
Human capital in public authorities and innovation institutions: a model of mutual influence

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To cite this article:

Ilyina Anastasiya: Human Capital in Public Authorities and Innovation Institutions: A Model of Mutual Influence. *International Science Journal of Management, Economics & Finance*. Vol. 4, No. 2, 2025, pp. 29-46. doi: 10.46299/j.isjmef.20250402.04.

Received: 03 13, 2025; **Accepted:** 03 31, 2025; **Published:** 04 01, 2025

Abstract: The article explores the mutual influence of human capital in public authorities and innovation institutions as a key factor in effective governance and the national innovation system development. The proposed model of mutual influence considers the use of human resources analytics to optimize managerial decision-making, funding of innovation projects through the state grants and venture capital funds, as well as the formation of educational alliances between universities, the state, and businesses. The analysis of international experience has demonstrated that effective human capital management in the public sector is a key driver of innovation development. The implementation of analytical human resources systems in public administration, funding of research, and commercialization of scientific developments, along with simplifying the regulatory environment through public-private partnership mechanisms, contribute to increasing innovation activity. The practical significance of this study lies in the potential application of the proposed model to reform public policy in human capital management. The implementation of initiatives such as developing a national human capital management platform, enhancing international workforce mobility, and supporting educational initiatives will contribute to increased productivity, reduced bureaucratic barriers, and the formation of a competitive knowledge-based economy. The prospects for further research include a detailed analysis of the impact of digital technologies on human capital development, an assessment of the effectiveness of the proposed interaction mechanisms, and the adaptation of international experience to the Ukrainian context. The research findings can be applied to the development of strategic policies in the field of human resource management in public administration and the business environment.

Keywords: human capital, public authorities, innovation institutions, human resources analytics, public-private partnership, innovation funding, educational alliances, regulatory environment, model of mutual influence.

1. Introduction

At the present stage, the sustainable development of a country is impossible without the effective utilization of human capital as a key resource for ensuring the flow of innovation processes in economic entities. In the era of digital transformation, globalization, and increasing demands for the effectiveness of managerial decision-making, particular importance is placed on how human capital should interact within public authorities and innovative institutions.

In public authorities, the formation of human capital occurs under the influence of internal and external factors, including professional training/retraining, specialization, competence, and the level of employee motivation, as well as organizational culture and opportunities for career growth. At the

same time, innovative institutions engaged in the development and implementation of technological, social, and economic innovations (works, goods, and services) significantly depend on the level of human capital, the quality of its application, creativity, and adaptability to changes.

Thus, the issue of developing an effective model of mutual influence of human capital in the human capital management system is relevant and requires the integration of workforce potential in public authorities and innovative institutions. Such an approach will contribute to increasing the efficiency of public administration, improving the quality of public service delivery, and creating favorable conditions for the development of the national innovation system.

In this context, the interconnection between human capital in the public and private sectors is a crucial factor in the development of a knowledge economy and enhancing a country's competitiveness. The research in this area allows for a better understanding of human resource management mechanisms in the conditions of digital transformation and the development of recommendations for improving human resource policies in public authorities and innovative institutions.

2. Object and subject of research

The object of research is human capital in public authorities and innovation institutions as a key resource for effective public administration in the context of its impact on the innovation-driven development of economic entities. Human capital, in this case, encompasses the level of qualification, competence, organizational culture, motivation, innovation potential, and digital literacy of personnel.

In international practice, various models of human capital management exist: the Singaporean model (professional training and digitalization of institutions), the Scandinavian model (balancing public service and innovative entrepreneurship), the American model (application of flexible HR approaches), and the European model (institutional reforms supporting innovation development and implementation).

At the same time, the use of human capital in public authorities and innovation institutions has several shortcomings, including slow adaptation to change, low staff motivation, bureaucratic barriers, uneven levels of digital literacy, and the outflow of qualified professionals.

Given these aspects, the study focuses on developing an effective model for the interaction between human capital in public authorities and innovation-active economic entities, taking into account global experience and the specific features of the national governance system.

Accordingly, the subject of the study is the mechanisms of interaction and mutual influence of human capital on the effectiveness of public administration and the national innovation system development.

3. Target of research

The target of research is to develop an effective model of the interaction between human capital in public authorities and innovation institutions, illustrating improvements in public administration efficiency, acceleration of adaptation to change, elimination of bureaucratic barriers, enhancement of motivation and digital literacy among personnel, as well as the retention of human resources.

To achieve this target, the following tasks need to be addressed:

- analyze existing approaches to human capital management in public authorities and innovation institutions, identifying their strengths and weaknesses;
- examine international experience in human capital management, considering the adaptation of best practices to the national governance system;
- identify key impacts of human capital on public administration efficiency and the national innovation system development;

- develop a model of human capital interaction in public authorities and innovation institutions, whose implementation will contribute to improving the effectiveness of managerial decision-making in the long run;
- assess the impact of the proposed model on public administration efficiency and innovation-driven development, providing practical recommendations for its implementation.

4. Literature analysis

According to the analysis of recent research and publications, most scholars focus on analyzing human capital and determining its impact on the efficiency of public administration, as well as the process of developing and implementing innovations. However, none of the relevant sources directly examine the model of mutual influence between public authorities and innovative institutions, where human capital plays a crucial role.

For instance, Álvarez-Gutiérrez et al. (2022) systematically review human resource analytics from the perspective of sustainable management, applying modern approaches to data utilization to improve personnel management efficiency. However, it would be beneficial to focus on studying the specifics of personnel work in public authorities and its impact on the effectiveness of regulating the innovative activities of business entities [1].

Bodnar (2023) explores the role of human capital in Ukraine's sustainable development during the post-war period, emphasizing its influence on the formation and implementation of public policy. However, it would be appropriate to detail the mechanisms of interaction between public authorities and innovation-active business entities as a factor influencing the development of innovative institutions [2].

Cho et al. (2023) examine concepts and practical cases of applying human resource analytics in public personnel management. The scholars analyze the advantages and limitations of using data to improve personnel management in public sector. However, it would be useful to consider aspects of mutual influence between personnel of public and private sectors in the context of making innovative decisions [3].

