

Digital Technologies for Attracting the Labor Force to Industry in Ukraine

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Abstract: The article considers the problem of attracting labor resources to Ukrainian industry in the conditions of demographic decline, migration losses and large-scale war. The relevance of the study lies in the urgent need to overcome the labor force shortage and ensure sustainable development of industry through the use of digital technologies. The purpose of the study is to analyze the potential of modern digital tools in forming an effective system of attracting, selecting, motivating and retaining personnel at industrial enterprises. The methodological basis is the structural-functional and systemic approaches, which allowed building a conceptual system of providing labor force with the use of digital tools, such as national employment platforms, artificial intelligence algorithms, candidate management systems, chatbots, mobile applications, e-learning systems and predictive analytics. It is assumed that the use of digital technologies will significantly reduce the time and costs of personnel selection, increase the efficiency of HR processes, and also contribute to the growth of employee competencies through continuous training and professional development. At the same time, international integration mechanisms, in particular electronic visa services and migration platforms, open up access to foreign labor resources and accelerate the adaptation of labor migrants. The theoretical contribution of the study lies in the proposed conceptual system for attracting labor force to industrial enterprises using digital technologies, which is presented as a multi-level architecture of socio-technical innovations, connecting state institutions, enterprises and employees into a single digital system. The practical significance of the results is reflected in providing industrial enterprises with a roadmap for the implementation of digital tools in personnel management, which ensures sustainable growth even in wartime conditions.

1 INTRODUCTION

Digital transformation is becoming a key driver of economic growth, labor force development, and public administration efficiency. Using various digital innovation platforms, regulatory mechanisms, and strategic partnerships, the country is ensuring the development of relevant competencies as a key asset of its labor force.

Ukraine is currently experiencing a severe brain drain, labor force reduction, and the largest demographic crisis. Since the beginning of the war, a significant part of the Ukrainian labor force has emigrated or changed its place of residence,

becoming victims of military violence. This difficult labor situation will continue to affect business operations throughout Ukraine and threaten its future recovery. A survey conducted by the Ukrainian Institute for Economic Research and Policy Consulting in October 2024 showed [1] that labor shortages are the biggest concern for the private sector: more than 60% of surveyed companies are experiencing difficulties in hiring qualified employees. At the same time, according to the latest estimates, the current unemployment rate in Ukraine at the end of 2024 was 12.7%. This means that unemployment coexists with a labor shortage. Even before the war, Ukraine voiced a difficult

demographic situation: low fertility rates, premature mortality among men, and emigration of young Ukrainians in search of better economic opportunities abroad. According to estimates by the International Labor Organization, by 2032 Ukraine will lack 8.6 million workers (compared to 2022). And now the Government of Ukraine, in cooperation with the international community and relevant stakeholders, should develop and implement a comprehensive human capital development strategy to meet current and future labor needs. This will require a combination of short-term and long-term measures aimed at expanding the country's labor potential. However, the current labor problems in Ukraine are part of a broader demographic problem. The country has the lowest fertility rate in Europe, with less than one child per woman, compared to an average of 1.3–1.8 children per woman in Eastern Europe. In addition, Ukraine currently has a high rate of premature mortality, especially among men, and it is not just the country's traditional problems of alcoholism, accidents, but other current trends such as emigration, general ill health, and rapid aging that are complicating the country's demographic landscape. The last census of Ukraine, conducted in 2001, recorded a population of 48.5 million. The war caused many Ukrainians to emigrate abroad, with an estimated 20,000 Ukrainian children forcibly deported to Russia, and thousands more living under temporary occupation. Sadly, many Ukrainians died during the war. As of December 2024, the President of Ukraine reported that 43,000 Ukrainian military personnel had been killed. In addition, about 12,000 civilians had been killed, and thousands more Ukrainians had been injured or disabled. According to the Office of the United Nations High Commissioner for Refugees, as of November 2024, there were about 4 million internally displaced persons in Ukraine. Another 6.8 million refugees were registered in other countries, and approximately 14.6 million people were in need of humanitarian assistance. As a result of these trends, the population of Ukraine had decreased to 35.8 million as of July 2024 - or to 31.1 million if only the territories under the control of the Ukrainian government were taken into account. If this situation is not changed, the population of Ukraine could subsequently decrease to 28.9 million by 2041 and to 25.2 million by 2051, according to the National Academy of Sciences of Ukraine [1].

