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The Human Capital Gap in Wartime Ukraine: Business Adaptation and the State–Business–Education Model for Recovery

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Abstract

Background: The full-scale war in Ukraine has caused severe disruptions to the national economy and labour market, making the preservation and development of human capital a critical national priority. Understanding these transformations is essential for ensuring effective post-war recovery and long-term stability.

Objective: This study aims to analyse the transformation of human capital in Ukraine during wartime, identify the primary factors contributing to its decline, and explore effective adaptation mechanisms developed by the private sector.

Methodology: The research utilised data from international organisations and national statistics spanning 2010–2025. Comparative and statistical analyses were applied to assess trends in the Human Capital Index, employment structures, and education funding. Case studies of leading Ukrainian firms, including Rozetka, Nova Poshta, Myronivskyi Hliboproduct, SoftServe, and EPAM Ukraine, were examined to identify specific adaptive strategies.

Results: In 2024, the Human Capital Index in Ukraine decreased by 19% compared to the European average. Unemployment reached 17–20%, informal employment rose to 24%, and education funding dropped from 6.1% to 5.2% of GDP. Despite these challenges, businesses implemented successful practices such as corporate training centres, flexible employment models, mentoring, and psychological support systems.

Unique Contribution: The study proposes an innovative state–business–education model that integrates multi-sectoral efforts to restore human capital and enhance institutional resilience during and after the conflict.

Conclusion: Investing in human capital during wartime is a fundamental element of national security and a prerequisite for successful post-war recovery.

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Key Recommendation: Future research should focus on quantifying the long-term effects of wartime migration and assessing the longitudinal efficiency of the proposed tri-sectoral cooperation model.

Keywords: human capital index, Ukrainian business, war, labour market, adaptation, resilience, recovery, social responsibility.

Introduction

The modern global economy is undergoing a profound structural transformation, caused by the consequences of several interconnected crises – financial, energy, environmental and security. The period after 2020 has been marked for most countries of the world not only by a series of economic shocks, but also by the need to rethink development models, at the centre of which people increasingly appear as the main factor of sustainability. Traditional resources – capital, labor and natural resources – no longer guarantee competitiveness without a high level of human potential, knowledge and innovation (Radchenko et al., 2023).

For Ukraine, which has been in a state of armed conflict since 2014 and has been experiencing the consequences of a full-scale war since 2022, the issue of human capital development has acquired existential importance. According to the State Statistics Service of Ukraine (2025), over the period 2022-2024, the number of the economically active population decreased by more than 15%, and migration processes caused a significant shortage of qualified personnel in most sectors of the economy. The experience of other countries that have faced large-scale crises – including Croatia, Bosnia and Herzegovina, and Japan after World War II – demonstrates that investments in human capital, education, retraining, and mental health are the foundation for sustainable recovery. As the World Bank's (2024) analytical report states, maintaining an emphasis on human resources during the war led to GDP recovering, on average, 3.5 percentage points faster in the post-war period.

At the same time, Ukraine is developing its own mechanisms for preserving human potential – from corporate employee support programs to state-level initiatives, such as the "Human Capital Sustainability Charter", developed in 2023. These measures reflect the trend towards a transition from reactive solutions to a systemic approach based on the principles of social responsibility, inclusiveness and psychological support for personnel.

Literature Review

In the scientific literature, the concept of human capital is considered as a set of knowledge, skills, health and social competencies that determine labour productivity and the ability to innovate (; Alekseieva et al., 2023). In times of crisis and military conflict, human capital acquires strategic importance as the basis for economic resilience, production recovery, and social cohesion (Makedon et al., 2025).

According to Organisation for Economic Co-operation and Development (2024a), restoring human capital in crisis economies involves integrating three areas: protecting workers, investing in retraining, and strengthening labour market institutions. The Employment Outlook report (Organisation for Economic Co-operation and Development 2024b) states that countries that increase funding for vocational training and employment support programs by at least 0.5% of GDP during military or humanitarian crises reduce the duration of recession by 1–1.3 years. According to the World Bank (2025), the effectiveness of human capital management

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directly affects the speed of economic recovery from conflicts. In the scientific discussion, three main approaches to the study of human capital in the period of war and crisis can be distinguished:

1. Economic, centred on the measurement of the losses in production, income, and jobs due to the destruction of infrastructure and migration processes (Clark et al., 2023; Kolos et al., 2023).
2. Social, emphasizing the importance of education, health, mental well-being and gender equality in reproduction of human capital (Islam & Amin, 2022).
3. Institutional, studying varying state policies and corporate practice toward the preservation of labor potential (Lu et al., 2023).