Fedyk & Fedyk (2025) review the experience of developed countries in implementing innovations in public administration and the prospects for their application in Ukraine. They examine various models and approaches to innovation development in public sector. However, it would also be beneficial to detail the role of human capital in these processes [4].

George (2020) investigates the factors behind the successful implementation of strategic plans in public organizations, particularly the interrelationship between people, processes, and plans. However, the research should focus more on the impact of innovative processes on public sector development [5].

Gorodetska et al. (2025) define the impact of human capital on the effectiveness of scientific research and innovations in the modern economy, emphasizing the importance of human capital development for enhancing innovation potential. However, it would be useful to examine the specifics of public authorities' work as an impact on the process of innovation development and implementation in the private sector [6].

Londar (2021) studies the development of human capital in Ukraine through expanded public funding. The researcher analyzes the impact of budgetary investments on education, healthcare, and other economic activities that contribute to human capital development. However, it would be appropriate to detail the impact of budgetary support on the activities of innovation-active business entities as a factor influencing the development of relevant industries [7].

Monferdini & Bottani (2024) examine how businesses utilize change management to optimize processes by conducting a comparative analysis across various industries within the industrial sector. The researchers analyze change management strategies and their impact on business process efficiency. At the same time, it would be beneficial to explore aspects of human capital development

in public authorities and its influence on the implementation of investment project mechanisms based on public-private partnerships [8].

Podra (2020) studies the specifics of innovation-driven human capital development in Ukraine, identifying its key trends, challenges, and prospects. The researcher examines Ukraine's position in global innovation rankings and reviews the regulatory framework for scientific, technical, and innovation activities. However, it would be beneficial to conduct a comparative analysis of human capital development in public authorities and business entities responsible for the development and implementation of innovations in priority economic sectors [9].

Rahayu & Kala'lembang (2023) outline the role of human capital in the post-pandemic COVID-19 period, examining the impact of the pandemic on employee motivation and productivity across enterprises, institutions, and organizations. At the same time, it would be helpful to explore the specifics of public sector personnel activities and their interaction with national manufacturers as suppliers of innovative products, particularly software [10].

Rodrik (2020) examines the role of global governance in economic development, emphasizing the need to adapt effective international governance to national interests. The study provides valuable insights into the relationship between public authorities and international governance. However, it would be appropriate to focus directly on studying human capital in public authorities and its impact on the national innovation system development [11].

Shevchenko (2023) examines mechanisms for state regulation of human capital in Ukraine, identifies challenges, and proposes measures to improve the efficiency of the human capital management system. A key aspect is the emphasis on the state-administrative approach. Alongside this, it would be beneficial to explore ways to improve human capital management systems in both the public and private sectors to support the national innovation system development [12].

Stephan (2022) studies cross-cultural aspects of innovation and entrepreneurship, investigating cultural factors influencing entrepreneurial activities. The work contains useful insights into innovation development across different countries. At the same time, it would be helpful to examine how innovation activities of business entities impact the public sector [13].

Tereshchenko (2020) focuses on mechanisms of state regulation for human capital development. The researcher outlines political tools that contribute to improving human capital quality through education, healthcare, and other priority economic sectors. However, it would be valuable to pay attention to studying the cooperation between public and private sector entities involved in these areas [14].

de Wit & Bekkers (2020) explore the potential of charitable donations to compensate for reductions in government funding, studying the role of information in attracting charitable resources. The study is valuable for analyzing alternative financial mechanisms supporting socially significant projects. However, it would be appropriate to examine human capital as a key factor in the efficiency of the state funding for innovation-active enterprises, institutions, and organizations [15].

5. Research methods

Achieving the set target requires a comprehensive approach that combines methods for analyzing human capital in public authorities and innovation institutions, namely:

- analysis and synthesis – systematization of scientific approaches to human capital management with the identification of its key characteristics;
- SWOT analysis – identification of strengths and weaknesses in human capital management, as well as assessment of potential threats and development prospects;
- comparative analysis – evaluation of international experience in human capital management, considering the adaptation of best practices to national conditions;
- system analysis – identification of key human capital's impact on the efficiency of public administration and the national innovation system development;

- case study method – analysis of successful practices in human capital development within public authorities and innovation institutions;
- abstraction and generalization – formation of a conceptual model of the interaction between human capital in public authorities and innovation institutions;
- predictive modeling – assessment of the potential impact of the proposed model on the effectiveness of public administration and innovation development.

6. Research results

Human capital management is a significant factor in achieving the sustainable development of a country, as it greatly impacts the efficiency of the activities of public authorities (state authorities at the central and local levels, local self-government bodies, and accountable state and municipal enterprises) and innovatively active business companies, whose activities determine the national innovation system development. The main components of this system are innovation institutions (scientific institutions, technopolises, technology parks, and business incubators). Since all of them have specific functions related to scientific research and development, special attention should be paid to the study of the specifics of accumulating and modernizing human capital in both the public and private sectors, as its development promotes the creation and implementation of innovations and technological progress to the benefit of innovation institutions. Therefore, the effectiveness of human capital management depends on the correctness of the chosen approaches and mechanisms.

In the context of rapid changes in the technological environment, the need for highly qualified personnel capable of adapting to the conditions of globalization transformations becomes even more relevant. Human capital management in both the public and private sectors requires the use of innovative approaches, including the application of analytical tools, strategic planning, and active engagement with international experiences and practices. Therefore, the main approaches in the context of human capital management should be human resources analytics, strategic personnel management planning, and the development of intersectoral cooperation through the integration of international experience. A more detailed analysis of each of these approaches requires conducting a SWOT analysis.

So, human resources analytics is a powerful tool that allows for the evaluation of personnel management effectiveness through the collection and processing of large volumes of data. This approach encompasses not only quantitative indicators (labor productivity) but also qualitative aspects, which enable a more accurate understanding of the staffing needs within an organization. In innovation institutions, particularly in technology parks and scientific institutions, this approach helps to ensure the development of highly qualified personnel and optimize their performance (Table 1).

