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A multilevel model for regional planning and forecasting of skilled workforce training needs in Ukraine: integrating strategic and statistical analysis

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Purpose. This study develops and substantiates a multilevel organisational and analytical model for regional planning and forecasting of skilled workforce training in Ukraine, taking into account the interests of key labour market stakeholders and the influence of political, legal, economic, social, and technological factors shaping demand for skilled workers and vocational education.

Methodology. The study employs a combination of strategic and statistical methods. Strategic analysis tools, including PEST analysis and stakeholder-oriented approaches, are used to assess the external environment and institutional factors influencing workforce training. Quantitative methods, including correlation analysis and regression modelling with lagged variables, are applied to evaluate and forecast the impact of demographic trends and educational enrolment patterns on demand for vocational education and training.

Findings. The results demonstrate that demand for skilled workforce training is shaped by a complex interaction of economic, demographic, social, technological, and political and legal factors. In particular, the study highlights the significant impact of Russia's full-scale military aggression, which has intensified labour market imbalances through demographic losses, migration processes, and structural changes in regional economies. At the same time, recent updates to the legislative framework regulating vocational education and regional workforce planning have strengthened the institutional basis for forecasting and aligning training provision with labour market needs. Empirical analysis based on data from the Lviv region confirms a strong relationship between enrolment in vocational education institutions, demographic indicators, and higher education enrolment. The forecasting results indicate a potential decline in vocational education enrolment in the medium term, driven by demographic changes and persistent educational preferences. Based on the integration of strategic and statistical analysis, a three-level model for regional planning and forecasting of skilled workforce training - comprising basic (inertial), forecasting (analytical), and strategic (corrective) levels - is proposed.

Originality. The originality of the study lies in the development of an integrated conceptual framework for regional workforce training planning and forecasting that combines strategic analysis tools with quantitative forecasting methods. The proposed approach contributes to the formation of a regional workforce forecasting system aligned with European practices of skills anticipation and labour market analysis.

Practical Value. The proposed model can be used to improve the analytical basis for regional decision-making in workforce development, enhance coordination between vocational education systems and labour market needs, and increase the effectiveness of planning and forecasting of workforce training in the context of economic transformation and post-war recovery.

Keywords: regional workforce training plan; workforce forecasting; skills demand; vocational education and training (VET); higher education; regional labour market; multilevel model; human capital; skilled workers; strategic analysis; statistical analysis; regression analysis.

Introduction

In recent years, regional labour markets in Ukraine have experienced growing structural imbalances between the supply of and demand for skilled workers (Mulska, Vasylytsiv 2024; Sadova et al., 2025). These imbalances have been further aggravated by the consequences of Russia's full-scale invasion, including demographic losses, large-scale migration, labour mobilization, business relocation, and profound changes in the sectoral structure of regional economies. As a result, shortages of qualified workers have become a major constraint on regional economic development and post-war recovery.

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A significant contributor to these labour shortages is the long-standing imbalance in Ukraine's education system, where educational preferences have increasingly favoured higher education over vocational education and training (VET). Despite the growing demand for skilled workers, VET remains considerably less attractive to young people than university education. According to data from the Main Department of Statistics in Lviv Region, during 2020–2025, the share of VET entrants among graduates of basic and complete secondary education fluctuated between 18% and 22%. The Ministry of Education and Science of Ukraine indicates that only about 14% of secondary school graduates choose vocational education pathways. Consequently, the limited inflow of students into VET institutions contributes to the persistent shortage of skilled workers across many sectors of the Ukrainian economy.

The strategic importance of addressing this challenge is reflected in several national policy documents. The Concept of the State Target Social Programme for the Development of Vocational Education and Training for 2022–2027 (Cabinet of Ministers of Ukraine, 2021) emphasizes the lack of systematic labour market monitoring, particularly at the regional level, and calls for the development of methodologies for analysing regional labour market needs and forecasting workforce demand. Similarly, the Strategic Action Plan of the Ministry of Education and Science of Ukraine until 2027 («Education of Winners») highlights the necessity of aligning publicly funded VET enrolment with labour market requirements through the regular assessment of employers' needs and skills demand.

The issue is also embedded in the State Strategy for Regional Development for 2021–2027 (Cabinet of Ministers of Ukraine, 2020), which identifies the modernization of vocational education and its alignment with regional labour market needs as a key priority. Furthermore, the recently adopted Methodological Recommendations for Forming and Allocating Regional Orders for the Training of Specialists and Skilled Workers (Cabinet of Ministers of Ukraine, 2025) establishes a framework for forecasting workforce demand and determining publicly funded enrolment quotas at the regional level.

Under conditions of wartime uncertainty and the future reconstruction of Ukraine, workforce forecasting has become a strategic component of human capital development policy. Effective planning of vocational training requires not only statistical forecasting techniques but also analytical tools capable of identifying the broader political, legal, economic, social, and technological drivers shaping labour demand. Strategic analysis methods, particularly PEST analysis and stakeholder analysis, provide opportunities to assess these external influences and incorporate the interests of key labour market actors into workforce planning processes.

Against this background, there is a growing need for integrated approaches that combine strategic analysis with quantitative forecasting methods to improve the evidence base for the development of a regional workforce training plan (regional order).

Literature Review

The alignment of VET systems with labour market needs, workforce demand forecasting, and regional workforce planning has attracted increasing attention in both national and international research. Existing studies can be broadly grouped into several interconnected strands.

