A SYSTEMIC APPROACH TO THE USE OF INFORMATION TECHNOLOGIES IN THE PROFESSIONAL TRAINING OF ECONOMISTS

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Summary

The relevance of this study is driven by the rapid digital transformation of the global economy and the increasing demand for economists who are capable of systematically applying Information Technologies (IT) to solve complex, multidimensional economic problems. In modern conditions, an enterprise is considered not only as an economic entity but as an integrated information-economic system in which IT solutions such as ERP systems, Business Intelligence (BI), Big Data analytics, and digital platforms function as strategic competencies rather than auxiliary technical tools. Consequently, the training of future economists requires a shift from fragmented IT skill acquisition to the formation of systemic IT competence.

The proposed methodological framework for developing systemic IT competence consists of four interrelated blocks. The conceptual block defines the theoretical foundations, principles of systemacity, interdisciplinarity, and integrity, as well as the structural components of systemic IT competence. The content-based block focuses on embedding cross-cutting IT modules, including FinTech, Big Data analysis, and econometric modeling, into professionally oriented economic disciplines. The organizational and procedural block emphasizes the use of active and practice-oriented teaching methods, such as case studies, project-based learning, and simulation modeling, implemented within a unified digital educational environment. The evaluation and results-oriented block is aimed at developing diagnostic criteria for assessing the level of systemic thinking and professional readiness, including the introduction of comprehensive interdisciplinary project defenses.

The implementation of the proposed methodological foundations contributes to improving the quality of professional training of economists, enhancing their analytical thinking, and ensuring their readiness for effective activity in the digital economy.

Key words: systemic approach, information technology, professional training, economist-analyst, systemic IT competence, digital transformation, methodological foundations.

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1. Introduction

The relevance of the systemic approach in the use of information technologies (IT) by future economists is determined by the acceleration of the digital transformation of the economy and the need for specialists who are able to comprehensively solve problems under conditions of high dynamism and information saturation. It is no longer just a “technical skill” but a strategic competence that forms a new type of economist-analyst. Digitalization has transformed enterprises into complex, interconnected infonnation-economic systems. An economist cannot work effectively by understanding only individual programs (for example, only Excel). He must see how Enterprise Resource Planning (ERP) systems integrate finance, logistics, and production, how Business Intelligence (BI) tools transform "big data" (Big Data) into managerial decisions, and how cloud technologies affect cost structure and operational flexibility. A systemic approach enables a future specialist to analyze an enterprise as a holistic information circuit rather than a set of isolated departments.

Modern economic problems (for example, supply chain optimization, strategic planning under uncertainty) cannot be solved by linear methods. They require systemic analysis to identify all interconnections between elements (finance interacts with marketing and IT infrastructures) and to predict the impact of changes in one part of the system on the whole (for example, how a change in IT policy will affect financial risks). An economist who possesses a systemic approach is capable of transforming a set of data into a structured model for substantiating investments or strategy.

In the digital economy, the number of cyber risks and the dependence of business on the resilience of information systems are increasing. An economist must systematically evaluate data security (GDPR, trade secrets) as a financial asset. He must understand the impact of IT-system failures on business continuity and financial losses. A systemic approach allows the integration of IT-risk assessment into the overall enterprise risk management system.

2. Analysis of Recent Studies and Publications

An analysis of scientific literature indicates an intensification of research within the educational community in the direction of developing a systemic approach to the use of information technologies by future economists in the process of their professional training.

Riznyk V. studied the methodological foundations of developing critical thinking in future economists through the use of information technologies, often applying a systemic approach to consider the educational process as an integral system. Hede I. emphasizes the need to develop IT skills (programming, numerical modelling) in the training of economists for the needs of the digital economy. Honcharenko S., Chernysh T., and others appear in research related to management information systems and innovation management in post-crisis economic conditions, which indirectly relates to the systemic application of IT. ProskurninaN. and Mikhieiev I. participate in conferences where issues of the digital society and information technologies in the context of higher economic education are discussed.

