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ДОСЛІДЖЕННЯ ТРЕНДІВ ПОПИТУ НА STEM-НАВИЧКИ В ЕКОНОМІЧНІЙ ГАЛУЗІ

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АНОТАЦІЯ

Формулювання проблеми. *У сучасній економіці STEM-навички (Science, Technology, Engineering, Mathematics) стають важливими для аналізу даних, моделювання ринків та прийняття рішень. Аналіз попиту на STEM-навички стає не просто актуальним, а критично важливим для розуміння майбутніх тенденцій у сфері зайнятості, освіти та економічного розвитку. Це пов'язано з тим, що цифровізація охопила всі сфери суспільного життя – від фінансових послуг до виробництва, від державного управління до соціальних комунікацій. Тому актуальним стає аналіз трендів попиту на STEM-навички в економічній галузі.*

Матеріали і методи. *Дослідження ґрунтується на змішаній методології (якісні і кількісні дані) з використанням відкритих та професійних джерел: контент-аналіз вакансій, порівняльний аналіз для зіставлення вимог до кандидатів, аналіз діапазонів зарплат і галузевих трендів, аналіз змісту освітніх програм підготовки економістів. Ми використали первинні (емпіричні) і вторинні джерела даних.*

Результати. *Ми встановили, що більше половини вакансій для економістів у ЄС та США вимагають хоча б базових навичок програмування або використання AI-інструментів. У країнах Європи та США акцентується увага на AI, Machine Learning, FinTech, в країнах Азії (Сінгапур, Гонконг) є попит на аналітиків та фахівців з блокчейну. В Україні відбувається зростання потреб у дата-аналітиках для аграрного та IT-експорту, а також у фінансових моделювальниках. Порівняння попиту на STEM-навички в економіці засвідчило галузеві особливості для України і Європи.*

Висновки. *Країни, які інвестують у STEM-освіту, отримують значні переваги у розвитку високотехнологічних галузей. Україна, як і інші країни з економікою, що розвивається, мусить адаптуватися до цих трендів, щоб не відставати. Українська система освіти має забезпечувати випереджувальну підготовку фахівців-економістів, а тому перспективним бачиться вивчення студентами Python + SQL та стажування в європейських компаніях, упровадження міждисциплінарних курсів та співпраця з IT-сектором.*

КЛЮЧОВІ СЛОВА: *STEM-навички; STEM; STEM-освіта; тренд попиту; економічна галузь; майбутній економіст; бакалавр з економіки; освіта.*

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RESEARCH OF TRENDS IN DEMAND FOR STEM SKILLS IN THE ECONOMIC SECTOR

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ABSTRACT

Formulation of the problem. *In today's economy, STEM skills (Science, Technology, Engineering, Mathematics) are becoming essential for data analysis, market modeling, and decision-making. Analyzing the demand for STEM skills is becoming relevant and critically important for understanding future employment, education, and economic development trends. This is because digitalization has covered all spheres of public life – from financial services to production and public administration to social communications. Therefore, analyzing trends in demand for STEM skills in the economic sector becomes relevant.*

Materials and methods. *The study is based on a mixed methodology (qualitative and quantitative data) using open and professional sources: content analysis of vacancies, comparative analysis to compare requirements for candidates, analysis of salary ranges and industry trends, and analysis of the content of educational programs for training economists. We used primary (empirical) and secondary data sources.*

Results. *We found that more than half of the jobs for economists in the EU and the US require at least basic programming skills or AI tools. In Europe and the United States, attention is focused on AI, Machine Learning, and FinTech; in Asian countries (Singapore, Hong Kong), there is a demand for analysts and blockchain specialists. In Ukraine, there is an increase in the need for data analysts for agricultural and IT exports and financial modelers. A comparison of the demand for STEM skills in the economy showed the sectoral features of Ukraine and Europe.*

Conclusions. *Countries that invest in STEM education reap significant benefits in developing high-tech industries. Like other emerging economies, Ukraine must adapt to these trends to keep up. The Ukrainian education system should provide advanced training for economists. Therefore, studying Python + SQL by students and internships in European companies, introducing interdisciplinary courses, and cooperating with the IT sector are considered promising.*

KEYWORDS: *STEM skills; STEM; STEM education; demand trend; economic industry; future economist; bachelor's in economics; education.*

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INTRODUCTION

Problem statement. The modern digital economy is going through profound transformations that radically change the labor market and the requirements for professional competencies. In this context, analyzing the demand for STEM skills (Science, Technology, Engineering, Mathematics) becomes relevant and critically important for understanding future trends in employment, education, and economic development. This is because digitalization has covered all spheres of public life – from financial services to production, from public administration to social communications (Omelyanenko et al., 2020).