Table 1. SWOT analysis of the human resources analytics approach

| | |
|---|---|
| <p>Strengths:</p> <ol style="list-style-type: none"> 1. Improved management efficiency. 2. Personalization of management. 3. Transparency of decision-making. | <p>Weaknesses:</p> <ol style="list-style-type: none"> 1. Dependence on data quality. 2. Difficulty of implementation in small companies. |
| <p>Opportunities:</p> <ol style="list-style-type: none"> 1. Integration of new technologies. 2. Optimization of HR processes. | <p>Threats:</p> <ol style="list-style-type: none"> 1. Data privacy. 2. Overreliance on data. |

Source: developed by the author.

Speaking about the strengths, human resources (HR) analytics significantly improves personnel management efficiency by using data to make informed decisions. This approach helps assess work productivity, staff needs for professional growth, and motivation. In this context, analytics should be used to enhance the efficiency of management processes and achieve results in a highly competitive environment [3].

This approach allows for the creation of individualized development strategies for each employee. Through accurate analysis, businesses, institutions, and organizations can improve training effectiveness and reduce employee turnover. It enables personalized work with each employee, identifying their strengths and weaknesses, which contributes to a more precise selection and development of qualified personnel [14].

It also ensures transparency in personnel management, based on clear, reasoned, and objective criteria for evaluating employee performance. As a result, trust among the staff increases, as decisions regarding promotions, dismissals, or task distribution become transparent and understandable. It also reduces subjectivity in managerial decision-making, where it is crucial to maintain a balance between efficiency and moral management principles [9].

Despite the numerous advantages of human resources analytics, this approach also has its weaknesses. First and foremost, it relies on the quality of the data. To bring value, it is necessary to have accurate, up-to-date, and complete data. Incorrectly collected or incomplete data can lead to wrong conclusions and decisions, negatively impacting the organization's effectiveness and causing serious management errors [1].

It also requires significant investments in technology, software, and staff training. This can become an issue for technology parks or business incubators, where companies have limited financial and human resources to implement complex analytical systems. Therefore, for small companies, this can be a significant barrier to adopting new technologies in personnel management [8].

At the same time, the use of cutting-edge technologies, particularly artificial intelligence (AI) and machine learning, opens up new opportunities for improving human capital management processes. These technologies not only enhance the accuracy of forecasting but also improve personnel management by automating routine processes, which help identify the knowledge, skills, and abilities of staff, facilitating more accurate workforce planning [3].

It significantly reduces costs associated with recruitment, training, and development, which is a significant advantage for enterprises, institutions, and organizations with limited budgets. Analytics allow for more precise workforce planning and improve the processes of staff adaptation and development, enabling companies to maintain financial stability while simultaneously enhancing employee performance [8].

When examining threats, the primary concern is the issue of data privacy. The collection and processing of large volumes of personal data can raise serious questions regarding the confidentiality and security of information. The application of such an approach is associated with the risk of data leaks or misuse, which undermines the trust of staff in the institution. This is particularly important in innovative institutions where highly qualified personnel are often involved, and the protection of their personal information is a critical aspect of the management strategy [5].

Another threat is the excessive reliance on analytics, which may lead to the neglect of the human factor. If an institution depends solely on numbers and statistics, it may result in decisions that overlook important contextual factors or intuitive knowledge from leaders. Therefore, it is essential to maintain a balance between analytical data and emotional intelligence to make decisions that are most suitable for the specific functioning of the institution and its employees [12].

Strategic human resource management planning is an important component of the overall strategy of an organization, enabling effective management of human resources while considering long-term goals and changing market conditions. This approach involves developing a clear strategy that defines staffing needs, develops key employee competencies, and integrates them with the organization's overall objectives. Strategic planning helps ensure alignment between personnel policies and business strategy, optimizing the use of human resources and contributing to the achievement of set goals. At the same time, this approach also presents several challenges that may arise during its implementation in the context of rapid changes in the external environment and internal processes of the organization (Table 2).

Table 2. SWOT analysis of the approach of strategic personnel management planning

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|---|---|
| Strengths: 1. Management with a focus on long-term goals. 2. Compliance with the company's strategic goals. 3. Optimization of human resources. | Weaknesses: 1. Uncertainty of the future. 2. High complexity in implementation. |
| Opportunities: 1. Flexibility in responding to change. 2. Improving talent acquisition and retention. | Threats: 1. Changes in the economic and legal environment. 2. Planning overload. |

Source: developed by the author.

In the context of strengths, strategic human resource planning primarily allows institutions to focus their efforts on achieving long-term goals, which is especially important in the rapidly changing labor market. With this approach, institutions will not only be able to respond to current challenges but also prepare their employees for future needs, enabling them to identify staffing requirements and develop the necessary competencies to achieve set goals [3].

This approach helps align staffing decisions with the institution's overall objectives. It allows not only to meet current staffing needs but also to create an environment that fosters the implementation of long-term plans. Effective strategic planning helps shape human resource strategies that align with business goals and contribute to organizational efficiency [1].

It also enables institutions to efficiently accumulate human capital, an important factor in reducing costs and increasing effectiveness, thus contributing to the optimization of organizational processes and reducing recruitment and training costs [5].

Highlighting the weaknesses, one of the main problems of strategic planning is the unpredictability of the future. Economic changes, technological innovations, or even legal reforms can alter staffing needs. Therefore, institutions should consider external factors that could influence their personnel policies and human resource development strategies [10].

The implementation of strategic planning is a complex process that requires a significant amount of resources and time. Changing existing management practices and adapting to new strategic approaches can be difficult, especially in the context of rapid changes. The implementation of new management practices may require considerable efforts and resources, particularly in public authorities [4].

The opportunities of applying the mentioned approach primarily focus on providing institutions with greater flexibility in responding to changes in the external environment. This enables them to quickly adapt their personnel strategies to new conditions and maintain stability in operations, allowing to respond swiftly to changes, which gives them a competitive advantage [6].

The strategic approach enables more effective attraction and retention of highly qualified personnel, which is an important aspect in today's competitive conditions. This helps institutions not only find the best candidates but also create conditions for their long-term retention [2].

