

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

НАУКОВИЙ ВІСНИК

МУКАЧІВСЬКОГО ДЕРЖАВНОГО
УНІВЕРСИТЕТУ

СЕРІЯ
«ЕКОНОМІКА»

Науковий журнал

ТОМ 13, № 2
2026

МУКАЧЕВО
2026

**Рішення Національної ради України
з питань телебачення і радіомовлення № 1564,**
протокол № 15 від 09 травня 2024 року.
Ідентифікатор медіа - R30-04571.

*Рекомендовано до друку та поширення
через мережу Інтернет Вченою радою
Мукачівського державного університету
(протокол № 12 від 25 травня 2026 року)*

Журнал входить до переліку наукових фахових видань України
Категорія «Б». Спеціальності: 051 – Економіка; 071 – Облік та оподаткування;
072 – Фінанси, банківська справа та страхування; 073 – Менеджмент; 075 – Маркетинг
(Наказ Міністерства освіти і науки України № 1693 від 23.12.2025 р.)

Кластер – Економічні перетворення, бізнес та адміністрування

**Журнал представлено у міжнародних наукометричних базах даних,
репозитаріях та пошукових системах:**

Google Scholar, Фахові видання України, Національна бібліотека України імені
В. І. Вернадського, EconBiz, ERIH PLUS, Polska Bibliografia Naukowa, UCSB Library, Dimensions,
German Union Catalogue of Serials, University of Oslo Library, University of Hull Library,
SOLO - Search Oxford Libraries Online, European University Institute, Leipzig University Library,
Cambridge University Library,
OUCI (Open Ukrainian Citation Index), WorldCat, Litmaps

Науковий вісник Мукачівського державного університету. Серія «Економіка» / Ред. кол.:
В.С. Шебанін та ін. – Мукачево: Вид-во МДУ, 2026. – Том 13, № 2. – 123 с.

Засновник і видавець:

Мукачівський державний університет
89600, вул. Ужгородська, 26, м. Мукачево, Україна
E-mail: info@economics-msu.com.ua
<https://economics-msu.com.ua/uk>

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

SCIENTIFIC BULLETIN

OF MUKACHEVO STATE
UNIVERSITY

**SERIES
“ECONOMICS”**

Scientific Journal

**VOL. 13, No. 2
2026**

**MUKACHEVO
2026**

ISSN 2313-8114
E-ISSN 2518-1254

**Decision of the National Council
of Television and Radio Broadcasting of Ukraine No. 1564.**

Minutes No. 15, dated 09.05.2024.

Media identifier - R30-04571.

*Recommended for printing and distribution
via the Internet by the Academic Council
of Mukachevo State University
(Minutes No. 12 May 25, 2026)*

The journal is included in the list of scientific professional publications of Ukraine

Category “B”. Specialties: 0311 – Economics; 0411 – Accounting and taxation;

0412 – Finance, banking, and insurance; 0413 – Management and administration;

0414 – Marketing and advertising

(Order of the Ministry of Education and Science of Ukraine No. 1693 of 23.12.2025)

Cluster – Economic transformation, Business and Administration

**The journal is presented at international scientometric databases,
repositories and scientific systems:**

Google Scholar, Professional publications of Ukraine, Vernadsky National Library of Ukraine,

EconBiz, ERIH PLUS, Polska Bibliografia Naukowa, UCSB Library, Dimensions,

German Union Catalogue of Serials, University of Oslo Library,

University of Hull Library, SOLO - Search Oxford Libraries Online,

European University Institute, Leipzig University Library, Cambridge University Library,

OUCI (Open Ukrainian Citation Index), WorldCat, Litmaps

Scientific Bulletin of Mukachevo State University. Series “Economics”: / Editorial Board:
V. Shebanin *et al.* – Mukachevo: MSU Publishing House, 2026. – Volume 13, No. 2. – 123 p.

Founder and publisher:

Mukachevo State University

89600, 26 Uzhhorodska Str., Mukachevo, Ukraine

E-mail: info@economics-msu.com.ua

<https://economics-msu.com.ua/en>

НАУКОВИЙ ВІСНИК МУКАЧІВСЬКОГО ДЕРЖАВНОГО УНІВЕРСИТЕТУ

СЕРІЯ «ЕКОНОМІКА»

Том 13, № 2. 2026

Головний редактор:

В'ячеслав Сергійович Шебанін

д-р технічних наук, професор, академік Національної академії аграрних наук України, ректор, Миколаївський національний аграрний університет, Україна

Національні члени редколегії

Марина Василівна Реслер

д-р екон. наук, професор, Мукачівський державний університет, Україна

Маріанна Іванівна Стегней

д-р екон. наук, професор, Мукачівський державний університет, Україна

Лариса Миколаївна Зомчак

канд. екон. наук, доцент, доцент, Львівський національний університет імені Івана Франка, Україна

Іван Вікторович Заюков

д-р екон. наук, доцент, професор, Вінницький торговельно-економічний інститут Державного торговельно-економічного університету, Україна

Сергій Володимирович Козловський

д-р екон. наук, професор, професор, Донецький національний університет імені Василя Стуса, Україна

Ольга Миколаївна Яценко

д-р екон. наук, професор, професор, Київський національний економічний університет імені Вадима Гетьмана, Україна

Марина Володимирівна Негрей

канд. екон. наук, доцент, доцент, Національний університет біоресурсів і природокористування України, Україна

Міжнародні члени редколегії

Ришард Пукала

д-р екон. наук, професор, Державна вища технічно-економічна школа імені Броніслава Маркевича в Ярославі, Польща

Артур Кісіолек

д-р екон. наук, професор, декан, Великопольський соціально-економічний університет, Польща

Радован Кастратович

канд. наук, доцент, доцент, Белградський університет, Сербія

SCIENTIFIC BULLETIN OF MUKACHEVO STATE UNIVERSITY

SERIES "ECONOMICS"

Vol. 13, No. 2. 2026

Editor-in-Chief:

Vyacheslav Shebanin

Doctor of Technical Sciences, Professor, Academician of the National Academy of Agrarian Sciences of Ukraine, Rector, Mykolaiv National Agrarian University, Ukraine

National Members of the Editorial Board

Maryna Resler

Doctor of Economics, Professor, Mukachevo State University, Ukraine

Marianna Stehnei

Doctor of Economics, Professor, Mukachevo State University, Ukraine

Larisa Zomchak

PhD in Economic Sciences, Associate Professor, Associate Professor, Ivan Franko National University of Lviv, Ukraine

Ivan Zayukov

Doctor of Economic Sciences, Associate Professor, Professor, Vinnytsia Institute of Trade and Economics, State University of Trade and Economics, Ukraine

Sergey Kozlovsky

PhD in Economic Sciences, Professor, Professor, Vasyl Stus Donetsk National University, Ukraine

Olga Yatsenko

PhD in Economic Sciences, Professor, Professor, Vadym Hetman Kyiv National Economic University, Ukraine

Marina Negrei

PhD in Economic Sciences, Associate Professor, Associate Professor, National University of Life and Environmental Sciences of Ukraine, Ukraine

International Members of the Editorial Board

Ryszard Pukala

Doctor of Economics, Bronisław Markiewicz State Higher School of Technology and Economics in Jarosław, Poland

Artur Kisiołek

Doctor of Economics, Professor, The Great Poland University of Social and Economics, Poland

Radovan Kastratović

PhD, Assistant Professor, Assistant Professor, University of Belgrade, Serbia

ЗМІСТ

Н. Проскуріна, В. Гончарова, А. Коновалова

Якість фінансової звітності за МСФЗ: роль облікових моделей
у формуванні інформаційної корисності 9

І. Шапка

Економічні підходи до оцінювання розвитку працівників організації 20

Є. Терехов

Роль бухгалтерського обліку та аудиту
у підвищенні прозорості фінансової звітності аграрних підприємств
у контексті міжнародних стандартів 32

О. Литвинова, Н. Слободян

Теоретико-методологічні засади делегування
управлінських повноважень
у менеджменті закладів охорони здоров'я 44

І. Манвелідзе

Економічний вплив «тіньового ШІ»
на кадровий потенціал державного сектору Грузії 56

О. Підодня

Моделі техніко-економічного обґрунтування доцільності
реконструкції підприємств будівельної галузі 68

Н. Гульмалієва, Р. Бабаєв, Г. Ісмаїлзада, Л. Гусейнова, Е. Ісаєв

Бізнес-середовище для робочих місць, інвестицій та експорту:
реальний вплив зелених переходів ЄС на країни, що розвиваються 84

Ю. Кривенко, А. Овсієнко

Зелені облігації як інструмент фінансування
екологічних проектів в Україні 101

Р. Осадчук

Проблеми експорту через блокаду портів,
перебудову на сухопутні та альтернативні маршрути 114

CONTENTS

N. Proskurina, V. Goncharova, A. Konovalova

Quality of IFRS financial reporting: The role of accounting models
in shaping informational usefulness 9

I. Shapka

Economic approaches to assessing employee development in organisations.....20

Ye. Terekhov

The role of accounting and auditing in enhancing the transparency
of financial reporting of agricultural enterprises
in the context of international standards32

O. Lytvynova, N. Slobodian

Theoretical and methodological foundations
of delegating management powers in healthcare institutions44

I. Manvelidze

The economic implications of shadow AI in Georgia's public sector56

O. Pidodnia

Models for technical and economic justification
of the feasibility of reconstruction in the construction industry68

N. Gulmaliyeva, R. Babayev, G. Ismayilzada, L. Huseynova, E. Isayev

Business environment for jobs, investments and exporting:
The real effects of EU green transitions on developing countries.....84

Yu. Kryvenko, A. Ovsiienko

Green bonds as a financing instrument
for environmental projects in Ukraine..... 101

R. Osadchuk

Export challenges caused by blockade of ports
and shift to overland and alternative routes..... 114

Scientific Bulletin of Mukachevo State University

Series

Economics

Volume 13, No. 2, 9-19

Journal homepage: <https://economics-msu.com.ua/en>

UDC 657.37:657.1:336.71

DOI: 10.52566/msu-econ2.2026.09

ISSN 2313-8114

E-ISSN 2518-1254

Quality of IFRS financial reporting: The role of accounting models in shaping informational usefulness

Nelia Proskurina

*Doctor of Economic Sciences, Professor
Zaporizhzhia National University
69600, 66 Zhukovsky Str., Zaporizhzhia, Ukraine
<https://orcid.org/0000-0001-8674-1720>*

Valentina Goncharova

*PhD in Public Administration, Associate Professor
Zaporizhzhia National University
69600, 66 Zhukovsky Str., Zaporizhzhia, Ukraine
<https://orcid.org/0000-0001-5556-7192>*

Anastasia Konovalova*

*Chief Accountant
LLC NMC "Global Account Audit"
01033, 20V Shota Rustaveli Str., Kyiv, Ukraine
<https://orcid.org/0000-0001-5036-1603>*

Abstract. In the context of the globalisation of financial markets and the widespread adoption of International Financial Reporting Standards, the issue of the quality of financial reporting prepared in accordance with these standards is becoming increasingly relevant. The principle-based nature of these standards implies the extensive use of various accounting models, which directly influence the formation of financial indicators and the level of their informational usefulness for users. At the same time, the absence of a single rigid algorithm for the application of accounting models creates risks of reduced comparability, increased complexity of interpretation, and ambiguity in analytical conclusions. The purpose of the article was to investigate the role of accounting models in shaping the quality of financial reporting prepared in accordance with International Financial Reporting Standards and to assess their impact on the informational usefulness of financial indicators for different groups of users. The methodological basis of the study included methods

Received: 22.12.2025, Revised: 15.04.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Proskurina, N., Goncharova, V., & Konovalova, A. (2026). Quality of IFRS financial reporting: The role of accounting models in shaping informational usefulness. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 9-19. doi: 10.52566/msu-econ2.2026.09.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (nastygn07@gmail.com)

of theoretical generalisation, comparative analysis, a systematic approach, and logical modelling, which made it possible to comprehensively analyse the relationship between the principles of International Financial Reporting Standards, accounting models, and the qualitative characteristics of financial information. The study found that the quality of financial reporting prepared in accordance with International Financial Reporting Standards is determined not only by compliance with standards, but primarily by the selection and application of specific accounting models. It was substantiated that different measurement models for assets and liabilities affect the relevance, reliability, comparability, and understandability of financial information in different ways. The presence of a conceptual trade-off between increasing the economic realism of indicators and the growing complexity of their interpretation has been identified. It was proven that the informational usefulness of financial reporting largely depends on professional judgment and the analytical capacity of users. The practical significance of the obtained results lies in the possibility of their application to improve analytical approaches to the evaluation of financial reporting prepared in accordance with International Financial Reporting Standards, enhance the quality of managerial and investment decision-making, and further develop the methodology of financial analysis in a principle-based accounting environment

Keywords: financial information; principle-based accounting; professional judgement; accounting system; financial statements

Introduction

The quality of financial reporting prepared under International Financial Reporting Standards (IFRS) has become a central issue in contemporary accounting theory and practice, particularly in the context of global capital markets integration and increasing reliance on financial information for economic decision-making. IFRS were originally designed as a principles-based system aimed at enhancing transparency, comparability, and informational usefulness of financial statements across jurisdictions. However, the growing complexity of economic transactions and the expansion of valuation-based accounting models have significantly transformed the way financial information is generated and interpreted.

Recent studies indicated that the informational usefulness of IFRS-based financial reporting depends not only on formal compliance with standards but also on the underlying accounting models, professional judgments, and estimation techniques applied in the reporting process. As noted by M.E. Barth *et al.* (2021), the application of IFRS involves significant managerial discretion, which directly affects the quality and comparability of financial reporting across entities. In particular, L.V. Bezkorovaina (2023) argued that the formation of financial reporting indicators under IFRS was substantially influenced by methodological choices and estimation approaches applied by reporting entities. As a result, financial reporting quality was increasingly shaped by methodological choices embedded within IFRS rather than by uniform rule application. This shift raised important questions regarding the extent to which accounting models enhance or undermine the qualitative characteristics of financial information, particularly relevance, faithful representation, comparability, and understandability.

The principles-based nature of IFRS granted significant discretion to preparers in selecting accounting policies and measurement bases, which may improve economic realism but simultaneously reduced consistency across entities and reporting periods. O. Tyvonchuk & O. Mykiiievych (2023) emphasised that the transition to

IFRS created both opportunities and challenges for ensuring consistency in financial reporting. At the same time, O. Yarmoliuk *et al.* (2021) demonstrated that differences in disclosure practices and valuation approaches led to variations in the presentation of financial results. Consequently, the quality of IFRS financial reporting could not be assessed solely through formal adherence to standards but had to be analysed through the lens of accounting model selection and its impact on information interpretation.

In parallel, the digitalisation of financial reporting and the introduction of structured reporting formats, such as eXtensible Business Reporting Language (XBRL) and the European Single Electronic Format (ESEF), have intensified the demand for high-quality, comparable, and analytically meaningful financial information. European Securities and Markets Authority (ESMA, 2023) highlighted the importance of structured reporting for ensuring transparency and comparability of financial data, while XBRL International (2024) emphasised the role of digital standards in improving data accessibility. While these technologies enhance data accessibility and standardisation, they did not eliminate conceptual differences arising from accounting model diversity. Instead, they further exposed inconsistencies rooted in measurement and recognition choices permitted under IFRS.

