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Human Capital as a Key Factor of Innovation Policy in the Context of Digitalization of the Economy

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ABSTRACT

The objective of the research is to identify human capital as the basis of innovative development in the context of the digitalising economy and its growing role within the framework of automation, AI and global competition. The impact of human capital on innovation processes and strategies of the leading countries worldwide is analysed, including the challenges of digitalisation, automation-driven risks and ethical aspects of AI. The methodology employed is comparative analysis of various types of intellectual capital (human, structural and customer ones), as well as its practice in Germany, the USA and China. The article describes modern digital technologies (cloud solutions, AI), their impact on the labour market. It also conducts a critical analysis of relevant statistics and reports (e.g. on scarce information security personnel).

Findings. The article emphasises the significance of training personnel in the domain of security and digital technologies, which is of particular relevance for the Russian economy. Reference to specific universities and training programs serves to enhance a practical value to the given research.

Keywords: human capital; intellectual labor; intellectual capital; digital technologies; cybersecurity; educational programs; technical innovations; artificial intelligence

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INTRODUCTION

An individual innovative and entrepreneurial potential serves as the foundation for the research of the labour phenomenon and trends of development of contemporary society. In this environment, labour is explored as a self-developing, multi-level system for transforming activity oriented to reach material and spiritual values. However, such a definition extends beyond the framework of usual perception of labour as a mere “work for pay”. It describes labour as a complex, dynamic, and intellectual phenomenon, as well as a multi-level system.

The term *system* indicates that labour is not merely a set of random activities but an integral, organised complex of interrelated elements. If one element is removed, the entire system may malfunction or change its nature. That is why, the elements are the following:

- the subject of labour: an individual or collective (with knowledge, skills, and creative potential);
- the object of labour for some efforts (material, informative, data, other persons);
- the means of labour: tools, technologies, software, equipment (starting from a hammer to a powerful graphic editor or CRM system);
- the goal of labour: the intended result of material or spiritual value;
- the process of labour: the algorithms, methods, and operations interrelating all of the above.

The *multi-level* nature of labour implies:

1. The individual level: the labour of a specific person. This level examines that person's individual actions, thought processes, creativity, and problem-solving abilities (for example, a programmer writing code, a designer creating a layout, or a scientist running an experiment).
2. Collective (team) level: within teams, department, projects. The key aspects become interaction, communication, coordination, and role distribution, thus, the system becomes more complex due to social ties, (for example, for film production requires director, stars, cinematogra-

pher, editor, as to developing a new car they need engineers, designers, marketing specialists etc.).

3. The organisational level: labour within an entire company or corporation. This level includes such elements as corporate structure, strategy, management, business processes, and organisational culture.

4. The societal (global) level: labour as a socio-economic category on the scale of society or even the whole world. This concerns the division of labour and international cooperation, global value chains, the impact of labour on the economy and culture. A prime example is the virtualised labour (a remote work for the entity of another country).

Thus, by describing labour as a multi-level system, we emphasise, that even the simplest action, like for example, producing a video for social media requires involvement of a complex hierarchy: an individual (level 1) by *means* of software and creativity operates within the strategy of a blog (level 3) for an audience (level 2) on a global platform (level 4).

Thus, to clarify the topic, it is necessary to investigate several important questions:

1. How does the system transform activity?

By the word *activity* we mean the initial, often disorganised or routine flow of actions and efforts. The labour system (with all its levels) operates as a mechanism or a machine for processing this activity and it transforms it in the following ways:

(a) It structures and arranges transforming chaotic actions into ordered processes, algorithms, and projects. For example, a brief, a technical specification, or a feasibility plan become elements of the system that transform a designer's creative revelation into a sequence of concrete steps;

(b) It endows with meaning and purpose: it directs activity not just somewhere, but towards a specific result (value). Activity without a goal is largely wasted. The labour system sets the vector for this transformation.

(c) It increases efficiency: the system facilitates achieving a better result losing less time



and effort through the division of labour, cooperation, and the use of technologies;

(d) It intellectualises production process, which is a key point from the author's definition. The contemporary labour system transforms physical efforts into mental ones. Activity increasingly consists not of manipulating objects but of data analysis, generation of ideas, decision-making, and process management.