The threats to the strategic approach are primarily related to constant changes in the economic and legal environment, which can create uncertainty for strategic planning. Changes in labor legislation or economic shifts may require a rapid revision of personnel policies. This can have a significant impact on human resource management strategies, making it essential for institutions to be ready to adapt [11].

It also can become overly complex if an institution attempts to address all aspects of development simultaneously. In this context, an overload of planning processes may result in the institution being unable to clearly define priorities and respond promptly to changes [13].

The approach of developing intersectoral cooperation through the integration of international experience is a key to enhancing the effectiveness of institutions in a global context. In a rapidly changing world, institutions should not only respond to current challenges but also adapt to future changes. The integration of international experience allows for the use of successful practices from

other countries, promoting innovation and more efficient resource utilization. This approach creates conditions for long-term development, but requires careful planning due to potential risks and challenges (Table 3).

Table 3. SWOT analysis of the approach of the development of intersectoral cooperation

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|---|--|
| <p>Strengths:</p> <ol style="list-style-type: none"> 1. Access to innovative practices and technologies. 2. Strengthening interaction between sectors. 3. Involvement of international experts. | <p>Weaknesses:</p> <ol style="list-style-type: none"> 1. Cultural and legal barriers. 2. Dependence on external factors. 3. High costs of adaptation and training. |
| <p>Opportunities:</p> <ol style="list-style-type: none"> 1. Improving international collaboration. 2. Innovative development. 3. The possibility of using international standards. | <p>Threats:</p> <ol style="list-style-type: none"> 1. The need for constant monitoring and adaptation. 2. Risk of loss of national identity. 3. Political and economic instability in partner countries. |

Source: developed by the author.

When discussing the strengths, this approach primarily allows for the utilization of advanced practices that have proven effective in other countries. The application of cutting-edge technologies and human resource management methodologies helps institutions achieve sustainable development and enhance their competitiveness on a global scale. The implementation of such practices within the framework of intersectoral cooperation enables adaptation to rapid changes and effective responses to new challenges, which is crucial in the modern context [1].

It fosters collaboration between different sectors – government institutions, business enterprises, and public organizations – contributing to more effective resolution of economic and social issues. Effective intersectoral interaction is a key factor in the development of human capital and the promotion of long-term economic growth. Strengthening cooperation helps adapt international experience to local conditions, positively influencing the efficiency of governance processes [2].

Involving international experts in intersectoral cooperation processes allows for the utilization of their experience and knowledge to improve the efficiency of national institutions. Engaging qualified professionals from other countries facilitates the adoption of best global practices and helps optimize management processes. This also provides a broader understanding of global trends and assists in better aligning national policies with international requirements [3].

At the same time, the application of this approach has its weaknesses. The use of international experience may be constrained by differences in cultural and legal contexts. Practices that work in some countries may not necessarily be successful in others. Implementing international practices requires consideration of local traditions and legal norms, which can significantly complicate the adaptation of new approaches [11].

The integration of international experience can create a certain dependence on external factors, particularly international politics, economics, or experts. This dependency poses risks in case of changes in global or political conditions, which may limit institutional autonomy [10].

Adapting international practices requires substantial financial and human resources, including expenses for staff training, the development of new regulations and procedures, as well as the adaptation of infrastructure to new requirements. These costs can be significant, especially for countries with limited resources, necessitating careful planning and evaluation of benefits and expenses [8].

Outlining the opportunities associated with this approach, the integration of international experience provides a chance to strengthen international connections, fostering mutual exchange of resources, knowledge, and expertise. Such interactions can have long-term benefits in addressing global issues related to climate change, economic inequality, and security [15].

Leveraging international experience stimulates innovative approaches and solutions that may not be readily apparent within the national context. Cross-cultural exchange and the adoption of foreign technologies can significantly accelerate the process of developing and implementing innovations in economic and social spheres [13].

The use of international standards helps improve the quality of management processes and ensures their compliance with global requirements. The standardization of processes allows countries and institutions to enhance the efficiency of their functions and build trust among the international community [5].

In its turn, the threats associated with this approach are largely linked to the need for constant monitoring and adaptation. The practical process of developing and implementing innovations can change rapidly. This requires ongoing monitoring and readiness to adapt to new conditions, as the pace of economic and globalization changes demands continuous institutional flexibility [9].

The integration of international practices may lead to the loss of national characteristics and values. This can result in a decline in cultural identity and national pride. It is crucial to strike a balance between international influences and the preservation of local traditions and social norms [11].

Political and economic fluctuations in partner countries can negatively affect cooperation and lead to instability in the implementation of international initiatives. Such instability may result in the loss of benefits from international partnerships [12].

In the modern globalized world, achieving effective interaction between the human capital of public authorities and innovative institutions requires high-quality management. Considering the SWOT analysis conducted above, there is a need to minimize threats and strengthen weaknesses by applying effective approaches to human capital management. Given the challenges facing Ukraine, it is essential to study foreign experience in human capital management, focusing on its adaptation to the national management system in Ukraine (Table 4).

Table 4. International experience in human capital management and its adaptation to Ukraine

| No | Country | Management experience | Adaptation to Ukraine |
|----|---------------|---|--|
| 1 | USA | <ol style="list-style-type: none"> 1. High role of human capital management in economic and social spheres 2. Development of inclusive policies 3. System of performance assessment through feedback 4. Support for innovative institutions | <ol style="list-style-type: none"> 1. Implementation of an evaluation and feedback system to increase the responsibility of public authorities' employees 2. Creation of specialized professional development programs |
| 2 | Germany | <ol style="list-style-type: none"> 1. Dual education 2. Retraining programs 3. Cooperation between public authorities and businesses to develop employee skills | <ol style="list-style-type: none"> 1. Implementation of dual education and programs for retraining personnel in public authorities 2. Strengthening partnerships between public and private sectors |
| 3 | Great Britain | <ol style="list-style-type: none"> 1. Development of strategic initiatives and inclusive initiatives for equal opportunities 2. Attracting women to scientific and managerial positions 3. Stimulating the development of innovations | <ol style="list-style-type: none"> 1. Implementation of inclusive programs among women and underrepresented social groups 2. Integration of different social strata into public authorities |

Continuation of Table 1

| | | | |
|---|-------|--|---|
| 4 | Japan | <ol style="list-style-type: none"> 1. Implementing a corporate culture of innovation 2. Investing in training and leadership development 3. Developing long-term relationships with employees | <ol style="list-style-type: none"> 1. Developing corporate culture in Ukraine to support innovation 2. Creating employee development programs 3. Maintaining employee motivation for long-term relationships |
|---|-------|--|---|

Source: developed by the author.