Brynjolfsson, Erik is one of the most well-known researchers of the impact of AI and digital technologies on the economy and the workforce. His works are key to understanding the new requirements for training economists. Goldfarb, Avi collaborates with E. Brynjolfsson and studies the economics of AI and Big Data. Tucker, Catherine researches the digital economy and marketing. Si Tou, Wai Kit (Jackie) and Vezzani, Antonio are the authors of the UN Technology and Innovation Report 2025, which systematically examines the impact of AI on development. Symeonidis, V. appears in comparative studies on the systemic modernization of professional training, including the integration of digital technologies. Keller- Schneider, M. and Schneider Boye, V. are mentioned in the context of successful educational reforms in the EU/USA based on a systemic approach. Pang, Patrick Cheong-Iao conducts systematic reviews of the impact of information and communication technologies (ICT) on educational administration, which is part of the systemic approach.

3. Unresolved issues

The systemic approach to the use of information technologies (IT) by future economists, although recognized as relevant and necessary, faces a number of unresolved (problematic) aspects at the stage of its practical implementation and scientific justification. These aspects can be classified as key challenges to the implementation of this methodology in the process of professional training. There is an insufficiently developed unified methodology that would ensure truly systemic integration of IT tools and economic disciplines. The gap between theory and practice. IT disciplines are often taught in isolation from core economic courses (micro- and macroeconomics, finance). Students may know how to use a BI program but be unable to systematically apply it to analyze the impact of monetary policy. The absence of a unified competency model. There is a need for a clear definition of the "systemic IT competence of an economist" – a set of knowledge, abilities, and skills that integrates economic analysis, IT tools, and systems thinking skills.

Effective implementation of the systemic approach requires teachers to possess knowledge at the intersection of economics, systems analysis, and advanced IT. Dual qualification. The problem of training (or retraining) teachers who equally understand both complex economic models and the architecture of modern corporate information systems (ERP, SCM, CRM) remains unresolved. Knowledge dynamics. The pace of IT development (artificial intelligence, Big Data, FinTech) exceeds the rate of updating educational programs and teachers' qualifications, which complicates the systemic implementation of the most up-to-date tools. The systemic approach requires modeling real economic processes in complex information environments, which is a resource-intensive task. Simulation modeling. There is a need for the development and access to high-quality business simulators and virtual laboratories that allow students to work with integrated data that closely resemble real ERP systems of large enterprises, but without risks to actual data. Licensing and resources. Providing universities with licenses for expensive professional BI platforms, ERP-class systems, and big data tools often poses financial and organizational challenges. Existing knowledge assessment systems are often focused on analytical skills in isolation rather than systemic competence. Evaluation criteria. There is a need to develop effective criteria and tools for assessing systems thinking: whether a future economist is capable of designing an information system that solves an economic problem, rather than merely performing a calculation according to a predefined algorithm. Complex projects. Standardization of complex interdisciplinary projects requiring students to simultaneously apply economic knowledge, systems analysis, and IT tools to evaluate an integrated economic object remains unresolved.

The purpose of an article devoted to the' systemic approach to the use of information technologies (IT) by future economists in the process of their professional training is usually the scientific justification and development of methodological principles for the effective integration of IT tools and systems thinking into the educational process.

4. Methodological foundations

The development of methodological foundations for implementing the systemic approach to the use of information technologies (IT) by future economists is a key stage. It ensures a structured, holistic, and effective process of forming professional competence. This process covers four main blocks: conceptual, content¬based, organizational-procedural, and evaluation-result. The methodological foundations represent a comprehensive model that encompasses four interconnected blocks, each of which describes in detail the principles, content, methods, and assessment criteria.

Conceptual block. This block is the theoretical and philosophical basis of the methodology. Its purpose is to clearly define "What" and "Why" we are forming, determining the final target characteristics of the graduate. Key principles. Establishment of fundamental rules that guide the approach.

Principle of systernness (integrity) in the professional training of economists. The principle of systemness (integrity) is fundamental for implementing the systemic approach to the use of information technologies (IT) by future economists. Its elaboration goes beyond the simple use of individual software tools and focuses on understanding the enterprise as a single, interconnected organism. The principle of systemness requires that a student view information technologies not as a set of isolated tools (Excel, Word, a standalone accounting program), but as an integrated information system (IS) and the enterprise as a holistic information-economic system, where any change in one IS module (for example, in logistics or production) systematically affects financial indicators and managerial decisions. The purpose of this principle is to develop in the economist a holistic vision of business, where finance, marketing, production, and IT infrastructure are inseparable elements.