The population decline and the shrinking labor force will be a major shock to Ukraine's economy, and the negative effects will be felt for many years to come. Empirical research shows that time spent out

of work can not only lead to skill depreciation, but also affect national productivity and wages. A protracted war will have even more serious consequences for Ukraine's education, and this will directly affect the country's future human capital. Schooling has been and continues to be interrupted by the hostilities. Students have suffered significant educational losses. According to previous research by the Organization for Economic Cooperation and Development, the war in Ukraine will lead to a 7% reduction in the overall national productivity factor by 2035 [1]. In addition, poor mental health affects individuals and has a ripple effect on society and the economy. Even before the outbreak of the large-scale war, an estimated 30% of Ukraine's population had a mental disorder at some point in their lives. During the first year of the Russian invasion, approximately 26% of Ukrainians met the diagnostic criteria for post-traumatic stress disorder alone.

All of the above factors lead to missed working days, reduced labor productivity, quality and efficiency of labor potential use, and necessitate the involvement of innovative digital technologies in the process of providing labor to industry in Ukraine.

2 ANALYSIS OF LATEST RESEARCH AND PUBLICATIONS

The issues of digitalization of labor processes and labor force involvement in industrial enterprises have received wide coverage in the works of both domestic and foreign researchers.

Thus, Nemchenko T.A. and Divizyniuk B.M. [2] consider the transformation of labor under the influence of digitalization, and Androsova O. [3] analyzes digital tools used at Ukrainian enterprises. Research by the Razumkov Center [4] and Rumyantsev A., Kovbuch T. [5] identify global risks and the need for retraining of the labor force. Shatalova L. [6] focuses on digital competencies, while in previous publication Kalinesku T., Likhonosova G., Zelenko O. [7] emphasize the importance of integrating innovations into business processes. The works of Maksymenko I., Akimova A., Markova S. [8] and Dziubenko O., Galaz L., Baly O. [9] highlight the impact of war on digital transformation. At the same time, Azmuk N., Grishnova O., Kuklin O. [10] explore the global digital labor market. Cepeda-Cardona J., Arias-Pérez J. [11] reveal the risks of "technostress", and Markaryan M., Bilyi D., Yuldashev S. [12]

emphasize the importance of legal aspects of the digital transformation of the economy.

In general, the analysis of the literature demonstrates several key contradictions and gaps in the scientific discourse. First, digitalization is most often viewed as either a technical upgrade of enterprises or a change in employee competencies, but there are almost no approaches that synthesize these levels into a single system of digital human resources. Second, research rarely takes into account the specifics of the industrial sector, which differs significantly from IT or service industries in terms of the nature of competencies, personnel development strategies, and social risks. Third, modern publications pay insufficient attention to the integration of analytical tools - from systems for forecasting personnel needs to indicators of intellectualization of labor potential - although it is precisely such systems that determine the effectiveness of digital transformation in industry.

Thus, scientific publications outline the general trends in the digital transformation of labor, but do not form a holistic concept of attracting labor resources to industry based on digital technologies. This gap necessitates the development of an integrated approach that combines digital recruitment tools, HR process automation, competency development systems, analytical forecasting methods, and mechanisms for international personnel mobility.

3 RESEARCH METHODOLOGY

The methodological basis of the study is a systemic, structural-functional approach and a comparative-analytical method, which allowed to characterize comprehensively the impact of digital technologies on the processes of attracting labor force to industrial enterprises in Ukraine. The systemic approach provided the study of digitalization as a multi-level interaction of technological, organizational and social factors, while the structural-functional approach made it possible to identify the key elements of digital staffing - recruitment, automation of HR procedures, training, motivation and labor market analytics - and determine their role in the formation of modern labor potential. The comparative-analytical method was used to compare Ukrainian practices of digital recruitment and personnel development with international approaches, which allowed to outline

the directions of adapting global solutions to the conditions of war and demographic decline. Methods of analysis, synthesis and logical generalization were used to form the author's conceptual system for attracting labor force to industrial enterprises in Ukraine based on digital technologies that integrates various digital solutions into a holistic model of enterprise HR work.

The study also applied content analysis of analytical reports, statistical data and reviews of business practices, which allowed identifying key trends: workforce shortage, changing structure of demand for competencies, increasing role of HR process automation and use of artificial intelligence in recruiting.

