ABSTRACT
to the dissertation work of Gimranova Renata Ramilevna on the topic: "Structural transformation of human capital in the innovation economy of Kazakhstan: factors and activation mechanisms" presented for the doctor of philosophy degree (PhD) by specialty 8D04101 "Economics"

Relevance of the research topic. The body of knowledge on human capital indicates that the strategic benchmarks set out in the "Kazakhstan-2050" Strategy remain relevant; however, their practical implementation runs up against persistent contradictions. There is a mismatch between the scale of the stated objectives and the actual pace of the economy's technological renewal. The predominance of the traditional economic model constrains labor productivity growth, narrowing the prospects for intensive development. The National Development Plan through 2029 rightly underscores the interdependence between the technological base and the workforce's qualification potential, yet observations show that this balance in Kazakhstan is still far from optimal.

It is widely held that demographic resources and a relatively stable intellectual base do provide a foundation for moving toward a knowledge economy. At the same time, the real activation of human capital runs up against institutional barriers, shortcomings in education policy, and regional disparities. World Bank experts highlight the need to fuse traditional occupations with digital competencies. Practical analysis confirms that it is precisely at this intersection that a new professional identity is emerging one that changes not only the content of work but also its social significance.

Kazakhstan's integration into global clusters heightens the demands on the flexibility and mobility of its human capital. Interaction with MNCs reveals a need to build research competencies and to operate within networked structures where teams are assembled from ecosystem resources for specific tasks. Innovation ecosystems depend on the unique potential of network structures, whereas knowledge ecosystems require a consistently high level of educational attainment across the entire country. This factor becomes critical in shaping long-term competitive advantage.

The completion of the national project "Quality Education: An Educated Nation" exposed the weak effectiveness of existing instruments. Regional imbalances in educational and research capacity, low doctoral activity, and disproportionate requirements for dissertations create a systemic constraint. Sustainable growth of human capital is possible only if regional disparities are reduced, incentives for research activity are established, and an environment is built in which knowledge is converted into innovative outcomes. Human capital thus appears not as an abstract resource, but as a core capable of ensuring sustainable development and strengthening Kazakhstan's position in the global economy.

Degree of scholarly development of the dissertation topic. The classics of human capital theory include J. Mincer, T. Schultz, G. Becker, and others. The first justifications of the factor's significance appeared in macro-level studies and later

at the individual level. All of them substantiated the link between economic growth and the aggregate qualities of human resources. Since then, the growth models of S. Kuznets, R. Solow, P. Romer, and other economists can no longer be conceived without accounting for human resources as a driver of long-run economic growth.

Scholars with significant contributions to human capital theory include S. Fischer, M. Blaug, L. Thurow, J. Kenrick, E. Denison, and others. In the post-Soviet space, extensive studies were conducted under the leadership of A. Koshanov, U. Baymuratov, E. Aimaganbetov, A. Suyeubayeva, S.N. Mukhametzhanova, R. Kapelyushnikov, R. Nureyev, V. Radayev, M. Meldakhanova, F. Alzhanova, M. Kritsky, O. Ivanov, Z. Chulanova, A. Kibaeva, G. Podvoysky, V.V. Biryukov, G.T. Kunurkuldzhayeva, and others. The measurement of human capital's impact remains a matter of debate; macro-level models by I. Ben-Porath, J. Heckman, S. Yu. Malkov, and others attempt to address it, yet none are universally accepted. At the international level, the UNDP's Human Development Index is officially adopted, and the World Bank's Human Capital Index is also used.

Efforts to justify the specific functioning of human capital in the context of particular forms of economic activity led to the emergence of corporate human capital concepts in the works of S. Vaiks, V. G. Balashova, and others. This category has been elaborated through the lenses of intellectual, social, and organizational capital in studies by K. Kastopoulos, K. Shahdadi, J. Young, F. Blackler, A. Kianto, and others.

Technico-technological paradigms based on digital technologies have transformed the most competitive form of industrial/post-industrial economy clusters into ecosystems, which in turn demand a new level of both professional and extra-professional training of human capital. Systemic research on the phenomenon of business ecosystems, their origins and functioning including through the prism of human capital has been carried out by J. Moore, W. Pidun, M. Reeves, N. Knust, R. Kapoor, D. Cobbins, and others. Such international benchmarks of competitiveness for economic actors necessitate a sufficiently high level of human capital, which is formed across all stages of education. These issues are already being actively developed in the works of N. A. Litvinova, A. G. Izotova, A. A. Butanova, S. Y. Umirzakov, and others.