Despite extensive research on IFRS implementation and convergence processes, insufficient attention was paid to the systemic role of accounting models in shaping the informational usefulness of financial reporting. I. Shushakova *et al.* (2021) examined the convergence of accounting systems, while L.I. Lezhnenko & M.M. Kruhla (2024) analysed the historical aspects of IFRS implementation, yet these studies did not provide an integrated theoretical perspective on how accounting models influenced reporting quality as a whole. Against this background, the purpose of this study was to examine the role of accounting models within IFRS in shaping the quality and informational usefulness of financial reporting. The research aimed to conceptualise the relationship between principles-based

standards, accounting model selection, and the qualitative characteristics of financial information. The study contributed to accounting theory by systematising existing approaches and proposing a structured analytical framework for assessing IFRS-based reporting quality.

Literature Review

The issue of financial reporting quality under IFRS has been widely examined in academic literature; however, existing studies demonstrated considerable fragmentation in conceptual approaches to its assessment. Most research strands focused either on regulatory convergence and implementation challenges or on isolated qualitative characteristics of financial information, without sufficiently addressing the systemic role of accounting models in shaping informational usefulness. A substantial body of literature analysed IFRS as a global harmonisation mechanism aimed at improving transparency and comparability of financial reporting. N. Melnyk (2013) analysed the historical development of the international accounting system and highlighted the evolution of financial reporting standards as a prerequisite for the emergence of modern IFRS-based approaches. O. Tyvonchuk & O. Mykiiievych (2023) noted that the adoption of IFRS contributed to improved consistency of financial reporting across countries and enhanced access to global capital markets. Similarly, L.I. Lezhnenko & M.M. Kruhla (2024) examined the historical evolution of IFRS implementation and confirmed its role in strengthening international comparability. At the same time, I. Shushakova *et al.* (2021) argued that convergence at the regulatory level did not ensure uniform reporting outcomes due to institutional differences between countries.

Another stream of research focused on the qualitative characteristics of financial information as defined in the IFRS Conceptual Framework, primarily relevance and faithful representation. S.O. Kuznetsova & A.V. Doromandzhy (2019) emphasised that IFRS improved the relevance and understandability of financial reporting through enhanced disclosure practices. In turn, M. Kusano (2020) demonstrated that the recognition and measurement approaches influenced the risk relevance of reported information. However, E. Eberhartinger *et al.* (2020) showed that increased reliance on professional judgement and estimation techniques reduced comparability and complicated user interpretation.

Accounting model selection has emerged as a critical but underexplored determinant of reporting quality. H.B. Nazarova *et al.* (2020) identified that different accounting procedures significantly influenced the formation of financial results. Similarly, L.V. Bezkorovaina (2023) argued that methodological choices in IFRS application directly affected the structure and quality of financial reporting indicators. V. Müller *et al.* (2021) considered accounting and auditing in accordance with international standards as an important management tool that influences decision-making processes and the overall effectiveness of financial management. These findings suggested that alternative

models permitted under IFRS—such as historical cost versus fair value or amortised cost versus revaluation—led to materially different financial results without corresponding changes in underlying economic performance.

The literature also highlighted the growing importance of disclosure quality in mitigating limitations associated with accounting model diversity. O. Yarmoliuk *et al.* (2021) demonstrated that expanded disclosure practices improved the completeness and interpretability of financial reporting information. At the same time, earlier studies, such as S.B. Shypina (2016), analysed international experience in disclosure of financial results and confirmed the importance of detailed explanatory information. Nevertheless, disclosure practices remained uneven, and users' ability to process complex information varied significantly.

Recent contributions further examined the impact of digital reporting technologies, such as XBRL and ESEF, on financial reporting quality. ESMA (2023) emphasised that structured reporting formats enhanced comparability and transparency of financial data, while XBRL International (2024) highlighted the role of digital standards in improving accessibility and analytical usability of financial information. In addition, O.V. Vakun *et al.* (2020) investigated the implementation of XBRL in Ukraine and identified challenges related to standardisation and data comparability. However, these technologies did not resolve conceptual inconsistencies arising from accounting model heterogeneity.

At the institutional level, O. Antoniuk *et al.* (2021) analysed the development of accounting and auditing services in Ukraine and identified discrepancies between regulatory frameworks and practical implementation. Similarly, T. Shepel (2021) examined the problems of IFRS implementation in Ukraine and highlighted methodological and organisational challenges. It was confirmed that IFRS integration into the national accounting system influenced both reporting practices and institutional development. In addition, M. Dziamulych *et al.* (2021) explored the impact of regulatory indicators on financial institutions and demonstrated the increasing role of standardisation in financial reporting processes. Further research also addressed the relationship between IFRS compliance and reporting quality. M. Kabwe (2023) found that compliance with IFRS significantly improved the quality of financial reporting in developing economies. At the same time, N. Kuzyk *et al.* (2025) analysed the application of IFRS in asset revaluation and impairment and demonstrated that accounting model selection directly influenced financial reporting outcomes.

Despite the breadth of existing research, a conceptual gap persisted in understanding how accounting models function as an intermediary mechanism between IFRS principles and the resulting informational usefulness of financial reporting. Prior studies tended to analyse standards, qualitative characteristics, or disclosures in isolation, leaving insufficient theoretical integration of these elements. Consequently, the role of accounting models as a systemic

determinant of financial reporting quality remained inadequately conceptualised. This study addressed the identified gap by developing an integrated analytical perspective that links principles-based IFRS, accounting model selection, and the qualitative attributes of financial information. By shifting the focus from compliance-oriented evaluation to model-based analysis, the research contributed to a deeper theoretical understanding of financial reporting quality in a principles-based accounting environment.

Materials and Methods

This study adopted an analytical-conceptual research design aimed at examining the role of accounting models in shaping the informational usefulness of IFRS-based financial reporting. Given the theoretical nature of the research, the methodology was grounded in qualitative analysis rather than empirical testing and focused on the systematic interpretation of accounting principles, measurement models, and reporting outcomes. The methodological framework was based on a structured analysis of IFRS as a principles-based accounting system, with particular attention to the interaction between accounting standards, professional judgement, and financial reporting quality. The research drew on authoritative international standards, including the IFRS Conceptual Framework and IAS 1 Presentation of Financial Statements (Supreme Council of Ukraine, 2012), as well as on recent academic literature addressing financial reporting quality, accounting policy choices, and comparability issues.

The study employed the following methodological approaches: (1) conceptual analysis, which was used to examine the theoretical foundations of financial reporting quality and to clarify the role of accounting models as a mediating mechanism between IFRS principles and reported financial information; (2) comparative analysis, which was applied to identify differences between alternative accounting models permitted under IFRS (e.g., historical cost versus fair value) and to assess their implications for relevance, faithful representation, and comparability; (3) systematisation and synthesis, which were utilised to integrate fragmented findings from prior studies into a coherent analytical framework linking accounting model selection with informational usefulness; (4) critical interpretation, which was aimed at evaluating the limitations of existing approaches to assessing reporting quality and at formulating theoretically grounded conclusions. The analytical focus was placed on accounting models as structured sets of recognition, measurement, and presentation choices that directly influence the formation of financial reporting indicators. Rather than assessing compliance with IFRS requirements, the study examined how different accounting models affected users' ability to interpret financial information and make informed economic decisions.

The research did not involve primary data collection or statistical sampling. Instead, the empirical base of the study consisted of secondary sources, including peer-reviewed journal articles, regulatory documents, and methodological

guidelines published within the last decade. Selection of sources was guided by their relevance to IFRS application, financial reporting quality, and accounting model analysis. To enhance transparency and reproducibility, the methodological logic of the study was explicitly articulated, allowing other researchers to replicate the analytical approach using the same standards and conceptual criteria. No AI systems were used for generating scientific content, formulating theoretical conclusions, or interpreting research results. The authors bore full responsibility for the accuracy, originality, and academic integrity of the study.

Results and Discussion

The transition to IFRS represented not merely a change in accounting regulation but a fundamental transformation of the logic underlying financial reporting. Unlike rule-based systems, IFRS were constructed as a principles-based framework that deliberately limited detailed prescriptions and instead relied on professional judgement to reflect the economic substance of transactions. Prior studies emphasised that the principles-based nature of IFRS aimed to enhance relevance and faithful representation by allowing entities to adapt accounting treatments to complex and evolving economic realities. L.I. Lezhnenko & M.M. Kruhla (2024) examined the historical development of IFRS and highlighted their role in improving comparability across jurisdictions, while O. Tyvonchuk & O. Mykiiievych (2023) noted that IFRS adoption contributed to the integration of financial reporting into global capital markets. However, this flexibility simultaneously shifted the focus of standardisation away from uniform numerical outcomes toward standardised reasoning processes. As a result, IFRS did not ensure comparability through identical accounting solutions but through a shared conceptual approach to financial reporting.

The Conceptual Framework for Financial Reporting (Supreme Council of Ukraine, 2010) explicitly acknowledged that judgement, estimation, and model-based measurement were inherent components of high-quality financial information. International Accounting Standards Board (IFRS Foundation, 2012) defined the Conceptual Framework as a basis for ensuring relevance and faithful representation of financial information, while Supreme Council of Ukraine (2010) adapted these principles within the national regulatory environment. Consequently, accounting under IFRS became inseparable from the selection and application of accounting models that translate economic phenomena into reported figures. These models incorporate valuation techniques, assumptions about future cash flows, risk assessments, and discount rates, which collectively shape reported performance and financial position.

Empirical and analytical research indicated that this shift had ambiguous implications for reporting quality. On the one hand, S.O. Kuznetsova & A.V. Doromandzhy (2019) emphasised that IFRS improved the relevance and understandability of financial reporting, while M. Kusano (2020) demonstrated that valuation approaches

influenced the risk relevance of financial information. On the other hand, L.V. Bezkorovaina (2023) argued that methodological flexibility led to variations in financial reporting indicators, and E. Eberhartinger *et al.* (2020) showed that reliance on professional judgement increased heterogeneity in reported outcomes, thereby complicating comparability. Importantly, this heterogeneity did not arise from inconsistent application of standards but from the legitimate diversity of accounting models permitted within the IFRS framework. Thus, comparability under IFRS was no longer a purely technical attribute embedded in reporting formats; it became an analytical challenge that depends on users' ability to identify, understand, and adjust for differences in underlying accounting models.

Accordingly, the first substantive result of this study was the conceptualisation of principles-based IFRS as a system that transforms financial reporting from a rule-driven mechanism into a model-dependent interpretative process. In this process, accounting models functioned as the critical link between economic reality and the informational usefulness of financial statements. The principles-based architecture of IFRS inevitably led to the centralisation of accounting models as a core determinant of financial reporting quality. While standards defined recognition criteria and general measurement bases, they deliberately left significant discretion in the choice and design of accounting models that operationalise these principles in practice.

Prior research demonstrated that accounting models under IFRS extend far beyond technical calculation tools and should be interpreted as structured frameworks that combine valuation techniques, assumptions, and professional

judgement. H.B. Nazarova *et al.* (2020) identified that accounting procedures significantly influenced financial results, while L.V. Bezkorovaina (2023) confirmed the role of methodological choices in shaping reporting indicators. Consequently, the informational usefulness of IFRS-based financial statements depended not only on compliance with standards but also on the conceptual soundness and consistency of the underlying models.

From a qualitative perspective, accounting models influenced all fundamental qualitative characteristics of financial information. M. Kusano (2020) showed that fair value measurement enhanced relevance but reduced verifiability, while S.B. Shypina (2016) demonstrated that historical cost approaches improved understandability but limited relevance in dynamic economic environments. This trade-off highlighted that reporting quality under IFRS was not absolute but conditional upon the analytical objectives of users and the economic context in which reporting occurs.

Empirical evidence further suggested that differences in accounting models contributed significantly to cross-entity variation in reported performance indicators. E. Eberhartinger *et al.* (2020) identified that judgement-based reporting increased variability, while O. Yarmoliuk *et al.* (2021) demonstrated that disclosure practices influenced the comparability of financial results. Such variation was not indicative of reporting deficiencies but reflects the pluralistic design of IFRS, which prioritises faithful representation over mechanical uniformity. To systematise the role of accounting models in shaping financial reporting quality, it was appropriate to summarise their key characteristics and analytical implications in a comparative format (Table 1).

Table 1. Accounting models under IFRS and their impact on financial reporting quality

Accounting model	Measurement basis	Key assumptions	Impact on qualitative characteristics	Analytical implications
Historical cost model	Acquisition cost	Stability of prices; realisation principle	High verifiability and understandability; lower relevance	Facilitates trend analysis; limited reflection of current economic value
Fair value model	Market-based valuation	Market efficiency; availability of inputs	High relevance; reduced verifiability	Requires sensitivity analysis and disclosure assessment
Value-in-use model	Discounted cash flows	Forecasted cash flows; discount rates	Relevance dependent on assumptions; high subjectivity	Demands evaluation of assumptions and scenario testing
Expected credit loss model	Probability-weighted estimates	Credit risk dynamics; macroeconomic forecasts	Forward-looking relevance; complexity	Necessitates analytical adjustment and risk interpretation

Source: developed by the authors based on IFRS Foundation (2012), M. Kusano (2020), E. Eberhartinger *et al.* (2020), H.B. Nazarova *et al.* (2020)

The comparative analysis demonstrated that accounting models functioned as embedded analytical lenses through which financial information was constructed. Their selection directly affected the balance between relevance and reliability, as well as the extent to which financial statements supported predictive versus confirmatory analysis. These findings were consistent with the conclusions of IFRS Foundation (2012), which emphasised the role of measurement approaches in ensuring the qualitative characteristics of financial information.

In order to complement the tabular synthesis and to clarify the systemic role of accounting models within the IFRS environment, it was necessary to visualise their position in the broader architecture of financial reporting. This allowed for a more coherent understanding of how principles-based standards were translated into informational outcomes. In particular, IFRS Foundation (2023) highlighted the importance of structured representation of financial data for improving analytical interpretation. Accordingly, a conceptual illustration was proposed (Fig. 1).

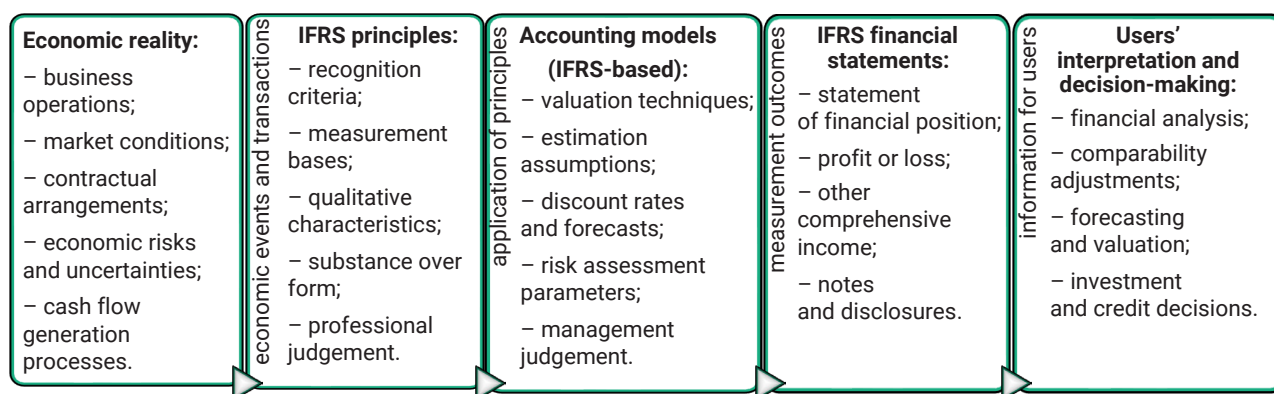


Figure 1. Conceptual positioning of accounting models within IFRS-based financial reporting

Source: developed by the authors

The conceptual model underscored that accounting models occupied a pivotal intermediary position within IFRS-based reporting. They operationalised abstract principles into measurable outcomes and, at the same time, conditioned how users interpreted financial performance and position. Thus, reporting quality could not be assessed independently of the models employed to generate financial information. This led to the second key result of the study: under IFRS, informational usefulness was not solely a function of standard compliance but emerged from the interaction between accounting principles, model selection, and analytical interpretation.