2. What is activity transformed into?

A. It is converted into material values. This is not merely a physical product (a chair, a house, a smartphone). Today, information "packaged" into a digital product (software, database, virtual prototype, etc.) often becomes a material value. Nowadays, the process of producing an automobile starts not with metal spare parts, but with 3D modelling and simulation. This is the transformation of activity into a virtual value, which is nonetheless extremely material in its significance.

B. It is converted into spiritual values. This is an even more important product of contemporary labour, including:

- knowledge: scientific discoveries, patents, methodologies;

- cultural products: films, music, books, games, articles, blogs, anything that enriches a person's intellectual personality;

- services and experiences: education, consulting, psychological aid, travel planning;

- social relations: community moderation, the creation of platforms for communication, generally, labour that transforms communication into new digital social capital.

Hence, contemporary labour is not a linear process "you've made-you're paid", it is a complex assembly line that "refines seeping human activity through itself", enriching it with intellect, creativity, and interaction, and producing at the output high-tech products and meanings, which are the principal values in the modern world. The system does not merely consume activity but it qualitatively changes both the activity itself and its outcome.

Resulting from the above analysis, we now turn to the definition of human capital.

Contemporary technologies of information, telecommunication, etc. become determining factors in the modern social system. They objectively influence human creativity, the ability to design

Table 1

Classification of Intellectual Capital

Classification criterion	Capital classification	Characteristics
Object of management	Human	Knowledge, experience, competencies, qualifications, personal skills, creativity, etc.
	Structural	Brands, information systems, patents, licences, corporate culture and ethics, organisational
	Stakeholder (client)	Relationships established by the organisation: with consumers, suppliers, partners, etc.; cooperation with stakeholders
Уровень формирования	External	At the state level as a whole
	Organisational	At the level of the company
	Team/group	At the level of a project-oriented team/group
	Individual	At the level of an individual person/employee/scholar

Source: compiled by the author.

and create something new, and change the nature of labour in the sphere of intellectual and entrepreneurial capital [1].

Initially, in 1969, J. Galbraith introduced the concept of “intellectual capital” as a new factor of production: the aggregate of people with diverse technical knowhow and experience in the functioning of industrial technologies [2].

We shall define the essence and structure of this concept regarding an organisation (*Table 1*).

Human capital is characterised by the worker’s individual qualities and cannot to be adequately replaced by machines. Its impact on the development of entity’s innovations at the micro-level enhances competitiveness allowing it to win effective positions in the market and create competitive advantages through consumer loyalty, reputation, and operational efficiency.

EXPERIENCE OF LEADING COUNTRIES OF THE WORLD

In Germany human capital is regarded as national wealth [3]. German managers are graduates of higher education institutions. The most studied disciplines are mechanics, production technology, business economics, computerisation and information technology, as well as public administration.

Competition in terms of human resource development begins at the school age.

There are three types of German schools depending on pupils’ abilities. Parents inculcate cognitive skills in their children, so that they may be fit for the best category.

Stability of managerial staff in companies is ensured through training and professional development at the corporate level, in view of the industry-specific features and the entity’s profile. There exist academic courses with programmes such as “Sales Management”, “Labour Relations”, etc. The level of German human capital is distinguished by the fact, that one-third of board member in each entity hold doctoral degrees. Management provides employees with comfortable working conditions, fosters enabling climate for young specialists, values the competence and

experience of older colleagues, as well as disabled employees as well as observes ecological standards, avoiding harm to the surrounding environment. The German government provides financial support to universities, thus facilitating the active development of the scientific and research sector.

The USA implies the dominant role in innovative activity assigned to universities, which focus on the main research in fundamental science and applied research. The University of California, Berkeley, Harvard University, Yale University, Columbia University, Stanford University, the Massachusetts Institute of Technology, and others are among top rank leaders worldwide.

The structure of the US innovation system is supported by national laboratories in the field of applied science and by private research corporations, which run fundamental and applied research on a commercial basis [4]. It is focused on training highly qualified experts, developing new high-tech projects, interacting with business and the state, and raising profit from research findings. This three-component approach, including government, business, and science, has been termed the “triple helix”.