The first strand focuses on institutional mechanisms that facilitate cooperation between vocational education providers, employers, and public authorities. Yu et al. (2025) examine political, institutional, socio-economic, and organisational factors influencing industry–education integration in vocational education systems. Their findings highlight the importance of coordinated stakeholder engagement in improving workforce development outcomes. Similarly, Vasylytsiv, Mulaska,

and Mahas (2021) emphasize the role of collective bargaining mechanisms and partnership governance models in strengthening regional vocational education systems. Expanding this perspective, Mulcka et al. (2024) analyse instruments for balancing labour supply and demand among VET graduates and underline the importance of considering regional labour market characteristics. Storonyanska and Benovska (2025) investigate European approaches to harmonising vocational education with labour market needs, paying particular attention to partnership arrangements among education providers, employers, and public authorities, as well as the use of skills forecasting tools.

The second strand of research addresses the transformation of vocational education systems under conditions of economic disruption, security challenges, and structural change. Kostrytsia, Blyzniuk, and Burlai (2025) consider vocational and higher education as essential institutions for rebuilding Ukraine's labour market during the post-war recovery period. Their study stresses the need to adapt educational systems to changing employment structures and emerging occupational requirements. From a security-oriented perspective, Radkevych and Yershova (2022) analyse the resilience of Ukraine's vocational education system under external and internal threats, arguing for continuous updating of curricula and training content in response to rapidly evolving socio-economic conditions.

A third strand focuses on workforce forecasting methodologies and strategic human resource planning. Hrynkevych, Levytska, and Baranyak (2023) propose a methodological framework for determining regional training needs that combines statistical forecasting techniques with labour market demand assessments. Sydorenko and Horoshkova (2024) advocate the use of regional labour market mapping tools to identify promising occupations and qualifications consistent with regional economic specialisation. In a broader human capital context, Sidenko (2025) highlights the growing influence of demographic instability, migration processes, and global uncertainty on labour force development.

Recent international studies have further expanded the discussion by examining the relationship between vocational education systems and future skills demand. Lopes et al. (2023) demonstrate the importance of aligning regional VET provision with labour market requirements through evidence-based forecasting mechanisms. Morris, Vanino, and Corradini (2019) show that regional skill shortages and skill gaps negatively affect productivity and economic performance, thereby reinforcing the importance of effective workforce planning. OECD research (Jeon, 2025) and CEDEFOP studies emphasize that technological change, digitalisation, automation, and the green transition require continuous adaptation of vocational education systems and more sophisticated approaches to forecasting future skills needs.

Despite substantial progress in the literature, several important gaps remain. Existing studies typically focus on individual aspects of workforce planning, such as institutional cooperation, labour market forecasting, demographic change, or educational reform. However, limited attention has been paid to integrated analytical frameworks that simultaneously consider the influence of political, legal, economic, social, and technological factors while incorporating the interests of multiple stakeholder groups in the process of determining regional training priorities.

This gap is particularly relevant in the context of Ukraine, where wartime disruptions, demographic transformations, migration flows, technological change, and post-war reconstruction create unprecedented challenges for workforce planning. Consequently, there is a need for comprehensive approaches that combine strategic analysis tools with quantitative forecasting methods to support evidence-based formation of regional training orders and improve coordination between vocational education systems and labour market needs.

Purpose of the Study

The study aims to develop and substantiate a multilevel organisational and analytical model for regional planning and forecasting of skilled workforce training in Ukraine, taking into account the interests of key labour market stakeholders and the influence of political, legal, economic, social, and technological factors shaping demand for skilled workers and vocational education.

Methodology

The study employs strategic analysis methods, including PEST analysis, to assess the influence of environmental factors on labour demand under conditions of security challenges in Ukraine and global economic trends. Stakeholder analysis is used to ensure the balancing of the interests of labour market participants in substantiating an organizational and analytical model for the development of a regional workforce training plan. Statistical methods, including correlation and regression analysis, are applied to assess and forecast the influence of demographic factors on the key parameters of demand for vocational education.

The forecast is based on official statistics on birth rates and admission volumes to vocational education and training (VET) institutions and higher education institutions, as well as administrative data from the Department of Education and Science of the Lviv Regional State Administration on admissions to VET institutions financed through the regional order (regional workforce training plan).

Results and Discussion

PEST factors influencing the formation of regional workforce training orders in Ukraine

The regional workforce training plan represents an important tool of labour market regulation and regional development policy in Ukraine. Its primary purpose is to determine the volume and occupational structure of publicly funded vocational education and training (VET) programmes in accordance with regional labour market needs and long-term economic development priorities.

Effective workforce planning requires a comprehensive assessment of the external environment shaping labour demand. In this regard, PEST analysis provides a useful analytical framework for identifying and evaluating the political, legal, economic, social, and technological factors that influence the formation of regional workforce training orders. These factors affect both the quantitative demand for skilled workers and the qualitative requirements regarding occupational profiles and competencies.

Table 1 summarises the key PEST factors influencing the formation of regional workforce training orders in Ukraine and their potential implications for vocational education planning.

Political and Legal Factors

Political and legal factors create the institutional framework within which regional workforce training orders are formed and implemented. In Ukraine, the regulation of state and regional workforce planning is based on a comprehensive legislative framework, including the Constitution of Ukraine, the Labour Code of Ukraine, and the Laws of Ukraine «On Education», «On Higher Education», «On Professional Pre-Higher Education», «On Vocational Education», «On Professional Development of Employees», and «On the Formation and Placement of the State Order for the Training of Specialists, Academic, Research, Teaching and Skilled Personnel».

The financial framework for implementing regional training orders is defined by the Budget Code of Ukraine and relevant legislation governing local public administration, vocational education financing, and public procurement. At the

Table 1

PEST Analysis Factors Shaping Regional Demand for Workforce Training in Ukraine

Group of factors	Characteristics	Implications for regional workforce planning
Political and Legal	Security conditions, education reforms, workforce planning regulations, state and regional development policies	Define institutional and financial frameworks for regional workforce training orders and priority occupations
Economic	Regional economic specialisation, business relocation, investment projects, reconstruction programmes, sectoral labour demand	Determine the scale and occupational structure of workforce training needs
Social	Demographic trends, migration, educational aspirations, labour market participation, prestige of vocational occupations	Influence the size and composition of the future workforce and demand for vocational education
Technological	Digital transformation, AI, Industry 4.0, automation, green technologies, lifelong learning requirements	Drive changes in occupational standards, competency requirements, and training content

Source: Proposed by the authors

regional level, annual admission quotas and occupational structures are approved through decisions of regional state administrations.