4 MAIN RESEARCH RESULTS

Digital technologies, based on the implementation of advanced information and communication tools in all spheres of economic life [7], not only lead to an increase in the efficiency of production and commercial processes, but also create numerous challenges to the functioning of traditional economic mechanisms, transforming traditional business models, changing the nature of labor activity and creating the need to adapt labor potential to new working conditions. It is digitalization that creates new economic requirements for providing labor, where the formation of intellectual, creative, and innovative capital, which is based on the creation of the latest digital platforms and the use of innovations, is decisive. It is also necessary to emphasize that strengthening the role of information resources is becoming a fundamental criterion for ensuring the competitiveness of individual industrial enterprises, organizations and the country as a whole.

At the same time, the digital environment stimulates the development of innovations, which in turn lead to substantive shifts in the functioning of the labor market, affecting the organization of labor processes, labor supply, employment structure and the nature of labor activity. The key factors that influence the labor force supply of industrial enterprises in Ukraine are presented in Table 1.

In addition to the requirements for the modern labor force involved in industry, it is also necessary to talk about digital technologies that are traditionally used for its recruitment, namely [2, 3]:

Table 1: Key factors influencing labor force supply [2].

Key factors	The nature of the impact
Automation and digitalization of work processes	Transition from manual to routine work, using automated systems and algorithms, artificial intelligence, for big data analysis, forecasting and decision-making, integration of digital platforms for business process management
Changing professional competencies and qualification requirements	Growing demand for highly qualified specialists with digital skills, analytical and creative thinking, and the ability to work with large databases and artificial intelligence
Work flexibility and personalization	Transition to the use of digital technologies to individualize work tasks and increase worker mobility
Intellectualization of labor	Strengthening the role of cognitive processes and strategic thinking, the use of neural networks in performing professional tasks, and the analysis and adoption of management decisions
New forms of labor interaction	Using digital switching platforms for robot coordination, interactive collaboration, and working in virtual teams

- 1) Social networks and specialized platforms that allow companies to post vacancies and find candidates, as well as use advertising to attract the necessary specialists.
- 2) Candidate management systems that allow you to automate the hiring process, from the stage of submitting resumes and interviews to making a hiring decision and help process a large number of applications, sort them by key criteria, and track candidates during the hiring process.
- 3) Video interview software that allows you to interview candidates who are in different locations, which significantly saves time and resources.
- 4) Chatbots and artificial intelligence (AI), used to automate initial contact with candidates, answer questions, and collect basic information. AI can analyze large amounts of data to help identify the best candidates and predict their job performance. However, the current level of AI adoption among Ukrainian companies remains low (38.2%) [3], although future plans indicate a high level of readiness for its use (91%) by industrial enterprises. Overall, AI adoption in Ukrainian industrial enterprises is at an early stage, as the majority of existing enterprises (45.9%) believe that AI has the potential to increase productivity, and 43.3% expect AI to improve innovative products [3].
- 5) Mobile applications used to simplify the process of applying for jobs, receiving notifications about new vacancies, and communicating with recruiting firms.

In general, it is planned to create 344 million jobs in the international labor market (which includes Ukraine) by 2030 through the use of digital technologies, including 190 million jobs to solve the current problem of unemployment [4, p. 72]. Moreover, global GDP may grow by \$9 trillion due

to the automation of jobs using AI technologies. 375 million workers (about 14% of the global labor force) will be forced to change their profession. Therefore, enterprises that have to adapt to new digital technologies in the 21st century should take into account the following trends in the world, which are characterized by [5]:

- 1) Industrialization technologies. As a rule, most of these technologies are introduced in industries where new computer communication technologies and various means of electronics are widely used, which allows to increase the efficiency and capacity of production, labor productivity and create conditions that force workers to use these technologies, which are becoming more accessible due to the development of digital technologies.
- 2) Globalization processes that allow the majority of the working population of different countries of the world to establish certain information connections, which allows to interconnect the flows of money, goods, services and ensure their growth.
- 3) Competition. Globalization processes and digital technologies force enterprises to compete not only in the domestic market, but also for a share of the world market, which can be obtained on the basis of the rapid application of technological innovations.
- 4) Continuous and rapid changes in social life. Therefore, each enterprise must build its production mobile and flexible, so that it can quickly adjust to changing development conditions. Today's changes occurring in the environment cannot be resolved on the basis of past experience and traditions. Therefore, modern enterprises must learn new unprecedented ways to solve problems.
- 5) The technological speed of changes in business, which must correspond to the speed of the life

cycle, which is associated with the intensification of competition under the influence of the application of technological innovations.