A significant contribution to the formation of a systemic approach to the preservation of labour potential was made by the initiative "Charter of Resilience of Human Capital" (2023), which defines the principles of corporate responsibility in wartime – organisation of employee safety, flexible working formats, and development of competences.

This corresponds to European policy practices aimed at creating a sustainable, adaptive and inclusive labour system that is able to withstand crises and respond quickly to changes (Goniewicz et al., 2023; Arsawan et al., 2024). According to World Bank (2025), prolonged war leads to a "lost generation" in the workforce if systematic investments in education, health care, and vocational training are not made.

Ukrainian researchers also pay considerable attention to the study of human capital in the context of the war economy. Thus, in the works of Prokhorova et al. (2025), Dubyna et al. (2022) emphasise that the main determinants of human potential reproduction are the integration of education and business systems, the digitalisation of work processes, and the formation of flexible employment support institutions.

Simultaneously, there exists a large asymmetry of results between the countries, owing to differences in the degree of development of institutions, access to educational resources, and the possibilities of the enterprises to make investments in personnel.

Materials and Research Methods

The empirical base is based on the data of the World Bank (2024), Organisation for Economic Co-operation and Development (2024a, 2024b), International Labour Organisation (2024a; 2024b), United Nations Development Programme (2024), as well as the official statistics of the Ministry of Economy of Ukraine (2024) and the State Statistics Service of Ukraine (2025). The use of these sources makes it possible to obtain a comprehensive assessment of the dynamics of changes in human capital under conditions of war, in particular, indicators of employment, migration, demographic trends, the level of education, and the Human Capital Index (HDI).

The chronological boundaries of the study cover the years 2014-2025, allowing observation of the dynamics of human capital evolution in Ukraine from the beginning of the armed conflict in the east of the country to the full-scale invasion and the subsequent stage of economic recovery.

The methodological basis of the study is a combination of systematic, comparative, index, and statistical approaches. The systemic approach makes it possible to consider human capital as a

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complex category shaped by economic, social, demographic, and cultural factors. Comparative analysis is used to compare Ukrainian indicators with those of Central and Eastern European countries (Poland, Lithuania, Croatia, the Czech Republic), which share a similar socio-economic context and experience of post-war transformation. The index approach allows us to generalise the results using integral indicators, such as the Human Capital Index, the Human Development Index, the employment rate and the share of employees in sectors with high added value. Statistical methods provide a quantitative assessment of the relationships between the level of human capital, labour productivity, income level, employment structure and social stability.

To ensure comparability of results, indicators were normalised according to Organisation for Economic Co-operation and Development (2024a) and World Bank (2024) methodology. Bank, which allowed to minimize the impact of national differences in statistical practices. The study used data characterising the participation of the population in the labour force, the unemployment rate, internal and external migration, the educational structure, state and corporate spending on education and vocational training, as well as indicators of inclusion and gender balance.

Research Results

In 2024-2025, the global economy demonstrates a moderate but unsustainable recovery, which is also reflected in the dynamics of the labour market. According to the report of the International Labour Organisation (2024b), the global unemployment rate in 2024 is 4.9%, which is 0.1 percentage point lower than in 2023. This indicates a gradual decrease in labour market tensions after the pandemic and energy shocks.

Global employment, unemployment and human capital indicators based on data: International reports from the Labour Organisation and the World Bank (2024; 2025) are summarised in Table 1.

Table 1. Global indicators: employment, unemployment and human capital

Indicator	2023	2024 (estimate)	2025 (forecast)	Trend
Total unemployment rate, %	5.0	4.9	4.9	Stabilization after decline
Youth unemployment (15-24 years old), %	12.8	12.6	12.5	Slight improvement, but level remains high
Share of women in the total labour force, %	46.4	46.6	46.7	Slow growth
Share of workers in the informal sector, %	58.0	57.5	57.0	Slight reduction

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Average annual growth in labour productivity, %	1.5	1.7	1.8	Slow recovery
Global Human Capital Index	0.61	0.62	0.63	Gradual increase

Source: International Labour Organisation (2024b), World Bank (2024; 2025)

As the data show, in 2024-2025, the global labour market is characterised by a gradual transition to stabilisation, but the quality of the recovery remains asymmetric. North American and EU countries demonstrate a moderate decrease in unemployment (to 4-5%), while in Latin American, Middle East and North African countries the unemployment rate exceeds 8-10%.