In addition to regulatory instruments, strategic planning documents play an increasingly important role in determining workforce development priorities. Regional development strategies, action plans, and sectoral programmes provide valuable information regarding future labour market needs and identify priority sectors for workforce investment. For example, the updated Development Strategy of Lviv Region for 2021–2027 identifies growing shortages of skilled workers as one of the key constraints on regional development. These shortages have been intensified by wartime labour mobilisation, population displacement, business relocation, and demographic decline.

The ongoing war has also altered the occupational structure of labour demand. In Lviv region, increasing demand has been observed for occupations related to digital technologies, security systems, and modern industrial equipment, including drone operators, computer numerical control (CNC) operators, specialists in electronic vehicle diagnostics, and technicians responsible for security and fire alarm systems. To respond effectively to these changes, regional authorities have introduced mechanisms for continuous monitoring of employers' workforce needs and labour market developments.

The existing regulatory framework therefore provides a solid institutional basis for workforce planning. However, current regional training orders remain largely dependent on contractual arrangements between vocational education institutions and employers. Under this approach, vocational schools formulate admission proposals based primarily on cooperation agreements concluded with individual enterprises.

Such agreements create important incentives for employer participation in vocational training and contribute to improving graduate employability. They also facilitate the introduction of new occupational programmes aligned with the needs of specific employers. Nevertheless, reliance on contractual arrangements alone has significant limitations.

Survey evidence suggests that many employers are reluctant to formalise cooperation with VET institutions through long-term contracts. The reasons include uncertainty regarding future labour demand, difficulties associated with long-term workforce planning, administrative burdens, and concerns about contractual

obligations. Consequently, the existing approach may fail to capture the full range of labour market needs across the regional economy.

This limitation is further confirmed by the results of a nationwide survey of VET graduates. Only 11.3% of respondents reported obtaining employment through cooperation agreements between educational institutions and employers (Sudakov, 2026). This finding indicates that contractual mechanisms, although important, cannot serve as the sole basis for determining regional workforce training priorities.

Therefore, the formation of regional training orders should be based on a broader analytical framework that combines information from employers, labour market forecasts, regional development strategies, demographic trends, and other strategic intelligence sources. Such an approach would enable a more comprehensive assessment of current and future workforce needs and improve the responsiveness of vocational education systems to labour market transformations.

Economic factors

Economic factors largely determine both the scale and occupational structure of demand for skilled workers. These factors include the sectoral composition of the regional economy, investment activity, enterprise relocation, industrial development dynamics, infrastructure projects, and post-war recovery processes.

Forecasting workforce demand requires integrating labour market analysis with broader economic forecasting. In Ukraine, medium-term forecasts of labour demand by occupational groups and economic sectors are periodically prepared by the Ministry of Economy. According to the latest projections, labour demand is expected to increase in 2026–2027, particularly in industry, construction, infrastructure development, and related service sectors. These sectors are expected to play a crucial role in supporting economic recovery and reconstruction efforts.

At the regional level, labour demand is strongly influenced by the economic specialization of individual territories. Evidence from nationwide surveys of vocational education graduates demonstrates significant regional differences in employment outcomes. Higher employment rates among VET graduates are typically observed in regions characterised by a strong industrial base, developed construction sectors, and dynamic agricultural production. Regional security conditions and geographical proximity to European Union markets also contribute to differences in labour demand and employment opportunities.

The case of Lviv region illustrates the importance of economic factors in workforce planning. Since the beginning of the full-scale war, the region has become a major destination for internally displaced persons and relocated enterprises. This has strengthened economic activity in several sectors while simultaneously increasing demand for skilled workers. Alongside traditional occupations such as welders, electricians, machine operators, and construction workers, employers increasingly seek specialists capable of operating technologically advanced equipment and digital systems.

Employer surveys constitute an important source of information for identifying future workforce requirements. According to a survey conducted among enterprises in Lviv region, approximately one-third of employers maintain systematic cooperation with vocational and higher education institutions (Sadova et al., 2025). However, a considerable proportion of enterprises either cooperate only occasionally or have no formal partnerships with educational institutions. This finding highlights the need to strengthen employer engagement in workforce planning and forecasting processes.

To improve the reliability of workforce demand forecasts, periodic employer surveys should be conducted using representative samples based on the methodology applied by the State Statistics Service of Ukraine in labour statistics surveys. Such an approach would ensure adequate coverage of enterprises across different sectors

of the regional economy and allow survey results to be extrapolated to the broader population of employers.

International experience further supports the importance of evidence-based workforce forecasting. In particular, the European Centre for the Development of Vocational Training (CEDEFOP) employs an integrated forecasting framework that combines macroeconomic projections with replacement demand estimates. This approach enables policymakers to account not only for job creation but also for workforce replacement resulting from retirement, migration, and occupational mobility.

Social Factors

Social factors shape labour supply and significantly influence educational choices and career trajectories. Among the most important determinants are demographic trends, migration processes, educational preferences of young people, the social prestige of vocational occupations, and labour market participation rates.

One of the most significant challenges facing vocational education in Ukraine is its relatively low attractiveness among school graduates. According to the Institute of Educational Analytics, only 14% of secondary school graduates enrolled in vocational education institutions in 2023, while the majority continued their studies in academic pathways leading to higher education. This trend contributes directly to shortages of skilled workers and increases structural imbalances in regional labour markets.

