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## Human Capital Development Management under Demographic Change Conditions

Vadym Lukianykhin <sup>1\*</sup> ● Olena Lukianykhina <sup>2</sup> Andriy Andrieiev <sup>3</sup>

<sup>1</sup> Sumy State University (Ukraine). Associate Professor at the Department of Management named after Oleg Balatsky, Candidate of Economic Sciences, Associate Professor.

<sup>2</sup> Sumy Branch of the Kharkiv National University of Internal Affairs (Ukraine). Head of the Department of Socio-Economic Disciplines, Candidate of Economic Sciences, Associate Professor.

<sup>3</sup> Sumy State University (Ukraine). Postgraduate Student at the Department of Management named after Oleg Balatsky.

\* Corresponding Author, e-mail: [luk\\_work@i.ua](mailto:luk_work@i.ua)

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### ABSTRACT

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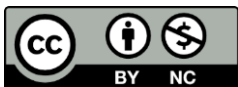
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The article examines the problem of human capital development management under conditions of demographic change, characterized by population decline, workforce ageing, and intensified migration processes. The relevance of the study is determined by the need to adapt management approaches to new structural constraints of the labor market and to ensure sustainable economic development. The purpose of the study is to substantiate the theoretical and methodological foundations of human capital development management in the context of demographic transformations and to develop a conceptual model of its adaptive reproduction, taking into account structural changes in the labor market. The research is based on generalization, comparative analysis, a structural-functional approach, and elements of statistical analysis of demographic indicators. The economic essence and structural characteristics of human capital have been examined, and the influence of demographic changes on its formation, reproduction, and utilization processes has been identified. Modern approaches and tools of human capital management have been generalized, and the necessity of their integration into a coherent system aimed at enhancing adaptability has been substantiated. It has been found that the key problems include the mismatch between the structure of workforce training and the needs of the economy, the narrowing of the demographic base for human capital formation, increasing regional disparities, and the inefficient use of available labor potential. It has been proven that traditional management approaches are insufficient to respond adequately to demographic challenges and require transformation toward predictive and adaptive models. As a result of the study, a conceptual model of human capital development management has been developed, based on the integration of demographic analysis, forecasting of competency needs, and adaptation of work organization. A step-by-step logic for its implementation has been proposed, ensuring the alignment of human capital parameters with the dynamics of the economic environment. It has been concluded that the implementation of the proposed model will contribute to improving the efficiency of human capital utilization, reducing structural imbalances, and forming a sustainable system of its reproduction. Prospects for further research include the improvement of quantitative assessment methods, the development of forecasting tools, and the study of the impact of digitalization and migration processes on the long-term sustainability of human capital.

### KEYWORDS

human capital, population ageing, migration processes, labor market, lifelong learning, labor productivity, flexible employment, digitalization, competency-based approach, economic adaptation.



## Управління розвитком людського капіталу в умовах демографічних змін

Вадим О. Лук'янихін <sup>1\*</sup> ● Олена А. Лук'янихіна <sup>2</sup> Андрій Ю. Андрєєв <sup>3</sup>

<sup>1</sup> Сумський державний університет (Україна). Доцент кафедри управління імені Олега Балацького, канд. екон. наук, доцент.

<sup>2</sup> Сумська філія Харківського національного університету внутрішніх справ (Україна). Завідувачка кафедри соціально-економічних дисциплін, канд. екон. наук, доцент.

<sup>3</sup> Сумський державний університет (Україна). Аспірант кафедри управління імені Олега Балацького.

\* Автор-кореспондент, e-mail: [luk\\_work@i.ua](mailto:luk_work@i.ua)