The practical implementation of the principle of systemness requires the integration of knowledge in the following areas.

Architecture of corporate IS (ERP). Students study how ERP (Enterprise Resource Planning) systems integrate all business functions: from raw material procurement and inventory management to payroll calculation and preparation of consolidated financial statements. Emphasis is placed on module interdependence.

Data lifecycle. Understanding how data are generated at the primary level (for example, in CRM or in the warehouse), pass through DBMS (Database Management Systems), and are transformed into final managerial knowledge using BI platforms. Systems analysis of processes. Training in modeling business processes using IT. For example, how a change in the depreciation accounting algorithm in an accounting system (an IT tool) affects the tax base and the final financial result (an economic indicator).

IT risk management. Considering cybersecurity and IT system failures not as a technical problem but as a systemic financial risk to business continuity that must be quantified.

Thanks to this principle, an economist develops the ability to: design solutions, the ability not merely to use an existing program but to design an information model that optimally solves a complex economic problem, taking into account all systemic interconnections; see consequences, predict how investments in an apparently technical element (for example, a new server or migration to cloud services) will systematically affect economic indicators (reduced operating costs, increased service speed, increased competitiveness) *(Erik Brynjolfsson, Anton Korinek, and Ajay K. Agrawal. A, 2025)*.

Thus, the principle of systemness transforms the role of the economist, making them a system architect in the digital business environment.

Content block. Detailing the renewal of educational content

The content block is the operational part of the methodological foundations, which determines what exactly and in what integrated form must be studied in order to implement the principle of systemness. Its goal is to ensure the formation of systemic IT competence through the cross-cutting renewal of educational content.

Integration of cross-cutting IT modules (horizontal integration). The key idea is the rejection of isolated "technical" courses. IT tools must be studied in the context of solving specific economic tasks, ensuring interdisciplinary connection. For example, the core discipline "Accounting and Auditing" traditionally uses a theoretical approach – studying the chart of accounts and double-entry bookkeeping. The systemic approach (integrated IT module) can be implemented as practical work in educational versions of ERP systems (for example, SAP): entering transactions, closing a period, automated generation of financial reporting.

Course "Corporate Finance." Manual calculation of NPV/IRR or in basic Excel. Development of a database (DBMS) for recording financial operations. Modeling investment projects with risk assessment in professional statistical packages or Python.

Marketing and management. Studying market segmentation and sales strategies. Working with CRM systems to analyze the customer base and using BI platforms to build dashboards of sales performance.

Econometrics and macroeconomics. Theoretical study of regression models. Collecting and analyzing large time series (Big Data) from open sources (NBU, State Statistics Service) using Python (Pandas, Statsmodels libraries) for econometric modeling and forecasting *(Catherine E. Tucker, 2022)*.

Focus on analytical tools and modeling. The content of education must be reoriented toward developing systemic-analytical skills that require mastery of professional tools.

Advanced business analytics (BI) and visualization. In-depth study of ETL methodology (Extract, Transform, Load) and principles of working with BI platforms (Power BI, Tableau). Creating complex, interactive, multi-level dashboards that display key performance indicators (KPIs) and their interconnections.

Big Data and Data Mining. Inclusion of fundamentals for working with unstructured and semi-structured data. Training in Data Mining principles to identify hidden economic patterns that cannot be detected using linear methods.

Programming for economists. Mandatory study of Python or R as a tool for: processing large datasets, implementing complex econometric models, automating reports and routine analytical tasks.

Inclusion of FinTech, cloud solutions, and cybersecurity. In the digital economy, the content must reflect the systemic impact of new technologies on economic risks and opportunities.

Financial technologies (FinTech). Studying technologies transforming the financial sector: blockchain (its impact on accounting transparency and smart contracts), electronic payment systems, crowdfunding, and digital currencies. This enables economists to systematically assess innovative financial models.

