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From Skills to Innovation: The Evolution of Human Capital in the Age of Technology

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Abstract. The purpose is to analyze the transformation of human capital under the influence of digitalization, automation, and the introduction of artificial intelligence, with special attention to the changing requirements for professional competencies and the formation of the concept of digital human capital as a new paradigm in the knowledge economy. Methods – a comprehensive methodological approach is employed, incorporating statistical data analysis, content analysis, and comparative analysis. Results – the key factors of human capital development are highlighted here: digital and "soft" skills, continuous learning, emotional intelligence, and the ability to adapt quickly. The data of international organizations (UN, World Bank, OECD) on the current state of human capital and the human development index in various countries are analyzed. Recommendations on reforming the educational system, corporate training, and government policy in order to build sustainable human potential are proposed. Conclusions – In the context of the modern digital economy, a new paradigm of human capital has emerged – digital human capital, which requires new assessment and development. There is a need to adapt educational, corporate, and government strategies to support the formation and enhancement of competencies that are in line with the challenges of the digital age.

Keywords: human capital, digital technologies, soft skills, innovation, knowledge capital, jobs.

Introduction

In the context of rapid digitalization and technological transformation, human capital is becoming a key resource for sustainable economic development. Modern changes in the labor market require not only new technical knowledge, but also the ability to adapt, critical thinking and continuous learning. Under the influence of automation, artificial intelligence, Big Data and digital platforms, not only the content of professional competencies is being transformed, but also approaches to education, personnel management and the formation of an institutional environment.

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The concept of human capital dates back to the works of Theodore T. Schultz (1961) and G. Becker (1964), where the economic value of investments in education and health was emphasized. Subsequently, the research of J. Stiglitz (2012), James J. Heckman and Tim Kautz (2012), and other authors expanded the theoretical framework by adding factors of social inequality, emotional intelligence, and the role of soft skills. In recent years, researchers have focused on the digital component of human capital (Brynjolfsson & McAfee, 2014; Acemoglu & Restrepo, 2019), as well as on changing employment patterns in the face of technological shifts (Autor, D.H., 2015; World Economic Forum, [WEF], 2023).

Literature review

In international practice, the development of human capital is considered as a comprehensive task requiring coordination of efforts by the state, educational institutions and business. The reports of the World Bank and the OECD emphasize the need to adapt educational strategies to the realities of the digital economy, investment in digital literacy and staff retraining (The World Bank Group, 2018; OECD, 2023).

At the same time, the issues of digital transformation of human capital are becoming increasingly relevant in the Republic of Kazakhstan. Research (Omar, A.D., & Shildibekov, Y. Z., 2019; Turekulova, A.N., Arystanbayeva, S.S., & Chereyeva, V. T., 2023) shows both positive trends and existing risks, from digital inequality to a shortage of qualified personnel.

The object of this research is human capital as a set of knowledge, skills and abilities in demand in the modern labor market. The subject is the impact of technological changes (including automation, digitalization, and the introduction of AI) on the structure, content, and value of human capital, as well as on the qualifications and competencies of employees in a rapidly changing economic environment.

The purpose of this study is to analyze the impact of technological changes on the structure and content of human capital, as well as to identify key competencies needed to adapt to the digital economy. Special attention is paid to approaches to the development of digital and "soft" skills, the role of education, corporate training and public policy.

Thus, the analysis focuses on the transformation of human capital as a factor of sustainable development, innovation and social adaptability in the context of the transition to a digital society.

Research methods

The present study is aimed at studying the processes of transformation of human capital under the influence of digitalization, automation and the introduction of new technological solutions. Within the framework of the work, the author seeks to determine how the requirements for professional skills and competencies are changing, as well as how the education and personnel management system can be adapted to the challenges of the digital economy.

The research questions underlying this study are: How are modern technologies transforming the structure and content of human capital? What skills and competencies are becoming key in the digital economy? How can public and private institutions contribute to the effective development of digital human capital?

The research hypothesis (thesis) is as follows: in the context of technological change, effective human capital development is possible only with an integrated approach combining digital skills, soft competencies, continuing education and adaptive educational policy.