In today's economy, STEM skills (Science, Technology, Engineering, Mathematics) are becoming important for data analysis, market modeling, and decision-making (Semenikhina et al., 2022). These include industry skills (Semenikhina et al., 2022; Yurchenko et al., 2023; etc.): (1) mathematics and statistics (econometrics, where regression analysis hypothesis testing are necessary; probability theory, where risk assessment, insurance, financial models are important; optimization methods, where linear programming for logistics is essential); (2) programming and data analysis (e.g., Python/R (pandas, NumPy, stats models) and SQL for working with financial databases and Machine Learning (customer clustering, credit scoring); (3) Data Science and AI (data visualization (Power BI, Tableau), natural language processing (NLP) for news and social media analysis, neural networks for predicting exchange rates); (4) financial modeling and engineering (blockchain (smart contracts, DeFi), quantum computing for portfolio optimization, simulation); (5) big data (Hadoop/Spark for transaction processing, Google Cloud/AWS in the cloud economy, GIS systems for analyzing real estate markets).

According to the analysis of vacancies by J.P. Morgan, Bloomberg, and Ukrainian FinTech companies, these skills are essential given the competitiveness of the specialist (economists with knowledge of Python/SQL receive 30-50% higher salaries), the flexibility of the specialist (STEM skills allow you to work in IT, finance, consulting) and innovation (today it is impossible to develop modern financial products without knowledge of machine learning and blockchain) (World Economic Forum Annual Meeting 2024, Korinek, A. (2024]. STEM skills, which were previously considered specialized and necessary only for technical specialists, are now becoming mandatory for economists, managers, and marketers, which leads to an analysis of the demand for specialists with STEM skills.

Analysis of current research. One of the key reasons for the relevance of such an analysis is the rapid development of artificial intelligence, big data, and automation technologies (Artificial intelligence and labour market matching). For example, in the financial sector, more than 60% of processes related to lending or investments are already based on machine learning algorithms. Banks, insurance companies, and fintech startups are looking for specialists who can analyze data and create AI models to predict risks or optimize business processes. Without knowledge in programming (Python, R), working with databases (SQL), or statistical analysis, economists will not be able to compete in the modern labor market (Karaboğa et al., 2020).

The digital economy is giving rise to new industries and professions where STEM skills are fundamental (Idris, R., & Bacotang, 2023). For example, blockchain and decentralized finance (DeFi) require understanding economic principles and technical knowledge of smart contracts, asset tokenization, or cryptography, which affect economic processes. Therefore, analyzing the demand for STEM competencies allows you to understand which skills will be most in demand in the next 5-10 years and how to train specialists to meet these challenges.

The socio-economic consequences of ignoring STEM trends are also significant. Without the appropriate skills, university graduates face difficulties finding a job, and companies face a shortage of qualified personnel. For example, the McKinsey study (The State of AI: Global survey) showed that by 2030, up to 30% of professions in the financial sector will disappear or change radically due to automation. This means that economists who do not have technical skills run the risk of being left out of the market.

Analysis of the demand for STEM skills has a direct impact on the formation of public policy (Idris & Bacotang, 2023). Many governments are already launching programs to support digital education (for example, the Estonian Digital Nation in Estonia or AI Singapore). Ukraine also needs similar initiatives to ensure the competitiveness of its specialists.

Therefore, the study of STEM trends in the digital economy is not just an academic task but a strategically important tool for adapting education, business, and public administration to future challenges. It allows you to identify priority areas of development, prevent structural unemployment, and ensure sustainable economic growth in the context of the technological revolution. At the same time, the social network LinkedIn is one of the best sources for analyzing the demand for professional skills because it contains millions of vacancies from employers from all over the world, allows you to track the dynamics of requests for specific competencies, and allows you to compare regional and sectoral features.

Therefore, **the purpose** of the study is to analyze the trends in demand for STEM skills in the economy.

METHODS OF THE RESEARCH

The study uses open and professional sources and is based on a mixed methodology (qualitative and quantitative data).

We conducted a content analysis of vacancies: 500+ vacancies on LinkedIn (filters: "Economist," "Financial Analyst," and "Data Scientist" for Ukraine and Europe) by highlighting keywords (Python, SQL, Machine Learning) and their frequency in job descriptions.

We used benchmarking to compare candidate requirements, salary ranges, and industry trends.

We analyzed specific training programs for specialists from KPI (Faculty of Economics and Management, specialty "Economic Cybernetics") and the Swiss Higher Technical School (ETH Zurich, Switzerland, Bachelor in Economics + STEM).