### СТАТТЯ

### АНОТАЦІЯ

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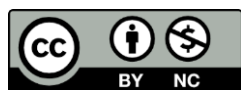
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У статті досліджено проблематику управління розвитком людського капіталу в умовах демографічних змін, що супроводжуються скороченням чисельності населення, старінням трудових ресурсів та посиленням міграційних процесів. Актуальність зумовлена необхідністю адаптації підходів до управління людським капіталом до нових структурних обмежень ринку праці та забезпечення стійкості економічного розвитку. Метою статті визначено обґрунтування теоретико-методичних засад управління розвитком людського капіталу в умовах демографічних трансформацій і розроблення концептуальної моделі його адаптивного відтворення з урахуванням структурних змін ринку праці. У дослідженні використано методи узагальнення, порівняльного аналізу, структурно-функціонального підходу, а також елементи статистичного аналізу демографічних показників. Досліджено економічну сутність та структурні характеристики людського капіталу, виявлено особливості впливу демографічних змін на процеси його формування, відтворення та використання. Узагальнено сучасні підходи та інструменти управління, доведено необхідність їх інтеграції у цілісну систему, орієнтовану на підвищення адаптивності людського капіталу. Виявлено, що ключовими проблемами є невідповідність структури підготовки кадрів потребам економіки, звуження демографічної бази формування людського капіталу, посилення регіональних диспропорцій та недостатня ефективність використання наявного трудового потенціалу. Доведено, що традиційні підходи до управління не забезпечують належної реакції на демографічні виклики та потребують трансформації у напрямі прогнозно-орієнтованих і адаптивних моделей. Результатом дослідження є розроблення концептуальної моделі управління розвитком людського капіталу, яка базується на поєднанні демографічного аналізу, прогнозування потреб у компетентностях та адаптації організації праці. Запропоновано покрокову логіку її реалізації, що забезпечує узгодження параметрів людського капіталу з динамікою економічного середовища. Зроблено висновок, що впровадження запропонованої моделі сприятиме підвищенню ефективності використання людського капіталу, зменшенню структурних дисбалансів і формуванню стійкої системи його відтворення. Перспективи подальших досліджень пов'язані з удосконаленням методів кількісної оцінки ефективності управління людським капіталом, розвитком прогнозних інструментів та дослідженням впливу цифровізації і міграційних процесів на його довгострокову стійкість.



### КЛЮЧОВІ СЛОВА

людський капітал, старіння населення, міграційні процеси, ринок праці, безперервне навчання, продуктивність праці, гнучка зайнятість, цифровізація, компетентнісний підхід, економічна адаптація.

## **1. Introduction**

Management of human capital development in the context of demographic changes is becoming especially relevant due to stable trends in population reduction, aging of labor resources and intensification of migration processes, which directly affect the reproductive capabilities of the economy and the structure of the labor market. Under these conditions, human capital ceases to be only a factor of production and is transformed into a key resource of long-term growth, which requires systematic management, taking into account the quantitative and qualitative parameters of its formation. At the same time, existing management approaches are often focused on inertial demographic assumptions and do not provide adequate adaptation to structural shifts, in particular to imbalances between labor supply and demand, reduced productivity due to age-related changes and loss of human potential due to external migration.

The problem is aggravated by the fact that managerial decisions in the field of human capital development are intersectoral in nature and require coordination of educational, social, innovation and economic policies, while in practice these areas function in fragments. This complicates the formation of effective mechanisms for the reproduction of human capital, improving its quality and ensuring its compliance with the structural needs of the economy. In the scientific dimension, the task is to clarify the theoretical foundations of the interaction of demographic processes and the development of human capital, as well as to substantiate management models that can take into account the dynamism of the demographic environment. In practice, the need to develop tools aimed at increasing the economic activity of the population, prolonging labor longevity, developing competencies and minimizing the loss of human potential, which together determine the strategic capacity of the economic system for recovery and growth, is actualized.

## **2. Literature Review**

The analysis of modern research on the topic of human capital development management in the context of demographic changes shows a combination of macroeconomic, institutional and applied approaches to the analysis of this problem. K. Okada substantiates the relationship of demographic dynamics with the accumulation of human capital within the endogenous growth model, proving that population aging changes the incentives to invest in education and innovation [1]. M. Bastan et al. develop these provisions through system-dynamic modeling of educational demography, emphasizing the need to align educational policy with demographic trends to ensure the sustainable reproduction of human resources [2]. M. Hirono specifies the impact of demographic changes on the sectoral structure of employment, emphasizing the role of human capital as a factor in the structural restructuring of the economy [3]. Y. Amornkitvikai et al. expand the analysis by proving the complex impact of demographic structure, migration, and human capital quality on economic growth in the context of globalization [4].

At the same time, a significant contribution to the development of applied aspects of human capital management has been made in Ukrainian research. Sidenko S. substantiates modern global trends in the development of human capital, emphasizing the strengthening of the role of demographic factors in the formation of labor potential [5]. Bondarenko S. considers the relationship of demographic changes with the processes of digitalization of the economy, emphasizing the need to adapt human capital management tools to new technological conditions [6]. Orekhova A. and Goma O. summarize innovative approaches to human capital management, focusing on the integration of global practices with national characteristics [7]. Kokhan M. et al. investigate the relationship between human capital development and social cohesion, which is of particular importance in the context of demographic instability [8].