One of the most critical consequences of principles-based financial reporting under IFRS was the transformation of comparability from an inherent reporting attribute into an analytically constructed characteristic. Unlike rule-based accounting systems, where uniform application of detailed prescriptions could mechanically enhance numerical similarity, IFRS comparability emerged only through interpretative and analytical processes performed by users of financial statements. Recent academic research emphasised that the adoption of IFRS did not automatically guarantee comparability across firms or jurisdictions, even when identical standards were formally applied. S.O. Kuznetsova & A.V. Doromandzhy (2019) argued that IFRS-based reporting improved relevance but required additional interpretation, while M. Kusano (2020) demonstrated that recognition and measurement approaches influenced the comparability of financial information. Instead, comparability depended on how accounting principles were operationalised through valuation models, estimation techniques, and disclosure practices. As a result, financial statements prepared under IFRS often reflected economically justified diversity, which had to be analytically decoded rather than eliminated.

From an analytical perspective, IFRS-based comparability required a shift from direct indicator comparison toward contextualised interpretation. Analysts had to reconstruct comparability by adjusting reported figures for differences in accounting models, risk assumptions, and managerial judgments embedded in measurement

processes. E. Eberhartinger *et al.* (2020) showed that users' judgement played a key role in interpreting disaggregated financial information. This reconstruction process acknowledged that two entities with similar economic performance could report substantially different financial outcomes due to divergent valuation approaches rather than underlying inefficiencies or performance gaps.

Importantly, comparability under IFRS operated at multiple analytical levels. At the statement level, users had to distinguish between profit or loss and other comprehensive income to identify the sources of volatility and transitory valuation effects. At the disclosure level, notes to the financial statements played a decisive role by revealing key assumptions, sensitivity analyses, and measurement hierarchies, without which meaningful comparison became impossible. In particular, S.B. Shypina (2016) analysed international practices of disclosure, while O. Yarmoliuk *et al.* (2021) demonstrated that disclosure quality significantly influenced the interpretability of financial reporting. Consequently, analytical reconstruction extended beyond numerical data and incorporated narrative and qualitative information.

The necessity of analytical reconstruction also varied across user groups. Professional investors, auditors, and financial analysts typically possessed the expertise required to adjust for model-driven differences and to interpret IFRS-based figures within an economic framework. M. Kusano (2020) confirmed that professional users were better able to interpret measurement-based information. In contrast, non-professional users often perceived reduced comparability due to the increased complexity and abstraction of reported numbers, reinforcing concerns about informational asymmetry under principles-based accounting. L.V. Bezkorovaina (2023) highlighted that differences in methodological approaches complicated the understanding of financial reporting indicators.

In this context, comparability under IFRS should be understood not as uniformity of outcomes, but as consistency of economic interpretation. Analytical reconstruction enabled users to align reported figures with comparable economic benchmarks by neutralising the effects of

differing accounting models while preserving the informational richness intended by IFRS principles. This approach aligned with the conceptual foundations of IFRS, which prioritise faithful representation and relevance over mechanical standardisation. IFRS Foundation (2012) emphasised these qualitative characteristics as fundamental principles of financial reporting. To systematise the role of different

user groups in the analytical reconstruction of comparability, it is appropriate to summarise these aspects in a comparative format (Table 2). Such a presentation clarified how interpretative efforts vary depending on users' objectives, competencies, and decision-making contexts, thereby reinforcing the argument that comparability under IFRS was analytically achieved rather than inherently embedded.

Table 2. Analytical reconstruction of comparability under IFRS-based reporting: user-oriented perspective

User group 1	Primary analytical objective 2	Key sources of IFRS-based complexity 3	Analytical reconstruction mechanisms 4	Impact on perceived comparability 5
Investors and financial analysts	Assessment of profitability, risk, and future cash flows	Fair value measurements; impairment models; estimates of expected credit losses; OCI volatility	Normalisation of earnings; separation of recurring and non-recurring components; adjustment for valuation assumptions; sensitivity analysis	Comparability is achieved through adjusted performance metrics rather than reported profit figures
Auditors	Evaluation of faithful representation and risk of material misstatement	Management judgments; estimation uncertainty; measurement hierarchy under fair value	Professional scepticism; benchmarking assumptions; consistency checks across periods and entities	Comparability is reconstructed through consistency of judgment and methodological coherence
Regulators and supervisory authorities	Ensuring transparency, compliance, and market discipline	Diversity of accounting policies; disclosure depth; national enforcement differences	Analytical review of disclosures; cross-entity monitoring; enforcement of disclosure standards	Comparability depends on disclosure completeness rather than numerical uniformity
Corporate management	Performance evaluation and stakeholder communication	Choice of accounting models; classification between profit and OCI; disclosure strategies	Internal reconciliations; narrative explanations; use of non-GAAP indicators	Comparability is selectively framed to reflect strategic positioning
Non-professional users	General understanding of financial performance	Complexity of valuation techniques; lack of interpretative guidance	Limited analytical reconstruction; reliance on headline figures	Comparability is often perceived as reduced or distorted

Note: OCI – Other Comprehensive Income, GAAP – Generally Accepted Accounting Principles

Source: developed by the authors based on IFRS Foundation (2012), S.O. Kuznetsova & A.V. Doromandzhy (2019), M. Kusano (2020), E. Eberhartinger *et al.* (2020)

Table 2 demonstrated that comparability under IFRS was not a uniform reporting outcome but a user-dependent analytical construct. Each group of financial statement users applied distinct interpretative mechanisms shaped by professional competence, informational needs, and decision-making objectives. As a result, IFRS-based comparability emerged through analytical adjustment and contextual interpretation, rather than through mechanical alignment of reported figures. The table further confirmed that increased informational richness under IFRS simultaneously enhanced relevance and complicated comparability, particularly for non-professional users. This reinforced the argument that the quality of IFRS-based financial reporting depended not only on accounting standards themselves, but also on the analytical frameworks employed by users to reconstruct economic meaning from reported data.

The principles-based nature of IFRS implied that the informational usefulness of financial reporting was not predetermined solely by compliance with standards, but was critically shaped by the accounting models selected to measure and present economic phenomena. These models determined how transactions and events were translated into financial information and, consequently, how users perceived financial performance, financial position, and risk. Under IFRS, alternative accounting models coexisted

for key balance sheet and performance elements, including historical cost, fair value, amortised cost, and expected value-based measurement. While such diversity enhanced the relevance of information by aligning measurement with economic substance, it simultaneously introduced variability in reported figures across entities operating under similar economic conditions. S.O. Kuznetsova & A.V. Doromandzhy (2019) noted that IFRS improved the relevance of financial reporting but required additional analytical interpretation, while M. Kusano (2020) demonstrated that valuation approaches influenced the decision-usefulness of financial information. As a result, informational usefulness under IFRS emerged from the interaction between measurement relevance and interpretative complexity rather than from numerical stability alone.

From an analytical perspective, accounting models influenced informational usefulness through three inter-related dimensions. First, they affected predictive value, as forward-looking models (e.g., expected credit loss, fair value) embedded expectations about future cash flows and risks. Second, they shaped confirmatory value, since model-based estimates could either corroborate or obscure realised performance. Third, they determined comparability, as identical economic transactions could be reflected differently depending on valuation assumptions and policy

choices. E. Eberhartinger *et al.* (2020) showed that user judgement significantly affected the interpretation of financial reporting data.

Importantly, the use of advanced valuation models shifted part of informational usefulness from primary financial statements to disclosures. Notes explaining assumptions, sensitivity analyses, and methodological choices became essential components of decision-relevant information. Consequently, the analytical value of IFRS-based reporting increasingly depended on the user's ability to reconstruct economic meaning by integrating numerical data with qualitative explanations. IFRS Foundation (2012) emphasised the role of qualitative characteristics and disclosures in ensuring the usefulness of financial information, while the regulatory framework for IFRS application in the European Union was established by European Parliament & Council (2002) and further developed within the framework of cooperation between the European Union and Ukraine, as outlined in European Union & Ukraine (2014). To systematise the relationship between accounting models and informational usefulness, it was appropriate to conceptualise IFRS reporting not as a static representation of economic reality, but as a multi-layered informational system, where measurement choices mediated between economic activity and analytical outcomes. Such systematisation enabled a clearer understanding of why identical profitability or asset structures could lead to divergent analytical conclusions across firms and jurisdictions (Fig. 2).

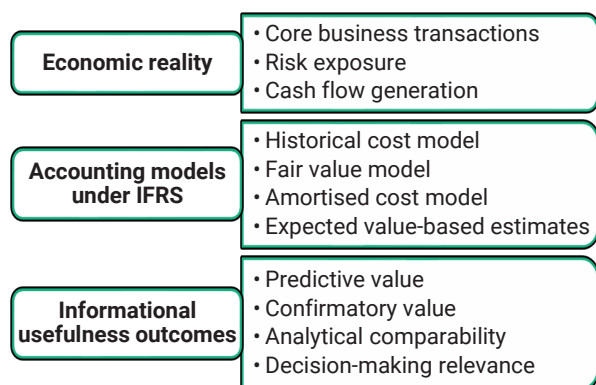


Figure 2. Conceptual framework linking accounting models to informational usefulness under IFRS

Source: developed by the authors

Figure 2 illustrated that accounting models functioned as informational filters, transforming economic reality into analytically usable financial data. Informational usefulness under IFRS was thus not an inherent property of reported numbers, but a result of how measurement models, professional judgment, and disclosure practices interacted. The framework reinforced the argument that high-quality financial reporting required not only technically sound accounting models, but also analytically competent users capable of interpreting model-driven information.

The analysis confirmed that IFRS-based financial reporting enhanced informational relevance while simultaneously increased interpretative demands on users. This duality necessitated a shift in analytical focus – from mechanical comparison of reported figures to the structured reconstruction of their underlying economic meaning. In this context, the following discussion synthesised the key implications of this trade-off and provided the conceptual foundation for the final conclusions regarding the conditions under which IFRS principles improved or constrained reporting quality and comparability.

One of the central theoretical tensions embedded in IFRS was the trade-off between relevance and comparability of financial information. While the principles-based approach enhanced the capacity of financial statements to reflect economic substance, it simultaneously weakened formal uniformity across entities. As a result, comparability under IFRS became conditional rather than automatic. Relevance-oriented measurement models, such as fair value and expected credit loss, improved the timeliness and decision-usefulness of information by incorporating market signals, risk assessments, and forward-looking expectations. However, these benefits were achieved at the cost of increased reliance on professional judgment, valuation techniques, and entity-specific assumptions. Consequently, reported figures could diverge significantly even when underlying economic activities are similar. M. Kusano (2020) demonstrated that recognition and valuation approaches influenced the decision-usefulness of financial information, while E. Eberhartinger *et al.* (2020) showed that increased reliance on judgement contributed to variability in reported outcomes.

Comparability, in its traditional sense, presupposed standardised measurement rules and stable accounting treatments. Under IFRS, this notion was replaced by functional comparability, where users had to actively reconstruct economic equivalence through analytical adjustments rather than rely on surface-level numerical alignment. This shift redefines comparability as an analytical outcome rather than an accounting property. S.O. Kuznetsova & A.V. Doromandzhy (2019) argued that IFRS-based reporting required additional analytical interpretation to ensure comparability of financial information. Importantly, IFRS did not eliminate comparability but relocated it. Instead of being embedded in uniform accounting rules, comparability emerged through disclosures, reconciliations, sensitivity analyses, and consistent application of judgment over time. Thus, informational usefulness increasingly depended on transparency and explanatory depth rather than on strict measurement homogeneity. IFRS Foundation (2012) emphasised the importance of qualitative characteristics and disclosure in ensuring the usefulness of financial information. From a conceptual standpoint, this trade-off implied that high-quality IFRS reporting could not be evaluated solely by the stability of reported figures. Instead, quality should be assessed by the extent to which financial statements enabled users to understand the economic rationale

behind reported outcomes and to adjust them analytically when necessary. This perspective aligned with the evolving role of financial reporting as a communication mechanism rather than a mechanical record-keeping system. The relevance-comparability trade-off also had implications for regulatory oversight and financial analysis. Regulators faced the challenge of balancing flexibility with enforceability, while analysts had to develop methodological frameworks capable of interpreting model-driven information. Failure to recognise this trade-off could lead to misplaced expectations regarding the uniformity and objectivity of IFRS-based financial results.

Conclusions

The study confirmed that the quality of IFRS-based financial reporting could not be assessed solely through the formal compliance with accounting standards or the numerical stability of reported indicators. Instead, informational usefulness emerged from the interaction between accounting models, professional judgment, disclosure practices, and users' analytical capabilities. The research demonstrated that accounting models played a decisive role in shaping the informational content of financial results. Fair value measurement, impairment models, and forward-looking estimations enhanced relevance and economic realism but simultaneously increased complexity and subjectivity. This created a structural trade-off between relevance and comparability, which defined the contemporary logic of IFRS-based reporting.

It was established that the principles-based nature of IFRS fundamentally transformed the concept of comparability. Uniform application of standards did not guarantee comparable financial outcomes, as measurement models embedded in IFRS allowed for significant discretion in valuation techniques, assumptions, and risk assessments. Consequently, comparability under IFRS should be understood as an analytical construct that had to be actively reconstructed by users rather than as an inherent property of financial statements. It was substantiated that high-quality financial reporting under IFRS required a shift from mechanical interpretation of profit and performance

indicators toward a structured analytical framework. Such a framework had to integrate disclosures, sensitivity to estimation assumptions, and consistency of applied judgments over time. Without this approach, users risked misinterpreting IFRS-based figures as purely operational outcomes rather than as model-driven representations of economic reality.