This principle contributed to the foundation of Silicon Valley, the world’s leading technopolis designed for the progress of leading companies in the field of modern electronic and computer technologies, focused on innovations that generate high revenues and develop the national economy [5].

Experts of the US research company Garther have determined cyber threats (from phishing to social engineering)¹ as one of the potential risks from the implementation of neural networks. The latter can lead not only to the loss of valuable data but also to misinformation, which can affect key organisational decisions. Innovations in IT technologies involve automatic uploading of data to cloud services and the use of “invisible intelligence”. This concept implies the integration of smart systems into everyday life by means of inexpensive sensors and tags, with smart devices,

¹ URL: <https://blog.rt.ru/b2c/trendy-cifrovizacii-na-2025-god-inovaya-nacionalnaya-programma-ekonomika-dannykh.htm>



which offer users what they need: recommendations to customers in retail, and patient monitoring in healthcare.

China has become one of the global innovation leaders within the last eight years. The national economy is rapidly developing, improving people's living standards and contributing to the accumulation and development of human capital [6], which is considered a decisive factor in economic growth.

Besides Chinese scientists have empirically proven that a higher behavioral motivation improves human performance [7].

Public funding for education in China has doubled from 2 per cent of GDP in 1978 to 4 per cent in 2022. Xi Jinping has pinpointed the vital significance of talents and emphasised the educational function of university learning. As part of new socio-economic development model, China has developed a long-term plan and an aggregation of the following new strategies, entitled "The Chinese Dream":

- "New Normal" in the economy;
- "Law-Based Governance" in public life;
- "One Belt, One Road" in international economic relations.

China set a course for itself from "New Normal" to "National Revival" and it has become a driving force for the global economy. In 2016, its contribution to the global economy was 30 per cent (exceeding the combined total of the USA, the EU, and Japan), and its GDP was 14.8 per cent of the global total, which is 3.4 per cent higher than in 2012.

The "New Normal" calls for not so much a prioritisation of GDP growth as rather a transition to high-quality development, but also a reorientation toward the domestic market through rising incomes, the migration of rural residents to cities, and a rapid reduction in poverty.²

² URL: <https://nic-pnb.ru/analytics/chelovecheskij-kapital-kak-glavnyj-resurs-bezopasnosti-i-razvitiya-rossijskaya-epoha-fu-sin/>

Table 2

Development of Cloud Technologies in Russia

Digital technology	Characteristics
Cloud technologies	A key asset for the public sector, financial institutions, and manufacturing companies; development of hybrid and multi-cloud infrastructures
AI and machine learning	An integral part of software solutions implemented in corporate software and government agencies; usage of computer vision processing and artificial automation technologies
Containerization and micro-service architecture	A transition from monolithic solutions to more flexible, modular systems; containerization facilitates easy deployment, and application of fault tolerance; the development of microservice architecture accelerates upgrading cycles
Strengthening cybersecurity	Cybersecurity was transformed from a support function into an end-to-end development strategy; the implementation of constructive information security practices allows customers to independently configure and develop IT systems without involvement of developers

Source: compiled by the author.

In 2025, China showcased success in innovation, establishing a center of advanced technology in the framework of the “Made in China 2025” national strategy aimed at industrial modernisation and the integration of new technologies.³ The volume of technical innovations increased by 69 per cent, and the number of patents issued expanded by 40 per cent.

Artificial intelligence (AI) and machine learning are rapidly developing. Advanced technologies enable the automation of production processes, boost productivity and reduce production costs. For example, Foxconn plans to substitute up to 30 per cent of its workers with robots, accelerating production and minimising human error.

Nowadays, “smart factories” operate in China without human involvement developing the industrial Internet of Things that allows companies to optimise production processes and reduce risks.

In view of sanctions and restrictions on semiconductor supplies from other countries, China has developed its own 7-nanometer chips. Hence, now leading companies commercially manufacture them for the domestic needs and for the export, strengthening the global market position of China.

It is worth noting China’s autonomous 5G networks deployed in key regions: they become the foundation for the development of “smart cities”, autonomous vehicles, and other technologies. Today, the Chinese capacity of cloud technology has exceeded \$ 30 billion, which demonstrates its competitiveness.