A separate group consists of studies that indirectly reveal institutional and technological factors of human capital transformation. L. Yatsemyrskyi analyzes the impact of artificial intelligence on the transformation of customer interaction procedures, which indicates a change in the requirements for employees' competencies [9]. Ilyina A. O. explores the application of artificial intelligence in public administration, emphasizing the need to develop digital skills as a component of human capital [10]. A. Riabokon substantiates the institutional effectiveness of decentralized organizations that form new models of use and development of human capital in digital ecosystems [11]. V. Ishchenko demonstrates the effectiveness of algorithmic pricing, which also changes the requirements for the analytical competencies of employees [12]. R. Kondratiuk investigates the transformation of marketing

communications under the influence of digital platforms, which indirectly affects the structure of human capital through the change of professional roles [13]. Gayevska A. V. analyzes the impact of migration processes, in particular the integration of Ukrainian refugees, on local labor markets, which is directly related to the redistribution and reproduction of human capital [14].

Despite a significant number of studies, the issue of a holistic combination of demographic processes with structural characteristics of human capital remains unresolved, since most approaches consider them in isolation. It is not sufficiently clarified how demographic transformations systematically affect the parameters of its formation and use, which is due to the fragmentation of scientific interpretations and the limited consideration of long-term structural shifts.

As a result, there is a shortage of integrated management decisions that can ensure the coordination of human capital development with demographic dynamics. The relevance of further research is determined by the need to form a coordinated theoretical basis and substantiate adaptive approaches to management, which will increase the efficiency of using human potential in the context of its quantitative reduction.

### **3. Problem Statement**

The article is aimed at substantiating the theoretical and methodological foundations of managing the development of human capital in the context of demographic changes and developing a conceptual model of its adaptive reproduction, taking into account the structural transformations of the labor market.

Objectives of the article:

1. To reveal the economic essence of human capital and assess the impact of demographic changes on its formation, reproduction and use.
2. To generalize approaches to human capital development management and identify key problems of their implementation in the context of demographic transformations.
3. To substantiate the conceptual model of human capital development management, taking into account demographic changes.

### **4. Methods and Materials**

The study is based on a combination of theoretical and applied approaches to the analysis of human capital development in the context of demographic changes. The methodological basis is a systematic approach, which made it possible to consider human capital as an integral multi-level category in relation to demographic processes and parameters of the labor market. To generalize the theoretical provisions, the methods of scientific abstraction, analysis and synthesis were used, which provided clarification of the economic essence and structural characteristics of human capital.

The assessment of the impact of demographic changes was carried out using comparative and structural analysis, which made it possible to identify key trends in the transformation of the processes of formation, reproduction and use of human capital. To substantiate modern approaches to management, elements of functional analysis and generalization of practical experience were used, which made it possible to identify effective tools for adaptation to demographic challenges.

The information base of the study is made up of data from international organizations, in particular statistical indicators of the demographic structure of the population, employment and labor market, as well as the results of scientific publications, analytical reports and regulatory documents. To visualize the dynamics of demographic processes, statistical data from open databases were used, which made it possible to confirm the identified patterns with quantitative indicators.

### **5. Results and Discussion**

In the modern economy, it is advisable to consider human capital as a multidimensional category that combines intellectual, professional and socio-behavioral characteristics of an individual, which form his economic performance. Demographic transformations – population aging, depopulation and migration losses – change the structure of this capital, enhancing the importance of its qualitative parameters and reducing the role of extensive reproduction of labor resources (Table 1).

**Table 1. Structural characteristics of human capital in the context of demographic transformations**

<b>Structural component</b>	<b>Content characteristics</b>	<b>Economic importance</b>
<b>Educational and qualification</b>	Level of education, professional knowledge, digital competencies	Determines labor productivity and innovation potential
<b>Demographic</b>	Age structure, health status, active life expectancy	Affects labor supply and labor longevity
<b>Motivational</b>	Work values, level of engagement, readiness to learn	Ensures the efficiency of the use of human capital
<b>Socio-behavioral</b>	Adaptability, mobility, communication skills	Promotes labor market flexibility and integration into new conditions
<b>Innovative and creative</b>	Ability to generate ideas, entrepreneurial thinking	Forms the competitiveness of the economy

Source: Developed by the authors according to the data given in [1, p. 229; 5, p. 28; 6, p. 270; 7; 8; 10, p. 386].

