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Advancing the Knowledge Economy: The Impact of Innovations and Human Capital

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Abstract

The study's relevance is due to the need to form a knowledge economy through the rational use of human capital and the introduction of innovations. The structural elements of the innovation environment that stimulate professional development, realisation of intellectual potential and growth of labour efficiency are studied. A qualimetric toolkit for analysing human capital in the context of an innovative economy has been introduced, which allows assessing its status and effectiveness of application in production and management. A strategic model for the development of human resources for the knowledge economy has been formed, which provides for the modernisation of the educational system, intensifying innovations, and adapting professional skills to global challenges. The importance of balance in human capital development is substantiated by the principle of the golden ratio and the mechanisms for synchronising human capital management with the goals of innovative progress are proposed.

Keywords: *digitalisation, intellectual resources, innovation, human capital, knowledge economy, management in IT.*

Introduction

In the context of the rapid spread of globalisation and the active introduction of digital technologies covering all spheres of public life, the knowledge economy is becoming the primary driver of sustainable economic development and competitiveness of national economic systems, as it creates new opportunities for efficient use of resources, creation of innovative products and transformation of traditional approaches to the organisation of production activities (Abiddin & Talha, 2024). The high level of the knowledge intensity of modern technological processes, the dynamic development of information systems and digital platforms, as well as the growing importance of human capital as a carrier of knowledge, skills and ideological resources, determine fundamentally new trends in economic growth based on knowledge and intellectual assets that can ensure the creation of high-tech products, increase labour productivity, stimulate innovation and develop entrepreneurship in areas focused on the use of intellectual property.

Given the profound transformations taking place within the framework of the fourth industrial

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revolution, which led to the massive introduction of digital technologies, artificial intelligence and automation of production processes, human capital is gaining particular importance as a strategic resource capable of providing an innovative breakthrough and competitive advantages in the knowledge economy. The relevance of this study is due to the urgent need to develop effective mechanisms to stimulate innovation, which will contribute to the formation of a favourable environment for the development of human capital, expand the possibilities of using its potential and enhance the impact of knowledge resources on economic growth.

Literature Review

Considering the essence of the innovation economy in the context of its knowledge-based development, it can be noted that although the definition of this concept as an economic system based on the use of knowledge is reasonable, it does not reflect the full range of relationships between innovation, human capital and economic development. Thus, Ilyina (2024) and Rafique et al. (2024) emphasise that knowledge is the fundamental basis of any human activity, including economic processes. However, to form an innovation economy, it is necessary to consider the availability of knowledge and the mechanisms of its practical application in creating, using, and commercialising innovations.

According to Semenets-Orlova et al. (2022), Xu and Li (2019), the key characteristic of the innovation economy is the targeted stimulation of all economic actors to develop and implement innovative technologies and products, accompanied by the commercialisation of intellectual property. In this context, Kozhyna et al. (2022) emphasise that the innovation economy is a system in which innovation is the main driving force, and its development should be aimed at the proactive creation and active use of technological innovations that determine the country's competitive position at the international level.

At the same time, Dakhli and De Clercq (2004) and Makedon et al. (2024b) point out that the main drivers of the development of the innovation economy are enterprises that not only create and implement new technologies but also adapt existing innovations to market needs, thus forming an ecosystem of constant renewal of economic processes. In turn, Agarwalla and Sahu (2024) and Balan and Shepel (2024) expand on this idea, noting that the effective functioning of the innovation economy depends not only on the generation of knowledge and the creation of innovations but also on the level of their implementation in various spheres of public life, which requires appropriate training of human capital. They emphasise the need for a high level of professional competence, flexibility of thinking and readiness for continuous learning, as only under these conditions can human capital become a true catalyst for economic growth.

According to Adkhamjonovich (2024) and Chen (2024), the development of the idea of human capital as the leading resource of the innovation economy is the result of the transformation of the role of humans in production processes, which is taking place as a result of digitalisation and automation of economic activity. They note that modern economic systems require not only the intellectual potential of specialists but also their active involvement in developing and implementing technological solutions that contribute to the sustainable development of the knowledge economy.

