness of higher education institutions in the Republic of Kazakhstan.

Director of the DSA **Nurbatsin A.S.:**

To the Dissertation Council
of Kenzhegali Sagadiyev University of
International Business

IMPLEMENTATION ACT
on the implementation of the results of the dissertation research

This is to certify that the scientific outcomes obtained within the framework of the dissertation research conducted by Olzhebayeva Gulbakhyt Serikovna on the topic "Mechanisms of Human Capital Capacity Management of Higher Education System of Kazakhstan in the Context of the Green Transition" have been implemented in the educational process of Penza State University.

The following results of the dissertation research have been used in the educational process:

– theoretical and methodological approaches to human capital management in the higher education system in the context of the green transition, applied in the preparation of teaching and methodological materials and in the delivery of courses related to human resource management, economics of education, and sustainable development;

– an integrated model for managing the human capital capacity of the higher education system, used in examining issues related to the assessment, formation, and development of the human capital of universities;

– scientific and practical provisions on the development of green competencies and the improvement of personnel training in accordance with the principles of sustainable development and the needs of the green economy.

The implementation of these results contributes to updating the content of academic courses, improving the teaching and methodological support of the educational process, developing students' systemic understanding of human capital management in universities, and fostering competencies in the field of sustainable development and the green economy.

The results of the dissertation research conducted by Gulbakhyt Serikovna Olzhebayeva are of scientific and practical significance and may be used in the training of students enrolled in economics and management degree programmes.

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Department of Management and Public Administration
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Личную подпись
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