In the United States (USA), human capital management plays a significant role in both the economic and social spheres, greatly influencing the partnership relations between the state and business. One of the main strategies of such management is the development of an inclusive policy aimed at professional growth and supporting highly qualified personnel [1, 4]. In this context, it is crucial to continuously assess employee performance through feedback systems, using tools to evaluate the effectiveness of public authorities and innovative institutions in the context of their interaction. Moreover, the American management system includes state regulation of the creation of innovative institutions that support intellectual property (scientific institutions) and the implementation of new technologies (technological parks). Training and development programs, including higher education, allow businesses, institutions, and organizations to quickly adapt their staff to the new demands of the modern labor market.

In Ukraine, implementing such evaluation and feedback systems would be a useful factor in improving the employee evaluation system in public authorities, enhancing their accountability for regulating innovative processes. Specialized professional development programs should be developed to promote innovation in public administration. However, to avoid excessive dependence on international experience, it is important to consider cultural features and the specifics of the legal system that regulates innovation in Ukraine.

In Germany, dual education and continuous learning play a significant role. The country has created specialized programs for training and retraining personnel that ensure close cooperation between public institutions and business companies [4]. Completing these programs helps maintain a high level of employee qualifications and adapts them to changing labor market conditions, thus fostering the development of business incubators. These institutions ensure proper conditions for newly established businesses responsible for developing and implementing innovations.

Ukraine can benefit from Germany's experience in implementing dual education and retraining programs, which would help improve the qualifications of employees in public authorities. At the same time, it is necessary to adapt these programs to Ukrainian realities, strengthening partnerships between public institutions and innovation-active private enterprises.

In the United Kingdom (UK), great attention is paid to developing strategic initiatives in human capital management. A key strategy is supporting inclusive initiatives that provide equal opportunities for all social groups [4, 5]. Innovative programs are actively implemented in the country that attract qualified personnel to public authorities, fostering effective state regulation of innovation activities, and innovative institutions responsible for pre-project research (scientific institutions), the implementation of research and development (R&D) results (technological parks), the creation of innovation cities (technopolises), and ensuring the competitiveness of new businesses (business incubators). The activities of such institutions also contribute to the effective work of public servants, providing the supply of innovations to public authorities. This, in turn, plays a significant role in human capital development. It is also worth noting the successful implementation of programs aimed at attracting women to scientific and managerial positions, which helps prevent staff shortages due to employee turnover.

The UK's experience could be applied in Ukraine in the context of implementing inclusive programs that would stimulate the development of human capital among women and other underrepresented social groups in management structures. At the same time, initiatives for integrating

different social groups into the public administration system should be developed to achieve sustainable innovation development. Social groups with different experiences will be able to offer unique proposals for preventing negative factors that could affect the innovation ecosystem during the development of innovative institutions.

Japan is an example of successful human capital management through the implementation of norms of innovation culture. In this context, it is important to maintain corporate culture and focus on developing long-term relationships with employees. Japanese institutions actively invest in the development of their employees' knowledge and skills through internal training programs and leadership development programs [4, 11]. This helps staff acquire the knowledge and skills necessary for making managerial decisions during planning, implementation, and reporting on innovation implementation.

Japan's experience in developing corporate culture could help Ukraine optimize the management system of business entities in performing management functions (setting goals, planning, organizing, motivating, controlling), thus stimulating long-term relationships between business entities related to common goals of further integration for the creation of innovative institutions (technology parks, technopolises). It is important to develop internal employee training programs, completion of which will contribute to maintaining their motivation and, consequently, effective performance in the long term.

The aforementioned review of international experience highlights the multifaceted impact of human capital on the effectiveness of public administration within the system of public authorities and the national innovation system development [1]. These factors encompass not only the professionalism, qualifications, and motivation of employees but also their mutual influence during interactions between various enterprises, institutions, and organizations responsible for the country's innovative development (Table 5).

Table 5. Human capital factors' interaction in public administration and their innovative impacts

| No | Human capital factors | Interaction in public administration | Impact on national innovation system development |
|----|---|---------------------------------------|--|
| 1 | Qualification and professionalism | Efficiency of public administration | Support for innovation processes |
| 2 | Motivation and responsibility | Active implementation of innovations | Development of national innovation system |
| 3 | Involvement of innovative ideas | Investments in science and technology | Intersectoral cooperation |
| 4 | Inclusiveness of professional development | Qualification improvement | Increase in workforce efficiency |
| 5 | Collaboration between public authorities, business-companies, and scientific institutions | Support for business incubators | Stimulating entrepreneurship |
| 6 | Leadership and management skills | Strategic planning | Flexibility in management |
| 7 | Information technology and digital skills | Improving decision-making efficiency | Adaptation to changes |
| 8 | Adaptation to changes | Flexibility in public administration | Accelerated innovation development |

Source: developed by the author.

The qualifications and professionalism of employees are key factors in the efficiency of public administration. The higher the level of knowledge and skills among public officials, the more

effectively they address tasks related to innovation processes [2]. This is important both for management functions and for direct regulation of innovation processes. For example, in the context of technology parks and technopolises, the presence of highly qualified personnel enables the creation of an appropriate legislative environment and supports the innovation activities of business entities, motivating specialists to work [3].

Employee motivation is a critical factor in achieving effective results in public administration. Motivated employees have a clear understanding of their role within an institution and, accordingly, work toward creating favorable conditions for the development and implementation of innovations [4]. Here, motivation should not be limited to material incentives but should also include opportunities for professional growth and participation in managerial decision-making regarding innovation projects, contributing to the national innovation system development [5].

Innovation institutions require support from qualified public sector employees capable of properly organizing and coordinating research and innovation projects [6]. They should be prepared to support investments in scientific research, the development of new technologies, and their implementation into the country's economy. The successful development of the national innovation system depends on effective collaboration between scientific institutions, business companies, and public authorities [7].