Specifically relevant is the structural inequality between men and women. Despite a gradual increase in women's participation in the workforce, the employment gap remains too significant. According to the International Labour Organisation's estimates (2024 a), only about 47 % of women of working age worldwide participate in the labour market, compared with 72 % of men. One more worrying indicator is the high level of informal labour employment (over 57%), which signifies the absence of social insurance, casual incomes, and the low appeal of labour for investment.

Ukraine has experienced the largest decline in employment among all European countries since 2022. According to the World Bank (2025), in the first year of the full-scale invasion, about 5 million people lost their jobs or were forced to change their place of residence.

Basic indicators of the market labour in Ukraine according to the World Bank (2024), the International Labour Organisation (2024b) and the State services and statistics of Ukraine (2025) are summarised in Table 2.

Table 2. Basic indicators market labor Ukraine

Indicator	**2019 (pre-war level)**	**2021 (latest complete data)**	**2023 (estimate)**	**Comparison with the EU average**
Labor force participation rate (15+)	62.0 %	55.0 %	~52–54%	64–66%
Share of women in the workforce	48.1 %	47.4 %	~ 46.8 %	50–52%
Total unemployment rate	8.5 %	9.8 %	17–20% (2023 estimate)	6.0 %

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Youth unemployment (15-24 years old)	17.2 %	19.0 %	~ 25% (estimate 2023)	14.5 %
Level of informal employment	21.5 %	22.0 %	~ 24%	13.0 %
Human Capital Index	0.63	0.61	0.60 (2023 ratings)	0.72 (EU average)

Source: World Bank (2024), International Labour Organisation (2024b), State services and statistics Ukraine (2025).

The data presented demonstrate the deepening structural problems of the Ukrainian labour market, which complicate the post-war economic recovery. The main trends are as follows:

1. Decline in economic activity – caused by forced migration, demographic ageing, and job losses in the eastern regions. At the same time, the share of employment in the public sector has increased due to mobilisation needs.
2. Growing youth unemployment – due to reduced opportunities for internships and the development of digital competencies.
3. The informal economy has become one of the main sources of income for a significant part of the population, especially in the services sector, agriculture, and construction.
4. Deterioration of human capital indicators – according to the World Bank in 2024, the Human Capital Index has decreased to 0.60, which means that an average child born in Ukraine today realises only 60% of their productivity in work in adulthood. The Human Capital Index in the EU is on average 0.74, while, for example, in the Czech Republic and Poland, it reaches 0.77 and 0.74, respectively, which gives an indication of a strong gap in the quality of education, health care, and social conditions between Ukraine and European countries. The war created unprecedented challenges for the Ukrainian business in preserving human capital and losses in personnel through migration to the need for restructuring employment models; nonetheless, some internal companies show effective examples of adaptation. The company "Rozetka" in particular introduced flexible work models, distance education programs for personnel, and psychological support programs, which made it possible to retain the majority of personnel and maintain the stability of internal processes. On the territory, "Nova Poshta", despite severe conditions, continues building the logistics network, offers new employment opportunities also in the front line areas, and actively invests in training personnel. A strong program of retraining of personnel and models of internal mobility is also conducted by the industry company "Myronivsky Hliboproduct", which has found pockets of prosperity and employment in rural communities.

According to the World Bank (2024), Ukraine's Human Capital Index was 0.63, which means that a child born in Ukraine today, under current conditions of education, healthcare, and social support, realises only 63% of his potential level of productivity in adulthood. For comparison: the average HCI value in the European Union countries is 0.72, and in OECD countries, 0.75.

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One of the key components of the Human Capital Index is the expected duration of education: 13.4 years in Ukraine, 14.9 years in Poland, and 15.3 years in the Czech Republic. Despite the high level of education (about 50% of the population aged 25-64 have higher education), the effectiveness of knowledge implementation in the production sector remains limited.

Human capital indicators of Ukraine compared to EU countries according to the World Bank (2024; 2025), the International Labour Organisation (2024a; 2024b), and the State Services and Statistics of Ukraine (2025) are summarised in Table 3.