Proposals to strengthen the factors of human capital formation on the basis of activation mechanisms will always be needed, since both the economy and its requirements are in continuous flux.

The aim of the dissertation is to examine the factors affecting human capital in Kazakhstan's economy and to activate mechanisms for its improvement in the context of innovative development.

To achieve this aim, the following tasks were set and accomplished:

– to review the evolution of human capital theory amid the innovative development of the global economy and shifts in techno-technological paradigms;

– to study the transformation of human capital under the dominance of digital business ecosystems;

– to consider the methodology for researching human capital as a factor of innovative development;

– to analyze international indices that account for a country's human capital and to assess Kazakhstan's position;

– to analyze the problems of structural transformation of human capital under the innovative development of Kazakhstan's economy;

– to analyze the structural modeling of business competitiveness in ecosystems in the context of human capital and innovation;

– to identify priority areas and mechanisms for improving the quality of human capital;

– to develop tools for educational programs under the digital economy and the 5th-6th techno-technological paradigms.

The object of the research is human capital in the Republic of Kazakhstan under the formation and development of an innovative economy. The subject of the research is the set of theoretical, methodological, and practical provisions for developing Kazakhstan's human capital in the context of innovation and business ecosystems.

The theoretical and methodological significance of this study lies in the development of an approach to the category of network human capital, as well as mechanisms for activating its growth at the macro level and in business ecosystems in the digital economy. The multilevel and interdisciplinary nature of the study predetermined the use, alongside methods of systems, institutional, and economic-statistical analysis, of an empirical sociological research method, with the results processed in the PLS-PM software.

The empirical base consists of the results of a sociological survey of respondents representatives of companies that are participants and organizers of ecosystems as well as official statistics, including international statistics.

The scientific novelty of the dissertation results is determined by the assessment of Kazakhstan's human capital within the context of global indices and internal criteria, and by proposals developed for mechanisms to activate it:

– the category of network human capital is proposed as a synthesis of formal and informal knowledge of a technical, technological, and managerial nature that ensures the functioning and development of business ecosystems as a competitive form of economic development within the 5th and 6th techno-technological paradigms;

– macro-level factors influencing the level of high-tech production in the countries of the Caucasus and Central Asia are substantiated, among which the population's education level, the number of university graduates in science and engineering, and the number of researchers per one million inhabitants proved significant;

– factors of positive and negative influence of human capital on the competitiveness of Kazakhstan's industrial ecosystems are identified, including in the course of introducing innovations of a digital and geoeconomic nature into the ecosystem;

– tools for higher education programs under the digital economy are developed that activate mechanisms for generating and renewing human capital in university and post-university learning processes;

– measures of a direct and indirect nature are proposed to increase motivation and expand individuals' opportunities for accumulating their human capital, including in areas that are not traditionally considered within this problem field.

Key scientific propositions submitted for defense:

– Macro-level factors influencing the level of high-technology production in the CCA countries, which confirm the importance of the number of graduates in science and technology and the number of researchers per one million inhabitants;

– Factors of network human capital that exert positive and negative effects on the competitiveness of Kazakhstan's ecosystems;

– The foundations of the professional standards "Ecosystem Digital Manager (sectoral)" and "Design Engineer of Flexible Processes in Mechanical Engineering," which define the core job functions, knowledge, and skills for two professions aligned with the 5th and 6th technological paradigms;

– The organizational scheme and scenario of the business game "Modeling an Ecosystem as a Subject of the Digital Economy," which enables the interactive mastering of qualification norms for embedding a company into an ecosystem;

– A set of administrative, organizational, and economic mechanisms for the structural transformation of human capital in Kazakhstan, which expand the opportunities to raise its average level nationwide.

Practical significance of the recommendations is reflected in the development of the following proposals to activate the mechanisms for human capital growth:

– methodological approaches to the instruments of educational programs in the digital economy;

– proposals for adding amendments to the regulatory and legal framework, as well as to the organizational and economic mechanisms of school education, targeted social assistance, employment promotion, and social services, which implement a multi-level approach to the issue of human capital growth.

The study's recommendations are part of a fundamental research project carried out under a grant from the Committee of Science of the Ministry of Science and Higher Education of the Republic of Kazakhstan: "Kazakhstan in the Global Value Chain: Export Potential, Strategy, and Integration Mechanisms (AP19680334)," state registration number 0123RK01027.

Approbation and implementation of the results. The main results of the dissertation research have been published in 9 scholarly works, including 4 articles in journals recommended by the Committee for Quality Assurance in the Sphere of Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan, 1 article in a peer-reviewed journal indexed in Scopus, and 4 articles in proceedings of international scientific conferences.