This structuring allows us to interpret human capital as a dynamic system, in which the key role is played not only by the presence of individual characteristics, but also by the intensity of their interaction. In practical terms, this is manifested in the fact that enterprises and organizations are forced to move from the traditional logic of “availability of personnel” to the management of their quality and functional suitability – in particular, through continuous learning systems, internal corporate educational platforms and retraining programs for employees of older age groups. For example, in manufacturing industries with a high share of employees of pre-retirement age, there is an active introduction of mentoring, where experienced employees transfer knowledge to younger ones, which allows maintaining intellectual potential in conditions of demographic reduction [1, p. 229]. At the same time, in the field of services and IT, the importance of socio-behavioral and creative components is growing – companies invest in the development of soft skills, team interaction and adaptability, since these characteristics provide a quick response to market changes [6, p. 270].

The demographic component increasingly determines economic decisions at the macro and micro levels – the extension of active life expectancy stimulates the spread of flexible forms of employment, remote work and part-time employment, which makes it possible to involve older age groups in economic activities without reducing productivity. At the same time, the institutional component is becoming critical – the effectiveness of educational and medical systems directly affects the ability of human capital to adapt to structural changes in the economy. In countries and regions where these institutions function in concert, there is a decrease in the loss of human potential even in conditions of intensive migration – this is achieved by stimulating the return of qualified personnel and creating conditions for their professional realization [7; 15]. Thus, in modern conditions, human capital functions as a complex adaptive system, the effectiveness of which is determined not only by the accumulation of characteristics but by the ability to transform them in accordance with demographic challenges.

Demographic changes form a new logic of reproduction of human capital, in which the key role is played not only by the volume of the population, but also by the dynamics of its structure, mobility and life trajectories. Declining birth rates, population aging and intensive migration change the ratio between the stages of formation, accumulation and use of human capital, which leads to imbalances in the provision of the economy with labor resources. Under these conditions, the processes of formation of human capital increasingly depend on the quality of educational systems and the availability of investments in human development, while its reproduction is complicated by a decrease in natural growth and the loss of the able-bodied population. At the same time, the use of human capital is transformed under the influence of the need to increase productivity, continue labor activity and adapt to new technological and organizational conditions (Table 2).

The practical implementation of these transformations demonstrates that demographic factors actually “flash” the mechanisms of human capital management at the level of organizations and public policy. In particular, the aging of the population is already being transformed into specific management practices – enterprises of the industrial sector are implementing programs of ergonomic adaptation of workplaces and rotation of functions, which allows maintaining the productivity of employees of older age groups without increasing production risks [4, p. 221]. At the same time, there is a demand for mixed age teams, where the combination of experience and digital skills creates a synergistic effect that cannot be achieved in same-age teams.

**Table 2. Impact of demographic changes on the processes of formation, reproduction and use of human capital**

Demographic factor	Manifestation of process transformation	Consequences for the economic system
<b>Population aging</b>	Shifting the emphasis from primary education to continuing education and retraining	Rising costs to support labor productivity and social security
<b>Decreased birth rate</b>	Reduction of the base for the initial formation of human capital	Shortage of labor resources in the medium and long term
<b>Migration processes</b>	Outflow or redistribution of qualified personnel between countries and regions	Loss of intellectual potential or its concentration in individual centers
<b>Urbanization</b>	Concentration of human capital in economically active regions	Increasing regional development disparities
<b>Change in life expectancy</b>	Extension of the period of economic activity of the population	The need to adapt the labor market to older age groups
<b>Transformation of households</b>	Changing Models of Investing in Education and Human Development	Differentiation of the quality of human capital by social groups

Source: Developed by the authors according to the data given in [1, p. 236; 3, p. 170; 4, p. 221; 5, p. 31; 6, p. 273; 14; 15, p. 350].

The decline in the birth rate directly affects the behavior of employers – in the long run, they are forced to move from extensive involvement of the workforce to its “cultivation” within the organization through corporate universities, internship programs and early professional involvement of young people [14]. This changes the very logic of investment – training costs begin to be considered not as auxiliary, but as strategic, ensuring the reproduction of human capital in conditions of limited demographic resources.