The main problems of human capital formation are as follows:

1. Migration loss of labour resources – about 6 million people of working age are abroad (International Labour Organisation, 2024a; 2024b).
2. Deficit of investment in skills development – the share of state spending on education decreased from 6.1% of GDP (2019) to 5.2% (2024).
3. Educational-professional mismatch – over 35% of graduates do not work in their speciality, which indicates a gap between education and business demand.
4. Deterioration of the population's health – increasing levels of stress, injuries, and psychological disorders among military and civilians.

Table 3. Human capital indicators of Ukraine compared to EU countries

Indicator	Ukraine (2020)	Ukraine (2023, estimate)	EU average (2023)	Change (2020–2023)
Human Capital Index	0.63	0.60	0.72	– 0.03
Expected duration of study (years)	13.4	13.2	15.0	– 0.2
Quality of learning (Learning Outcomes Index, 0 – 1)	0.70	0.68	0.80	– 0.02
Life expectancy at birth (years)	71.6	69.8	80.5	– 1.8
Share of population with higher education (25–64 years)	50%	48%	39%	– 2 pp.
Gender equality index in education (women/men)	1.03	1.02	1.01	≈ stable

Source: World Bank (2024), International Labour Organization (2024a; 2024b) and State services and statistics Ukraine (2025)

The dynamics of the Human Capital Index demonstrate the general trends in the development of Ukraine's educational, labour, and demographic potential relative to the average level of European Union countries. The HCI indicator reflects the extent to which a child born today

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will be able to realise his or her productivity potential in adulthood, taking into account the level of education, health and employment opportunities.

As shown in Fig. 1, Ukraine has lagged behind the average level of EU countries throughout the study period (2010–2024). If in 2010 the difference was about 0.07 points, then in 2024 it was already 0.14 points. This indicates a gradual widening of the "human capital gap".

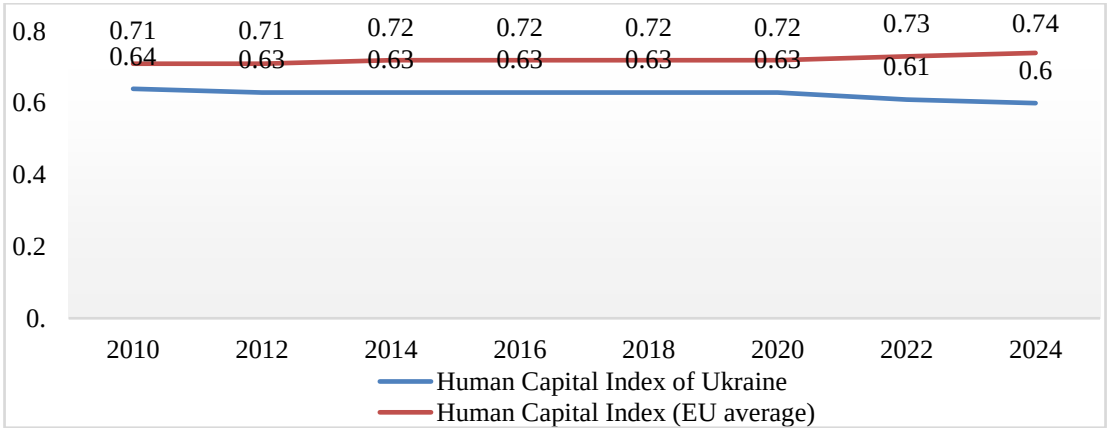

Figure 1. Dynamics of the Human Capital Index in Ukraine and the world (2010-2024)
Source: World Bank (2024), International Labour Organization (2024a) and State services and statistics Ukraine (2025)

Based on the World Data Bank (Human Capital Index, 2010 – 2024), Ukraine demonstrates a gradual decrease in the Human Capital Index from 0.67 in 2010 to 0.60 in 2023, which means a decrease in the potential labour productivity of future generations by approximately 10.4%.

For comparison: Poland: growth from 0.70 (2010) to 0.74 (2023); Czech Republic: from 0.73 to 0.77; Romania: from 0.65 to 0.69. Thus, Ukraine's gap with the average level of Central European countries has increased from 0.04 points (2010) to 0.12 points (2024). This indicates the structural degradation of human capital, which occurs under the influence of war, migration, and inadequate investment in education and public health.

The methodological basis of the study was a generalised multifactor regression model, which reflects the dependence of the Human Capital Index indicator on the degree of education, employment, economic development and innovative activity.