The findings highlighted that improving the quality of IFRS financial reporting did not primarily depend on further standardisation of measurement rules but on enhancing transparency, methodological clarity, and analytical literacy among users. In this context, the role of accounting models extended beyond technical measurement and became a core determinant of how financial information was perceived, compared, and utilised in decision-making processes. The scientific novelty of the research lies in its theoretical synthesis of IFRS principles, accounting model diversity, and information quality attributes into a unified conceptual perspective. The findings were expected to support a more informed interpretation of IFRS financial statements and to provide a methodological foundation for further research into improving the analytical value of financial reporting in a principles-based accounting environment. Future research should focus on developing analytical tools and methodological guidelines that would support users in reconstructing economic comparability under IFRS. Particular attention should be paid to sector-specific applications of accounting models, the behavioural effects of disclosure complexity, and the interaction between digital reporting formats and users' interpretative practices.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] Antoniuk, O., Kutsyk, P., Brodska, I., Kolesnikova, O., & Struk, N. (2021). Institutionalization of accounting and auditing services in Ukraine: Genesis, evaluation, analysis. *Independent Journal of Management & Production*, 12(3), 123-137. [doi: 10.14807/ijmp.v12i3.1530](https://doi.org/10.14807/ijmp.v12i3.1530).
- [2] Barth, M.E., Landsman, W.R., & Lang, M.H. (2021). International accounting standards and accounting quality: Updated evidence. *Journal of Accounting Research*, 46(3), 467-498. [doi: 10.1111/j.1475-679X.2008.00287.x](https://doi.org/10.1111/j.1475-679X.2008.00287.x).
- [3] Bezkorovaina, L.V. (2023). Problems of forming financial reporting indicators of Ukrainian enterprises under IFRS. *Entrepreneurship and Trade*, 39, 17-24. [doi: 10.32782/2522-1256-2023-39-02](https://doi.org/10.32782/2522-1256-2023-39-02).
- [4] Dziamulych, M., Shmatkovska, T., Krupka, M., Yastrubetska L., Vyshyvana, B., & Derevianko, S. (2021). Introduction of NSFR ratio in the activities of commercial banks in Ukraine Universal. *Journal of Accounting and Finance*, 9(6), 1544-1550. [doi: 10.13189/ujaf.2021.090631](https://doi.org/10.13189/ujaf.2021.090631).
- [5] Eberhartinger, E., Genest, N., & Lee, S. (2020). Financial statement users' judgment and disaggregated tax disclosure. *Journal of International Accounting, Auditing and Taxation*, 41, article number 100351. [doi: 10.1016/j.intaccudtax.2020.100351](https://doi.org/10.1016/j.intaccudtax.2020.100351).
- [6] ESMA. (2023). *ESEF reporting manual*. Retrieved from <https://www.esma.europa.eu>.

- [7] European Parliament & Council. (2002). *Regulation (EC) No 1606/2002 on the application of international accounting standards*. Retrieved from <https://eur-lex.europa.eu>.
- [8] European Union & Ukraine. (2014). *Association agreement between the European Union and Ukraine*. Retrieved from <https://eur-lex.europa.eu>.
- [9] IFRS Foundation. (2012). *IAS 1 presentation of financial statements*. Retrieved from <https://www.ifrs.org>.
- [10] IFRS Foundation. (2023). *IFRS taxonomy illustrative examples*. Retrieved from <https://www.ifrs.org>.
- [11] Kabwe, M. (2023). Effect of international financial reporting standards compliance on financial reporting quality: Evidence from a developing country. *International Journal of Finance and Accounting*, 8(1), 36-57. doi: 10.47604/ijfa.1802.
- [12] Kusano, M. (2020). Does recognition versus disclosure affect risk relevance? Evidence from finance leases in Japan. *Journal of International Accounting, Auditing and Taxation*, 38, article number 100303. doi: 10.1016/j.intaccaudtax.2020.100303.
- [13] Kuznetsova, S.O., & Doromandzhy, A.V. (2019). Improving relevance and understandability of IFRS-based financial reporting. *Economic Space*, 149, 60-64. doi: 10.32782/2224-6282/149-10.
- [14] Kuzyk, N., Shevchuk, K., Mishchenko, T., & Venher, A. (2025). International Financial Reporting Standards in the national practice of accounting for revaluation and impairment of fixed assets. *Economics and Business Management*, 16(1), 214-233. doi: 10.31548/economics/1.2025.235.
- [15] Lezhnenko, L.I., & Kruhla, M.M. (2024). Historical aspects of IFRS implementation in the world and in Ukraine. *Entrepreneurship and Trade*, 41, 54-60. doi: 10.32782/2522-1256-2024-41-07.
- [16] Melnyk, N. (2013). *History of origins and development of system of international accounting*. *European Journal of Political Economy*, 12(4), 507-518.
- [17] Müller, V., Kuznetsova, A.Ya., Khrystoforova, O.M., Karpachova, O.V., & Sulyma, M.O. (2021). Accounting and auditing according to international standards as a management function. *Financial and Credit Activity: Problems of Theory and Practice*, 4(35), 60-68. doi: 10.18371/fcaptp.v4i35.221787.
- [18] Nazarova, H.B., Kononenko, L.V., & Kalashnikova, A.K. (2020). Accounting procedures for forming financial results: Current state and directions for improvement. *Economic Space*, 156, 206-212. doi: 10.32782/2224-6282/156-38.
- [19] Shepel, T. (2021). Development of accounting in Ukraine based on the implementation of IFRS: Problems and prospects. *Accounting and Finance*, 1(91), 36-43. doi: 10.33146/2307-9878-2021-1(91)-36-43.
- [20] Shushakova, I., Ziabchenkova, H., & Kuzub, M. (2021). Concepts of convergence of accounting and financial reporting systems. *Economy and Society*, 30. doi: 10.32782/2524-0072/2021-30-9.
- [21] Shypina, S.B. (2016). *Foreign experience of disclosure of financial results in financial reporting and IFRS*. *Scientific Bulletin of Kherson State University. Economic Sciences*, 17(4), 147-150.
- [22] Supreme Council of Ukraine. (2010). *The conceptual framework for financial reporting*. Retrieved from <https://zakon.rada.gov.ua>.
- [23] Supreme Council of Ukraine. (2012). *International Accounting Standard 1 (IAS 1)*. Retrieved from https://zakon.rada.gov.ua/laws/show/929_013#Text.
- [24] Tyvonchuk, O., & Mykiiievych, O. (2023). Challenges and prospects of transition to IFRS in Ukraine and globally. *Acta Academiae Beregsasiensis. Economics*, 4, 448-457. doi: 10.58423/2786-6742/2023-4-448-457.
- [25] Vakun, O.V., Horodyskyi, M.P., Hrabchuk, I.L., & Soloviov, B.S. (2020). Problems of implementing the XBRL reporting standard. *Problems of Theory and Methodology of Accounting, Control and Analysis*, 2(46), 3-8. doi: 10.26642/pbo-2020-2(46)-3-8.
- [26] XBRL International. (2024). *XBRL standards and digital reporting*. Retrieved from <https://www.xbrl.org>.
- [27] Yarmoliuk, O., Hubaryk, O., Savanchuk, T., Dmytrenko, O., & Khomiak, N. (2021). Coverage of information in financial reporting: Practical experience of IAS and IFRS application. *Financial and Credit Activity: Problems of Theory and Practice*, 5(40), 276-287. doi: 10.18371/fcaptp.v5i40.245101.

Якість фінансової звітності за МСФЗ: роль облікових моделей у формуванні інформаційної корисності

Неля Проскуріна

Доктор економічних наук, професор
Запорізький національний університет
69600, вул. Університетська, 66, м. Запоріжжя, Україна
<https://orcid.org/0000-0001-8674-1720>

Валентина Гончарова

Кандидат наук з державного управління, доцент
Запорізький національний університет
69600, вул. Університетська, 66, м. Запоріжжя, Україна
<https://orcid.org/0000-0001-5556-7192>

Анастасія Коновалова

Головний бухгалтер
ТОВ НМЦ «Глобал Аккаунт Аудит»
01033, вул. Шота Руставелі, 20В, м. Київ, Україна
<https://orcid.org/0000-0001-5036-1603>

Анотація. У сучасних умовах глобалізації фінансових ринків та поширення міжнародних стандартів фінансової звітності (МСФЗ) питання якості фінансової звітності за цими стандартами набуває особливої актуальності. Принципо-орієнтований характер цих стандартів передбачає широке використання різних облікових моделей, що безпосередньо впливають на формування фінансових показників та рівень їх інформаційної корисності для користувачів. Водночас відсутність єдиного жорсткого алгоритму застосування облікових моделей породжує ризики зниження порівнянності, ускладнення інтерпретації та неоднозначності аналітичних висновків. Метою статті було дослідження ролі облікових моделей у формуванні якості фінансової звітності за міжнародними стандартами фінансової звітності та оцінка їх впливу на інформаційну корисність фінансових показників для різних груп користувачів. Методологічну основу дослідження становили методи теоретичного узагальнення, порівняльного аналізу, системного підходу та логічного моделювання, що дозволило комплексно проаналізувати взаємозв'язок між принципами міжнародних стандартів фінансової звітності, обліковими моделями та якісними характеристиками фінансової інформації. У результаті дослідження встановлено, що якість фінансової звітності за міжнародними стандартами фінансової звітності формується не лише через дотримання стандартів, а передусім через вибір і застосування конкретних облікових моделей. Обґрунтовано, що різні моделі оцінки активів і зобов'язань по-різному впливають на релевантність, достовірність, порівнянність та зрозумілість фінансової інформації. Виявлено наявність концептуального компромісу між підвищенням економічної реалістичності показників та зростанням складності їх інтерпретації. Доведено, що інформаційна корисність фінансової звітності значною мірою залежить від професійних суджень та аналітичної здатності користувачів. Практична цінність отриманих результатів полягає у можливості їх використання для вдосконалення аналітичних підходів до оцінки фінансової звітності за МСФЗ, підвищення якості управлінських і інвестиційних рішень, а також розвитку методології фінансового аналізу в умовах принципо-орієнтованого обліку.

Ключові слова: релевантність фінансової інформації; принципо-орієнтований бухгалтерський облік; професійне судження; система бухгалтерського обліку; фінансова звітність

Economic approaches to assessing employee development in organisations

Iryna Shapka*

Postgraduate Student

Ukrainian State University of Science and Technology

49010, 2 Lazaryana Str., Dnipro, Ukraine

<https://orcid.org/0000-0003-1171-6445>

Abstract. The relevance of the study is driven by the absence of a unified approach to the economic assessment of employee development, the fragmentation of indicators used, and insufficient alignment between theoretical models and practical management tools. The purpose of the article was to systematise and generalise economic approaches to assessing employee development applied in contemporary re-search, as well as to substantiate the author's proposals for improving the economic evaluation of development outcomes. To achieve this purpose, the study analysed the main approaches, methods, and indicators used in assessing employee development, identified research gaps and problematic aspects that limit comprehensive economic analysis. As a result, the article generalised the principal economic approaches to evaluating employee development within the frameworks of labour economics and organisational economics and established their multilevel nature from the individual to the organisational and macroeconomic levels. It was determined that most approaches rely on indicators of labour productivity, costs, performance, and the economic return on investments in employee development. The feasibility of integrating quantitative, analytical, and behavioural indicators into a unified system of economic evaluation has been substantiated, and a structural-logical algorithm as well as an economic-analytical model for managerial decision-making have been developed. The practical testing of the proposed approach, carried out using aggregated data from retail enterprises in Ukraine for 2019-2024, confirmed its effectiveness. Specifically, an increase in labour productivity by 10-14%, an improvement in employees' professional competencies by 20-25%, a reduction in the adaptation period by more than 30%, and an increase in the return on investment in personnel development by over 60% were observed. At the same time, a decrease in staff turnover by approximately one-quarter and an increase in income per employee by 10-15% were recorded. The results also demonstrated positive trends in industry-level indicators, including growth in labour productivity, the wage fund, and employment levels. The practical significance of the results consists in forming an analytical basis to enhance the soundness of managerial decisions regarding investments in employee development

Keywords: economic evaluation; labour productivity; resource efficiency; investment in development; managerial decisions

Received: 14.01.2026, Revised: 22.04.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Shapka, I. (2026). Economic approaches to assessing employee development in organisations. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 20-31. doi: 10.52566/msu-econ2.2026.20.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (irinaschapka@ukr.net)

Introduction

The economic performance of organisations largely depends on employee development (ED). Growing competitive pressure and a complex economic environment increase requirements for labour productivity (LP) and efficient human resource (HR) utilisation. ED is thus not only the improvement of professional skills but also a key economic factor for achieving strategic goals and long-term competitiveness. Its effectiveness is reflected in higher LP, cost optimisation, and better organisational outcomes, requiring economic evaluation to support managerial decisions. However, the lack of a unified theoretical and methodological approach, fragmented indicators, and ambiguous results hinder comprehensive evaluation. Diverse academic approaches exist, but the absence of an integrative framework limits practical application, highlighting the need to systematise and generalise economic evaluation methods for ED.

Issues related to personnel management and the economic analysis of the outcomes of this process have been examined in the works of many Ukrainian and international scholars. V. Miklovdá & O. Popovych (2021) in their work noted that personnel constitute is one of the key factors of an organisation's competitiveness, while their development is a necessary condition for increasing LP. The authors proposed assessing productivity at three levels: first – the level of social perception, where the employee's image and social success are of primary importance; second – the level of professional development, where performance is determined by employees' competitiveness; and third – the level of work organisation, where efficiency depends on the application of appropriate technologies, taking into account specific conditions and industry characteristics.

According to the position of I. Zastrozhnikova (2022), contemporary ED is characterised by a complex combination of interrelated elements, among which training, professional adaptation, motivation of work behaviour, and career management play a key role. Personnel training is viewed as a fundamental component of the development system, ensuring the formation and continuous updating of professional knowledge, skills, and competencies in accordance with the requirements of organisational activities. At the same time, professional adaptation facilitates employees' integration into the work environment, the assimilation of organisational norms and standards, and enhances their ability to perform job functions effectively. An important element of ED is career management, which encompasses the planning of professional advancement, the formation of a talent reserve, and the creation of conditions for employees' professional growth. Motivation, in turn, ensures the alignment of employees' individual interests with organisational goals and facilitates the realisation of their potential. At the same time, the author emphasises that contemporary ED practices face a number of challenges, including an insufficient level of specialised education and limited proficiency in modern technologies, which necessitates a systematic approach to the design and implementation of ED systems.

Research by O. Chatchenko (2025) indicated that accounting for employees' psychological and corporate well-being is an important prerequisite for increasing LP and achieving an organisation's strategic outcomes. In particular, satisfying employees' psychological needs, developing leaders' emotional intelligence, and fostering a partnership-oriented organisational culture contribute to higher motivation, stronger team cohesion, and greater work effectiveness, whereas neglecting these aspects leads to reduced productivity, increased staff turnover, and the loss of competitive advantages. According to I. Shapka (2025), effective management of ED requires a revision of traditional approaches in light of globalisation processes, digital transformation, and changes in the structure of knowledge. From an economic perspective, ED should be assessed through the systemic nature of managerial decisions, adaptability to institutional changes, a focus on the formation of innovative competencies, and support for professional mobility. The author also noted that increasing requirements for digital literacy, interdisciplinary interaction, and international cooperation necessitate the use of new models for evaluating ED outcomes, based on the principles of lifelong learning and the application of digital knowledge management tools. In this context, the economic evaluation of ED is viewed as a foundation for substantiating HR policy, enhancing organisational performance, and ensuring innovative capacity.