The level of qualification depends on the availability of accessible professional development programs that foster the growth of human capital in public administration. These may include training programs, workshops, and seminars that allow employees to continuously acquire new knowledge, abilities, and skills [8]. In Ukraine, for example, it is crucial to adapt new labor market requirements for public sector employees [9].

Human capital in the public management system should be capable of establishing effective communication between the public and private sectors, organizing partnerships, and ensuring the sustainable development of the national innovation system [10]. For instance, cooperation between technology parks, business incubators, and public authorities facilitates the development of small and medium-sized enterprises engaged in innovation [11].

Leadership qualities of managers play a key role in managing innovation processes within public authorities. This requires not only technical knowledge but also the ability for strategic planning, decision-making under uncertain conditions, and managing teams and resources [12]. Leadership in public administration creates the necessary environment for the development and implementation of innovations, which is particularly important for the effective functioning of innovation institutions in the digitalization era [13].

Modern information and communication technologies (ICTs) and digital skills play an essential role in developing the national innovation system. Public sector employees should possess IT knowledge to successfully manage innovations [14]. The implementation of digital tools for data collection, analysis, and exchange is a crucial element for enhancing the efficiency of innovation governance in the country. It also enables scientific institutions and technology parks to adapt more quickly to changes at the international level [15].

Human capital in public administration should be able to adapt swiftly to changes. In the context of digital transformations, public authorities should be prepared for flexible management changes that support innovation institutions [1]. For example, the development of technology parks and business incubators requires rapid adaptation to new technologies as well as the ability to effectively manage changes within the innovation environment.

The development of human capital in public authorities and innovative institutions is a key factor in effective governance and the advancement of the national innovation system. The interaction between these two groups enables the implementation of cutting-edge technologies, enhances the professional training of personnel, and ensures the sustainable development of the country.

Thus, it is advisable to develop a model of human capital interdependence that reflects the shared relationships among personnel, emphasizing the necessity of considering the impact factors of human

capital on the functioning of public authorities and innovative institutions in the context of systemic interaction (Fig. 1).

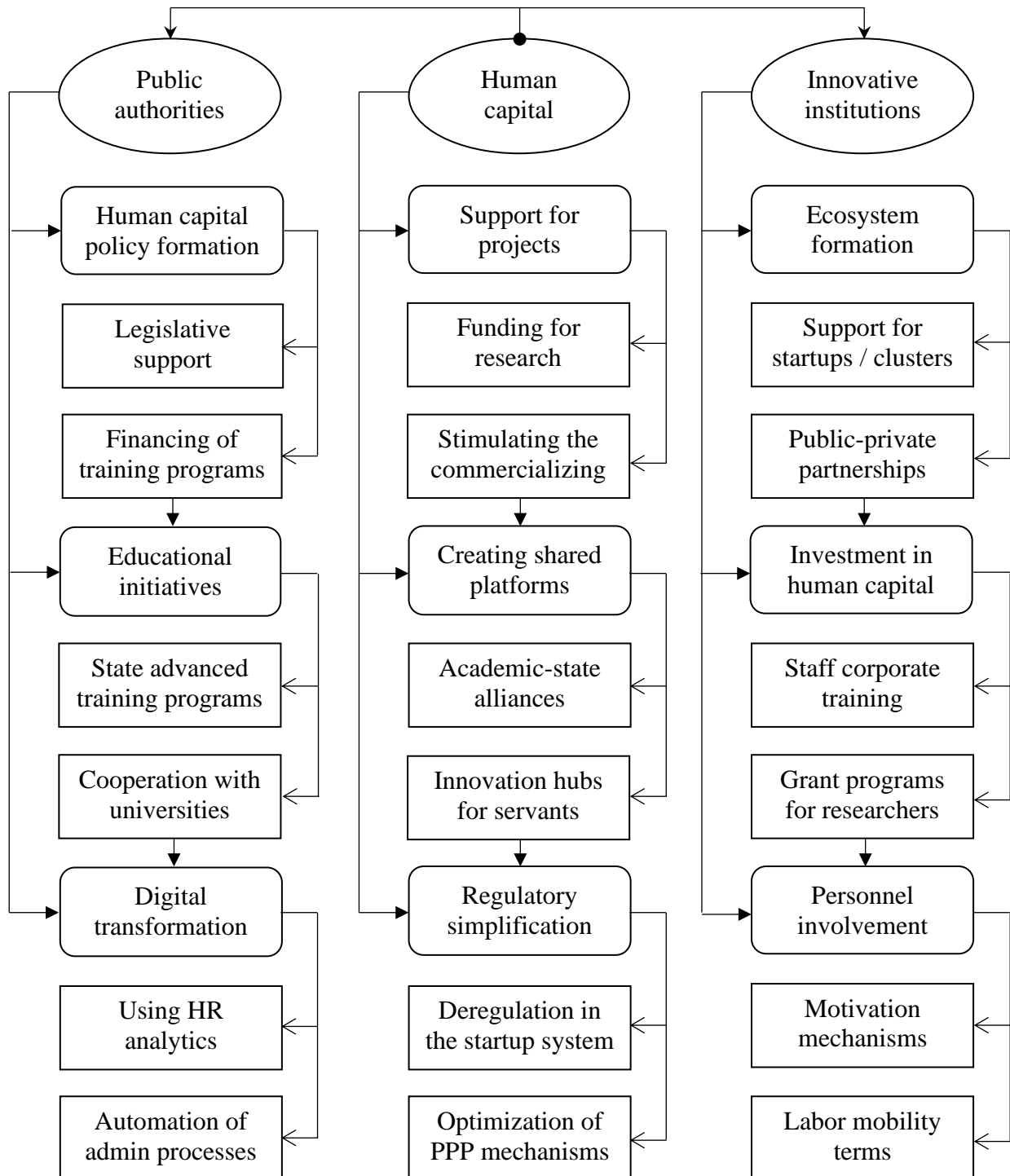


Fig. 1. Model of human capital interaction in public authorities and innovation institutions.

Source: developed by the author.