Structure and length of the dissertation. The dissertation consists of normative references, definitions, symbols and abbreviations, an introduction, three chapters, a conclusion, a list of references, and five appendices totaling

fourteen pages. The content spans 140 pages and draws on 309 sources, with 28 tables and 15 figures.

Chapter One shows how the neoclassical tradition adds microfoundations of rational choice: investments in education are explained by comparing marginal returns with the opportunity cost of capital. The decisive turn in the 20th century comes from T. Schultz, G. S. Becker, and J. Mincer: human capital is treated as a stock of innate and acquired abilities formed through education, health, and experience, which raises income and productivity. A specific feature of the asset is emphasized its inseparability from the bearer, so the market records not the "price of the asset" but its "rental price" via wages and skill premia.

At the macro level, the section links human capital theory to growth theories. In parallel, a technological perspective is introduced the shift of technological paradigms (uklads) as an exogenous "demand shock" for new competencies: the 5th and the emerging 6th paradigms raise the price of engineering, mathematical, and research skills, tightening requirements for education quality, health, and managerial capabilities. On this basis, a working definition is formulated: human capital is a multi-level asset (individual, corporate, national) that combines knowledge, skills, health, motivations, and other attributes which are embedded in production and institutional processes and converted into output, innovation, and welfare.

The section "Evolution of the Theory of Human Capital under the Innovative Development of the Global Economy and the Shift of Technological Paradigms" makes an important contribution: a detailed typology. By level: individual, corporate, and national human capital; by orientation: creative (innovative), passive, and negative. This lens is essential for applied policy: the mere "mass" of graduates is insufficient the share of the creative segment is crucial, i.e., competencies that actually launch innovations and improve business models. The distinction between "human capital" and "human potential" is also drawn. The chapter substantiates the need to work simultaneously with a "narrow" economic treatment (for calculations and modeling) and a "broad" one (for strategizing and institutional design).

The section "Transformation of Human Capital under the Dominance of Digital Business Ecosystems" shifts the focus to the contemporary context of digital ecosystems. The key thesis is that digitalization (IoT, AI, cloud, platforms, e-gov) changes not only technologies but also the architecture of cooperation from vertical and cluster ties to ecosystems. In this environment, human capital ceases to be an "intra-firm resource" and takes on a networked form: value is created through integrating the competencies of independent participants, standardized knowledge-exchange interfaces, interoperable data, and managed access rights. The notion of "network human capital" emerges a distributed stock of knowledge and practices ensured not by a single organization but by the architecture of interaction. Here the synergy of intellectual, social, and organizational capital is revealed: trust, willingness to share knowledge, quality standards, joint R&D, staff exchanges, and mentoring. It is shown why, in ecosystem logic, competitiveness depends less on a single product and more on the speed and quality of business-

model transformation and on management's ability to design roles, access rules, monetization mechanisms, and benefit sharing.

The section "Methodology for Studying Human Capital as a Factor of Innovative Development" defines the methodological framework of the research. First, the levels of analysis are set: international, macro-/meso-level, and micro-level. Second, the "triad of approaches" to measuring human capital is described: the cost approach (households and the state), the income approach (lifetime earnings or skill premia), and the index approach (composite indicators). The anchor indices considered are the UNDP's Human Development Index, the World Bank's Human Capital Index, as well as adjacent composites – GII (innovation performance) and GCI 4.0 (competitiveness in the Industry 4.0 era), which make it possible to link human capital with the innovation and institutional environment.

Chapter One substantiates the empirical toolkit for the subsequent analysis:

– regression analysis to assess the impact of human capital components on high-tech output/innovation in a comparable group of countries;

– structural modeling (PLS-SEM) using expert survey data from companies embedded in clusters/ecosystems to identify the direct and mediated effects of corporate and network human capital on competitiveness (via innovation, process modernization, access to capacities and software, logistics, quality standards, etc.).

The chapter formulates the following working hypotheses:

1) network human capital benefits all participants in the ecosystem;

2) access to digital solutions within the ecosystem increases firms' competitiveness;

3) business-model transformation upon entry into an ecosystem is the key channel for efficiency gains.

Chapter Two is devoted to an empirical analysis of how networked human capital and in ecosystem innovation affect firms' competitiveness. The study draws on a sociological survey of 72 economic sector representatives (metallurgy, mechanical engineering, pharmaceuticals, banking) and structural modeling via Partial Least Squares (PLS-SEM, SmartPLS 4). The conceptual framework specifies "firm competitiveness" as the dependent variable and two predictor blocks: "network and local human capital" (access to upskilling, graduates' digital skills, intra-network staff exchange) and "innovation" (access to new digital technologies and equipment, organizational change and business-model transformation, logistics, quality standards, etc.).