In academic literature, increasing attention is paid to a new generation of employees (in particular, millennials), who are characterised by distinct value orientations, expectations regarding professional development, and forms of interaction within organisations. This necessitates a revision of traditional approaches to ED and the assessment of professional growth outcomes. Drawing on the research of K. Gabrielova & A. Buchko (2021), it is emphasised that the specific features of motivation, work values, and interaction patterns of contemporary employees require more flexible and adaptive development management tools. In this context, the authors note that approaches to assessing ED should take into account not only formal performance indicators, but also behavioural changes and levels of engagement. This further reinforces the relevance of rethinking classical models of ED assessment.

A. Alexeyev *et al.* (2024) considered investment in employees to be an important factor in increasing LP, work efficiency, and organisational competitiveness. Investments in ED and health preservation generate long-term economic effects that depend on the duration of the active working period, as well as on the systematic nature and social relevance of such investments. The authors emphasised that investments in employees may both depreciate due to aging and the obsolescence of knowledge and accumulate over time, creating a "compounding effect" through the development of skills and abilities. According to the approach proposed by the authors, investments in employees are classified into intangible investments (financing of science,

development, and upbringing before working age), tangible investments embodied in employees (expenditures on education and healthcare), and tangible investments not directly embodied in employees (costs related to job search, on-the-job training, migration, and information support), all of which contribute to professional and social mobility.

Another important aspect of ED is motivation, which acts as a factor in activating labour activity, increasing engagement in professional growth, and ensuring sustainable growth in LP. In the study by T. Bondar & A. Krasnonos (2023), considerable attention is devoted to examining employee motivation methods based on a synthesis of domestic and international HR management experience. Summarising the findings of contemporary research, the authors identified the most effective methods, namely financial motivation (bonuses, incentives, and other material rewards), motivation through training and professional development, the use of flexible work schedules, recognition and rewards, as well as the application of modern technologies as highly effective tools for influencing employee motivation. The authors also emphasised that effective employee motivation involves not only the implementation of individual incentive factors, but also systematic work with personnel, continuous skills development, improvement of working conditions, the development of corporate culture, and the provision of effective communication at all levels of the organisation. The aim of the article was to systematise and synthesise economic approaches to the evaluation of ED within an organisation and to develop a conceptual and methodological framework for assessing ED across different levels of analysis, serving as an analytical basis for the further substantiation of managerial decisions. Achieving the stated objective involves analysing and classifying the main economic approaches, methods, and indicators used to evaluate ED; identifying methodological limitations and inconsistencies that complicate the formation of a comprehensive system of economic evaluation; generalising theoretical provisions regarding the interpretation of ED outcomes; and substantiating directions for improving economic evaluation based on an integrative approach.

Materials and Methods

The study was based on a combination of methods, including content analysis, systematisation, generalisation, and an integration approach. Content analysis was applied to scientific sources, which were analysed to identify existing approaches to the evaluation of ED. These sources included academic studies published between 2020 and 2025, addressing issues of LP, HR development, HR analytics, and the economic efficiency of personnel utilisation, as well as analytical reports and statistical data. Sources were selected based on criteria of relevance, scientific reliability, and methodological significance, with priority given to recent studies to ensure the timeliness of the findings.

The method of systematisation was used to group approaches and indicators according to levels of analysis – individual, organisational, and economic – thus allowing

for consideration of the multi-level nature of the economic effects of ED. The generalisation method enabled the formation of an integrated system of indicators combining performance-based, behavioural, and cost-related characteristics of ED. The integration approach was applied to ensure consistency across indicators at different levels of analysis and to form a unified analytical system for economic evaluation. In addition, the economic-analytical method was used to interpret the obtained results and to establish relationships between ED indicators and the economic performance of organisations. The resulting system of indicators was further structured in accordance with defined levels and functional purposes. The next step involved the formalisation of indicators through the development of analytical relationships suitable for quantitative analysis and further modelling.

To ensure the practical applicability of the proposed system, the methodological toolkit was further developed through the creation of a structural and logical algorithm for the economic evaluation of ED. The final stage involved the formation of an economic-analytical framework for managerial decision-making, ensuring the transformation of evaluation results into practical managerial actions aimed at the development of HR potential. The proposed system is based on principles such as the level-based approach (micro-, meso-, and macro-levels), functional orientation (performance, efficiency, and resource utilisation), economic relevance, and measurability. This ensured the consistency of the indicator system and enabled the integration of evaluation results into a unified analytical model.

To validate the proposed methodological approach, its practical application was demonstrated through its testing using aggregated data from the leading retail chain EVA (LLC "RUSH") for the period 2019-2024. The evaluation involved the calculation of key economic indicators, including LP, return on investment in human resources (ROI-HR), employee turnover rate, and revenue per employee. The obtained results were analysed and interpreted within the proposed economic-analytical framework, which made it possible to substantiate managerial decisions aimed at improving the efficiency of HR utilisation and enhancing the economic performance of the organisation.

Results and Discussion

Summarising the findings of scientific studies, devoted to the evaluation of ED, it can be stated that the corresponding approaches are implemented with consideration of different levels of analysis. Evaluation was carried out at the level of the individual employee, the organisation, and the economy as a whole, which is determined by the multidimensional nature of ED outcomes and the varying depth of their economic effects. Such a division according to levels of analysis makes it possible to identify the interconnection between individual ED outcomes, the effectiveness of managerial decisions within organisations, and macroeconomic consequences. The evaluation of ED by levels of analysis is systematised in Table 1.

Table 1. Systematisation of economic approaches to the evaluation of ED by levels of analysis

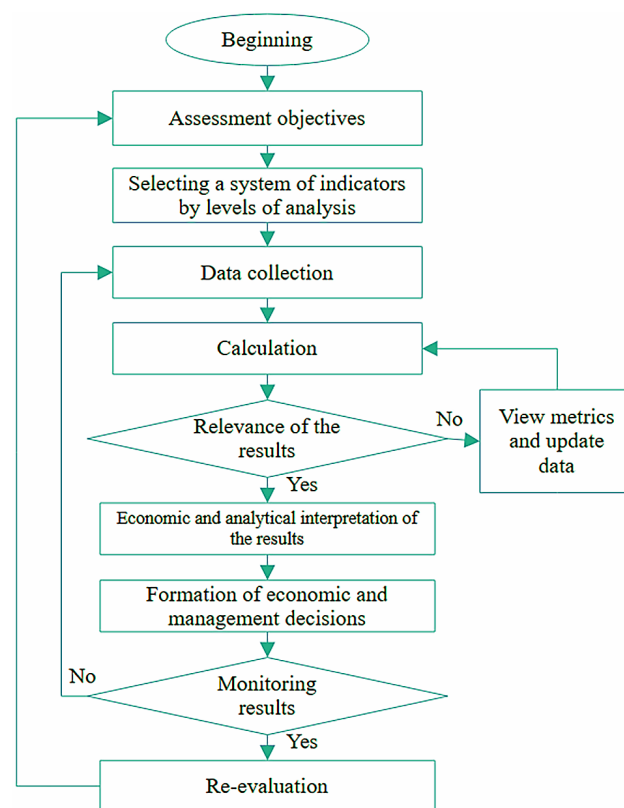
Level of analysis	Object of assessment	Main economic approaches	Focus of economic evaluation	Expected economic results
Employee	Professional development, changes in competencies and behavioural characteristics	Competency-based, performance-based, investment-based	Economic effectiveness of individual development	Increase in LP, reduction of adaptation time costs, and improvement in the quality of task performance
Organisation	ED system of the organisation, workforce potential	Cost-performance-based, resource-based, strategic	Economic efficiency of workforce potential utilisation	Increase in profitability, cost optimisation, reduction in employee turnover, and strengthening of innovation activity
Economy	Aggregate development of employees and human capital	Macroeconomic, institutional, socio-economic	Macroeconomic return on human capital development	Growth in overall LP, improvement in workforce quality, and strengthening of economic competitiveness

Source: developed by the author based on Y. Palamarenko (2020), V. Ushkalyov & M. Martiyanova (2021), A. Church *et al.* (2021), O. Panchenko (2024)

The generalisation of economic approaches to evaluating ED by levels of analysis provides a holistic understanding of the multi-level nature of the economic returns from workforce potential development. The differentiation of ED across micro-, meso-, and macro-levels ensures methodological consistency between individual development outcomes, the efficiency of workforce potential utilisation within organisations, and macroeconomic effects. Such systematised structuring forms the basis for integrating performance, behavioural, and cost indicators into a unified analytical system, thereby enhancing the substantiation of economic evaluation and the coherence of managerial decisions regarding ED.

At the employee level, development ensures not only an increase in individual productivity, but also enhances the employee's ability to perform job functions effectively under conditions of change, to master new tasks and technologies more rapidly, and to reduce the time and resource costs associated with professional adaptation. From a methodological perspective, this means that the outcomes of ED are transformed into economically measurable indicators of performance and the efficiency of the utilisation of their potential. At the organisational level, the economic effects of ED are manifested in improved overall performance, greater efficiency in the use of labour and financial resources, and reduced costs related to staff turnover and the training of new employees. Within the framework of economic evaluation, these effects are reflected through a system of coordinated performance and resource efficiency indicators, which makes it possible to link ED with the achievement of an organisation's strategic objectives. At the economic level, ED generates systemic and long-term outcomes manifested in increased overall LP, improved workforce quality, and greater adaptability of the labour market to structural changes. From the perspective of the methodology of economic evaluation, this implies the necessity of considering systemic effects that extend beyond the boundaries of an individual organisation and generate macroeconomic returns from investments in workforce potential development. To ensure the effective implementation of the proposed approach to the economic evaluation of ED,

its application should be carried out within a sequential system of interrelated stages. This sequence involves defining the objectives of the evaluation, selecting a system of indicators according to the levels of analysis, forming the information base, calculating integral indicators, and interpreting the obtained results for the substantiation of managerial decisions (Fig. 1).


Figure 1. Algorithm for implementing the approach to the economic evaluation of ED

Source: developed by the author

The cyclical nature of the proposed algorithm for the economic evaluation of ED enables the timely adjustment of the system of indicators and managerial decisions, thereby

enhancing the substantiation of the evaluation and the efficiency of workforce potential utilisation. As noted by F. Rosi (2020), the economic evaluation of ED requires the use of indicators with different functional orientations, which necessitates the formation of a comprehensive system of indicators. Taking this position into account, the study analysed the scholarly approaches, which present various indicators

for evaluating ED. The generalisation of these approaches made it possible to systematise the indicators of the economic evaluation of ED and group them according to levels of analysis. The characteristics of the economic evaluation indicators, the tools for their analysis, and the information base are presented in Table 2. The formalisation of the specified indicators for further modelling is presented in Table 3.

Table 2. System of indicators and instruments for the economic evaluation of ED by levels of analysis

Level of analysis	Key indicators of economic evaluation	Evaluation tools and methods	Information base
Employee	LP, ICI, speed of professional adaptation, task performance quality indicators, professional growth coefficient	Competency assessment, individual KPI system, evaluation of training outcomes, surveys, observation, HR analytics	HR system data, performance appraisal results, internal productivity indicators, training reports
Organisation	HR ROI, productivity per employee, employee turnover rate, return on investment in development, indicators of payroll fund efficiency	Cost-benefit analysis, managerial analytics, HR process audit, strategic KPI system, economic and analytical methods	Financial statements, managerial reports, HR analytics data, internal development budgets
Economy	Macroeconomic LP, employment rate, workforce quality indicators, human capital indices, gross value added per employee	Statistical analysis, comparative analysis, macroeconomic modelling, index methods	Data from the State Statistics Service of Ukraine, international statistical databases, human capital development indices

Note: ICI – Integrated Competency Index, KPI – Key Performance Indicators

Source: developed by the author based on S. Makarenko *et al.* (2021), T. Halaida & K. Oleshko (2022), M. Nochka (2022), V. Khudolei *et al.* (2025)

Table 3. Formalisation of indicators for economic evaluation of ED

Level of analysis	Indicator	Formula	Description of variables
Employee	LP	$P_i = \frac{Q_i}{T_i}$	Q_i – output produced by the i -th employee T_i – working time spent by the i -th employee
	ICI	$C_i = \sum_{j=1}^n w_j \cdot c_{ij}$	w_j – weight of the j -th competency c_{ij} – level of the j -th competency of the i -th employee
	Adaptation speed	$t_{adapt} = \frac{C_{max} - C(t_0)}{t}$	C_{max} – target competency level $C(t_0)$ – initial level t – adaptation period
Organisation	ROI-HR	$ROI_{HR} = \frac{E_{HR} - C_{HR}}{C_{HR}} * 100\%$	E_{HR} – economic effect of HR initiatives C_{HR} – HR-related costs
	Revenue per employee	$P = \frac{R}{N}$	R – total revenue N – average number of employees
	Employee turnover rate	$K_{turnover} = \frac{L}{N_{avg}} * 100\%$	L – number of employees who left N_{avg} – average headcount
	Return on development investment	$R_{ev} = \frac{\Delta P}{C_{dev}}$	ΔP – productivity growth C_{dev} – development costs
Economy	LP (macro level)	$P_{macro} = \frac{GDP}{L}$	GDP – gross domestic product L – employed population
	Employment rate	$E = \frac{L}{P_{op}} * 100\%$	L – employed population P_{op} – total population
	Gross value added per employee	$F = \frac{VAD}{L}$	VAD – gross value added L – employed population
	HCI	$HCI = f(\text{education, health, skills})$	Composite indicator reflecting education, health, and skills

Note: ROI – return on investment, HCI – Human capital index

Source: developed by the author

The system of indicators and instruments for the economic evaluation of ED elaborates the multi-level approach and creates opportunities for its practical application. The alignment of ED indicators across the

micro-, meso-, and macro-levels facilitates the integration of evaluation results into a unified analytical system and enhances the substantiation of economic and managerial decisions regarding ED.

I. Dashko *et al.* (2022) noted that the evaluation of ED acquires managerial significance only when it is integrated into the organisation's strategic management system, which highlights its functional and strategic importance. Understanding the value of evaluation allows this process to be directed toward aligning ED with organisational strategy and ensuring long-term socio-economic outcomes. In the absence of such an understanding,

evaluation tends to become formalised and loses its managerial relevance. Thus, the effectiveness of the economic evaluation of ED is determined not only by the accuracy of measurement but also by the recognition of its value as a managerial mechanism for shaping and implementing ED. For this reason, in order to generalise the characteristics of such value, they were differentiated according to levels of analysis, as presented in Table 4.

Table 4. The value of the economic evaluation of ED by levels of analysis

Level of Analysis	Characteristics of the value of assessment
Employee	Awareness of the level of professional development, formation of feedback, increased motivation for self-development, and responsibility for learning outcomes
Organisation	Alignment of ED with the organisation's strategy, enhancement of the substantiation of HR decisions, and ensuring the efficient utilisation of workforce potential
Economy	Formation of a competitive workforce, support for innovative development, and ensuring long-term socio-economic outcomes

Source: developed by the author

The value of the economic evaluation of ED across different levels of analysis demonstrates that evaluation results can serve as an analytical basis for substantiating managerial decisions and shaping the economic outcomes of workforce potential development. An analysis of contemporary scientific studies in the field of ED evaluation indicates a gradual complication of methodological tools and a transition from the isolated measurement of individual indicators to their comprehensive analysis (Nicolaescu *et al.*, 2020; Balakhonova & Pirniak, 2023). Most studies focus on assessing the economic return on investments in ED, changes in LP, professional competencies and behavioural characteristics of employees, as well as their impact on organisational performance. At the same time, modern scientific approaches demonstrate a tendency toward further generalisation of the results of such analyses through the formation of integral indicators of the economic effects of ED. Unlike comprehensive evaluation, which involves analysing a set of indicators, integral evaluation makes it possible to aggregate them into a composite indicator that summarises the economic outcome of ED.