To assess the influence of demographic factors on enrolment in vocational education and training, a correlation and regression analysis was conducted using data from Lviv region.

The correlation analysis revealed a strong positive relationship between enrolment in VET institutions and the birth rate with a fifteen-year lag ($r = 0.734$). An even stronger relationship was identified between VET enrolment and enrolment in HEIs ($r = 0.907$). These results suggest that both demographic processes and educational preferences substantially influence the size of the potential VET student population.

The multiple regression analysis (Table 2) demonstrated that approximately 82.5% of the variation in VET enrolment can be explained by the combined influence of lagged birth rates and enrolment in higher education institutions (RI = 0.825; Adjusted RI = 0.805). The overall model is statistically significant ($F = 42.38$; $p < 0.001$), indicating a high level of explanatory power and confirming its suitability for forecasting purposes.

Table 2

Model fit statistics for the multiple regression model

Indicator	Value
Multiple R	0.908
R Square	0.825
Adjusted R Square	0.805371347
Standard Error	1.40562539
Observations	21

Dependent variable: enrolment in VET institutions.

The estimated regression coefficients (Table 3) indicate that enrolment in higher education institutions is the strongest predictor of VET enrolment ($B = 0.593$; $p < 0.001$). This finding reflects the close interaction between vocational and higher education pathways within the educational system. Changes in the attractiveness of higher education directly influence the number of potential applicants to vocational institutions.

Table 3

Parameter estimates of the multiple regression model

	B	Std. Error	t-statistic	p-value	VIF
Constant	-3.268	1.872	-1.746	0.098	–
Birth rate (15-year lag)	-0.061	0.113	-0.540	0.596	3.42
Higher education enrolment	0.593	0.109	5.424	<0.001	3.42

Dependent variable: enrolment in VET institutions.

In contrast, the coefficient associated with the lagged birth rate is not statistically significant ($p = 0.596$). However, this result should not be interpreted as evidence that demographic factors are unimportant. Rather, it suggests that demographic effects operate indirectly through changes in the overall size of youth cohorts, which simultaneously determine the pool of potential applicants to both vocational and higher education institutions.

The correlation between the explanatory variables is relatively high ($r = 0.841$), reflecting the close relationship between demographic processes and educational enrolment patterns. Nevertheless, the variance inflation factor ($VIF = 3.42$) remains well below commonly accepted threshold values, indicating that multicollinearity does not pose a serious threat to the reliability of coefficient estimates.

Overall, the regression results support the conclusion that demographic factors and educational preferences jointly shape future demand for vocational education. Consequently, workforce planning mechanisms should account not only for demographic forecasts but also for changes in educational behaviour and career aspirations among young people.

The forecasting results suggest a gradual decline in enrolment in vocational education institutions during 2026–2030 (Fig. 1). This trend reflects the combined influence of demographic decline and the continuing preference of many secondary school graduates for higher education pathways.

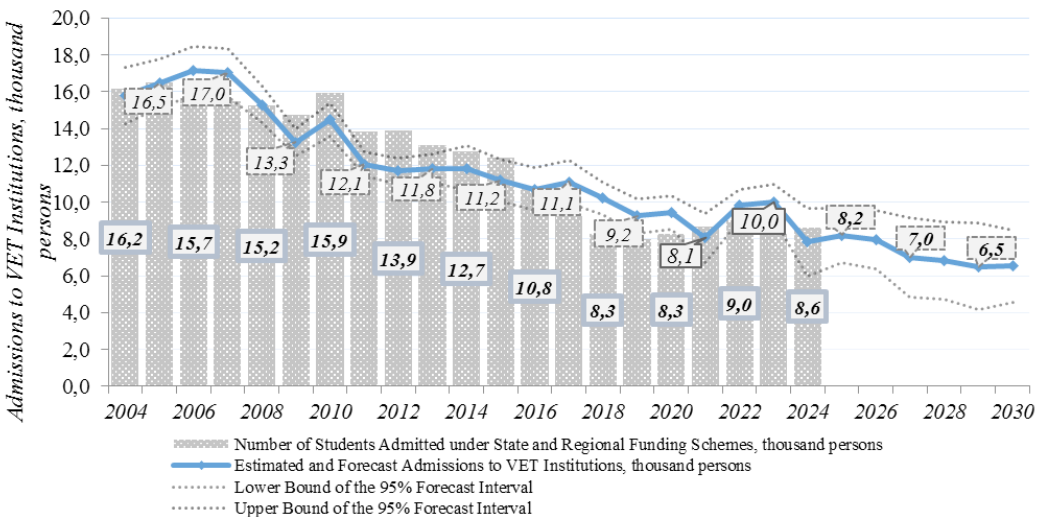


Fig. 1. Dynamics of Actual and Forecast Admission Indicators to VET Institutions in the Lviv Region of Ukraine up to 2030

Source: Authors' calculations based on data provided by the Main Department of Statistics in the Lviv Region of Ukraine, URL: https://www.lv.ukrstat.gov.ua/ukr/si/st_inf.php?191114; and the Department of Education and Science of the Lviv Regional Military Administration.

At the same time, the reliability of medium- and long-term forecasts remains constrained by wartime uncertainty. Large-scale internal displacement, international migration, and potential return migration may substantially alter demographic structures and educational demand patterns. In regions such as Lviv, which have experienced significant inflows of internally displaced persons, future enrolment dynamics will depend not only on demographic trends but also on the evolution of security conditions and migration trajectories.

Therefore, demographic forecasting should be viewed as one component of a broader workforce planning framework that incorporates economic, institutional, and behavioural factors affecting educational demand and labour market outcomes.