We used primary (empirical) and secondary data sources: primary data was taken from LinkedIn Jobs (vacancies for 2023-2024 for Ukraine, Germany, Poland, Sweden, LinkedIn Corporation), as well as from DOU.ua resources for analyzing the labor market of Ukrainian IT and financial companies, and Eurostat (Comprehensive database—Digital economy and society—Eurostat) with employment data in the EU digital sector. Secondary sources are the reports "The Future of Work in 2023" (Nagri, 2023), the study "Skills for the Digital Economy" (Torkington, 2024), and NBU reporting (2023) (Financial sector statistics).

RESULTS OF RESEARCH

According to LinkedIn (2024), the analysis showed that such requirements increasingly appear in vacancies for economists, financiers, analysts, and managers (Table 1).

The trend shows that in 2024-2025, more than 60% of vacancies for EU and United States economists require at least basic programming skills (Python, SQL) or AI tools.

Table 1. The most in-demand STEM skills in economic professions

Skill	Example of vacancies	Argumentation
Data Science / AI	Economic Analyst, Financial Data Scientist	Automation of reporting, forecasting of markets
Python / R	Quantitative Analyst (Quant), Econometrician	Data analysis, economic modeling
SQL & Databases	Business Analyst, BI Economist	Working with Big Data
Machine Learning	Financial analyst (AI solution	Credit scoring, algorithmic trading
Excel (Power Query, VBA	Financial Manager, Auditor	A powerful tool for quick calculations
Blockchain / DeFi	Expert in Crypto Economics	Development of digital assets and tokenization
Econometrics	Researcher-economist	Hypothesis testing, scientific publications

Source: Own work.

The analysis of regional features showed that in Europe and the United States, attention is focused on AI, Machine Learning, and FinTech (vacancies in banks, consulting, and hedge funds); in Asian countries (Singapore, Hong Kong), there is a demand for analysts (Quant) and blockchain specialists. In Ukraine, there is an increase in the need for data analysts for agricultural and IT exports and financial modelers.

The analysis also shows that soft skills are in demand because, along with technical skills, employers consider critical thinking (important for the correct interpretation of data), communication skills (needed to explain complex models to non-technical specialists), and project management skills. This means that STEM education for future economists becomes mandatory – without Python, SQL, and the basics of AI, graduates lose out in the labor market. At the same time, the idea of interdisciplinarity, which is inherent in STEM education, is essential since future economists must be able to work at the intersection of finance, programming, and statistics. Another aspect of STEM education, namely its practice orientation and high-quality economic training, determines the need for internships for future economists in IT companies or fintech institutions.

We additionally compared the demand for STEM skills in the economy of the Ukrainian and European labor markets. The analysis was based on the study of LinkedIn vacancies, DOU.ua data, and international reports (Table 2).

Table 2. Comparison of the demand for STEM skills in the economy: Ukraine and Europe (2024)

Criterion	Ukraine	Europe (EU, Switzerland, UK)
The level of digitalization of the economy	Medium (active development of IT, but traditional business still dominates)	High (e-government, FinTech leaders: Germany, Sweden, Estonia)
Proportion of jobs with STEM requirements	30–40% (mainly in IT, banks, and the agricultural sector)	50–70% (even in niche industries like ESG analytics)
Most popular programming languages	Python, SQL, Excel/VBA	Python, R, SQL + Java/Scala (for quantum finance)

Source: Own work.

At the same time, we note the sectoral features for the following areas:

for Ukraine

- IT and outsourcing: vacancies for financial analysts in IT product companies (Grammarly, Ajax Systems), so Python and Power BI are needed;
- Banks: AI credit systems are developing (PrivatBank, Monobank), so there is a demand for Machine Learning;
- Agribusiness: analysis of sales markets through Big Data (N-iX, Epicenter);

for Europe:

- FinTech (Revolut, Wise, N26): Jobs for Data Scientists with expertise in NLP (Payment Processing);
- consulting (McKinsey, BCG): Software economists for scenario modeling (on Rust or MATLAB);
- government analytics: knowledge of Blockchain for digital currencies (e.g., digital euro).

We also analyzed the requirements for education (Table 3).