- 6) The complexity of production, which is becoming an everyday norm and is associated with new opportunities, innovations and improvisation in solving emerging management problems.

The above characteristics of the use of digital technologies show certain changes that are taking place at industrial enterprises within the framework of providing jobs with labor resources. The main task of every modern industrial enterprise in Ukraine is not so much the filling of all workplaces with the necessary qualified labor force, but rather the readiness of all employees of enterprises for complex training based on digital and information technologies, innovative management and flexible methods of restructuring production processes to meet the requirements of the time. Enterprises seeking successful digital transformation must not only possess digital assets but also develop or acquire among their employees the competencies required for working with digital technologies [13]. According to recent studies across OECD countries, Finland, Norway, Sweden, and New Zealand demonstrate the highest levels of readiness for digital transformation, while Slovakia, Poland, and Greece show the lowest levels of readiness [14].

According to the results of the analysis, it is possible to formulate a conceptual system for attracting labor to the industry of Ukraine using digital technologies (Table 2).

The presented conceptual system for attracting labor to industrial enterprises of Ukraine based on digital technologies is imagined as a holistic, multi-level architecture of socio-technical innovation, which combines digital infrastructure for personnel search and selection, automation of HR processes, tools for motivation and professional development of employees, labor market analytics, and mechanisms for international integration of labor resources. At its center should be a national platform for interaction between labor market participants - government agencies, educational institutions, enterprises, and candidates - that implements the functions of a single access interface (web interface and mobile clients), a user registration and authentication module (integration with the national electronic identification system), a vacancy and resume management module, and a module for verifying educational and professional qualifications (digital certifications/verified certificates). Such a platform should be built on the principles of open architecture (API-first), microservice orchestration and the use of standardized data formats (for example, structured CVs), which will ensure interoperability with state information resources, corporate applicant tracking systems (ATS) and international recruitment portals.

Table 2: Conceptual system for attracting labor force to industrial enterprises in Ukraine based on digital technologies [8] - [11].

Stages of engagement	Digital tools	Digital tool functions
1) Search and selection of personnel	<ul style="list-style-type: none"> ▪ single national digital employment platform; ▪ AI recommendations; ▪ gamified competency tests. 	<ul style="list-style-type: none"> ▪ integration of public and private job databases; ▪ algorithms for selecting vacancies by skills; ▪ quick check of technical and soft skills.
2) Automation of HR processes	<ul style="list-style-type: none"> ▪ applicant tracking systems (ATS); ▪ video interviews with AI analytics; ▪ HR chatbots. 	<ul style="list-style-type: none"> ▪ automatic resume selection; ▪ interview scheduling, hiring analytics; ▪ initial screening and response to candidates 24/7.
3) Motivation and retention of personnel	<ul style="list-style-type: none"> ▪ mobile applications for employees; ▪ E-learning systems (LMS); ▪ personalized development trajectories. 	<ul style="list-style-type: none"> ▪ access to salary, bonuses, corporate news; ▪ online courses adapted to the company; ▪ AI-building of career plans.
4) Labor market analytics	<ul style="list-style-type: none"> ▪ big data & predictive analytics; ▪ management dashboards; ▪ scenario modeling. 	<ul style="list-style-type: none"> ▪ forecasting staffing needs; ▪ visualizing staff turnover, productivity; ▪ simulating the impact of automation on staff.
5) International integration	<ul style="list-style-type: none"> ▪ E-visa and migration services; ▪ international recruitment exchanges (LinkedIn, EURES); ▪ digital adaptation programs for migrants. 	<ul style="list-style-type: none"> ▪ simplified recruitment of foreign workers; ▪ access to the global human resources market; ▪ mobile applications with language and legal support.

The key element of the selection mechanism is the intelligent recommendation module, which combines multi-level selection algorithms: semantic analysis of job descriptions and resumes, skills profiling using professional competence parameters, machine learning models for predicting employee success in the position and multi-criteria ranking mechanisms taking into account geographical, social and motivational factors. Candidate assessment systems should include gamified tests for measuring technical skills and cognitive indicators, standardized situational tools for assessing behavioral competencies, as well as knowledge testing technologies in the "production task simulator" mode.