The model can be expressed in the following form (1):

$$HCI = a + b_1E + b_2Z + b_3GDP + b_4I + \varepsilon \quad (1)$$

where E is the average duration of education (in years); Z is the level of employment (% of working-age population); GDP – gross domestic product (GDP) per capita; I – innovation activity, measured by the share of research and development spending in GDP.

I is innovation activity, expressed as the share of expenditures on research and development in GDP. Data obtained from the World Bank (2024), Organisation for Economic Co-operation and DevelopmentOECD (2024a) and State statistics services and statistics Ukraine (2025) for 2010-2024. The results show that all these variables have a positive effect on the Human Capital Index, although the magnitudes of their effects differ. Detailed calculations are contained in Appendix A.

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The second most important is the employment rate. An increase in formal employment by 5% increases the Human Capital Index by approximately 0.015 points. Therefore, the impact of this factor in Ukraine is assessed as moderate. In Central European countries, on the other hand, economic growth has a stronger effect on the Human Capital Index indicator, as it is accompanied by active state support for education and innovation.

Innovative activity is the fourth, but strategically important factor. An increase in the share of R&D expenditures by 1% of GDP increases the Human Capital Index by approximately 0.25 points. This indicates a significant role of technological development in the formation of high-quality human capital. Unfortunately, in Ukraine, this indicator is traditionally low (on average, 0.5 –0.6% of GDP, compared with 1.2% in Poland and over 2% in the Czech Republic). This difference explains the lower level of innovation in the Ukrainian economy and lower returns from educational potential.

The calculated coefficient of determination ($R^2 = \approx 0.82$) indicates that the selected model describes the dynamics of the Human Capital Index quite accurately, and the main factors explain about 82% of its changes over the past 14 years. The remaining variations are attributable to crises, military events, political instability, and migration processes, which the model does not account for.

A comparative analysis for the countries of Central and Eastern Europe shows that in Poland, the Czech Republic and Romania, similar models provide even higher explanatory power ($R^2 \approx 0.85…0.90$). In Poland, the most influential factor is education, supported by stable financing of educational programs and the training of personnel for high-tech sectors. In the Czech Republic, innovation is of crucial importance – a high level of spending on scientific and research work (over 2% of GDP) ensures the continuous updating of knowledge and technologies. In Romania, the key role is played by the level of employment, which is growing due to structural reforms in the labour market. In Ukraine, the educational factor has the greatest potential, but without the development of innovative infrastructure, it cannot ensure a qualitative increase in human capital.

The paper proposes a structural scheme of “state – business – education”, which reflects a multi-level system of interaction among key actors in socio-economic development, where each element performs its own functions while also depending on the decisions and actions of others (Fig. 2).