Alongside this, the use of analytical research methods has intensified, which confirmed the growing tendency toward enhancing the evidence-based nature of managerial decisions in the field of ED. Contemporary studies in the field of the economic evaluation of ED are characterised by the use of diverse analytical approaches aimed at generalising evaluation results and forming integral development indicators based on the aggregation of quantitative parameters that reflect the level and dynamics of professional growth. In particular, A. Kotsur *et al.* (2021) emphasised that index-based approaches enable the generalisation of evaluation outcomes and the formation of composite indicators of ED.

At the same time, correlation and regression analyses are applied to identify relationships between ED and the economic performance of organisations, allowing the quantitative determination of the strength and direction of the influence of relevant factors, as demonstrated

by M. Rameshkumar (2020) and V.A. Tkalac (2021). The further development of these approaches within the framework of econometric modelling, according to Y. Xu & A. Li (2020), makes it possible to study the dynamics of ED and forecast its economic effects. In addition, P. Colnago & S. Dogliotti (2020) highlighted the importance of cost-benefit analysis for justifying the feasibility of investments in ED. Furthermore, T. Sagawe *et al.* (2022) argued that multicriteria methods allow the integration of economic, professional, and behavioural characteristics of development within a comprehensive evaluation framework, while O. Parkhomenko-Kutsevil (2025) pointed to the role of analytical dashboards and monitoring systems in ensuring the operational tracking of changes and supporting managerial decision-making based on aggregated data.

The analysis of the aforementioned approaches shows that, despite the diversity of analytical tools, most studies focus either on the application of individual quantitative measurement methods or on the evaluation of specific economic effects of ED. As a result, a certain methodological fragmentation can be observed, whereby index models, econometric estimates, and cost analysis are used as independent tools and are only partially integrated into a comprehensive system for substantiating managerial decisions regarding ED. A step-by-step approach to forming a comprehensive economic evaluation involves identifying the structural components of an organisation's economic potential, defining a system of indicators for each component, conducting their quantitative measurement, and subsequently aggregating them into a generalised indicator. This approach facilitates the systematisation of the parameters of employee development and enables consideration of interrelations between individual components of workforce potential. Its advantage lies in its structured nature and in the possibility of forming an integral indicator that reflects the overall state of development.

At the same time, a certain methodological limitation of the aforementioned approach can be observed. The

aggregation of indicators into a composite index, while enabling the generalisation of results, is not accompanied by a clear mechanism for transforming the obtained values into appropriate managerial decisions. The focus on structural components of HR potential does not fully account for the multi-level nature of the economic effects of ED, which manifest simultaneously at the micro-, meso-, and macro-levels. In addition, the lack of systematic consideration of evaluation dynamics restricts the ability to forecast the long-term consequences of investments in ED. To overcome these limitations, it is advisable to apply an integrative approach that combines a system of quantitative indicators with mechanisms for their analytical interpretation and subsequent transformation into managerial decisions.

One of the key methodological problems in evaluating ED remains the insufficient consideration of the time perspective. In HR management practice, the effectiveness of ED is often assessed only after the completion of training programmes and is typically limited to verifying the level of knowledge acquisition or the participants' satisfaction. Such an approach narrows the possibilities for a comprehensive analysis of development outcomes and does not allow for tracing sustainable behavioural and performance-related changes in employees' activities. To overcome this limitation, it is advisable to apply a staged evaluation approach that involves conducting assessments before the start of development programmes, during their implementation, and after their completion. Such a sequence enables tracking the dynamics of changes in LP indicators, competency levels, and the economic efficiency of HR utilisation.

At the same time, a significant challenge remains the insufficient objectivity of evaluation, which is caused by the heterogeneity of stakeholders' interests. Different evaluation actors apply diverse criteria for assessing the effectiveness of ED, and in the absence of their alignment this

may reduce the evidential value of the obtained results and their managerial relevance. One possible way to address this problem is the formation of a coordinated system of evaluation indicators that combines individual employee performance indicators, economic indicators of organisational performance, and macroeconomic characteristics of human capital development. The use of such a system enables the integration of various information sources and ensures a more objective interpretation of ED outcomes.

Moreover, the practical complexity of applying multi-level evaluation models often leads to the simplification of analytical procedures. As a result, evaluation is frequently reduced to the use of individual indicators or the identification of short-term effects, while the long-term economic consequences of ED remain insufficiently considered. Determining the economic effect of ED is particularly challenging, as isolating its impact from other factors that simultaneously influence organisational performance is methodologically difficult. In this context, the use of integral indicators and economic-analytical methods is advisable, as they enable the generalisation of various aspects of ED and the identification of relationships between investments in development and the economic performance of organisations.

To overcome the identified limitations and ensure a systematic interpretation of evaluation results, the provisions of the proposed structural and logical model are further elaborated through the development of an economic-analytical framework for managerial decision-making. This framework reflects the interrelationships between the indicators of ED assessment, the results of their economic-analytical interpretation, and the corresponding managerial actions (Table 5). Such a framework ensures the systematic transformation of economic evaluation results into consistent managerial decisions aimed at the development of the organisation's HR potential.

Table 5. Economic and analytical framework for managerial decisions regarding ED

Functional evaluation block	Indicators for evaluating ED	Methods of data collection and processing	Economic and analytical interpretation	Managerial decisions
Analytical (diagnostic)	Competence index, LP per employee, KPI	HR data analysis, statistical analysis of productivity, KPI evaluation	Identification of the gap between the actual and target levels of competencies, assessment of productivity changes	Determination of priorities for training and adaptation
Investment	ROI-HR, training costs per employee, turnover rate	Financial analysis of HR expenditures, ROI calculation, employee turnover analysis	Cost-benefit relationship of investments in ED	Decisions on the feasibility of investing in ED
Program-target	Implementation of individual development plans, share of employees participating in training, training effectiveness index	HR system data analysis, evaluation of training programme outcomes, comparative analysis	Segmentation of employees by development level, assessment of training programme effectiveness	Adjustment of development programmes and training modules
Motivational	eNPS, level of employee engagement, share of internal promotions	Employee surveys, HR analytics, correlation analysis	Assessment of the relationship between motivation and LP	Improvement of material and non-material motivation systems
Workforce planning	Staffing forecast, Sales/FTE	Econometric modelling, analysis of sales and LP	Assessment of workforce needs considering sales dynamics	Workforce planning and optimisation of staff numbers

Functional evaluation block	Indicators for evaluating ED	Methods of data collection and processing	Economic and analytical interpretation	Managerial decisions
Integrative (managerial)	Integral index of ED, HR potential development index	Integral evaluation of development indicators, aggregation of HR metrics	Comprehensive assessment of ED and its economic impact	Formation of a portfolio of managerial decisions regarding ED

Note: eNPS – Employee Net Promoter Score

Source: developed by the author

Thus, the proposed economic-analytical framework for managerial decision-making enables the identification of relationships between ED indicators, the methods of their analytical processing, and managerial decisions aimed at improving the efficiency of HR utilisation. The application of this approach makes it possible to consider the evaluation of ED not only as a tool for measuring results but also as an analytical basis for forming economically grounded managerial decisions that contribute to increasing LP, improving the efficiency of resource utilisation, and enhancing the economic performance of organisations. The practical implementation of the proposed approach is carried out in accordance with the developed algorithm for the economic evaluation of ED. The application of this algorithm involves the step-by-step execution of procedures for data collection and systematisation, calculation of key

economic indicators (in particular LP, ROI-HR, and employee turnover), their economic and analytical interpretation taking into account the interrelationships between indicators, and the formation of managerial decisions on this basis regarding the development of HR potential.

In order to verify the practical implementation of the proposed methodological approach to the economic evaluation of ED, its testing was conducted using aggregated data from retail organisations in Ukraine, in particular the leading retail chain EVA (LLC “RUSH”), for the period 2019-2024. The evaluation was carried out using a multi-level system of indicators covering the individual, organisational, and industry levels of analysis, which made it possible to trace the economic outcomes of ED and their impact on organisational performance indicators. The results of testing the proposed approach are presented in Table 6.

Table 6. Results of testing the author's approach to the economic evaluation of ED based on aggregated data from retail organisations in Ukraine (2019-2024)

Level of analysis	Indicator	Before implementation	After implementation	Change, %	Economic interpretation
Employee	LP per employee (Pi), thousand UAH	72	82	+13.9	Increase in individual productivity after training
	Competence index (Ci)	0.63	0.78	+23.8	Improvement of employees' professional skills
	Adaptation period, months (tadapt)	3.8	2.6	-31.6	Faster integration of new employees
Organisation	LP, thousand (Pyear), UAH/year	720	820	+13.9	Improved efficiency of personnel utilisation
	Return on investment in personnel (ROI-HR)	0.42	0.68	+61.9	Increase in the economic return on investments in ED
	Employee turnover rate (Kturnover), %	28.5	21.0	-26.3	Reduction in recruitment costs
	Revenue per employee (Rev), thousand UAH	310	355	+14.5	Improved performance of the retail network
Economy (industry level)	LP in retail (Pretail), thousand UAH/employee	640	710	+10.9	Impact of ED on the industry
	Payroll fund in retail (F), billion UAH	182	205	+12.6	Growth in employees' income levels
	Employment rate in the sector (E), %	58.4	60.1	+2.9	Expansion of employment in the retail sector

Source: developed by the author

To provide a clearer presentation of the testing results and to compare the dynamics of key indicators before and after the implementation of the proposed approach, the corresponding data are visualised in the form of a bar chart (Fig. 2). The results of the testing indicate an overall positive dynamic in ED indicators and their economic

performance. In particular, during the analysed period, LP increased on average by 10-14%, the level of professional competencies rose by approximately 20-25%, and the adaptation period of employees decreased by more than 30%. At the same time, a significant increase in the economic return on investments in ED was observed, exceeding 60%,

accompanied by a reduction in employee turnover by about one quarter and an increase in revenue per employee by approximately 10-15%. The aggregated results also demonstrate positive changes in industry-level indicators, including

growth in LP, the payroll fund, and the employment rate. Overall, the obtained results confirm the presence of a positive economic effect of ED and its contribution to improving the efficiency of HR utilisation.

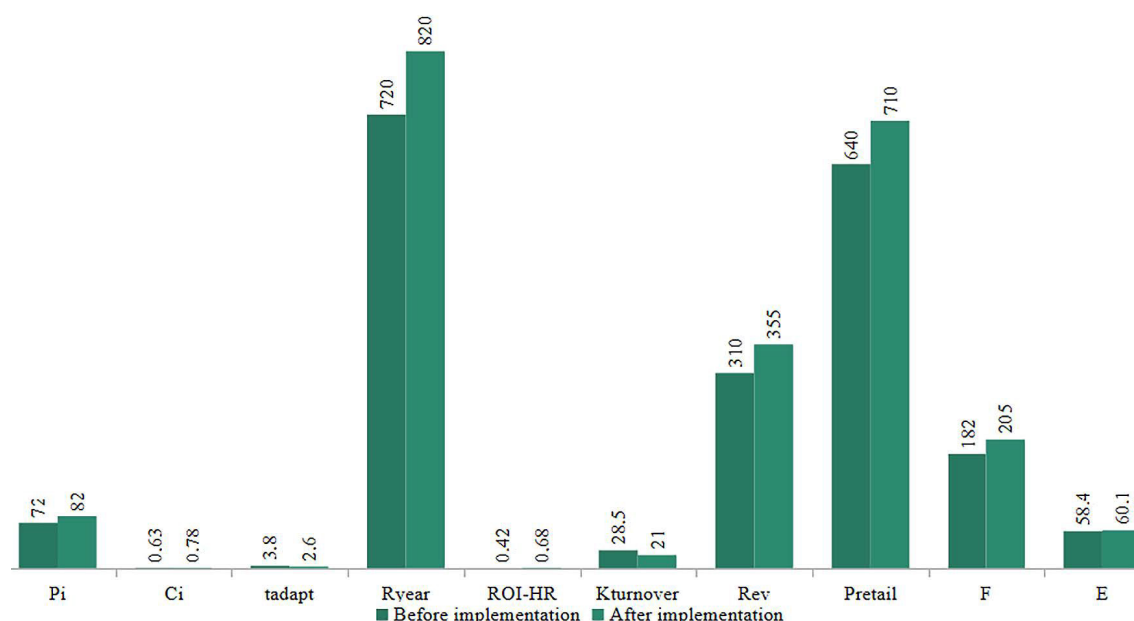


Figure 2. Dynamics of key indicators of ED before and after the implementation of the proposed approach

Source: developed by the author

The results of the study confirm the feasibility of applying an economic approach to the evaluation of ED, which involves analysing indicators at different levels of the economic system. The use of an economic-analytical framework for managerial decision-making regarding ED made it possible to align the results of economic evaluation with the process of managerial decision-making in the field of HR development. The application of a system of interrelated indicators enabled the identification of the economic outcomes of ED not only at the individual level but also within the organisation and the industry, which confirms the existence of a multi-level economic effect of employee competence development.

Discussion

Similar findings were reflected in the study by C. Gebara *et al.* (2023), which emphasised the importance of using economic indicators to evaluate the outcomes of ED and to substantiate managerial decisions in the field of HR management. The authors stressed that the evaluation of ED should take into account not only changes in professional competencies but also the economic performance of organisations. In the present study, this idea is further developed through the formation of an economic-analytical framework that integrates the results of ED evaluation into the managerial decision-making system.

A similar position is expressed in the study by B. Mustafa & S. Lleshi (2024), who examined the impact of ED on organisational performance. The authors noted that investments

in personnel development contribute to increased LP and more efficient utilisation of organisational resources. Their study demonstrates that the development of employee competencies can serve as one of the key factors in improving the economic performance of enterprises. The results obtained in the present study support these findings, as increases in LP and improvements in the efficiency of HR utilisation are considered economic outcomes of ED.

A number of studies emphasise the need to use a system of quantitative indicators to evaluate the outcomes of ED. In particular, D. Dadd & M. Hinton (2023) highlighted the importance of developing a system of indicators that makes it possible to assess the economic return on investments in personnel development. The authors propose the use of LP indicators, measures of the efficiency of labour resource utilisation, and financial performance indicators of enterprises. Compared with these approaches, the present study expands the system of indicators by grouping them according to levels of analysis, which makes it possible to comprehensively assess the outcomes of ED within the economic system.

The study by O. Morozova (2025) demonstrates that the evaluation of ED should be carried out using integral indicators that allow the results of evaluation to be generalised and a composite assessment of personnel development to be formed. The author emphasised the need to aggregate various indicators of ED into a single indicator, which simplifies the interpretation of evaluation results. In the present study, a similar approach to the generalisation

of evaluation outcomes is applied; however, its distinctive feature lies in the combination of integral indicators with a multi-level analysis of the economic outcomes of ED.

At the same time, the study by I. Churkina & M. Ternovskyi (2026) examined the relationship between ED and the innovative activity of organisations. The authors noted that the development of employee competencies enhances the ability of organisations to implement innovations and adapt to changes in the external environment. In comparison with these studies, the present research focuses on the economic dimension of ED, particularly on evaluating the impact of competency development on the economic performance of organisations.