The methodological section confirms the soundness of the measurement constructs: for most scales Cronbach's Alpha $\geq$ 0.60; rho_A and Composite Reliability meet accepted thresholds; Average Variance Extracted (AVE) $\geq$ 0.50. VIF values are within acceptable limits; indicators showing multicollinearity were removed prior to the final specification. Thus, the reliability and clarity of the measurement model and the robustness of subsequent causal analysis are ensured.

Structural modeling results support the key hypothesis on the importance of human capital: there is a statistically significant link with a high effect size between "networked human capital" and "competitiveness." The largest contributions come from mechanisms of accelerated knowledge diffusion: access

to upskilling programs, formal staff exchange within the ecosystem, and the quality of graduates' digital preparation. The hypothesis of a direct effect of internal innovation is also supported. Access to new digital technologies is positively (moderately) correlated with competitiveness; the effect of business-model transformation upon ecosystem entry is stronger, highlighting the role of organizational innovation as a "bridge" between technological possibilities and market outcomes.

At the same time, adverse adaptation effects are recorded. Access to digital technologies is associated with a negative impact on human capital due to learning costs: a shortage of practice-oriented skills, the need for mentorship, and staged IT integration. Expansion into new regions likewise reduces human resource quality (negative link with networked human capital), pointing to talent gaps outside major agglomerations and limited specialist mobility. Practical implications center on three tracks: first, prioritizing network mechanisms of workforce development; second, a "soft-landing" digitalization-tutoring, project-based integration of solutions, learning metrics, and managed pilots that minimize productivity dips during training; third, a regional agenda-fast-tracking local education pathways in industrial growth nodes and supporting mobility and attraction of scarce talent.

In sum, Chapter Two shows that sustained competitiveness gains in ecosystems depend less on mere access to technology and more on human capital's capacity to absorb it quickly and translate it into organizational innovation. A balanced "technology-skills-business model" link underpinned by institutional mechanisms of training, exchange, and regional leveling is the critical condition for converting innovation resources into market impact.

Chapter Three is devoted to shaping priorities and mechanisms for improving the quality of human capital as Kazakhstan transitions to an economy of innovation and ecosystems. Empirical results and benchmarking against international references show that the key to a technological leap lies not in "isolated breakthroughs," but in raising the broad baseline of skills that ensures standardized labor quality nationwide. The foremost task is to equalize territorial access to the basic services for building human capital early childhood education, schools, and adult training and retraining programs. These steps require regulatory specification of infrastructure parameters that account for settlement patterns, demographics, and logistics, as well as the introduction of multifunctional educational hubs with NGO participation and targeted subsidy mechanisms.

The second direction is to retune targeted social support toward children's education and health and toward upgrading parents' competencies. It is proposed to link benefit receipt to obligations on preschool attendance and schooling, and for able bodied adults to participation in employment programs and upskilling. This shift moves transfers from a distributive to an investment logic, lowering the "high entry threshold" to the labor market.

The third direction is a radical strengthening of adult-learning pathways: modular programs for those in work, distance formats, recognition of prior learning, qualification certification based on corporate centers, and expansion of the network of accredited assessment centers. Large-company practices (in house

training centers, digital simulators, mobile platforms) demonstrate how embedding learning in the production cycle accelerates the circulation of competencies while reducing transaction costs.

The fourth area involves the targeted modernization of higher-education instruments toward an ecosystem-based model. The business game "Modeling the Ecosystem as a Subject of the Digital Economy" creates conditions for implementing project cases developed within the game (mastering the functions of an "orchestrator" and a "complementor") and develops students' skills in strategizing, network interaction, and decision-making under market uncertainty. In this regard, it is proposed to introduce the professional standard "Ecosystem Digital Manager (industry-specific)." As an element of modern interdisciplinary training at the higher-education level, the professional standard "Flexible Processes Design Engineer in Mechanical Engineering," which synthesizes digital, engineering, and managerial competencies, is also proposed.

Taken together, a coherent package of institutional, educational, and social measures has been formed. It strengthens the durability of human capital accumulation, speeds adaptation to the 5-6 technological układs, and creates a foundation for long-term gains in productivity and competitiveness of Kazakhstan's economy.

Dissertation Author   **Gimranova R.R.**