Currently, China is transitioning to the next-generation cellular network: 5G-A, which is 10 times faster than previous technologies (10 Gbps vs. 1 Gbps).

Thus, comparing the experiences of leading countries in using intellectual capital, we can identify the following key factors for each of them:

- Germany is focusing on education and in-corporate training: a third of executives hold doctorates.

³ URL: <https://logichina.ru/blog/innovaczii-kitaya-2025/> Доступно на сайте: Инновации Китая в 2025 году: путь к устойчивому будущему.

- USA implemented the “triple helix” model (government, business and universities) with a highlight example of Silicon Valley.

- China: the strategy “Made in China 2025” leads to automation of manufacturing (Foxconn replaces 30 per cent of its labour work with robots).

DIGITAL TECHNOLOGY DEVELOPMENT IN RUSSIA

Currently, 96.5 per cent of Russian operators (VimpelCom, MegaFon, and MTS) use 4G networks. MTS has also launched a pilot 5G network in Moscow, covering 19 zones. The roadmap approved by the Russian Government allocates a budget of 21.463 billion rubles for the federal project “Digital Technologies”. The development of these technologies in Russia is presented in *Table 2*.

Currently, our country faces a shortage of qualified experts in the field of cybersecurity. For example, during the period 2022–2023, demand for cybersecurity specialists expanded by 12.6 per cent.⁴

Although 450 higher education institutions train InfoSec experts, and according to one report, the total number of specialists in this area grew by 8.7 per cent in 2022–2023, there is a persistent notable lack of practice-based programmes.

RISKS OF AUTOMATION AND ETHICAL ASPECTS OF ARTIFICIAL INTELLIGENCE

Constructive cybersecurity is necessary for the development and creation of any new product. The fail-safe operation of systems is essentially critical for industrial facilities, factories, and the energy sector [8, 9].

The principal challenge in the field of cybersecurity is the shortage of qualified personnel however, the shortfall in their numbers increased by 12.6 per cent over the same period.

It is worth noting that automation entails the following challenges:

⁴ URL: <https://www.kaspersky.ru/blog/cybersecurity-talent-shortage/38295/> (дата обращения: 07.08.2025)

- Social risks:
 - Job displacement (e.g., at Foxconn);
 - Rising inequality resulting from worker retraining requirements;
- Ethical risks:
 - Data confidentiality (e.g., in Healthcare system);
 - Algorithmic discrimination (AI bias in employee recruitment);
 - Disinformation (use of AI for manipulation on social media).

For example, the AI implementation in retail (through personalised recommendations) increases sales, but at the same time this raises risks related to the leakage of personal data.

CONCLUSIONS

At present, 450 Russian universities and 95 colleges groom InfoSec specialists according to established standards, yet, a shortage of practice-centered programmes still persists.

Traditionally, flexible learning formats are offered, including integrative courses, practical assignments, and internships together with industry experts, which facilitate the exchange of experience and new ideas, discussions of problems, case studies, new projects, etc. [10, 11].

Today, such programmes are advanced by, for example, Solar Group (GK Solar), which collaborates with more than 15 higher education institutions. These are Alekseev Nizhny Novgorod State Technical University (Nizhny

Novgorod), Lobachevsky State University of Nizhny Novgorod (Nizhny Novgorod), Don State Technical University (Rostov-on-Don), Samara State Technical University (Samara), Tomsk State University of Control Systems and Radioelectronics (Tomsk), Pacific State University (Khabarovsk), MIREA — Russian Technological University and Bauman Moscow State Technical University (Moscow).

Universities become subjects of innovation policy and join the development of human capital, which is a key factor in the context of economic digitalisation. They implement innovative educational programmes, develop start-up ecosystems, encourage an entrepreneurial culture among students, and supply the domestic economy with qualified experts.

Human capital is a core driver of innovation, however, its development requires [12, 13]:

- investment in education and workforce retraining;
- balanced approach between automation and social protection for employees;
- ethical aspects regulation of AI (data protection, transparency of algorithms).

Nowadays, Russia needs to strengthen practice-oriented training in the IT sector, develop public-private partnerships based on the “Triple Helix” model, and take into account the negative experience of large-scale automation in China for the formulation of various strategies.

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