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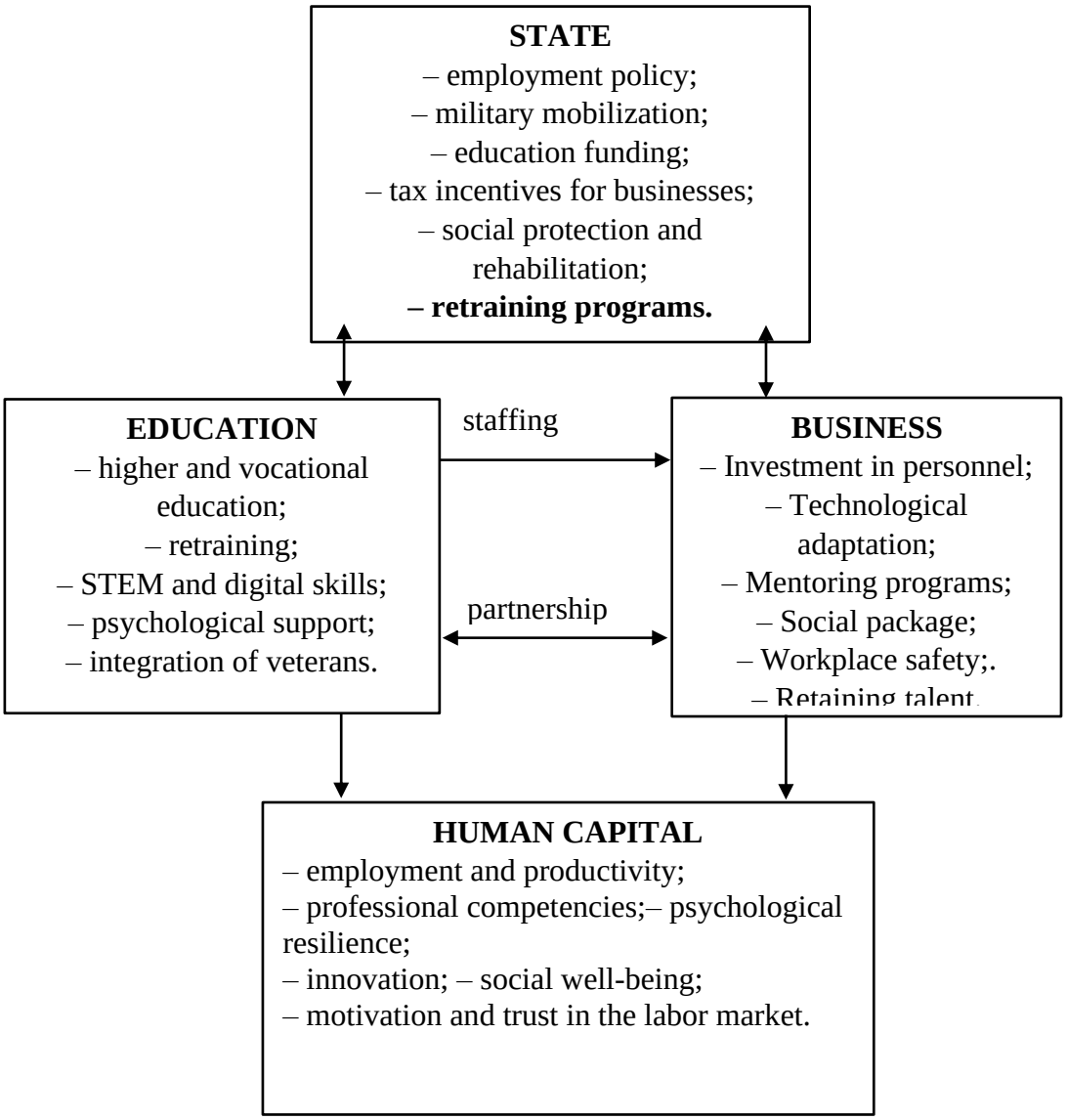

Figure 2. Structural diagram of a multi-level system of interaction between key actors of socio-economic development in Ukrainian business during the war
Source: compiled by authors

It is proposed to conduct a cluster analysis based on an assessment of enterprises according to key features: the level of investment in personnel development; the scale of socio-psychological support for employees; and the degree of operational flexibility and geographical sustainability of activities. This grouping will allow us to allocate generalised adaptation profiles – from proactive strategies with extensive human capital support programs to reactive approaches with minimal personnel investment. The application of cluster analysis not only has theoretical significance for understanding the differentiation of business practices, but also has practical significance for the development of differentiated state support policies.

Discussion

If earlier the main driver of productivity was investment in physical assets, now investments in knowledge, health, skills and motivation of employees play a leading role. According to World

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Bank (2024), countries with higher levels of human capital development demonstrate faster GDP growth and resilience to crises.

In Ukraine, business is increasingly acting not only as a consumer, but also as a creator of human capital. Data from the International Labour Organisation (2024b) show that corporate training programs and internal training systems can increase labour productivity by 10–20%, even with limited investment resources. At the same time, the national indicator of the Human Capital Index for Ukraine (0.60 in 2024 versus 0.74 on average in the EU) indicates the need for closer interaction among business, the state, and the education sector. More than 35% of employers (State Statistics Service of Ukraine, 2024) report a shortage of qualified personnel, indicating a gap between the structure of personnel training and the market's real needs. Another important area is the expansion of the business sector in partnership with universities, technical schools, and vocational education institutions. Successful examples of corporate academies (in particular those in the fields of IT, energy, and logistics) indicate that an organised form of training can partially compensate for the losses in human capital wrought by war.

Given the experience of EU countries, business can become a leading agent in restoring human potential through job creation, innovation, social investment, and the provision of decent working conditions. Stimulating corporate investment in human capital, preferential taxation for training programs, and support for small and medium-sized businesses in personnel training can form the basis of Ukraine's post-war reconstruction.

Thus, the restoration of human capital should consider business not as a passive participant in the labour market, but as a strategic partner of the state in creating a modern, competitive knowledge economy.