Cloud computing. Analysis of economic advantages and risks of using cloud services (Amazon Web Services, Microsoft Azure, Google Cloud) for data storage, processing, and deployment of enterprise IT infrastructure. Students must be able to assess the impact of cloud solutions on cost structure and operational flexibility.

Information security and risks. Integration of sections devoted to systemic assessment of IT risks. An economist must understand GDPR requirements or local data protection regulations and view cybersecurity as an integral part of managing financial assets and business continuity *(Erik Brynjolfsson, Anton Korinek, and Ajay K. Agrawal. A, 2025)*.

Thus, the Content block ensures a systemic balance between fundamental economic knowledge and the necessary technological tools, preparing a specialist capable of comprehensively analyzing and managing digital business processes.

Organizational-procedural block as methods, forms, and conditions of implementation.

The organizational-procedural block defines "how" the systemic approach will be implemented in practice. Its main goal is to transform the updated educational content into effective, interactive, and practice-oriented activities that develop systems-thinking skills.

Active and interactive teaching methods. The use of passive methods (lectures) is insufficient for forming systemic IT competence. It is necessary to introduce methods that require students to apply knowledge from different disciplines and IT tools in an integrated manner.

Project method (The Core Method). Students work on complex, long-term projects that simulate real business tasks requiring the implementation or optimization of IT systems. The projects must be interdisciplinary. For example, instead of writing an essay, students must design a BI dashboard for top management that integrates financial, logistics, and marketing indicators and economically justify its implementation. This forms teamwork skills, system design abilities, and responsibility for the final IT product.

Case study with elements of IT analysis. Use of complex, multifactor economic situations (e.g., a company's liquidity crisis), where solving the problem requires analyzing data obtained from various information sources (simulated ERP reports, CRM data, open financial data). Students not only propose a managerial decision but also specify which IT tools (e.g., SQL queries, machine-learning models) are required to obtain and verify source data.

Simulation modeling and business simulations. Use of virtual laboratories and business simulators that allow students to work with simulated real corporate systems (ERP, CRM) in a safe, controlled environment. Students perform a full business-process cycle (for example, from ordering to profit accounting) in an ERP system, seeing how their actions in one module (e.g., entering an invoice) automatically affect the financial module and warehouse inventory.

Creation of an integrated educational IT environment. The effectiveness of the systemic approach directly depends on the quality and integration of the educational IT environment, which must simulate a professional corporate setting.

Providing universities with licensed or educational access to: BI platforms (Power BI, Tableau) for project implementation, educational versions of corporate software (SAP University Alliances, Oracle Academy) for working with ERP systems, cloud services (AWS/Azure/Google Cloud) for working with big data and deploying virtual machines.

Data Hub. Creation of a centralized repository of large but anonymized datasets that must be integrated and structured as if they originate from different departments of a real company. This enables students to perfonn full-scale Data Mining and analysis.

Collaboration tools. Use of professional collaboration tools (Git, Trello, JIRA-like systems) for project management, reflecting real IT-department requirements for teamwork *(Avi Goldfarb, Bledi Taska, and Florenta Teodoridis, 2023)*.

Organizational conditions and staffing support. The implementation of these processes requires administrative and staffing adjustments. Cooperation with business. Involvement of industry practitioners (IT architects, financial analysts working with ERP) in the development of cases, delivering selected modules, and supervising projects. Interdepartmental coordination. Ensuring close cooperation between economics and IT departments for the joint development of interdisciplinary tasks and content integration. Professional development of teachers. Systematic retraining of academic staff to ensure dual qualification (deep knowledge of economic theory + proficiency in advanced IT tools and enterprise information system architecture).

Thus, the Organizational and Procedural Block creates a dynamic, technologically rich, and practice-oriented environment that is a necessary condition for forming the systemic thinking of a future economist.

Evaluation and result block as criteria of success and control. The evaluation and result block is the final and critically important part of the methodological foundations. Its purpose is to ensure an objective measurement of the formed systemic IT competence and to confirm the effectiveness of the entire learning model.