The study by O. Panchenko (2024) emphasised the importance of integrating HR analytics into the system of strategic management of organisations. The author demonstrates that the use of analytical data on ED contributes to improving the validity of managerial decisions and the effectiveness of human capital management. The results obtained in the present study are consistent with this position, as the proposed economic-analytical framework is specifically aimed at integrating the results of the economic evaluation of ED into the managerial decision-making system.

In turn, H. Koptieva & D. Sanzharov (2025) drew attention to the multidirectional nature of ED, emphasising its importance primarily for the professional growth of employees and for improving organisational performance. The authors noted that ED contributes to increased LP, the improvement of professional competencies, and better organisational performance outcomes. Building upon this approach, the present study substantiates the relevance of considering ED within a broader economic context. In particular, it demonstrates that the outcomes of ED should be evaluated in a multi-level dimension encompassing the employee, organisational, and economy-wide levels. Such an approach makes it possible to trace the relationship between individual professional development, the efficiency of HR utilisation within organisations, and the formation of the overall level of LP in the national economy.

At the same time, the study by N. Sablina (2025) emphasised the complexity of measuring the economic outcomes of ED, as organisational performance is influenced simultaneously by a wide range of factors. The author noted that isolating the impact of ED on the economic results of enterprises is methodologically challenging. In the present study, this problem is partially addressed through the use of a system of interrelated indicators that make it possible to evaluate the economic outcomes of ED in connection with other organisational performance indicators. Thus, the results of the study confirm that the economic evaluation of ED should be carried out within a multi-level framework, which makes it possible to comprehensively reflect the relationship between ED and the economic performance of organisations. The proposed approach ensures the integration of evaluation results into the managerial decision-making system regarding the development of HR potential and expands the possibilities

of using economic indicators within organisational management systems.

Conclusions

The conducted study made it possible to generalise contemporary economic approaches to the evaluation of ED and to substantiate the relevance of considering them in relation to the economic performance of organisations. It was established that the effectiveness of ED should be assessed using a system of interrelated economic indicators that make it possible to identify the impact of investments in ED on LP and the efficiency of HR utilisation. The necessity of integrating the results of the economic evaluation of ED into the managerial decision-making system has been substantiated, which contributes to improving the validity of personnel development management and supports the achievement of organisational strategic objectives. The results of the study confirm the feasibility of applying an economic-analytical approach to the evaluation of ED, which enables the integration of HR analytics with economic performance indicators of organisations and enhances the effectiveness of HR management.

The scientific novelty of the study lies in the development of methodological foundations for the economic evaluation of ED through the integration of performance indicators, behavioural and cost characteristics within a unified analytical framework. This approach ensures the consistency of theoretical provisions and practical evaluation tools and expands the possibilities for substantiating managerial decisions regarding the development of an organisation's employees. The practical significance of the obtained results lies in the possibility of applying the proposed approaches to substantiate managerial decisions regarding ED and to improve the economic efficiency of organisational performance.

At the same time, the results of the study have certain limitations. In particular, the testing of the proposed approach was conducted using aggregated data from retail organisations in Ukraine, which may limit the direct generalisation of the obtained results to other sectors of the economy. In addition, the economic outcomes of ED may depend on external factors, including macroeconomic conditions, labour market dynamics, and the organisational environment of enterprises. Prospects for further research are associated with improving the methods of economic evaluation of ED in the context of HR process digitalisation and expanding the use of analytical tools in HR management systems.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] Alexeyev, A., Bykova, A., & Datsenko, V. (2024). Theoretical and methodological foundations of investment in human capital development. *Economics and Organization of Management*, 1(53), 78-89. [doi: 10.31558/2307-2318.2024.1.8](https://doi.org/10.31558/2307-2318.2024.1.8).
- [2] Balakhonova, O., & Pirniak, A. (2023). Methods for assessing the personnel potential of an enterprise. *Podilian Scientific Bulletin*, 1(25), 25-32. [doi: 10.58521/2521-1390-2023-25-4](https://doi.org/10.58521/2521-1390-2023-25-4).
- [3] Bondar, T., & Krasnonos, A. (2023). Contemporary methods of personnel motivation. *Economy and Society*, 57. [doi: 10.32782/2524-0072/2023-57-114](https://doi.org/10.32782/2524-0072/2023-57-114).
- [4] Chatchenko, O.Ye. (2025). Corporate governance and psychology: New approaches to enterprise economics. *Current Issues of Sustainable Development*, 2(7), 74-82. [doi: 10.60022/2\(7\)-9S](https://doi.org/10.60022/2(7)-9S).
- [5] Church, A.H., Guidry, B.W., Dickey, J.A., & Scrivani, J.A. (2021). Is there potential in assessing for high-potential? Evaluating the relationships between performance ratings, leadership assessment data, designated high-potential status and promotion outcomes in a global organization. *The Leadership Quarterly*, 32(5), article number 101516. [doi: 10.1016/j.leaqua.2021.101516](https://doi.org/10.1016/j.leaqua.2021.101516).
- [6] Churkina, I., & Ternovskyi, M. (2026). Advancing innovative entrepreneurship through hybrid work models: Conceptual framework and practical implications. *Economic Scope*, 209, 182-189. [doi: 10.30838/ep.209.182-189](https://doi.org/10.30838/ep.209.182-189).
- [7] Colnago, P., & Dogliotti, S. (2020). Introducing labour productivity analysis in a co-innovation process to improve sustainability in mixed family farming. *Agricultural Systems*, 177, article number 102732. [doi: 10.1016/j.agsy.2019.102732](https://doi.org/10.1016/j.agsy.2019.102732).
- [8] Dadd, D., & Hinton, M. (2023). Performance measurement and evaluation: Applying return on investment (ROI) to human capital investments. *International Journal of Productivity and Performance Management*, 72(9), 2736-2764. [doi: 10.1108/IJPPM-10-2021-0573](https://doi.org/10.1108/IJPPM-10-2021-0573).
- [9] Dashko, I.M., Krylov, D.V., & Mykhailichenko, L.V. (2022). Personnel appraisal as a key method for assessing employee development. *Economic Space*, 179, 50-54. [doi: 10.32782/2224-6282/179-8](https://doi.org/10.32782/2224-6282/179-8).
- [10] Gabriellova, K., & Buchko, A. (2021). Here comes Generation Z: Millennials as managers. *Business Horizons*, 64(4), 489-499. [doi: 10.1016/j.bushor.2021.02.013](https://doi.org/10.1016/j.bushor.2021.02.013).
- [11] Gebara, C.H., Thammaraksa, C., Hauschild, M., & Laurent, A. (2023). Selecting indicators for measuring progress towards sustainable development goals at the global, national and corporate levels. *Sustainable Production and Consumption*, 44, 151-165. [doi: 10.1016/j.spc.2023.12.004](https://doi.org/10.1016/j.spc.2023.12.004).
- [12] Halaida, T., & Oleshko, K. (2022). Formation of a comprehensive personnel evaluation system based on a competence approach. *Eastern Europe: Economy, Business and Management*, 1(34), 61-68. [doi: 10.32782/easterneurope.34-11](https://doi.org/10.32782/easterneurope.34-11).
- [13] Khudolei, V.Yu., Karpenko, O.O., & Biriukov, Ye.I. (2025). A system for assessing and monitoring enterprise sustainable development. *Economic Synergy*, 1, 8-25. [doi: 10.53920/es-2025-1-1](https://doi.org/10.53920/es-2025-1-1).
- [14] Koptieva, H., & Sanzharov, D. (2025). Personnel management as a tool for ensuring enterprise competitiveness. *Bulletin of the National Technical University "Kharkiv Polytechnic Institute" (Economic Sciences)*, 2, 89-94. [doi: 10.20998/2519-4461.2025.2.89](https://doi.org/10.20998/2519-4461.2025.2.89).
- [15] Kotsur, A., Ostroverkhov, V., Prokhorovska, S., & Barska, J. (2021). HR analytics in the management system of a modern enterprise. *Regional Aspects of the Development of Productive Forces of Ukraine*, 26, 93-103. [doi: 10.35774/rarpsu2021.26.093](https://doi.org/10.35774/rarpsu2021.26.093).
- [16] Makarenko, S., Likanova, A., & Plieshtseva, A. (2021). Implementation of innovative human resource management technologies. *Economy and Society*, 33. [doi: 10.32782/2524-0072/2021-33-36](https://doi.org/10.32782/2524-0072/2021-33-36).
- [17] Miklovda, V.P., & Popovych, O.O. (2021). Personnel as a factor of enterprise competitiveness. *Scientific Bulletin of Uzhhorod University. Series: Economics*, 2(58), 54-59. [doi: 10.24144/2409-6857.2021.2\(58\).54-59](https://doi.org/10.24144/2409-6857.2021.2(58).54-59).
- [18] Morozova, O. (2025). Evaluation of the effectiveness of retail enterprise management: A scientific and practical approach. *Development Service Industry Management*, 3, 124-133. [doi: 10.31891/dsim-2025-11\(19\)](https://doi.org/10.31891/dsim-2025-11(19)).
- [19] Mustafa, B., & Lleshi, S. (2024). The impact of lifelong learning and investments in employee development on employee productivity and performance. *Multidisciplinary Reviews*, 7(8), article number e2024175. [doi: 10.31893/multirev.2024175](https://doi.org/10.31893/multirev.2024175).
- [20] Nicolaescu, S., Florea, A., Kifor, C., Fiore, U., Cocan, N., Receu, I., & Zanetti, P. (2020). Human capital evaluation in knowledge-based organizations based on big data analytics. *Future Generation Computer Systems*, 111, 654-667. [doi: 10.1016/j.future.2019.09.048](https://doi.org/10.1016/j.future.2019.09.048).
- [21] Nochka, M. (2022). Approaches to human capital assessment. *Bulletin of Sumy National Agrarian University*, 1(87), 51-57. [doi: 10.32845/bsnau.2021.1.8](https://doi.org/10.32845/bsnau.2021.1.8).
- [22] Palamarenko, Ya. (2020). Modern approaches to evaluate the level strategic development of the enterprise. *Efficient Economy*, 5. [doi: 10.32702/2307-2105-2020.5.80](https://doi.org/10.32702/2307-2105-2020.5.80).
- [23] Panchenko, O. (2024). The role of personnel audit in risk-oriented enterprise management. *Scientific Notes of "KROK" University*, 4(76), 155-164. [doi: 10.31732/2663-2209-2024-76-155-164](https://doi.org/10.31732/2663-2209-2024-76-155-164).
- [24] Parkhomenko-Kutsevil, O. (2025). Implementation of innovative mechanisms in the personnel assessment system of public administration. *Public Administration: Concepts, Paradigm, Development, Improvement*, 13, 85-92. [doi: 10.31470/2786-6246-2025-13-85-92](https://doi.org/10.31470/2786-6246-2025-13-85-92).

- [25] Rameshkumar, M. (2020). Employee engagement as an antecedent of organizational commitment – A study on Indian seafaring officers. *The Asian Journal of Shipping and Logistics*, 36(3), 105-112. [doi: 10.1016/j.ajsl.2019.11.003](https://doi.org/10.1016/j.ajsl.2019.11.003).
- [26] Rossi, F. (2020). Human capital and macroeconomic development: A review of the evidence. *The World Bank Research Observer*, 35(2), 227-262. [doi: 10.1093/wbro/lkaa002](https://doi.org/10.1093/wbro/lkaa002).
- [27] Sablina, N. (2025). Human capital as an object of financial controlling. *Sustainable Development of Economy*, 4(55), 256-261. [doi: 10.32782/2308-1988/2025-55-35](https://doi.org/10.32782/2308-1988/2025-55-35).
- [28] Sagawe, T., Tenório, F.M., Santos, M., & Gomes, C.F.S. (2022). Professional potential evaluation using a multicriteria approach: An AHP-ELECTRE-TRI proposal. *Procedia Computer Science*, 214, 628-635. [doi: 10.1016/j.procs.2022.11.221](https://doi.org/10.1016/j.procs.2022.11.221).
- [29] Shapka, I. (2025). Personnel development management in the conditions of globalization of knowledge and transformation of the scientific space. *Danish Scientific Journal*, 1(97), 68-71. [doi: 10.5281/zenodo.15789493](https://doi.org/10.5281/zenodo.15789493).
- [30] Tkalac, V.A. (2021). The impact of employee engagement, organisational support and employer branding on internal communication satisfaction. *Public Relations Review*, 47(1), article number 102009. [doi: 10.1016/j.pubrev.2021.102009](https://doi.org/10.1016/j.pubrev.2021.102009).
- [31] Ushkalyov, V., & Martiyanova, M. (2021). Theoretical and methodological principles of assessing the effectiveness of staff development. *Efficient Economy*, 5. [doi: 10.32702/2307-2105-2021.5.75](https://doi.org/10.32702/2307-2105-2021.5.75).
- [32] Xu, Y., & Li, A. (2020). The relationship between innovative human capital and interprovincial economic growth based on panel data model and spatial econometrics. *Journal of Computational and Applied Mathematics*, 365, article number 112381. [doi: 10.1016/j.cam.2019.112381](https://doi.org/10.1016/j.cam.2019.112381).
- [33] Zastrozhnikova, I. (2022). Contemporary features of enterprise personnel development. *Scientific Bulletin of Ivano-Frankivsk National Technical University of Oil and Gas (Series: Economics and Management in the Oil and Gas Industry)*, 2(24), 159-173. [doi: 10.31471/2409-0948-2021-2\(24\)-159-173](https://doi.org/10.31471/2409-0948-2021-2(24)-159-173).

Економічні підходи до оцінювання розвитку працівників організації

Ірина Шапка

Аспірант

Український державний університет науки і технологій

49010, вул. Лазаряна, 2, м. Дніпро, Україна

<https://orcid.org/0000-0003-1171-6445>

Анотація. Актуальність дослідження зумовлена відсутністю єдиного підходу до економічного оцінювання розвитку працівників, фрагментарністю показників і недостатньою узгодженістю між теоретичними моделями та практичними інструментами управління. Метою статті були систематизація та узагальнення економічних підходів до оцінювання розвитку працівників організації, що застосовуються в сучасних наукових дослідженнях, а також обґрунтування авторських пропозицій щодо вдосконалення економічного оцінювання результатів розвитку працівників. Для досягнення мети було проаналізовано основні підходи, методи та показники оцінювання, виявлено наукові прогалини й проблемні аспекти, які обмежують можливості комплексного економічного аналізу. У результаті дослідження було узагальнено основні економічні підходи до оцінювання розвитку працівників у межах економіки праці та організації, встановлено їх багаторівневий характер від індивідуального до організаційного та макроекономічного. Визначено, що переважна більшість підходів ґрунтується на використанні показників продуктивності праці, витрат, результативності та економічної віддачі від інвестицій у розвиток працівників. Обґрунтовано доцільність інтеграції кількісних, аналітичних і поведінкових показників у єдину систему економічного оцінювання, а також розроблено структурно-логічний алгоритм і економіко-аналітичну модель прийняття управлінських рішень. Практична апробація запропонованого підходу, здійснена на основі агрегованих даних підприємств роздрібної торгівлі України за 2019-2024 рр., підтвердила його ефективність. Зокрема, встановлено зростання продуктивності праці на 10-14 %, підвищення рівня професійних компетентностей працівників на 20-25 %, скорочення періоду адаптації більш ніж на 30 %, а також збільшення рентабельності інвестицій у розвиток персоналу більш ніж на 60 %. Водночас зафіксовано зниження плинності кадрів приблизно на чверть і зростання доходу на одного працівника на 10-15 %. Отримані результати також засвідчили позитивну динаміку галузевих показників, зокрема зростання продуктивності праці, фонду оплати праці та рівня зайнятості. Практична значущість результатів полягає у формуванні аналітичного підґрунтя для підвищення обґрунтованості управлінських рішень щодо інвестування в розвиток працівників.