Conclusions

The analysis confirms that the formation and development of human capital are key determinants of the national economy's competitiveness in the context of global transformations. At the global level, there is a gradual stabilisation of the labour market after the pandemic and geopolitical shocks; however, employment inequality, low-quality jobs, and youth unemployment remain key challenges.

In Ukraine, the situation is more complicated due to the consequences of the war, demographic losses, mass migration, and structural imbalances in the labour market. As noted by the World Bank (2024), Ukraine's human capital index in 2024 is 0.60, which is significantly lower than the EU average (0.74). which indicates that the country is losing its educational, professional, and health-care potential. At the same time, the results show that business is gradually becoming a leading actor in restoring human capital.

The participation of small and medium-sized businesses is especially important, as they act as “local stabiliser” of the labour market, maintaining employment in communities and supporting the professional mobility of the population.

Therefore, the strategic direction of Ukraine's labour policy should be based on the triune interaction of “state – business – education”. This approach can ensure the effective restoration

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of human capital, reduce structural unemployment, increase labour productivity, and promote sustainable economic growth.

Further research should aim to quantify the impact of corporate investments in training and occupational health and safety on the dynamics of Ukraine's Human Capital Index, as well as to develop models of public-private partnerships for workforce renewal.

Declarations

AI Use Statement: The authors confirm that no Artificial Intelligence tools were used in the writing or production of this manuscript.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Ethical Approval: Ethical approval was not required for this study as it did not involve human or animal subjects.

Author Contribution: Andrii Dligach conceived and designed the study, performed the analysis, and prepared the manuscript. The author read and approved the final version of the manuscript.

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Appendix A1

Table A1. Estimated Human Capital Index data (2010–2024) for Ukraine

Year	E (years)	Z (%)	GDP (thousands of $)	I (% of GDP)	A	B	C	D	HCI
2010	13.80	60.0	9.0	0.60	0.6210	0.1800	0.0540	0.1500	0.6450
2011	13.80	59.0	9.3	0.62	0.6210	0.1770	0.0558	0.1550	0.6488
2012	13.70	58.0	9.5	0.63	0.6165	0.1740	0.0570	0.1575	0.6450
2013	13.70	57.5	9.6	0.62	0.6165	0.1725	0.0576	0.1550	0.6416
2014	13.60	56.0	9.0	0.60	0.6120	0.1680	0.0540	0.1500	0.6240
2015	13.50	55.0	8.8	0.55	0.6075	0.1650	0.0528	0.1375	0.6028
2016	13.50	54.0	8.6	0.50	0.6075	0.1620	0.0516	0.1250	0.5861
2017	13.50	54.5	8.9	0.50	0.6075	0.1635	0.0534	0.1250	0.5894
2018	13.50	55.0	9.2	0.55	0.6075	0.1650	0.0552	0.1375	0.6052
2019	13.50	55.5	9.6	0.60	0.6075	0.1665	0.0576	0.1500	0.6216
2020	13.40	54.0	9.0	0.60	0.6030	0.1620	0.0540	0.1500	0.6090
2021	13.30	53.0	8.5	0.55	0.5985	0.1590	0.0510	0.1375	0.5860
2022	13.25	52.0	8.0	0.50	0.5963	0.1560	0.0480	0.1250	0.5653
2023	13.20	52.0	9.5	0.60	0.5940	0.1560	0.0570	0.1500	0.5970
2024	13.20	52.0	9.8	0.60	0.5940	0.1560	0.0588	0.1500	0.5988

Source: complied by authors

Notes:

HCI – Human Capital Index;

a – model constant (intercept), $a = -0.36$;

b_1, b_2, b_3, b_4 – elasticity coefficients (estimated by the least squares method, 2010 – 2024): $b_1 = 0.045$; $b_2 = 0.003$; $b_3 = 0.006$; $b_4 = {}^{0.25}$; $R2 = 0.82$

E – expected duration of study, years;

Z – employment rate, % of working-age population;

GDP – GDP per capita, thousand $ (adjusted for purchasing power parity);

I – research and development expenditures, % of GDP;

A – contribution of education level to HCI (0.045 – elasticity coefficient for education);

B – contribution of employment to HCI (0.003 – elasticity coefficient for employment level);

C – contribution of GDP per capita to HCI (0.006 – income elasticity coefficient);

D – contribution of innovative activity (expenditures on research and development).