In practice, migration processes form heterogeneous effects – in some cases, there is a loss of critical competencies, especially in high-tech industries, which reduces the innovative capacity of the economy; in others, new channels of knowledge transfer appear due to the return of specialists or remote employment in global companies. This stimulates the development of “circular migration” policies, when the state and business try not only to retain human capital, but also to integrate external experience into internal economic processes.

Urbanization, in turn, leads to the concentration of highly qualified human capital in individual centers of economic growth, which in practice forces companies from peripheral regions to actively use remote forms of employment or outsourcing to compensate for the local shortage of personnel [5, p. 31]. At the same time, this increases competition for talent and changes approaches to the organization of work – the workplace is less and less tied to geography.

An increase in life expectancy creates prerequisites for rethinking the life cycle of employment – “second career” practices appear when employees, after 50–60 years, change their field of activity, undergo retraining and remain economically active. This is no longer an exception, but a trend that is gradually being integrated into the personnel policy of organizations. At the same time, the transformation of households – an increase in the share of single or small families – is changing the models of investment in education, which manifests itself in more differentiated access to quality human capital and requires adjustment of state support mechanisms.

Thus, it can be stated that demographic changes in practice not only limit the reproduction of human capital, but also stimulate its qualitative restructuring – from mass to differentiated, from quantitative to intensive, from static to adaptive, which requires fundamentally new management approaches at all levels of the economic system.

It is advisable to support the generalization of the identified dependencies with a quantitative illustration that reflects the actual dynamics of the demographic structure of the population and allows for specifying the scale of changes that affect the reproduction of human capital (Figure 1).

Figure 1 confirms the presence of a long-term structural shift – the share of the population aged 15–64 years shows a gradual decline, which reflects a reduction in the base of human capital formation, while indicators of demographic burden have the opposite tendency to increase. This means that the economic system is simultaneously faced with a decrease in the potential supply of labor and an increase in the number of dependents, which objectively increases the requirements for the efficiency of the use of available human resources. In practice, such changes are manifested in the reorientation of

enterprises to intensive development models – the introduction of automation technologies, staff training and the use of flexible forms of employment.

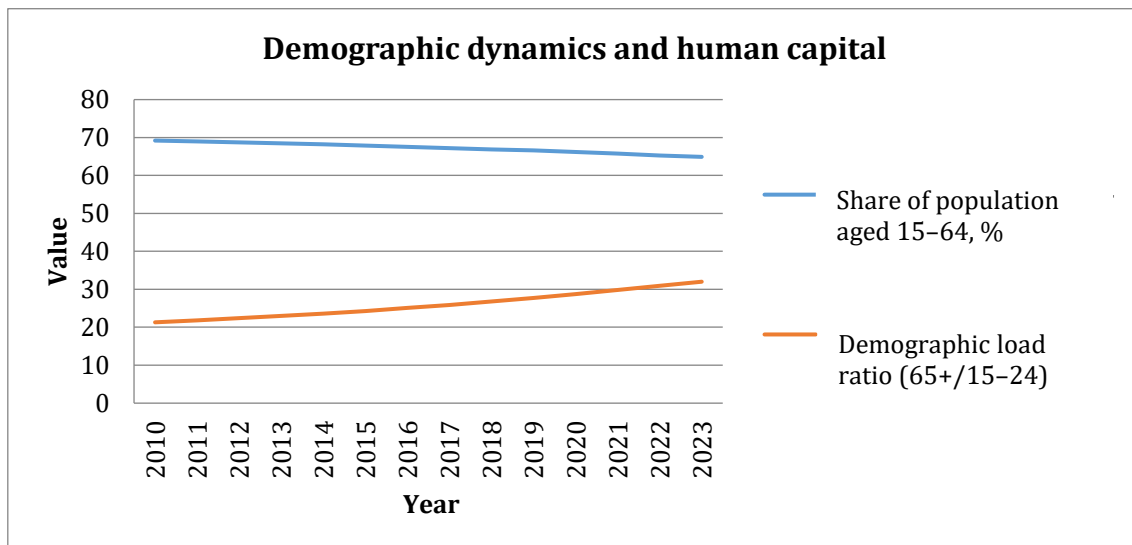


Figure 1. Dynamics of the share of the population of working age and the coefficient of demographic load

Source: Developed by the authors based on the data given in [16; 17].

At the same time, at the macro level, this stimulates the transformation of socio-economic policy in the direction of continuing the labor activity of the population, increasing investment in human capital and reducing losses from migration processes. Thus, graphically reflected trends not only illustrate demographic changes, but also confirm their systemic impact on the mechanisms of formation, reproduction and use of human capital.