Technological factors

Technological change has become one of the most influential drivers of workforce transformation and skills demand worldwide. In the context of digitalisation, Industry 4.0, and Ukraine's post-war reconstruction, technological factors play a critical role in shaping both the quantity and quality of demand for skilled workers.

International organisations, including the OECD and CEDEFOP, emphasise that VET systems must continuously adapt to technological innovation, changing production processes, and evolving labour market requirements. Consequently, workforce planning can no longer rely solely on historical employment patterns but must increasingly incorporate forward-looking assessments of technological trends and emerging skill needs.

Several technological developments are expected to have a particularly strong impact on workforce demand in the coming years. These include the growing adoption of artificial intelligence (AI), automation and robotics, digital manufacturing technologies, the Internet of Things (IoT), big data analytics, virtual and augmented reality (VR/AR), green technologies, and lifelong learning systems (Fig 2).

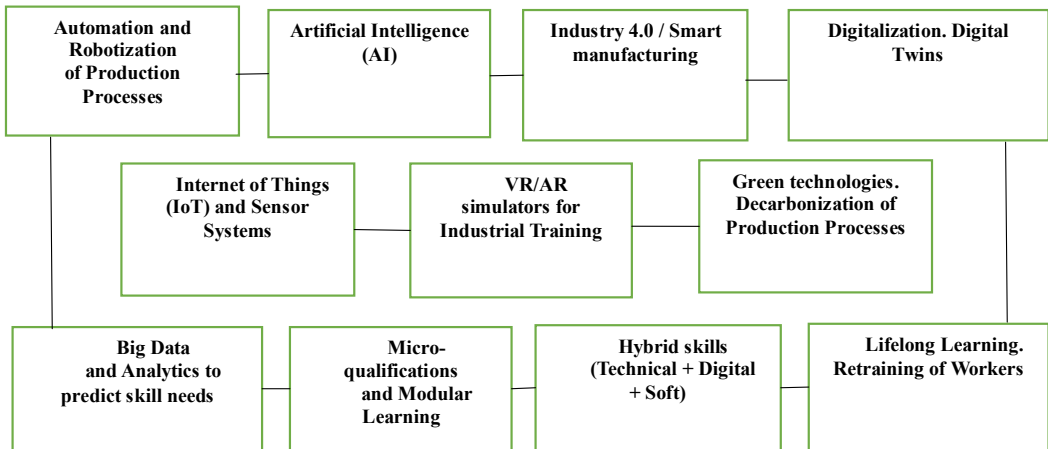


Fig. 2. Global technological trends shaping workforce transformation and skills demand
Source: Proposed by the authors

According to OECD assessments (Jeon, 2025), technological progress is driving a transition from traditional production models toward integrated digital ecosystems based on automation, real-time data processing, and intelligent decision-making systems. As a result, technological change not only creates new occupations but also transforms the content of existing professions.

This transformation is especially evident in vocational occupations. Modern machine operators, maintenance technicians, electricians, and industrial workers

increasingly interact with digital control systems, automated production lines, programmable equipment, and intelligent monitoring technologies. Consequently, vocational education institutions must develop training programmes that combine occupation-specific competencies with digital literacy, data-processing skills, and the ability to work effectively within technology-rich environments.

The concept of Industry 4.0 represents one of the most significant drivers of workforce transformation. The integration of automation, robotics, sensor networks, cyber-physical systems, and digital twins is increasing the technological complexity of many occupations traditionally associated with vocational training. As a result, employers increasingly require workers who possess not only occupation-specific skills but also digital competencies, problem-solving abilities, and the capacity to operate within technology-intensive production environments. As noted by CEDEFOP (2025), employers increasingly seek workers possessing hybrid skill sets that combine technical expertise, digital competencies, problem-solving abilities, and communication skills.

Artificial intelligence is becoming an increasingly important component of industrial and service-sector activities. AI technologies are now widely used for predictive maintenance, equipment diagnostics, quality control, logistics management, and process optimisation. These developments generate demand for workers capable of interpreting digital information, operating automated systems, and collaborating effectively with intelligent technologies.

Technological innovation is also transforming vocational training itself. The growing use of virtual and augmented reality, digital simulators, and digital twins enables educational institutions to reproduce complex production environments, improve training safety, and partially compensate for limitations in physical infrastructure and equipment. Such technologies are particularly valuable for occupations related to manufacturing, construction, transport, energy systems, and public safety.

Another important trend is the transition toward a green economy. Decarbonisation policies, renewable energy development, and sustainable infrastructure projects are creating demand for new competencies in energy efficiency, environmental technologies, renewable energy systems, and sustainable construction practices. For Ukraine, these trends are particularly relevant given the anticipated large-scale reconstruction and modernisation of infrastructure in the post-war period.

The rapid pace of technological change requires closer cooperation among educational institutions, employers, policymakers, and labour market analysts. Regular updating of occupational standards, curricula, qualification requirements, and forecasting methodologies is essential to ensure that workforce training remains aligned with future labour market needs.

Therefore, technological factors should be considered not only when designing educational content but also when determining the volume and occupational structure of regional workforce training orders. Failure to account for technological transformation may result in skills mismatches, labour shortages, and reduced regional competitiveness in the long term.

A Multi-Level Organisational and Analytical Model for Regional Workforce Planning.