In studying the development of the knowledge economy through innovation and human capital, the accumulation and efficient use of intellectual resources, which form the basis of the knowledge economy, is of particular importance (Debrah et al., 2018). Analysing the

mechanisms of functioning of socio-economic systems, a group of scholars (Balková et al., 2022; Ivinić et al., 2024; Yu & Lan, 2024) emphasise that a key characteristic of human capital is its ability to accumulate, which allows individuals to increase their potential by investing in their development. These researchers distinguish between the concept of "human resource", which reflects the natural abilities and innate characteristics of a person, and the concept of "human capital", which covers all acquired knowledge, skills and professional competences (Petrova & Pereira, 2024). At the same time, they emphasise that the relationship between human abilities and accumulated knowledge is causal, which indicates the need for continuous learning and adaptation to modern economic conditions.

Separately, Chaparro-Banegas et al. (2024) and Zayed et al. (2022), studying the role of human capital in the production process, define it as a complex economic category that combines the professional knowledge, skills and potential of both individual employees and labour collectives. These researchers emphasise that the use of human capital in the modern economy is aimed at increasing labour productivity and creating conditions for generating added value and ensuring sustainable reproduction of economic resources. At the same time, Farid AND Taher (2021) and Kichurchak (2024) consider human capital as a multidimensional category that includes not only the level of education and professional experience but also creativity, moral and psychological qualities, health and motivational aspects that determine the level of human involvement in innovation processes.

It should be noted that scientists emphasise the importance of a close connection between developing human capital, intensifying innovation activity and introducing scientific achievements into commercial use. At the same time, the question of how best to organise and optimise these interrelated processes at individual companies (microeconomics) and the entire economy of a country or region (macroeconomics) remains insufficiently understood. Further research and the development of models are required to manage this development.

The article aims to develop a methodological framework for developing the knowledge economy, focusing on stimulating innovation and optimising the use of human capital. It also aims to identify ways to coordinate these processes to achieve sustainable economic progress within the country.

Research objectives:

- to explore the formats and processes of combining human capital and innovation processes within the knowledge economy;
- to develop a methodological approach to assessing the efficiency of human capital use in the knowledge economy;
- to substantiate the model of harmonisation of human capital development processes by optimising its productivity in the coordinates of the knowledge economy.

Research Methodology

1. The structural modelling method, which involves constructing formalised models to represent the hierarchical connections between various elements of the studied system, is particularly useful in analysing the knowledge economy. This method allows for identifying the key

components of this complex system and highlights the main factors influencing its development. Furthermore, it establishes logical interconnections between these factors, enabling qualitative and quantitative analyses of the processes involved in forming the knowledge economy. These processes are based on the interaction of such critical spheres as human capital, innovative activity, education, science, technological progress, and public policy (Figure 1).

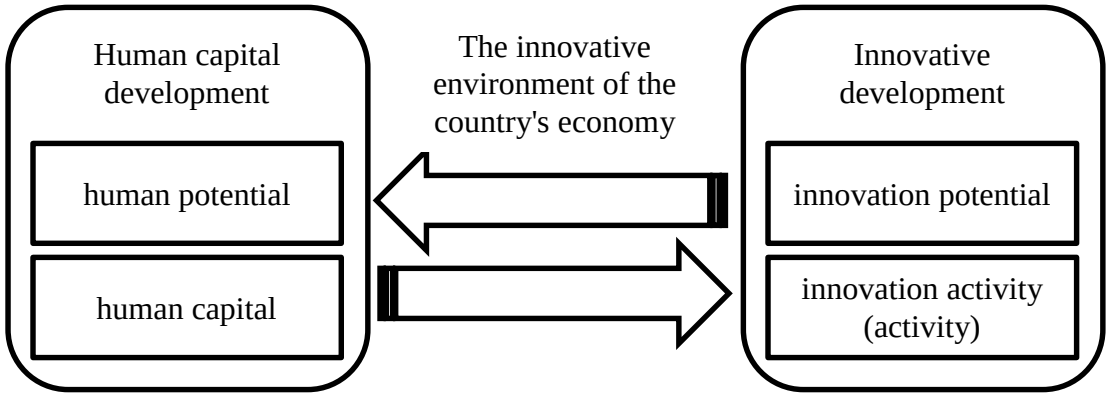

Figure 1. The use of the structural modelling method in shaping the interrelationships of human capital development and innovation development in the knowledge economy

An inherent component of the innovation development process is a knowledge economy, generally understood as the degree of readiness of the socio-economic system, management and personnel to accept innovations and ensure their creation and dissemination.