Table 3. Modern approaches and tools for managing human capital development in the context of demographic changes

Managerial approach	The nature of the implementation of the tools	Practical effect of application
<b>Human Capital Life Cycle</b>	Management of all stages of professional development – from education to career completion	Increasing the coherence between training and the needs of the economy
<b>Continuous learning</b>	Reskilling and upskilling programs, corporate educational platforms	Maintaining the relevance of competencies throughout life
<b>Active longevity</b>	Tools for involving older age groups in economic activity	Reducing labor shortages and retaining expertise
<b>Flexible employment</b>	Remote work, part-time, flexible schedules	Expanding the participation of the population in the labor market
<b>Mobility of human capital</b>	Stimulation of internal and external professional mobility	Optimization of the distribution of labor resources
<b>Digitalization of management</b>	Use of Human resource analytics (HR), digital HR platforms	Increasing the validity of management decisions

Source: Developed by the authors according to the data given in [2, p. 668; 5, p. 37; 6, p. 277; 7; 10, p. 389; 14].

The content of the approaches given in Table 3 is revealed through their combination in specific management decisions, where the key is not the isolated use of tools, but their functional consistency with demographic constraints. In practice, this is manifested in a change like investments in human capital – they acquire a targeted and differentiated character depending on the age structure of personnel, the level of their mobility and the expected horizon of use. Thus, in enterprises with a high share of employees of older age groups, expenses are directed not to long-term fundamental training, but to maintaining the relevance of key skills and adaptation to technological changes, which allows to extend the period of their productive employment without losing the quality of work [2, p. 668].

Empirical evidence of the effectiveness of such approaches can be traced in the implementation of active longevity programs at the level of public policy. In particular, according to the Organization for Economic Co-operation and Development, in the EU countries where comprehensive instruments have

been introduced to stimulate employment of people aged 55–64, the employment rate of this group exceeded 60%, which is accompanied by a decrease in the fiscal burden and a fuller use of available human capital [18]. This shows that the integration of educational, institutional and market instruments makes it possible to partially compensate for the effects of population aging.

At the level of enterprises, such approaches are implemented through the adaptation of labor organization and the development of internal training systems. In particular, Eurofound research demonstrates that companies that implement flexible working hours, targeted training programs and revision of the functional workload for older employees achieve a reduction in staff turnover and an increase in labor productivity at the level of individual departments [19]. The practical effect in such cases is formed by coordinating the requirements of workplaces with the capabilities of employees, which allows to extend the effective period of their participation in production processes.

In sectors with high dynamics of knowledge renewal, human capital development tools are integrated directly into production processes, reducing the time gap between the emergence of new requirements and their assimilation [10, p. 389]. This provides flexibility in responding to changes in demand for competencies and reduces the risks of structural unemployment, which are exacerbated by demographic factors. At the same time, the use of analytical systems makes it possible to predict changes in the structure of personnel and form a talent pool in advance, which is especially important in the context of an aging population and growing competition for qualified personnel.

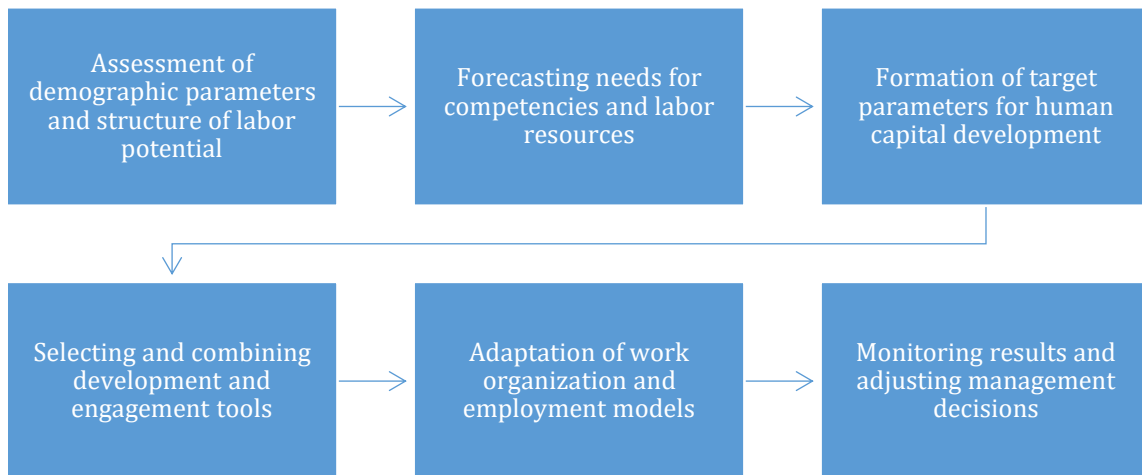
Taken together, the examples show that the effectiveness of modern approaches to managing human capital development is determined by their ability to integrate educational, organizational and socio-economic tools into holistic mechanisms that allow not only to respond to demographic challenges, but also to use them as a factor of structural renewal of the economy.