Automation of HR processes involves the integration of corporate ATS with the internal logic of the enterprise: routing of candidates (their documents), automatic scheduling of interviews, calendar management, collection of recruitment funnel analytics and reporting on key indicators. Video interview technologies should be supplemented with analytical modules – automatic transcription, semantic analysis of responses, tools for assessing communication skills and adaptation for remote platforms – while the use of methods for automatic interpretation of non-verbal signals should be accompanied by validation procedures, human control and transparent documentation of the methodology to minimize the risks of bias and incorrect conclusions. Chatbots and automated assistants serve as the first point of contact: they conduct initial screening, inform candidates about requirements, assist with document submission, and facilitate rapid communication, but the hiring decision should remain with the human dispatcher.

HR process automation involves integrating corporate ATS with the internal logic of the enterprise: routing candidates (their documents), automatic interview scheduling, calendar management, collecting analytics of the hiring funnel and reporting on key indicators. Video interview technologies should be supplemented with analytical modules - automatic transcription, semantic analysis of responses, tools for assessing communication skills and adaptation for remote platforms - while the use of methods for automatic interpretation of non-verbal signals should be accompanied by validation procedures, human control and transparent documentation of the methodology to minimize the risks of bias and incorrect conclusions. Chatbots and automated assistants play the role of the first point of contact: they conduct initial screening, inform candidates about the requirements, help with submitting documents and facilitate rapid

communication, but the hiring decision should remain with the human dispatcher.

To increase employee motivation and retention, the system offers a mobile "employee cabinet" that aggregates information about working conditions, payments, bonus programs, individual development trajectories and continuous learning opportunities. The LMS module integrates with the platform and provides modular training courses, certification tracks, adaptive learning paths with elements of micro-learning and testing in a production context; employee development is accompanied by electronic "career maps" that are automatically updated based on completed courses and performance assessments, and AI modules offer personalized training recommendations. This approach minimizes information asymmetry between the employee and the employer and promotes internal personnel transfers and retraining.

The analytical module is a data warehouse and analytics array (data warehouse/ data lake + BI/visualization) that collects and aggregates administrative, industrial and educational data to build predictive models of labor force needs. The use of Big Data and predictive analytics allows you to model the dynamics of demand for professions, identify clusters of competencies, predict shortages by region and technological profiles, as well as simulate scenarios of the impact of automation and changes in production chains on the need for labor. Dashboards (information panels) for management should display a set of KPIs (performance indicators), which will ensure prompt decision-making and long-term planning. In the context of international integration, the system should support modules for electronic coordination of migration procedures, interaction with international labor exchanges and verification services of foreign qualifications, as well as digital adaptation services - multilingual mobile guides, access to legal and medical information, platforms for finding housing and social support. For verification of documents and certificates, it is advisable to use distributed registry technologies (verifiable credentials) ensuring privacy and user control over their own data.

The implementation of such a system requires a legislative basis [12] of regulatory and organizational support: defining the legal framework for data exchange, rules for personal data processing and algorithmic transparency, standardization of data formats, cybersecurity guarantees and mechanisms for auditing algorithms.

5 CONCLUSIONS

The effectiveness of labor force involvement in the use of digital technologies directly depends on the ability of industrial enterprises and society to adapt to the challenges of modernity. Only with a comprehensive approach to the formation of employment strategies is it possible to achieve a balance between technological progress and the well-being of employees, which is the basis of sustainable economic growth and social stability in Ukraine.

The main results of the study are as follows: a holistic conceptual system for attracting the workforce of industrial enterprises has been developed, with the functions of each technological element highlighted; the relationship between the digital transformation of HR processes and increasing the sustainability, productivity and personnel competitiveness of industrial enterprises has been substantiated; key areas of practical integration of digital tools into the human resources management system have been identified.

For the gradual implementation of the presented conceptual system, industrial enterprises of Ukraine are recommended to: gradual deployment of a digital recruitment infrastructure; automation of key HR processes; implementation of platforms for employee training and development; creation and active use of an information and analytical HR database based on an analysis of the labor market and qualification requirements, competencies and career trajectories of employees for forecasting needs in human resources and planning recruitment.

The expected results of implementing the presented proposals are: reduction of the hiring period from several months to a few weeks; reduction of recruitment costs; increase in labor productivity due to targeted personnel selection; formation of a positive brand of industrial enterprises as employers; ensuring sustainable development of industry by improving the quality of labor potential.

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