2. In order to carry out a comprehensive analysis of the level of efficiency of the knowledge economy in the context of its transformational development under the influence of innovative factors and human capital, it is advisable to use a qualimetric static model that will allow a systematic study of evolutionary processes in socio-economic systems, identify the key structural elements of the knowledge economy, their interrelationships and patterns of change in dynamics:

$$\mathrm{Pr}_{(t)} = \mathrm{Pr}_0(1 + t\frac{IC - IE}{IA})^P, \quad (1)$$

$$\rho = \frac{IE}{IC - IE} \quad (2)$$

where $Pr_{(t)}$ is a differentiated performance function;

t is the time flow;

Pr_g is the initial value of system performance at time $t=0$.

In the context of studying the development of the knowledge economy through the prism of innovation and human capital, it can be said that the formation *(IC*) of intellectual potential, its application (*IE*) in the processes of innovation, as well as the accumulation (*IA*) of the achieved experience and competences are key stages that are organically intertwined in the system of information and synergistic flows of the innovation economy. The value of harmony (stability) of the links between the modelling of human capital development and innovation development processes within the knowledge economy is determined by the formula:

$$G = \frac{B}{B_{\max} - B} \qquad (3)$$

where *B* is the information and synergistic flow coming out of the system per unit of time;

B_{max} is the maximum information and synergy flow value in the analysed system.

These formats mean that human capital is not only an initial resource for the creation of new knowledge and technologies but also the result of this process, where each subsequent step determines the previous one. This forms a closed development cycle that ensures constant interaction between the generation of ideas, their implementation, and the recording of the achievements.

Results

Factor composition of the knowledge economy and its innovation and resource provision

The knowledge economy and innovation development are interdependent components that determine current trends in economic growth, as the constant exchange of intellectual resources, intensive use of information technology and systematic modernisation of production processes are fundamental prerequisites for the formation of innovation-oriented economic systems. Innovative processes generated in the knowledge economy contribute not only to the optimisation of production creation of new products and services but also to a significant increase in the efficiency of economic activity, which, in turn, activates the accumulation of intellectual capital, expansion of technological capabilities and, as a result, further growth of knowledge resources, forming a cyclical mechanism of mutual enrichment (Bolek et al., 2021).

In forming and developing a knowledge economy based on human capital and innovation, innovators play a key role - entities that generate and implement new ideas, developments, and technologies with commercial and social value. Innovators are the driving force behind transformational processes in society, as they create new knowledge and adapt it to the economy's needs through discoveries, inventions, patents, know-how and other innovative solutions (Capozza & Divella, 2019).

From the perspective of human capital development, innovators are highly skilled professionals, entrepreneurs and researchers who not only have deep knowledge in their fields but also have creative thinking, the ability to adapt quickly in the face of instability and a high level of social

responsibility (Lin, 2024). A study of the personal characteristics of innovators shows that they are proactive, strategically minded individuals who can transform their skills and potential into productive activities aimed at gaining new competitive advantages. Their ability to analyse non-standard situations, identify problem areas and find innovative solutions determines the dynamics of economic development and the growth of competitiveness of the knowledge economy (Figure 2) (Podra et al., 2020).