Management of human capital development in the context of demographic changes is accompanied by systemic problems arising from the gap between population dynamics and the needs of the economy. First of all, we are talking about the discrepancy between the structure of personnel training and the real demand – educational systems are lagging behind changes in technology and employment, which forms a deficit of critical competencies along with their excess in less demanded areas. The situation is complicated by the inertia of institutional mechanisms that do not ensure coherence between educational, social and economic policies.

Demographic reduction and migration losses narrow the base for human capital formation, while increasing regional disparities and competition for skilled resources. Under these conditions, the problem of incomplete use of the available potential is revealed – part of the population remains out of active economic activity due to access barriers, mismatch of skills or poor integration into the labor market [7]. The aging of the population additionally actualizes the limited mechanisms for continuing labor activity – jobs and training systems are often not adapted to the needs of older age groups, which leads to a loss of experience and a decrease in the efficiency of the use of human capital.

At the same time, continuous learning tools are often formal in nature and are not related to the practical needs of business, which reduces the effectiveness of investments in development. This is combined with a lack of an analytical base for forecasting competency needs and a fragmented use of digital management tools, which limits the possibilities of strategic planning. As a result, the key problem is the lack of adaptability of the human capital management system, which does not keep up with the pace of demographic and economic changes and requires a transition to more integrated and predictive-oriented approaches.

The proposed conceptual model of human capital development management is focused on coordinating the processes of its formation, transformation and use with the parameters of demographic dynamics. Its relevance is due to the need to move from reactive decisions to systemic predictive-oriented management, which takes into account the limited labor resources, changes in the age structure and mobility of the population. Unlike existing approaches, which are mainly focused on individual stages of human capital development, the model is based on the integration of demographic analysis, tools for the development of competencies and mechanisms of labor organization into a single adaptive system. It is based on a combination of data on demographic trends, labor market needs and the results of the functioning of educational and corporate development systems, which allows the formation of informed management decisions at different levels (Figure 2).



**Figure 2. Step-by-step model of human capital development management taking into account demographic transformations**

Source: Authors' own development

The functioning of the model in modern conditions provides for its use as a cyclical mechanism that ensures constant coordination of human capital with the dynamics of the economic environment. In practice, this means that decisions on training, retraining, or attracting personnel are not made situationally, but based on regular analysis of demographic and market changes. Enterprises get the opportunity to respond to the deficit of competencies promptly through the combination of internal personnel development with flexible forms of involvement, and state policy – to coordinate educational and social tools in accordance with projected needs. The implementation of such a model contributes to increasing the efficiency of the use of human capital, reducing structural imbalances in the labor market and forming a more sustainable system of its reproduction in the context of demographic transformations.

## 6. Conclusions

The study made it possible to establish that the development of human capital in the context of demographic changes is determined not so much by its quantitative parameters as by the ability to adapt structurally, renewal of competencies and effective use in the context of a narrowing of labor resources. It has been proven that demographic transformations form a stable imbalance between labor supply and demand, which cannot be compensated for by traditional approaches to management focused on extensive reproduction, which necessitates the transition to integrated and predictive-oriented management models.

It has been established that the key problems are manifested in the inconsistency of personnel training systems with the needs of the economy, limited adaptability of institutions, regional disproportions and inefficient use of existing human potential. Population ageing and migration processes exacerbate these imbalances, while development and digital governance tools remain insufficiently integrated into practice.

The proposed management model allows for increasing the coherence between demographic trends and the needs of the labor market through a systematic combination of analytics, competence development and organizational decisions. Prospects for further research are related to the improvement of methods for assessing the effectiveness of human capital, the development of predictive tools and the study of the impact of digitalization and migration on its sustainability in the long term.

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