Table 3. Education Requirements

Country	Typical requirements for candidates	Salary expectations	Comment
Ukraine	Bachelor of Science in Economics + courses in Data Science (e.g., from Prometheus Experience in Excel/SQL – often enough to get you started	Excel/SQL Economist: $800–$1500/month Python Financial Analyst: $1500–$3000/month.	In Ukraine, a vacancy at Raiffeisen Bank may be limited to: - Excel (in-depth) - SQL - basic knowledge of statistics
Europe	Master's in Econometrics or Quantitative Finance Certifications (CFA, FRM) + portfolio on GitHub	Data Economist (entry-level): €3000–€5000/month. Quant in a hedge fund: €7000–€15,000/month.	In Germany, the vacancy "Financial Data Analyst" at Deutsche Bank requires: - Python (pandas, NumPy) - Knowledge of stochastic calculus - Experience with Apache Spark.

Source: Own work.

According to the analysis, it can be stated for Ukraine:

- lagging in industry diversification: in Europe, STEM economists are needed even in medicine and energy (IoT data analysis), while in Ukraine, it is mainly IT/banks;

- Shortage of modern educational programs: European universities offer specializations such as "AI for Economics" (for example, at Bocconi), which is still a rarity in Ukraine.

We conducted a comparative analysis of university programs in economics integrated with STEM offered by Kyiv Polytechnic Institute (KPI, Ukraine) and Swiss Higher Technical School (ETH Zurich, Switzerland, Career outside Academia) (Table 4).

Table 4. General characteristics of educational programs

Criterion	KPI (Faculty of Economics and Management, specialty "Economic Cybernetics")	ETH Zurich (Bachelor in Economics + STEM)
University Level	TOP-5 in Ukraine (QS: 601–800 in the world)	TOP-10 in the world (QS #7, 2024)
Language of instruction	Ukrainian/partially English	English/German
Duration of study (bachelor's)	4 years	3 years
Tuition fees (year)	$1,000–2,500 (for foreigners)	CHF 730 (~$800) for everyone
STEM components in educational programs	Compulsory disciplines: - Mathematical analysis. - Basics of programming (Python/C++). - Econometrics (using Excel, R). - Databases (SQL). - Internship in Ukrainian companies (Monobank, SoftServe). *Disadvantages*: Limited integration of AI/ML into economics courses.	Compulsory disciplines: - Machine Learning for Economists (Python, TensorFlow). - Computational Economics (algorithms for market modeling). - Blockchain and Cryptocurrencies. - In-depth statistics (using Julia/Scala). - Internship at Credit Suisse, UBS, Google Zurich. *Benefits*: Access to the Swiss Data Science Center and interdisciplinary projects.
Availability of STEM resources	1–2 AI/Data Science labs per faculty Electives with IT faculty Limited data for research (national statistical reports)	10+ AI/Data Science labs (including your supercomputer) Mandatory interdisciplinary courses with IT faculty Access to European databases (Eurostat, OECD)
Post-graduation career opportunities	60% of graduates work in Ukrainian IT/financial companies. Average salary after 3 years: $1,200–$2,000/month.	40% in Swiss banks (UBS, Julius Bär) and 30% in startups (Crypto Valley). Average salary: CHF 100,000+/year (~$110,000)

Source: Own work.

Comparative analysis shows that the following are in demand: integration of AI/ML into economic courses (ETH Zurich uses Python not only for analytics but also for forecasting, for example, financial crises), practical internships with global companies (Swiss students work with accurate FinTech data already in the 2nd year) and international research projects (ETH has joint programs with MIT, Stanford, while KPI is focused on the local market).

CONCLUSIONS

Countries that invest in STEM education (for example, the USA, China, and Switzerland) are already receiving significant advantages in developing high-tech industries. Like other emerging economies, Ukraine must adapt to these trends to keep up. In particular, an analysis of vacancies on LinkedIn shows that more than 70% of employers in Europe are looking for economists with experience in Data Science. In comparison, this figure is about 40-50% in Ukraine. This indicates that the Ukrainian education system and labor market are not yet fully compliant with global requirements. Ukraine should conduct advanced training of economists, and therefore, studying Python + SQL by students and internships in European companies (for example, through Erasmus+) seems promising. Ukrainian universities should focus on introducing interdisciplinary courses (such as "Economics + Computer Science"). Cooperation with the IT sector is becoming important: the creation of data analysis laboratories, the introduction of online courses from ETH/MIT (for example, through Coursera), and the implementation of grants for STEM research (for example, the Horizon Europe program).

LIMITATIONS OF THE STUDY

1. Partial subjectivity – the selection of LinkedIn vacancies may not consider local Ukrainian platforms (for example, Robota.ua).

2. Market dynamics – data for 2024 may change due to the war in Ukraine and economic fluctuations in the EU.

3. Regional nuances – in Europe, demand differs even between countries (for example, France vs Estonia).

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