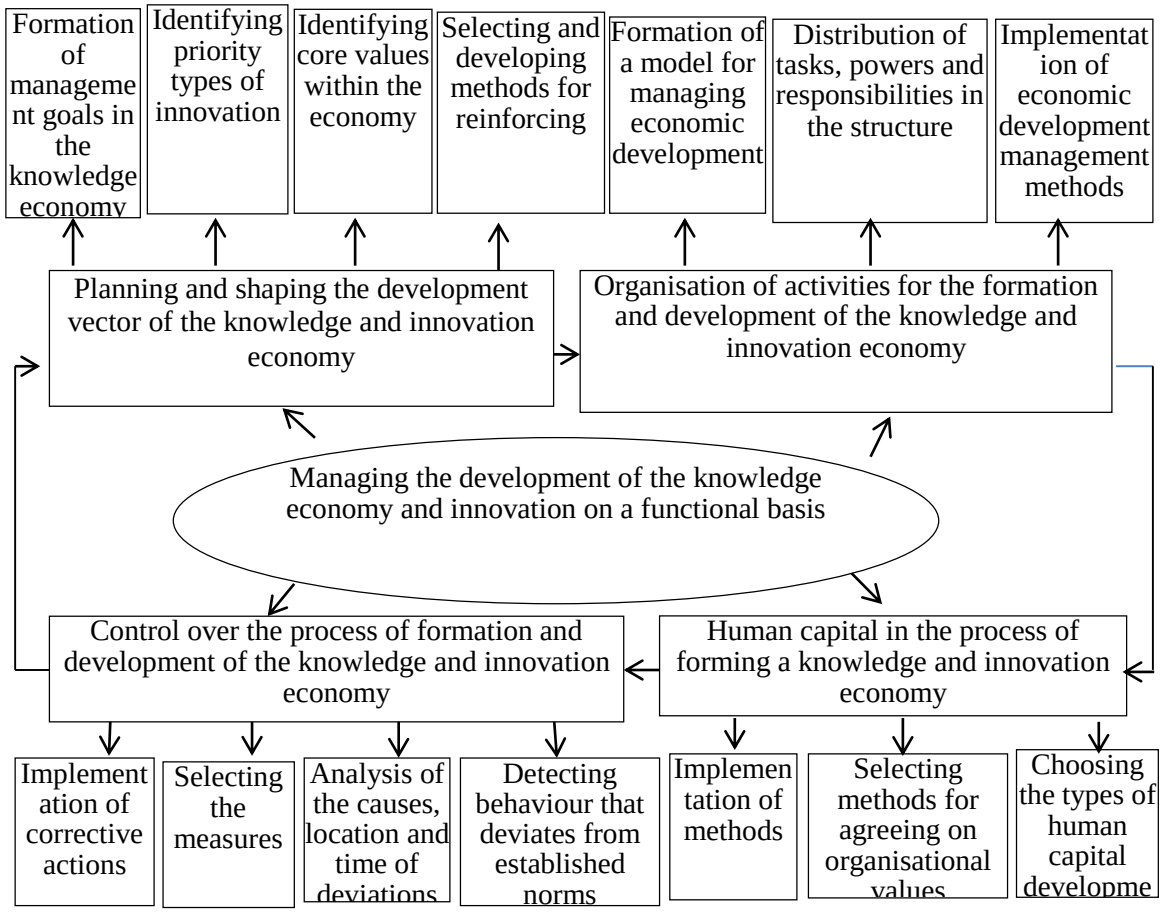

Figure 2. The impact of innovation and human capital on the development of the knowledge economy: Organisational aspects and cultural foundations

Source: based on Babenko et al. (2024), Metelenko et al. (2019)

In this context, creativity is particularly important, as it is the foundation of an innovative culture and one of the main mechanisms of professional and personal development. Creativity defines a person's ability to think outside the box, find original solutions and generate new knowledge, which is critical in a modern economy focused on intellectual resources. It is closely intertwined with the concept of creativity, as it is through creative activity that qualitatively new tangible and intangible values are formed that influence the development of innovation ecosystems (Štaffenová & Kucharčíková, 2024). In the process of interaction between the innovative

potential of an individual and the general innovation environment, the maximum level of their realisation is achieved, which can be defined as potential - a complex characteristic of the individual's ability to develop innovative activity, intellectual independence and professional creativity (Xu, 2024). This approach allows us to consider innovation culture as a key factor in forming a highly productive innovation environment, which, in turn, contributes to strengthening the role of human capital in the formation of the knowledge economy. As modern economic systems are increasingly focused on technological innovations, creating a favourable environment for the development of creative thinking, professional adaptability, research, and innovation are becoming determining factors in the competitiveness of national economies.

Quantimetric model for assessing the development of the knowledge economy through the use of innovation and human capital (case of Ukraine)

Analysing the mechanisms of formation, accumulation and efficient use of human capital in the knowledge economy, the methods of correlation and regression analysis were applied, which allowed identifying seven main static processes that determine the dynamics of human capital development for Ukraine (Kucharcikova et al., 2024). Indicators of human capital accumulation were used as the primary outcome indicators, allowing us to conclude the need for further research on the processes that affect knowledge quality, efficiency and adaptability in the context of its practical application (Martynovych et al., 2024). A map of strategic processes of human capital development and their role in shaping the knowledge economy through the prism of innovation is presented in Table 1.