The stages of the study included:

– Analysis and generalization of theoretical approaches to the concept of human capital (including digital).

– Study of international and national experience in the development of human capital in the context of digitalization.

– Collection and analysis of statistical data (World Bank, UN, OECD, etc.).

– Interpretation of data in order to develop recommendations for educational institutions and employers.

Research methods:

Content analysis was used to study scientific publications, strategic documents and reports of international organizations on human capital.

Comparative analysis was used to compare approaches of different countries to human capital management and digital transformation.

Statistical data analysis is based on reports from international institutions, as well as data from the national statistics of Kazakhstan.

This approach has made it possible to identify key areas of human capital transformation and formulate practical recommendations for adapting educational and management practices to the digital economy.

Results and discussion

1. Digital human capital: a new paradigm

In modern conditions, human capital is not limited to the traditional understanding of knowledge and skills acquired through training and professional experience. There is a need to rethink this category towards digital human capital, including digital literacy, the ability to work with information, programming skills, data analysis, interaction with AI, etc.

Digital human capital also encompasses the ability to collaborate in a virtual environment, willingness to innovate, and high adaptability to change. It is becoming a key element of the competitiveness of organizations and states in the era of digitalization.

According to the World Economic Forum report for 2023, employers in the digital economy attach special importance to such competencies as analytical thinking, technological literacy, creativity and emotional intelligence (Fig.1).

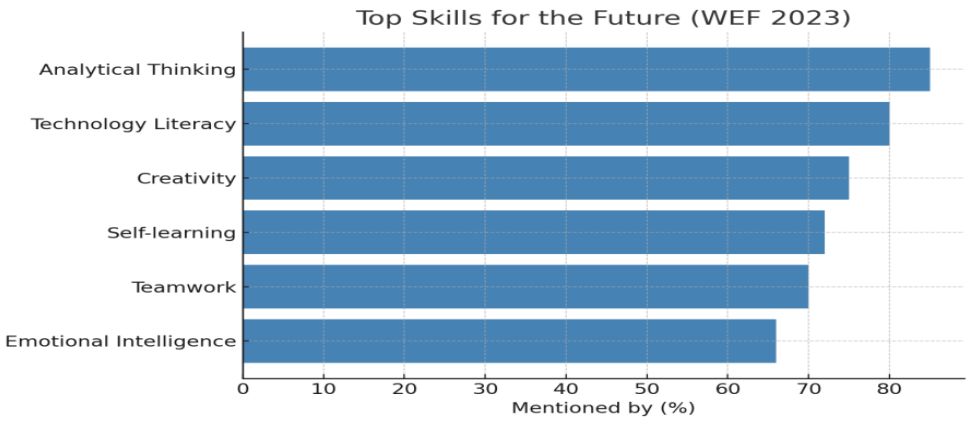

Figure 1 – Most sought-after skills of the future according to WEF, 2023

Note: compiled based on the data (WEF, 2023)

2. Relationship with the Human Development Index (HCI)

Technological development has a direct impact on the components of the human development index: education, health, and economic well-being. Digital tools improve access to services and their quality, contributing to the creation of new forms of employment. However, there remains a high degree of heterogeneity between countries.

According to the United Nations Development Program, the HDI reached record levels in 2023-2024, but there remains a significant gap between highly and low-developed countries (United Nations Development Programme [UNDP], 2023).

The World Bank has developed a human capital index that evaluates the potential productivity of future employees based on ideal conditions – complete education and excellent health. The value of the HDI for a particular country shows how much of the reference productivity a child born in a given country can achieve today by the time they reach working age. Table 1 illustrates the contribution of individual components to the overall performance index.