The findings of the strategic and statistical analyses demonstrate that workforce demand is shaped by a complex interaction of political, legal, economic, social, and technological factors. Consequently, the formation of regional workforce training orders requires an integrated analytical framework capable of incorporating both current labour market conditions and long-term development trends. To address this challenge, a multi-level organisational and analytical model for the formation of regional workforce training orders is proposed (Fig. 3). The model builds upon

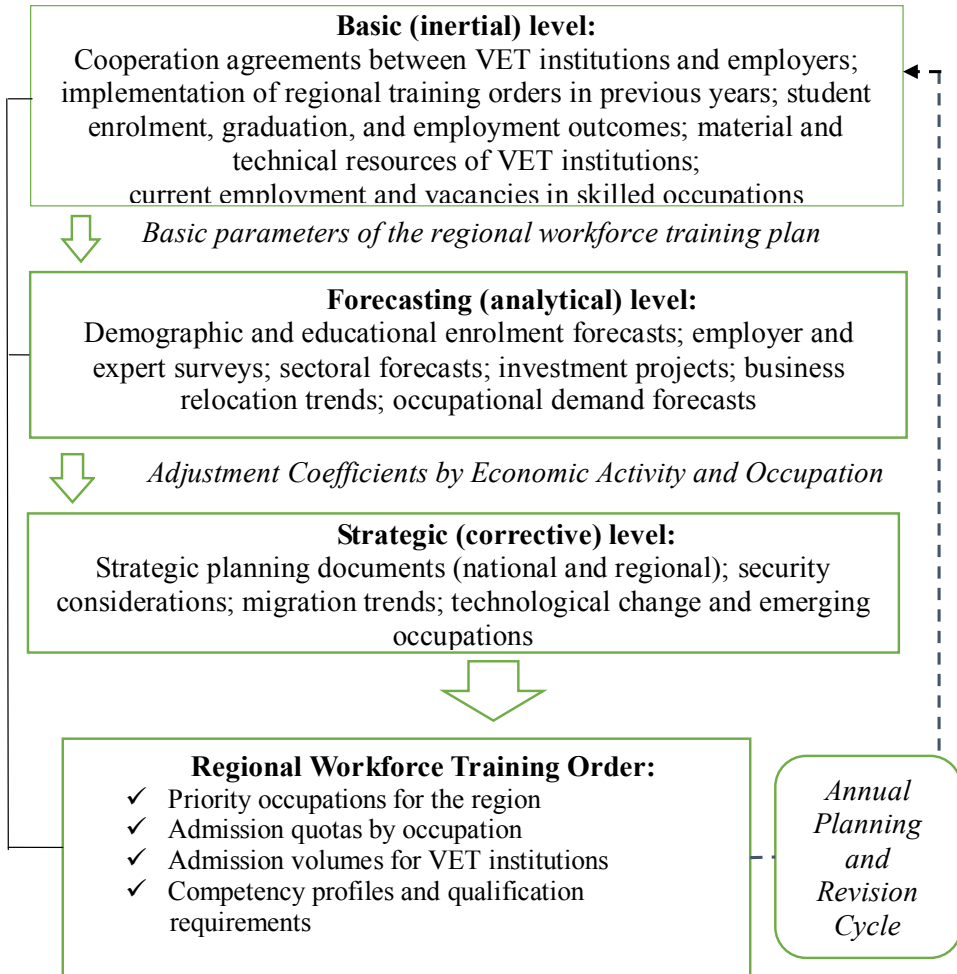


Fig. 3. Multi-level organizational and analytical model for the formation of regional workforce training orders

Source: Proposed by the authors

the existing practice of workforce planning in Ukraine while integrating strategic forecasting instruments, labour market intelligence, and stakeholder interests to enhance the evidence base of decision-making processes.

The proposed model enhances the analytical validity and evidence base of regional workforce planning by integrating multiple sources of labour market intelligence into a unified decision-making framework. It supports a more systematic approach to determining training volumes, occupational priorities, and competency requirements while improving coordination among stakeholders involved in workforce development.

However, effective implementation of the model requires adequate institutional capacity. The preparation of workforce demand forecasts, integration of statistical, administrative, and survey data, and application of strategic analysis tools necessitate specialised analytical expertise. International experience indicates that skills anticipation and workforce planning functions are frequently carried out by dedicated labour market observatories, skills partnerships, research institutions,

or multi-stakeholder analytical consortia involving public authorities, educational institutions, employers, and research organisations.

Accordingly, the proposed model should be viewed not only as an instrument for improving the allocation of regional workforce training orders but also as a foundation for establishing a comprehensive regional labour market intelligence system. Such a system would facilitate continuous monitoring of workforce needs, improve the responsiveness of vocational education to labour market change, and strengthen evidence-based policymaking.

In line with international practice, regional authorities should primarily perform a coordinating rather than an operational analytical role. Their key functions include defining strategic priorities, facilitating stakeholder cooperation, and incorporating forecasting results into policy decisions. Therefore, the successful implementation of the proposed model will depend on the development of sustainable partnerships among regional authorities, employment services, educational institutions, employers, and specialised research and analytical centres.

Conclusions and prospects for further exploration

This study demonstrates the importance of integrating strategic analysis tools with statistical forecasting methods in the formation of regional workforce training orders. The findings indicate that the current practice of determining training volumes primarily through contractual arrangements between VET institutions and employers does not fully capture the complexity of labour market dynamics or the long-term workforce needs of regional economies.

The analysis confirms that demand for skilled workers is shaped by a combination of political, legal, economic, social, and technological factors. These factors interact in complex ways and collectively influence both the quantitative demand for labour and the qualitative requirements regarding occupational profiles and competencies. In particular, demographic trends, migration processes, educational preferences of young people, technological transformation, and regional economic development trajectories play a crucial role in determining future workforce needs.

The empirical results reveal a strong relationship between vocational education enrolment, demographic processes, and participation in higher education. Although demographic variables primarily affect workforce supply through their influence on cohort size, educational choices significantly shape the distribution of young people between vocational and academic pathways. These findings highlight the importance of incorporating both demographic forecasts and behavioural factors into workforce planning models.

Based on the results of the strategic and statistical analyses, a three-level organisational and analytical model for forming regional workforce training orders is proposed. The model integrates a basic (inertial) level reflecting existing labour market and educational system conditions, a forecasting (analytical) level based on quantitative and qualitative labour market intelligence, and a strategic (corrective) level that accounts for long-term development priorities, security considerations, technological change, and structural economic transformation.