So, public authorities play a key role in shaping and developing human capital through the systematic implementation of strategic measures and mechanisms.

When discussing human capital policy formation, effective human capital development requires a solid legislative foundation and adequate funding. Legislative support serves as the primary tool of state influence, contributing to the development of a qualified workforce [2, 12]. The adoption of

relevant regulatory and legal acts will create conditions for modernizing personnel management systems in public administration, facilitating the adaptation of international experience. At the same time, providing budgetary support for the professional growth of public sector employees enables the integration of best international practices in education and training [7]. Additionally, participation in funding by international donors and partners allows for the implementation of long-term human capital development programs [15].

As part of educational initiatives, government-funded professional training programs are actively implemented to enhance the qualifications of public administration employees [5]. These programs contribute to improving managerial competencies, creating conditions for effective decision-making. This also involves close cooperation between public authorities, universities, and business companies [4]. Such interaction enables the integration of modern educational methodologies, the adaptation of training programs to real market needs, and the formation of a talent pool for public administration.

In the context of digital transformation, the use of HR analytics in public administration enables more efficient management of human resources, monitoring of employee performance, and forecasting of future competency needs [1, 3]. The implementation of administrative process automation enhances labor productivity, reduces bureaucratic burdens, and improves the efficiency of governance structures [8]. In this regard, the application of advanced digital solutions allows for rapid adaptation to changes and an overall improvement in the quality of public service delivery.

Innovation institutions play a key role in integrating human capital into modern economic processes, ensuring effective interaction with public authorities. This mutual influence is reflected in the creation of favorable conditions for the development of innovation ecosystems, the attraction of highly skilled professionals, and investment in employees' professional growth.

The formation of innovation ecosystems is one of the most significant areas of activity for innovation institutions, facilitating human capital development through the support of startups and technology clusters by business incubators [13]. Public authorities, in turn, establish the necessary legislative and financial framework by providing tax incentives, government grants, and investments in high-tech projects. One of the key mechanisms in this process is public-private partnership (PPP), which fosters the integration of public and private sector resources for human capital development [11]. Collaboration with public authorities enables business incubators to secure funding and contribute to the training of qualified specialists who will work in high-tech economic sectors.

Investment in human capital is an essential component of the activities of innovation institutions, as employees' professional development directly determines companies' competitiveness. Significant attention is given to corporate training and staff development, which includes implementing upskilling programs, training sessions, and courses tailored to the latest technologies and business models [10]. This process closely interacts with government educational initiatives that promote curriculum modernization and the introduction of dual education. Moreover, grant programs for researchers from scientific institutions and innovative entrepreneurs help attract young professionals to the development of innovative solutions, thereby contributing to the formation of a highly skilled workforce within the national innovation system [6].

Another crucial aspect is the attraction of highly skilled professionals, which involves developing motivation mechanisms and creating favorable working conditions. In this context, a flexible salary system, remote work opportunities, and career development prospects ensure a stable influx of talent into priority economic sectors [9]. At the same time, innovation institutions, particularly technology parks, work closely with public authorities to create conditions for labor mobility, facilitating simplified relocation and adaptation procedures for highly qualified specialists [14]. This, in turn, enhances the exchange of international expertise and integrates Ukrainian professionals into global scientific and technological processes.

It is worth noting that innovation-driven development depends on the effective interaction between public authorities, scientific institutions, and business companies. The key points of such mutual influence include government support for innovative projects, the creation of joint learning platforms, and the simplification of the regulatory environment.

The state support for innovative projects plays a crucial role in stimulating the development of scientific research within scientific institutions and their commercialization through technology parks. Public authorities develop grant programs and the state funding mechanisms to support fundamental and applied research, fostering the advancement of new technologies and their integration into production processes [12]. At the same time, a significant aspect is the stimulation of the commercialization of scientific developments, which involves the active participation of the state in creating venture capital funds, technological clusters, and business incubators [4]. Such support not only expands the innovation potential of the economy but also provides business companies with access to new technologies developed within scientific institutions.

The creation of joint learning platforms integrates the state, science, and business into a unified ecosystem. Academic-government alliances facilitate effective knowledge exchange, promoting the implementation of scientific research results into public administration and business processes [7]. Additionally, the establishment of innovation hubs for public officials contributes to their training and adaptation to new management technologies [1]. Such collaboration enables public authorities to develop more effective regulatory mechanisms tailored to the dynamic innovation environment, while business companies benefit from the state support in implementing new technological solutions.

Accordingly, the simplification of the regulatory environment is an essential condition for the efficient functioning of an innovation-driven economy. The state initiatives aimed at deregulating the startup and technology sector focus on reducing bureaucratic barriers and simplifying financing processes, thereby accelerating the development of business technologies [11]. Simultaneously, the optimization of PPP mechanisms allows the state to engage the private sector in joint innovation projects [15]. This fosters the development of flexible financial models, efficient resource utilization, and a faster adaptation of regulatory frameworks to meet the needs of innovation-driven business companies.

The adaptation of foreign experience in Ukraine is an important stage in the reform of public administration, which involves the implementation of advanced practices successfully applied in various countries. Among the key areas of such adaptation are the use of HR analytics in the public sector, state support for innovation-active enterprises, and educational alliances for public administration employees.

The use of HR analytics in the public sector is a practice that is actively applied in the USA to enhance the efficiency of public administration. The implementation of HR analytical systems in public sector allows public authorities to analyze personnel indicators, automate decision-making processes regarding staff, and forecast future staffing needs [3, 4]. In Ukraine, this practice can be adapted by using analytics to assess the performance of public servants and predict staffing needs [1]. This will not only increase the efficiency of the administrative apparatus but also help determine the need for training new specialists, optimizing personnel policy in public administration, particularly in the context of supporting innovation-active enterprises.

The state support for innovation-active enterprises, widely applied in EU countries, is another important area of adaptation. In Europe, the state actively supports startups through the state innovation funds, which provide financial assistance to promising projects in IT and entrepreneurship [4, 13]. For Ukraine, an effective step in this direction could be the launch of the state grant programs for Ukrainian innovative entrepreneurs and researchers from scientific institutions [6]. This will promote the growth of the innovative economy, create new jobs, and increase the competitiveness of Ukrainian businesses in the international market.