Table 1 – Potential labor productivity of a child born in 2018 (according to the World Bank)

	Component	**A country in the**		
		25th percentile	**50th percentile**	**75th percentile**
		of the X component, has the following indicator		
1	**Component 1: survival**			
	The probability of living up to 5 years	0.95	0.98	0.99
A	Contribution to productivity	0.95	0.98	0.99
	Component 2: school			
	Expected length of schooling (number of years)	9.5	11.8	13.1
	Points scored during testing (out of the maximum possible 600)	375	424	503
2	The number of quality-adjusted school years – Contribution to productivity	5.7	8.0	10.5
B	Contribution to productivity	0.51	0.62	0.76
	Component 3: health			
3	The share of children who do not suffer from stunting	0.68	0.78	0.89
4	Adult survival rate	0.79	0.86	0.91
C	Contribution to productivity *	0.88	0.92	0.95
	The Overall Human Capital Index (A×B×C)	0.43	0.56	0.72

* is compared as the geometric average of the contribution of points 3 and 4 to performance.
Note: compiled based on the data (World Bank, 2018)

For example, according to the HCI, a newborn in Kazakhstan realizes only about 75% of its production potential. At the same time, the country is showing positive dynamics in a number of indicators, but faces problems with the quality and duration of schooling.

3.Education as a strategic factor

The formation of digital human capital requires a review of educational strategies. An important area is the integration of digital courses into curricula: programming, analytics, cybersecurity, as well as the development of soft skills through practice-oriented forms of education.

The cooperation of educational institutions with business plays an important role as a source of relevant content, mentoring support and professional trajectories for graduates.

4.The impact of technological transformations on professions

Automation and artificial intelligence are radically changing the structure of employment. Professions with a high level of routine operations are at risk of extinction. At the same time, the demand for IT specialists, engineers, analysts and developers of digital solutions is growing.

Table 2 – The impact of automation on industries (forecast for 2025)

Branch	Automation level (%)	The risk of displacement of jobs
Production	60–70%	High
Logistics and transport	50–60%	High
Financial services	40–50%	Average
Education	20–30%	Low
Healthcare	15–25%	Low

Note: compiled based on the data (Schwab, K., 2016)

These changes form the demand for continuing education and retraining systems. Joint programs between companies and universities are becoming a necessary tool for the sustainable development of human capital.

5. Digital technologies and innovation potential

The introduction of digital solutions (automation of business processes, AI and Big Data) has a positive impact on the productivity and innovation activity of companies. The effect is manifested both in increasing the efficiency of internal processes and in creating new products and business models. Statistics show that companies investing in research and development (R&D) using new technologies demonstrate an increase in the level of innovation activity by 15-25%.

Innovative initiatives in IT and agricultural sectors, supported by government programs, are intensifying in Kazakhstan. The use of drones, IoT, and digital commerce platforms opens up prospects for both technological and social growth.

6. International practices and comparison

International experience (USA, India, Japan, Scandinavian countries) demonstrates diverse approaches to the development of human capital. The unifying element is the priority of digital education, large-scale investments in retraining and strategic planning in the face of technological change. (WEF, 2023).

Table 3 – Comparison of digital human capital by country (based on HCI and HDI.

Country	Human Capital Index HCI[1]	Human Development Index HDI[2]	Life expectancy	Годы обучения
Norway	0.80	0.961	83,1	18,1

Switzerland	0.79	0.962	84,0	17,8
South Korea	0.73	0.925	83,5	16,5
Kazakhstan	0.61	0.812	70,4	15,2
India	0.49	0.633	70,8	12,2

Note: compiled based on the data (UNDP, 2023; The World Bank,2023)

These data confirm that the formation of digital human capital requires a comprehensive and systematic policy based on close cooperation between the government, business and the educational system.

Conclusion

The conducted research has shown that the rapid development of digital technologies has a profound impact not only on the economy, but also on the fundamental characteristics of human capital. In the context of digital transformation, traditional approaches to the assessment and formation of human resources are losing relevance. They are being replaced by the concept of digital human capital, a dynamic complex of cognitive, communicative and digital competencies that promote adaptation and innovation.

Digital human capital is becoming a determining factor for competitiveness, sustainable growth, and technological leadership. Its development requires systemic transformations in the field of education, corporate training and public policy. The most important condition for successful transformation is the coordinated interaction of all stakeholders: the government, business, educational institutions and employees themselves.