Table 1. A map of strategic processes of human capital development and their role in shaping the knowledge economy through the prism of innovation

Process.	IC	IA	IE	Multiple regression equations
1	IC2 - the share of people with higher and secondary specialised education in the total population aged 25 to 65	IA1 - level of participation in continuing education	IE 2 - labour force participation rate graduates with secondary vocational and higher education	$IA_1 = 30.521 + 0.1111IS\ 2 - 0.1211IE_{(2}$
2	IC6 - share of expenditures on general secondary education in total education expenditures	IA2 is the share of expenditures on vocational training, retraining, and advanced training in total expenditures on education	IE 7 - share of R&D personnel employed in the economy as a whole	$IA_{\ 2} = 1.7628 - 0.0153IS_6 - 0.3088IE_{(2}$

3	IC3 - share of people with higher education in the total population aged 25 to 65	IA3 - share of wages in GDP	IE 4 - labour productivity index	$IA_3 = 119.7366 - 0.0357IS_3 - 0.6969IE_{(4}$
4	IS5 - share of education expenditure in the country's GDP	IA4 - Ratio of average accrued salary of employees with higher education to all employees	IE5 - the share of graduates employed by organisations that performed research and development in the total number of graduates of higher education institutions	$IA_4 = 1.3212+0.0194IS_5 - 0.0895IE_{(5}$
5	IC7 - share of higher education expenditure in total education expenditure	IA5 - the share of enterprises that implemented organisational innovations in total organisations	IE1 is the share of the employed population aged 25-64 with higher education in the total employed population	$IA_5 = 7.2137+0.0109IS_7 - 0.1322IE_{(1}$
6	IC4 - average expected years of schooling in the future for children aged 6	IA6 is the decile coefficient of employee differentiation by salary level	IE3 is the share of graduates working in the field of study in the total number of employed graduates	$IA_6 = 16.6422 - 0.5688IC_4 - 0.0154IE_{(3}$
7	IC9 is the share of expenditures on the formation of general human capital in the total amount of all expenditures on education, %.	IA7 is the inventive activity ratio (the number of domestic patent applications for inventions per 10 thousand people in the country)	IE10 - share of researchers employed in the business sector of science in the total number of researchers	$IA_7 = 11.5764 - 0.1046IC_9 + 0.0048IE_{(10}$

Source: constructed by the author

In our case, to process the indicators of Table 1, the formula will take the form:

$$G = \frac{IA}{IA_{\max} - IA} \qquad (4)$$

The value of the determining component $G = 0.63$ determines the stable position of the system by the harmonic value of the golden ratio; taking into account the rule of three sigmas (with an

error of 5%), the stability interval ranges from 0.54 to 0.73. In this case, the harmonic value of the system performance (Pr_g) can be calculated by the formula:

$$\Pr_{(g)} = 0,38\,\Pr_{(\max)} \quad (5)$$

where Pr_{max} is the maximum value of system performance.

For a particular set of static processes that affect the development of human capital in the knowledge economy, the optimal harmonious productivity values that need to be achieved to ensure the stability and efficiency of the system of formation and use of innovation potential were calculated (Makedon et al., 2024b). Achieving these parameters will create a balanced environment in which human capital is accumulated and effectively integrated into economic processes, contributing to the dynamic development of the innovation economy (Table 2).

Table 2. Sustainability and harmony of interaction between human capital and innovations in the coordinates of knowledge economy development (case of Ukraine)

Development processes	***G***	Pr_{max}	$Pr_{(g}$
Process 1	5,9157	4,2441	1,6128
Process 2	3,8535	1,2054	0,4578
Process 3	9,57075	171,113	65,0234
Process 4	54,6378	5,40015	2,0517
Process 5	6,07215	1,50465	0,5712
Process 6	20,5307	2,09055	0,7938
Process 7	14,427	1,113	0,42315

Source: constructed by the author

The formation and development of human potential and its transformation into human capital in the innovative economy in the leading countries of the world are based on the right policy and management culture, which ensures the creation of material and technical conditions that motivate a high culture of activity and highly productive work of citizens. This explains why labour productivity in Ukraine is several times lower than in other countries with similar human capital (Jalan & Pednekar, 2024). As a result of the calculations (Appendix A), a matrix of productivity of static human capital development processes in the knowledge economy was obtained (Table 3).