The proposed framework contributes to the development of a more evidence-based and forward-looking approach to workforce planning. Its key advantage lies in the integration of multiple information sources, including statistical and administrative data, labour market forecasts, employer surveys, demographic projections, and regional development strategies. Such integration enables more comprehensive assessment of workforce needs and supports better alignment between vocational education provision and labour market demand.

At the same time, effective implementation of the proposed model requires appropriate institutional capacity. International experience suggests that workforce

forecasting and skills anticipation are most successful when supported by specialised analytical institutions, labour market observatories, skills partnerships, and collaborative networks involving public authorities, educational institutions, employers, and research organisations. Consequently, the implementation of the proposed approach in Ukraine should be viewed not only as an improvement in the procedure for allocating regional training orders but also as a step toward establishing a comprehensive regional workforce intelligence system.

Future research should focus on empirical validation of the proposed model in different regional contexts and on the integration of big data analytics, administrative datasets, and real-time labour market information into workforce forecasting systems. Further studies may also explore the application of artificial intelligence and machine learning techniques to improve the accuracy and adaptability of regional workforce demand forecasts under conditions of high economic and demographic uncertainty.

References

1. Cabinet of Ministers of Ukraine. (2020). *State strategy for regional development for 2021-2027* (Resolution No. 695, August 5, 2020, as amended January 6, 2026). <https://zakon.rada.gov.ua/laws/show/695-2020-p#Text>
2. Cabinet of Ministers of Ukraine. (2021). *Concept of the state target social program for the development of vocational (vocational-technical) education for 2022-2027* (Order No. 1619-r, December 9, 2021, as amended January 6, 2026). <https://zakon.rada.gov.ua/laws/show/1619-2021-r#n11>
3. Cabinet of Ministers of Ukraine. (2025). *Methodological recommendations for forming and allocating regional orders for the training of specialists and skilled workers* (Order No. 994-r, revised December 9, 2025). <https://zakon.rada.gov.ua/laws/show/994-2016-p#Text>
4. European Centre for the Development of Vocational Training. (n.d.). *Digitalisation*. <https://www.cedefop.europa.eu/en/themes/digitalisation>
5. Hrynkevych, O., Levytska, O., & Baranyak, I. (2023). Human resources for regional development in Ukraine: A roadmap for forecasting and determining a regional training request. *Regional Science Policy & Practice*, 15(1), 95-107. <https://doi.org/10.1111/rsp3.12625>
6. Jeon, S. (2025). *How can innovative technologies transform vocational education and training: Insights for Ukraine*. OECD Publishing. <https://doi.org/10.1787/fb40f416-en>
7. Kostrytsia, V. I., Blyzniuk, V. V., & Burlai, T. V. (2025). The contribution of Ukraine's higher and vocational education systems to the recovery of the national labour market in the (post-)war period. *Economic Theory*, 4, 65-98. <https://doi.org/10.15407/etet2025.04.065>
8. Lopes, A. S., Rebelo, I., Santos, R., Costa, R., & Ferreira, V. (2023). Supply and Demand Matching of VET Skills – A Regional Case Study. *Cogent Education*, 10(1). DOI: 10.1080/2331186X.2023.2200550
9. Lviv Regional Council. (2026). *Development strategy of Lviv region for 2021-2027*. <https://loda.gov.ua/useful-info/93604>
10. Ministry of Economy, Environment and Agriculture of Ukraine. (2023). *Draft medium-term forecast of demand for specialists and skilled workers in the labour market for 2024-2027*. https://spo.fpsu.org.ua/wp-content/uploads/2023/10/5_proгноз_na_2027_rik.pdf
11. Ministry of Economy, Environment and Agriculture of Ukraine. (2026). *Consensus forecast: Ukraine's economic outlook for 2026-2028*. <https://me.gov.ua/view/ad731854-99d4-4850-82bb-e854b712bc3b>
12. Ministry of Education and Science of Ukraine. (2024). *Education of winners: Strategic activity plan of the Ministry of Education and Science of Ukraine until 2027*. <https://mon.gov.ua/static-objects/mon/sites/1/Docs%20Kampania%20Priyom%2024/Strateh.plan.diyalnosti.MON.do.2027.roku.pdf>
13. Ministry of Education and Science of Ukraine. (2024). *On the training of skilled workers under regional orders* (Letter No. 1/8932-24, May 21, 2024).
14. Morris, D., Vanino, E., & Corradini, C. (2019). Effect of Regional Skill Gaps and Skill Shortages on Firm Productivity. *Environment and Planning A: Economy and Space*, 1. 51(5), 933-952.
15. Mulaska, O. P., Vasylytsiv, T. H., & Pykus, I. O. (2024). Instruments for balancing labour supply and demand among graduates of vocational education institutions. *Regional Economy*, 2, 84-93. <https://doi.org/10.36818/1562-0905-2024-2-8>
16. Prasetya, F., Fortuna, A., Samala, A. D., Latifa, D. K., Andriani, W., Gusti, U. A., Raihan, M., Criollo-C, S., Kaya, D., & García, J. L. (2025). Harnessing artificial intelligence to revolutionize vocational education: Emerging trends, challenges, and contributions to SDGs 2030. *Social Sciences & Humanities Open*, 11, Article 101401. <https://doi.org/10.1016/j.ssaho.2025.101401>