In order to effectively develop human capital in the context of technological change, it is proposed to implement the following areas:

1. Integration of digital technologies into education programs at all levels, including modules on data analysis, programming, artificial intelligence, and cybersecurity.
2. Development of a lifelong learning system to ensure the flexibility of professional training and adaptation to the rapidly changing demands of the labor market.
3. Implementation of digital learning management systems (LMS), as well as analytical tools for personalizing educational trajectories and assessing competencies.
4. Formation of sustainable partnerships between universities, business and the state aimed at joint development of education programs, practices and mentoring initiatives.
5. Focus on the development of soft skills, including critical thinking, communication skills, and emotional intelligence as essential elements of digital literacy.
6. Development of a digital learning infrastructure that provides equal access to educational resources: broadband Internet, equipment, and methodological support.

The evolution of human capital requires rethinking previous models and developing a new development paradigm focused on flexibility, inclusivity and innovation. The ability of society to effectively adapt to the challenges and opportunities of the digital age will depend on the nature and focus of investments in human potential.

Conflict of interest: no conflict of interest.

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Дағдылардан инновацияға дейін: технологиялар дәуіріндегі адами капиталдың эволюциясы

Аңдатпа. Мақсаты – цифрландыру, автоматтандыру және жасанды интеллектті енгізудің әсерінен адамның капиталдарының трансформациясын талдау, кәсіби біліктілік талаптарының өзгеруіне және білім беру, бизнесті және мемлекеттік секторды цифрлық адам капиталының жаңа парадигмасы ретінде қалыптастыруға ерекше назар аудару. Әдістер – кешенді әдістемелік тәсіл қолданылды. Оған статистикалық деректерді талдау, мазмұнды талдау және салыстырмалы талдау еңгізілді. Нәтижелер – адамның капиталын дамытуда негізгі факторлар анықталды: цифрлық және «жұмсақ» дағдылар, үздіксіз оқыту, эмоционалдық интеллект және тез бейімделу қабілеті. Халықаралық ұйымдардың (БҰҰ, Дүниежүзілік банк, OECD) әртүрлі елдердегі адамның капиталын және адам дамуы индексін талдады. Білім беру жүйесін, кәсіпорындардағы оқытуды және мемлекеттік саясатты реформалау бойынша ұсыныстар жасалды, тұрақты адам әлеуетін қалыптастыру мақсатында. Қорытындылар – қазіргі цифрлық экономика жағдайында жаңа адам капиталы парадигмасы – цифрлық адам капиталы қалыптасып, ол жаңа бағалау мен дамуды

қажет етеді. Цифрлық дәуірдің шақыруларына сәйкес біліктіліктерді дамыту және жетілдіру үшін білім беру, корпоративтік және мемлекеттік стратегияларды бейімдеу қажет.

Түйін сөздер: адами капитал, цифрлық технологиялар, жұмсақ дағдылар, инновациялар, білім капиталы, жұмыс орындары

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От навыков к инновациям: эволюция человеческого капитала в эпоху технологий

Аннотация. Цель – анализ трансформации человеческого капитала под воздействием цифровизации, автоматизации и внедрения искусственного интеллекта, с особым вниманием к изменению требований к профессиональным компетенциям и формированию концепта цифрового человеческого капитала как новой парадигмы в экономике знаний. Методы – использован комплексный методологический подход, включающий анализ статистических данных, контент-анализ и сравнительный анализ. Результаты – выделены ключевые факторы развития человеческого капитала: цифровые и «мягкие» навыки, непрерывное обучение, эмоциональный интеллект и способность к быстрой адаптации. Проанализированы данные международных организаций (ООН, Всемирного банка, OECD) о текущем состоянии человеческого капитала и индексе человеческого развития в различных странах. Предложены рекомендации по реформированию образовательной системы, корпоративного обучения и государственной политики в целях формирования устойчивого человеческого потенциала. Выводы – в условиях современной цифровой экономики сформировалась новая парадигма человеческого капитала – цифровой человеческий капитал, который требует новой оценки и развития. Возникает необходимость адаптации образовательных, корпоративных и государственных стратегий для поддержки формирования и повышения компетенций, соответствующих вызовам цифровой эпохи.

Ключевые слова: человеческий капитал, цифровые технологии, мягкие навыки, инновации, капитал знаний, рабочие места.

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