Table 3. Matrix of productivity of processes of formation and use of human capital in the context of development of knowledge economy and innovations (case of Ukraine)

Year	**Process 1**	**Process 2**	**Process 3**	**Process 4**	**Process 5**	**Process 6**	**Process 7**
2013	1,4619	1,1638	1,8172	1,9778	1,2133	1,2364	1,1242
2014	1,8183	1,1748	5,1535	2,5245	1,3013	1,3673	1,1363
2015	2,1076	1,1869	10,0342	2,9029	1,3442	1,4949	1,144
2016	2,7632	1,1957	12,1066	3,3363	1,4146	1,6621	1,1484
2017	3,5079	1,1836	39,1457	3,6476	1,4278	1,7787	1,1583

2018	4,4462	1,1825	179,262	3,9237	1,4509	1,9107	1,1594
2019	3,344	1,1957	37,0271	4,2922	1,4762	2,0207	1,1517
2020	2,8336	1,2045	24,5003	4,774	1,4476	2,0405	1,166
2021	3,894	1,1979	28,798	5,6573	1,5059	2,1901	1,1627
2022	3,1042	1,2276	25,3055	5,5132	1,5378	1,9536	1,1539
2023	3,6509	1,2628	18,5141	5,1832	1,5763	1,9745	1,1627

Source: constructed by the author

Each process's evolutionary path choice is based on the degree's value (*P*). In our case, most productivity growth processes are described by identical functions. For processes 1, 2, 5, and 7, the value $0<P<1$ is in the region that ensures an annual productivity increase per unit of time slightly greater than 0, and the processes are described by irrational functions (Figure 3). Processes 4 and 6 are characterised by similar productivity dynamics, reflecting common trends in the development of human capital and its integration into innovation processes. Until 2019, the level of productivity remained in the range of $0<P<1$, approaching one, indicating a steady increase in the efficiency of these processes (Le et al., 2024).

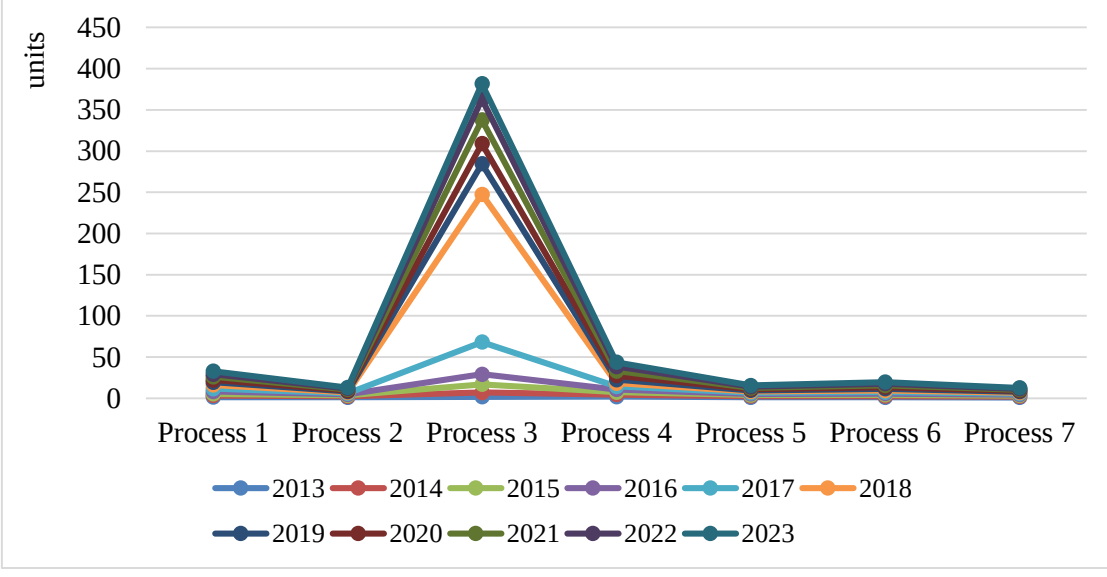

Figure 3. Dynamics of productivity of human capital formation and use in the context of knowledge economy and innovation development in 2013–2023 (case of Ukraine)

Source: constructed by the author

The graphical representation of the productivity-time relationship was hyperbolic. However, in 2021-2023, *the P-index* began to gradually approach zero, indicating a change in the dynamics of productivity growth in these processes.

In 2013-2016, the productivity of the human capital system and the innovation economy was characterised by negative values of $P<0$, and the annual increase in productivity per unit of time was insignificant, corresponding to uneven and irrational development. However, in 2017–2018,

the trend changed – negative productivity values were transformed into positive ones, accompanied by a sharp increase in *P*, forming an exponential relationship between productivity and time. Starting in 2019, the reverse processes were recorded, with similar dynamics, but in the direction of slowing down the pace of productivity. This indicates the need to revise the mechanisms of human capital management and stimulate innovation activity to stabilise the knowledge economy. The nature of the dynamics of productivity processes varies over the study period, but the overall average productivity growth over the study period is positive.