Educational alliances for public servants, as demonstrated by Singapore's experience, are an effective tool for the professional development of personnel in the public sector. In Singapore, the integration of educational programs into public administration significantly improved the qualification level of public servants, adapting them to contemporary challenges and management practices [4, 5]. In Ukraine, a similar practice could be implemented through the establishment of a national center for the training of public servants in partnership with universities [7]. Such a

cooperation model would contribute to more effective training of personnel that meets the current demands of public administration and ensure a continuous process of productive learning.

Assessing the impact of the proposed model on the efficiency of public administration and innovation development requires a review of the key aspects of systemic interaction between public authorities and innovation institutions.

The model envisions the integration of HR analytics into public administration, focusing on improving decision-making quality through workforce productivity analysis and forecasting the demand for skilled personnel, particularly in the context of financial support for innovative projects and scientific research. Here, the use of the state grants and venture capital funds to support researchers and entrepreneurs will contribute to the commercialization of innovative solutions. This will also enhance the country's global competitiveness by integrating into international innovation networks as a pathway to establishing a national innovation system. In this regard, cooperation between public authorities and research institutions, technopolises, technology parks, and business incubators will foster a favorable environment for startup development, where a key aspect will be stimulating the commercialization of scientific research and its implementation into production. Additionally, optimizing the regulatory environment by simplifying startup registration procedures and supporting PPP will facilitate the rapid growth of newly established companies and their adaptation to market conditions. This includes improving working conditions, expanding opportunities for remote employment, and enhancing the social status of both managers and innovators, which will promote international labor mobility to attract specialists with foreign expertise.

The implementation of the human capital interdependence model in public authorities and innovation institutions in Ukraine primarily requires the establishment of a national human capital management platform. The use of modern IT solutions for workforce management will enable more effective analysis of employee productivity and forecasting the demand for skilled personnel, supporting the launch of the state grant programs for researchers and entrepreneurs. In this context, it is crucial to develop a state financing mechanism for supporting innovative entrepreneurship and scientific research, which will stimulate the development of educational alliances between public authorities and universities.

As demonstrated by Singapore's experience, adapting the process of establishing training centers for public officials in partnership with universities aims to enhance the professional competency of public administration employees in strategic planning for innovation development, while also promoting international labor mobility. According to the experiences of Japan and Germany, the development of personnel rotation programs between public authorities and business companies is designed to integrate Ukraine into global innovation networks. This will also optimize PPP mechanisms, as simplifying the regulatory environment and enhancing state-business interaction through private capital involvement in innovation projects will allow public authorities to more effectively utilize available human, material, financial, and informational resources to support innovation institutions, thereby improving working conditions for public authorities' personnel.

7. Prospects for further research development

The prospects for further research on the mutual influence of human capital in public authorities and innovation institutions are linked to the need for continuous refinement of the proposed model and its adaptation to the evolving management environment. Primarily, this research object is valuable due to its practical significance in public administration and innovation development, as the effective utilization of human capital directly impacts the national economy's competitiveness. The use of a systematic approach in this research enables a deeper analysis of interaction mechanisms between public authorities and innovation-driven enterprises, facilitating the formation of a strategic vision for the innovation ecosystem development.

Further research can focus on the detailed examination of specific human capital management mechanisms in the context of digital transformation, globalization, and increasing professional competency requirements. In particular, an essential research direction is the study of the impact of automation in managerial processes and the application of HR analytics on the efficiency of decision-making in public administration. Additionally, expanding the analysis of PPP mechanisms as an instrument for involving business companies in the development of innovation clusters and startup ecosystems would be beneficial.

One of the promising directions for future research is evaluating the effectiveness of implementing educational alliances between the state, universities, and businesses, which would enhance professional training levels in alignment with market demands. Another crucial aspect involves analyzing international experiences in workforce mobility management and integrating Ukrainian specialists into global scientific and technological networks, fostering the country's innovation potential.

In the long term, the proposed model could be used for the development of regulatory policies aimed at stimulating human capital growth in public authorities and business enterprises engaged in innovation development and implementation. Additionally, empirical studies on the effectiveness of state-business interaction mechanisms in different regions of Ukraine could help tailor the model to the specifics of national governance.

Thus, further research in this field will expand the scientific understanding of the role of human capital in driving innovation development and enhancing public administration efficiency, enabling the creation of effective mechanisms for its stimulation and integration into modern economic processes.

8. Conclusions

The conducted study has provided an opportunity to examine the mechanisms of mutual influence of human capital in public authorities and innovation institutions, propose a model of their interaction, and assess its impact on the effectiveness of managerial decisions. The novelty of the research lies in the systematic approach to integrating human capital into innovation processes through PPP mechanisms, digitalization of personnel management, and the creation of educational alliances between public authorities and scientific institutions.

The proposed model of mutual influence has demonstrated that effective human capital management in public authorities directly impacts the development of an innovation-driven economy by implementing HR analytics, funding research projects, optimizing the regulatory environment, and integrating innovations into public administration. Ensuring stable development requires strengthening interaction between public authorities, universities, and business companies, which will facilitate the formation of a resilient innovation ecosystem.

At the same time, the effectiveness of PPP mechanisms in human capital development remains an open question, as different models of state-business cooperation yield varying results depending on the economic and social context. This necessitates further research into mechanisms for the internationalization of human capital, including attracting foreign specialists and integrating Ukrainian professionals into international innovation networks.

The practical significance of the study lies in the potential application of the proposed model for developing human capital management strategies in public authorities and innovation-driven business enterprises. The implementation of initiatives such as developing a national human capital management platform, introducing grant programs for researchers and entrepreneurs, and expanding educational alliances will contribute to the formation of a competitive national innovation system.

Thus, further research may focus on a detailed analysis of the impact of digital technologies on human capital development in public administration, an empirical assessment of the effectiveness of implemented reforms, and an exploration of opportunities to adapt international experience to

Ukrainian realities. This will help shape a flexible human capital management system that meets the challenges of the modern knowledge economy and promotes the sustainable development of Ukraine.

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