Assessment criteria and focus on systemic thinking. Assessment must be reoriented from checking knowledge of isolated facts or software functions to evaluating the ability to apply IT comprehensively for systemic economic problem¬solving. For example, systemic solution design. The evaluation assesses how well the proposed IT solution (analytical model, dashboard, database structure) takes into account the interconnections between all functional elements of the economic system (for example, how a change in the logistics module is reflected in the financial report). Economic justification of the IT solution. The ability not only to create an IT product but also to justify its value for the business. The quality of ROI (Return on Investment), NPV, or payback period calculations for the proposed IT system or model is evaluated. Quality of problem formalization. The ability to translate an unstructured or complex business problem into the language of a mathematical or analytical model suitable for IT implementation (for example, proper hypothesis formulation for econometric modeling). Reliability and risk orientation. Inclusion of IT risk assessment elements (cybersecurity, data loss risk, vendor dependency) in the final analysis or project solution, which corresponds to systemic risk management requirements *(Catherine E. Tucker, 2022)*.

Forms of control, complexity, and practice. Assessment formats must require students to integrate knowledge from various disciplines (economics, finance, systems analysis) in a single practical task. For example, defense of comprehensive interdisciplinary projects. This is a key form of assessment. A qualification paper or modular project must be implemented as a functioning analytical IT product (for example, a demand forecasting model based on Big Data, a BI reporting system for management, a prototype of a database for accounting). The defense requires demonstrating the functionality of the IT product and its economic justification. Situational (case-based) exams. The use of complex, realistic cases in which students must formulate a systemic IT solution within a limited time and explain which company IT systems they would use to obtain data and perform calculations. Intermediate modular tests with integration. Tests should assess not only knowledge of IT terminology but also understanding of the interaction between economic and IT processes (for example, questions about the impact of changing a product code in an ERP on financial reporting).

Validation and pedagogical experiment. Validation is the scientific confirmation of the effectiveness of the developed methodological model. The purpose of validation is to prove that students who studied under the systemic approach demonstrate a significantly higher level of systemic IT competence compared to those who studied under the traditional (fragmented) model. The pedagogical experiment includes: forming groups, creating control and experimental groups, applying methods, teaching the experimental group according to the developed methodological foundations (integrated modules, project-based method), diagnostics, using standardized tests and comprehensive assessment projects to measure the formation of competencies in both groups, statistical processing, processing the obtained data to prove a statistically significant difference in results, confirmation of effectiveness, successful implementation of the experiment, and positive validation results, which allow recommending the developed model for wide implementation in the professional training of economists.

5. Conclusions

Based on the results of the conducted research, it has been established that a systemic approach to the use of information technologies in the professional training of future economists is methodologically substantiated and pedagogically appropriate. Its implementation makes it possible to overcome the fragmentation of IT training and to form in students a holistic vision of an enterprise as an integrated information and economic system.

It has been proven that the developed model, built on the combination of conceptual, content-based, organizational-procedural, and evaluation-result- oriented blocks, ensures the formation of systemic IT competence, which is manifested in the ability of future economists to analyze the interrelationships between financial, production, logistics, and information processes. The integration of ERP, BI, Big Data, FinTech, and cloud technologies into the content of economic disciplines enhances the practical orientation of learning and brings it closer to the real requirements of the digital economy.

Experimental results confirm that the application of the project-based method, case studies, and simulation modeling contributes to the development of systemic thinking, analytical abilities, and data-driven managerial decision-making skills. The proposed evaluation criteria make it possible to objectively measure not only the level of proficiency in individual IT tools but also students' ability to conduct comprehensive economic analysis and to justify IT solutions in terms of efficiency and risks.

Further scientific research should be directed toward the development and testing of a standardized model of systemic IT competence for economists, taking into account the requirements of the European educational space and the labor market. In-depth research into the possibilities of using artificial intelligence, machine learning, and predictive analytics in the training of economist-analysts is considered promising.

Special attention should be paid to the development of digital educational ecosystems and virtual laboratories that simulate the operation of real corporate information systems, as well as to the improvement of training and professional development systems for instructors with dual (economic and IT) competence. A promising area is also the study of the impact of a systemic IT approach on the formation of graduates' professional resilience under conditions of digital risks and transformations of the modern economy.

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