Discussion

The study found that the process of development of the knowledge economy is significantly influenced by the interaction of innovation and human capital while comparing the results with previous scientific works showed that the conclusions about the importance of knowledge and innovation in the formation of a competitive economy are in complete agreement with the studies of such authors as Ilyina (2024) and Rafique et al. (2024), who emphasise not only the need to create new knowledge but also the need to effectively protect it.

In analysing the role of government stimulation of innovation, we relied on Semenets-Orlova et al. (2022), Xu and Li (2019), who point to the importance of this factor for sustainable economic growth. However, our results showed that government intervention alone, without integration with mechanisms for training and development of human capital, cannot provide sufficient efficiency in the long run, which indicates the need for a comprehensive approach to stimulating innovation.

As for the main drivers of the knowledge economy, according to Dakhli and De Clercq (2004), Makedon et al. (2024a), enterprises play a leading role in implementing innovative changes. However, our study emphasises that the key factor in the effectiveness of such changes is the level of human capital training, which is confirmed in the findings of Agarwalla and Sahu (2024) and Balan and Shepel (2024), who emphasise the importance of a high level of professional competence and continuous training of staff to ensure the sustainable development of the innovation economy.

Considerable attention has also been paid to the role of human capital. The results are consistent with the studies of Adkhamjonovich (2024) and Chen (2024), who emphasise the growing role of education, digitalisation, and automation in the modern economy. However, our study complements their findings by showing that the effective use of human capital requires adaptive mechanisms that ensure the integration of knowledge into actual economic processes, which is an important aspect of further research.

The novelty of our study lies in the construction of a qualimetric model for assessing the efficiency of human capital use in an innovative economy, which takes into account not only education and skills factors but also the level of integration of scientific knowledge into production processes, which is confirmed by the findings of Balková et al. (2022) and Ivinić et al. (2024), who investigated the mechanisms of human capital accumulation, while our study found that for stable economic growth, it is necessary to take into account the harmonious proportions between education, research and practical application of knowledge, which partially diverges from traditional approaches to the development of the innovation economy.

The practical contribution of the study is to determine the optimal levels of human capital productivity and mechanisms for its integration into economic processes, which allows the

creation of an effective system for the development of an innovative economy and, based on the concept of the golden section, harmonious values of productivity were calculated, which allows to achieve sustainable economic development, and prospects for further research include a detailed analysis of the relationship between the level of education, the level of innovation activity and long-term economic performance.

Conclusion

Human capital development should be based on an interconnected system of strategic goals that cover national priorities and regional and corporate aspects. Integrating human capital management policy with the key objectives of innovation development will help increase the competitiveness of the knowledge economy, stimulate high-tech production, and create conditions for the efficient use of intellectual resources.

The developed methodology of qualimetric assessment of human capital in the context of the innovation economy is based on a comprehensive analysis covering three key aspects: formation, accumulation and use of human capital. This approach allows the identification of systemic problems that hinder the development of the knowledge economy and the formulation of targeted public policy measures aimed at stimulating innovation activity and the efficient use of intellectual potential.

The study revealed a lack of sustainability and harmony in the dynamics of key processes related to human capital, which requires calculating optimal productivity levels. Applying the concept of the golden section to determine harmonious values allows for creating a stable system of human capital development capable of ensuring sustainable innovation development in the long term.

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Appendix A

Analytical table for assessing the productivity of human capital formation and use in the context of the development of the knowledge and innovation economy