17. Radkevych, V., & Yershova, L. (2022). Readiness of the vocational education system to counter real and potential threats to Ukraine's national security and national interests under external and internal challenges. *Professional Pedagogy*, 24(1), 4-17. <https://doi.org/10.32835/2707-3092.2022.24.4-17>
18. Sadova, U. Y., Hrynkevych, O. S., & Sorochak, O. Z. (2025). Workforce skills gaps analysis under security challenges: Business needs and regional resilience (A case study of Lviv region during wartime). *Security: Theory and Practice*, 1, 191-207. <https://doi.org/10.48269/2451-0718-btip-2025-1-012>
19. Sidenko, S. (2025). Human capital development under conditions of global instability. *Demography and Social Economy*, 59(1), 55-72. <https://doi.org/10.15407/dse2025.01.055>
20. State Statistics Service of Ukraine. (2023). *Methodological provisions of the state statistical survey «Enterprise survey on labour statistics»*. https://stat.gov.ua/sites/default/files/2026-03/3_2022.pdf
21. State Statistics Service of Ukraine. (2026). *Statistical information of Lviv region*. https://www.lv.ukrstat.gov.ua/ukr/si/st_inf.php?191114
22. Storonyanska, I. Z., & Benovska, L. Ya. (2025). Vocational education and the labor market in the European Union: challenges of alignment and directions for development. *Rehional'na ekonomika [Regional Economy]*, 118 (4), 57-67. DOI: <https://doi.org/10.36818/1562-0905-2025-4-5> [in Ukrainian].
23. Sudakov, M. (2026). *Skills4Recovery: Career trajectories of graduates. Issue 2. Report on the survey of 2024 graduates of vocational education and training institutions*. Kyiv.
24. Sydorenko, V., & Horoshkova, L. (2024). *Regional labour market maps: Occupations and qualifications*. Bila Tserkva Institute of Continuing Professional Education of the University of Educational Management of NAES of Ukraine. <https://lib.iitta.gov.ua/id/eprint/743786>
25. Vasylytsiv, T. H., Mulska, O. P., & Mahas, N. V. (2021). Instruments of the collective bargaining approach to managing the development of vocational education in a region. *Ukrainian Journal of Applied Economics and Technology*, 6(2), 147-155. <https://doi.org/10.36887/2415-8453-2021-2-19>
26. Yu, B., Li, R., Zhang, S., Mao, P., Xu, C., & Shi, J., et al. (2025). Constraints, mechanisms, and strategies for industry-education integration in vocational education: An empirical study. *PLoS ONE*, 20(12), e0339158. <https://doi.org/10.1371/journal.pone.0339158>

Гринькевич О. С., Пікус І. О., Бараняк І. Є. Багаторівнева модель регіонального планування і прогнозування підготовки робітничих кадрів в Україні: інтеграція стратегічного та статистичного аналізу

Мета статті - розроблення та наукове обґрунтування багаторівневої організаційно-аналітичної моделі планування та прогнозування підготовки кваліфікованих робітничих кадрів у регіонах України з урахуванням інтересів основних суб'єктів ринку праці та впливу політичних, правових, економічних, соціальних і технологічних чинників, що формують попит на робочу силу та професійну освіту.

Методологія дослідження ґрунтується на застосуванні методів стратегічного і статистичного аналізу. Для оцінювання зовнішнього середовища та інституційних чинників формування підготовки кадрів використано ПЕСТ-аналіз та підходи, орієнтовані на врахування інтересів стейкхолдерів. Кількісні методи, зокрема кореляційний аналіз і регресійне моделювання з латентними змінними, застосовано для оцінювання та прогнозування впливу демографічних процесів і освітніх траєкторій молоді.

Результати. Результати дослідження свідчать, що попит на підготовку кваліфікованих робітничих кадрів формується під впливом складної взаємодії політичних, правових, економічних, демографічних, соціальних, технологічних чинників. Зокрема, встановлено суттєвий вплив російської військової агресії, яка посилює дисбаланси на ринку праці внаслідок демографічних втрат, міграційних процесів і структурних змін у регіональній економіці. Оновлення нормативно-правової бази функціонування системи професійної освіти та формування регіонального замовлення посилює інституційні передумови для розвитку механізмів прогнозування та узгодження підготовки кадрів з потребами ринку праці. Емпіричний аналіз на основі даних Львівської області підтверджує наявність тісного зв'язку між контингентом здобувачів професійної освіти, демографічними показниками та обсягами вступу до закладів вищої освіти. Результати прогнозування свідчать про ймовірне скорочення обсягів підготовки у середньостроковій перспективі під впливом демографічних тенденцій і стійких освітніх уподобань. На основі інтеграції стратегічного і статистичного аналізу запропоновано трирівневу модель планування та прогнозування підготовки кадрів на регіональному рівні, що включає базовий (інерційний), прогнозно-аналітичний і стратегічний (коригувальний) рівні.

Оригінальність дослідження полягає у формуванні інтегрованої концептуальної моделі планування та прогнозування підготовки робітничих кадрів на регіональному рівні на основі поєднання інструментів стратегічного аналізу та кількісних методів прогнозування. Запропонований підхід сприяє розвитку регіональної системи прогнозування потреб у робочій силі відповідно до європейських практик аналізу навичок і ринку праці.

Практичне значення отриманих результатів. Запропонована модель може бути використана для підвищення обґрунтованості управлінських рішень у сфері розвитку людського капіталу на регіональному рівні, посилення взаємодії між системою професійної освіти та потребами ринку праці, а також підвищення ефективності планування та прогнозування підготовки кадрів в умовах економічної трансформації та післявоєнного відновлення.

A multilevel model for regional planning and forecasting of skilled workforce training needs in Ukraine: integrating strategic and statistical analysis

Ключові слова: планування підготовки кадрів; регіональне замовлення; прогнозування робочої сили; попит на навички; професійна освіта; вища освіта; регіональний ринок праці; базаторівнева модель; робітничі кадри, людський капітал; стратегічний аналіз; статистичний аналіз; регресійний аналіз.

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