t	*A*	*B*	*C*	*P*	$Pr_{(t}$	$Pr_{(max}$	$Pr_{(g}$
Process 1							
1	36,85	27,28	91,19	3,1361	1,4619	4,4462	1,6896
2	38,83	25,63	89,32	2,1362	1,8183		
3	40,26	24,2	89,32	1,6577	2,1076		
4	43,89	27,5	89,65	1,8458	2,7632		
5	48,026	30,03	89,65	1,8359	3,5079		
6	56,386	34,1	89,65	1,683	4,4462		
7	64,746	29,7	90,42	0,9317	3,344		
8	71,324	26,4	89,76	0,6468	2,8336		
9	75,24	32,45	89,65	0,8338	3,894		
10	82,83	29,7	98,45	0,6149	3,1042		
11	80,85	31,57	98,45	0,7051	3,6509		
Process 2							
1	50,71	0,781	1,397	0,0176	1,1638	1,2628	0,4796
2	51,26	0,77	1,397	0,0165	1,1748		
3	48,037	0,77	1,364	0,0176	1,1869		
4	47,696	0,792	1,364	0,0187	1,1957		
5	50,897	0,704	1,342	0,0154	1,1836		
6	50,611	0,671	1,342	0,0143	1,1825		
7	51,238	0,759	1,342	0,0165	1,1957		
8	48,048	0,759	1,342	0,0176	1,2045		
9	52,745	0,748	1,287	0,0154	1,1979		
10	44,803	0,814	1,188	0,0209	1,2276		
11	44,132	0,99	1,166	0,0253	1,2628		
Process 3							
1	29,59	52,14	115,5	-2,5432	1,8172	179,2615	68,1197
2	30,58	57,86	105,49	-2,3331	5,1535		
3	32,01	54,67	113,3	-2,6543	10,0342		
4	33,22	48,29	114,4	-3,5244	12,1066		
5	33,22	48,73	114,18	-3,4562	39,1457		
6	36,74	50,93	112,31	-3,9479	179,2615		
7	50,16	52,14	110,88	-28,9663	37,0271		
8	59,84	52,58	108,57	7,9662	24,5003		
9	61,82	53,02	110,11	6,6275	28,798		
10	65,23	52,58	112,31	4,5727	25,3055		
11	68,97	50,6	113,08	3,0294	18,5141		

Process 4							
1	5,39	1,441	0,99	0,4015	1,9778	5,6573	2,1494
2	5,39	1,485	0,99	0,418	2,5245		
3	5,39	1,485	0,99	0,418	2,9029		
4	4,84	1,452	1,1	0,4719	3,3363		
5	4,84	1,452	1,1	0,4719	3,6476		
6	5,06	1,463	0,99	0,4477	3,9237		
7	4,95	1,463	0,99	0,462	4,2922		
8	4,73	1,452	0,99	0,4873	4,774		
9	4,4	1,452	0,99	0,5423	5,6573		
10	4,51	1,463	1,1	0,528	5,5132		
11	4,62	1,419	1,1	0,4873	5,1832		
Process 5							
1	20,273	3,85	31,68	0,2574	1,2133	1,5763	0,5984
2	22,352	4,07	32,45	0,2453	1,3013		
3	21,945	3,74	33,11	0,2255	1,3442		
4	20,559	3,85	33,77	0,253	1,4146		
5	20,13	3,52	34,32	0,2332	1,4278		
6	19,514	3,41	35,86	0,2332	1,4509		
7	18,832	3,3	36,3	0,2332	1,4762		
8	21,967	3,19	37,18	0,187	1,4476		
9	17,908	3,08	37,73	0,2288	1,5059		
10	17,215	3,08	38,61	0,2398	1,5378		
11	16,621	3,08	38,61	0,2497	1,5763		
Process 6							
1	17,05	7,37	58,3	0,8371	1,2364	2,1901	0,8316
2	17,27	7,37	58,3	0,8184	1,3673		
3	17,27	7,37	58,3	0,8184	1,4949		
4	17,27	7,81	58,3	0,9086	1,6621		
5	17,38	7,81	59,62	0,8976	1,7787		
6	17,27	7,81	59,62	0,9086	1,9107		
7	17,27	7,81	60,83	0,9086	2,0207		
8	17,6	7,37	60,28	0,792	2,0405		
9	17,6	7,37	57,53	0,792	2,1901		
10	18,15	6,82	70,95	0,6622	1,9536		
11	18,15	6,82	75,9	0,6622	1,9745		
Process 7							
1	103,73	2,211	58,971	0,0242	1,1242	1,166	0,4433
2	103,84	2,211	58,971	0,0242	1,1363		

3	103,4	2,211	58,971	0,0242	1,144		
4	103,4	2,035	52,8	0,022	1,1484		
5	103,95	2,2	50,71	0,0242	1,1583		
6	104,5	2,2	57,75	0,0242	1,1594		
7	104,5	1,815	56,958	0,0198	1,1517		
8	105,38	2,2	57,442	0,0231	1,166		
9	105,49	2,013	56,65	0,0209	1,1627		
10	105,71	1,705	58,069	0,0176	1,1539		
11	106,59	1,87	54,142	0,0198	1,1627		