Ключові слова: економічна оцінка; продуктивність праці; ресурсоефективність; інвестиції в розвиток; управлінські рішення

The role of accounting and auditing in enhancing the transparency of financial reporting of agricultural enterprises in the context of international standards

Yevhen Terekhov*

*PhD in Economics, Associate Professor
Dnipro Polytechnic National Technical University
49005, 19 Dmytro Yavorskyi Ave., Dnipro, Ukraine
<https://orcid.org/0000-0002-4816-6072>*

Abstract. The aim of the study was to assess the impact of International Financial Reporting Standards and International Standards on Auditing on the transparency of the financial reporting of large agricultural enterprises in Ukraine during the period 2020-2024. The study covered the activities of four companies: the limited liability agricultural enterprise “NIBULON”, Kernel Holding, the private joint-stock company “Myronivsky Hliboproduct”, and the limited liability company “Agroprosperis Trade”. The research applied a combination of methods, including content analysis, comparative analysis, and SWOT analysis, which enabled a comprehensive assessment of the transparency of financial reporting among agricultural enterprises. The results demonstrated that Kernel Holding possessed the most transparent financial reporting, with an average transparency score of 4.6, followed by the private joint-stock company “Myronivsky Hliboproduct” with a score of 4.5. The limited liability agricultural enterprise “NIBULON” received a score of 4.3, while the limited liability company “Agroprosperis Trade” achieved 3.9. The frequency of identifying key audit matters ranged from 78% in “Agroprosperis Trade” to 92% in Kernel Holding, whereas the depth of audit procedures varied from 290 to 380 hours annually, respectively. The analysis of reporting structures revealed significant differences between national and international standards, particularly in the greater level of detail regarding assets, liabilities, income, and the disclosure of accounting policies and risks under international standards. The SWOT analysis indicated that the principal opportunities for enhancing transparency include the standardisation of reporting formats, the strengthening of internal controls, and the expansion of audit procedures, while the key threats comprise limited resources for conducting audits and the instability of the external environment. The obtained results are of practical significance for managers of agricultural enterprises, audit firms, and regulatory authorities, as they may be used to improve the transparency of financial reporting, adapt internal procedures to the requirements of international standards, and enhance auditing practices

Keywords: agricultural business; accounting policy; auditing practices; corporate governance; professional judgement

Received: 26.12.2025, Revised: 17.04.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Terekhov, Ye. (2026). The role of accounting and auditing in enhancing the transparency of financial reporting of agricultural enterprises in the context of international standards. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 32-43. doi: 10.52566/msu-econ2.2026.32.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (terekhov.ye.v@nmu.one)

Introduction

In the context of integration into the global economic environment and increasing requirements for corporate reporting, the importance of ensuring the transparency of financial information of agricultural enterprises is growing. This is associated not only with the strengthening role of investors, creditors, and government authorities in decision-making processes, but also with the necessity of aligning financial reporting with international standards. In the practice of Ukrainian agricultural companies, insufficient transparency and limited reliability of reporting data are frequently observed, which complicates external auditing, reduces the level of trust in business entities, and diminishes opportunities for attracting investment. Despite the formal implementation of International Financial Reporting Standards and International Standards on Auditing, the actual level of their application within the agricultural sector remains uneven and often superficial. The study of international experience and scholarly approaches to assessing the quality of financial reporting makes it possible to identify existing challenges and methods for adapting global practices to Ukrainian realities.

The issue of transparency in financial reporting within Ukraine's agricultural sector has attracted the attention of numerous scholarly works. O. Hubaryk (2025) examined the role of International Financial Reporting Standards (IFRS) and International Standards on Auditing (ISA) as a foundation for trust in accounting information. The study noted that the application of IFRS and ISA influences the quality of financial reporting preparation and the interaction of enterprises with external users of financial information. Considerable attention was devoted to the problems associated with the formal approach to IFRS implementation, emphasising that the depth of standards integration depends on the internal accounting culture and the level of professional training of personnel. Similar emphases were highlighted in the work of M. Dubinina *et al.* (2024), which examined an integrated approach to accounting in the agricultural sector within the context of sustainable development and the circular economy. The authors established that ensuring the transparency of financial information requires a comprehensive combination of accounting procedures, internal controls, and managerial practices. Furthermore, the study emphasised that the integration of environmental and social aspects into financial reporting contributes to enhancing data reliability and more effective risk management in agricultural enterprises.

In turn, O. Shebanina *et al.* (2023) examined the issue of economic planning in agricultural enterprises and improving data accessibility in the context of food security. The results of their analysis showed that the systematic implementation of transparent accounting and planning procedures significantly improves the accessibility of financial information. At the same time, it was emphasised that the existence of an internal control system and effective corporate governance is a prerequisite for ensuring genuine transparency regarding the financial condition of

enterprises. Research conducted by M. Vasilic & B. Savic (2025) analysed the level of transparency in the financial reporting of agricultural companies in Serbia. The authors compared disclosure indicators before and after the implementation of international financial reporting standards and noted changes in the structure and detail of financial statements, as well as highlighting the practical difficulties of adapting the standards in the operations of enterprises.

The analysis conducted by R. Rodriguez-Galindo *et al.* (2024) focused on non-profit sector organisations, assessing the impact of the adoption of International Financial Reporting Standards on small and medium-sized enterprises. The authors analysed the annual reports of non-profit organisations and demonstrated that the integration of standards alongside environmental requirements alters the structure of disclosures regarding assets and liabilities. In parallel, I. Golocalova & M. Cojocaru (2025) developed a matrix of indicators to identify agribusiness assets, demonstrating the convergence of the International System of Environmental-Economic Accounting and IFRS, which facilitates a comprehensive assessment of enterprise performance. The analysis demonstrated the consistency of approaches to asset classification and the possibility of a comprehensive assessment of enterprise performance. The research by A.M. Thijel *et al.* (2025) in the Iraqi banking sector found that the adoption of IFRS improves banks' credit ratings through enhanced corporate governance, which indirectly has a positive impact on the financing of the agricultural sector. The authors analysed the banks' annual reports and found that an improved structure for the disclosure of financial information contributes to greater accuracy in risk assessment, which indirectly affects the financing of the agricultural sector. These studies highlighted the importance of standardising financial reporting to enhance transparency and investment attractiveness, which is crucial for agricultural enterprises in the context of market transformation.

In connection with the identified gaps in existing research, particularly the insufficient consideration of the specific features of implementing International Financial Reporting Standards and auditing specifically in Ukraine's agricultural sector, the aim of the present study was to analyse the impact of international accounting and auditing regulatory practices on the quality of financial data disclosure by enterprises in the agricultural sector.

Materials and Methods

The study covered the period 2020-2024 and was based on the analysis of the application of the IFRS Foundation (2024) and the International Auditing and Assurance Standards Board (IAASB) (n.d.) in the practices of agricultural enterprises in Ukraine. The study examined the activities of LLC NIBULON (n.d.) and Kernel (n.d.). Particular attention was devoted to the private joint-stock company "Myronivsky Hliboproduct" (MHP, n.d.) and the Limited Liability Company "Agroprosperis Trade" (n.d.). The

sample was formed according to the following criteria: these enterprises prepare financial statements in accordance with the IFRS Foundation (2024); undergo annual external audits in compliance with the International Auditing and Assurance Standards Board (IAASB) (n.d.); and provide publicly available reports containing Key Audit Matters (KAM), which indicates adherence to high standards of transparency and control. Information was collected from the official websites of the companies, as well as from the Ministry of Finance of Ukraine (n.d.) regarding the regulatory and legal framework for accounting in the business sector (National Accounting Standards (NAS)).

A content analysis was conducted covering the 2023 reporting period, which had been audited in accordance with the requirements of the IFRS Foundation (2024) and the International Auditing and Assurance Standards Board (IAASB) (n.d.). The selection of this reporting period was due to the fact that, at the time of the study, it represented the most recent complete financial year for which audited financial statements had been published, thereby ensuring the relevance, completeness, and reliability of the data required for an objective assessment of the transparency of financial reporting. The evaluation criterion was compliance with the fundamental principles of International Financial Reporting Standards – transparency, completeness, reliability, neutrality, and comparability – defined in the Conceptual Framework for Financial Reporting approved by the IFRS Foundation (2024) in 2018. The assessment was carried out by the author using a five-point scale for each principle separately for every enterprise, which ensured consistency and integrity of the analysis.

To evaluate the impact of IFRS and IAASB on the transparency of enterprises' financial reporting, a comparative analysis was conducted. Financial statements of all four enterprises were compared using the Balance Sheet (Form No. 1) (Ministry of Finance of Ukraine, 2019) and

the Statement of Financial Results (Form No. 2) (iBuhgalter, 2025), together with the corresponding notes, taking into account the completeness and accuracy of key disclosures. The analysis covered the presence of KAM, the level of detail in the notes to the financial statements, the consistency between the Balance Sheet (Form No. 1) and the Statement of Financial Results (Form No. 2), as well as the systematic application of standards. Within the comparative analysis of financial reporting transparency and audit indicators, transparency indicators, the frequency of KAM identification, the depth of audit procedures, and the correlation between transparency and KAM were compared in order to identify differences in reporting transparency. Such an analysis makes it possible to trace the direct relationship between the application of international standards and the enhancement of reporting transparency in the practice of each enterprise.

To systematise the results, a SWOT analysis of the transparency of the enterprises' accounting systems was conducted, enabling the identification of strengths and weaknesses, opportunities for improving transparency and control, as well as potential threats that may affect the accuracy and completeness of financial reporting. Based on this analysis, practical recommendations were developed for enhancing the transparency of agricultural enterprises. To integrate all findings, a logical and structural framework was designed to demonstrate the interrelationship between the application of IFRS, internal control, and auditing as key factors of transparency.

Results

To assess the transparency of the financial reporting of the four enterprises under study, a comparative analysis was conducted using key parameters reflecting compliance with the IFRS Foundation (2024) and the IAASB (n.d.). The results are presented in Table 1.

Table 1. Characteristics of the transparency of enterprises' financial reporting (2020-2024)

Transparency indicator	LLC Agricultural Enterprise "NIBULON"	Kernel Holding S.A.	PJSC "MHP"	LLC "Agroprosperis Trade"
Presence of KAM (Key Audit Matters)	Partially disclosed	Fully disclosed	Fully disclosed	Partially disclosed
Level of detail in the notes (assessment of accounting policies and provisions)	Moderate	High	High	Low
Consistency between the Balance Sheet (Form No. 1) and the Statement of Financial Results (Form No. 2)	Good	Excellent	Excellent	Satisfactory
Completeness of operational risk disclosure	Moderate	High	High	Moderate
Level of systematic application of IFRS	Average	High	High	Average

Source: compiled by the author based on publicly available financial reporting data from companies

The comparative analysis demonstrates that Kernel Holding S.A. and PJSC "MHP" maintain a high level of transparency in financial reporting, which is reflected in the full disclosure of key audit matters (KAM), detailed notes concerning accounting policies and estimates, as well as a high degree of consistency between the Balance

Sheet (Form No. 1) and the Statement of Financial Results (Form No. 2). Such systematic reporting enables users of financial statements to obtain the most comprehensive and reliable information possible, thereby increasing the confidence of investors, creditors, and other stakeholders. LLC Agricultural Enterprise "NIBULON" demonstrated a

sufficient level of transparency; however, certain KAM disclosures were only partial and the notes were less detailed, which may limit the ability of external users to assess the specific nature of accounting estimates and risks. A similar situation was observed in LLC “Agroprosperis Trade”, where, in addition to partial KAM disclosure, there was a low level of detail regarding operational risks and reserve estimates, which may reduce the effectiveness of control and the transparency of financial reporting. The differences between the enterprises are partly attributable to the level of internal accounting organisation, the experience of financial and audit teams, and the degree of practical compliance with IFRS and IAASB standards. Overall, the results demonstrated that the full and systematic application of international standards significantly enhances reporting transparency, facilitates auditing, and ensures more accurate information for external users, whereas the

partial application of standards reduces the effectiveness of these processes.

As a result of the comparison between financial reporting prepared in accordance with the Ministry of Finance of Ukraine (n.d.) and the IFRS Foundation (2024), significant differences in the structure and content of reporting were identified. IFRS are oriented towards international requirements and reflect best global practices, whereas National Accounting Standards (NAS) are focused on local needs and the requirements of Ukrainian regulators. This leads to differences in approaches to the preparation of financial statements, which may affect their transparency and comprehensibility for users. The differences are manifested in the level of detail regarding assets and liabilities, the classification of income and expenses, as well as the disclosure of accounting policies, estimates, and key risks. Data concerning the principal differences are presented in Table 2.

Table 2. Comparison of national standards and IFRS in financial reporting

Reporting element	National accounting standards (NAS)	IFRS	Main differences
Balance Sheet (Form No. 1)	Limited detail regarding non-current assets; no separate category for “current liabilities” by counterparties.	Comprehensive detail of assets and liabilities, classification by maturity periods, with offsetting/unbundling permitted.	IFRS provides more extensive information for assessing liquidity and financial structure.
Statement of financial results (Income/Expenses) (Form No. 2)	Certain items are not separately identified (for example, income from financial instruments); in some cases, there is no distinction between operating and non-operating income.	Clear classification of income and expenses, mandatory disclosure of financial income, expenses, and taxes.	Users of IFRS have access to more accurate profitability analysis.
Notes to the financial statements	Formal in nature and often duplicating figures from the statements; absence of a description of accounting policies.	Mandatory disclosure of accounting policies, judgements, estimates, as well as risks and liabilities.	IFRS ensures more comprehensive information for investment decision-making.

Source: the author's own work

As demonstrated by the comparative results presented in Table 2, significant differences exist between financial reporting prepared under NAS and IFRS, which are not merely technical in nature but also deeply economic. These differences concern the structure, content, and functional capacity of reporting to satisfy the needs of stakeholders, including investors, creditors, regulators, and management. First and foremost, the Balance Sheet (Form No. 1) under IFRS is characterised by a higher level of detail regarding assets and liabilities, as well as their clear classification by maturity periods (current/non-current). Such an approach contributes to greater transparency concerning the liquidity and solvency of an enterprise, allowing more accurate modelling of financing risks, capital turnover, and the alignment of the balance sheet structure with the strategic objectives of agricultural enterprises. In contrast, NAS do not provide such flexible mechanisms, as the structure is rigidly regulated, with limited disclosure regarding specific categories of assets, such as financial instruments or biological assets. Even more striking differences can be observed in Form No. 2 (Statement of Comprehensive Income). Reporting under IFRS ensures an expanded presentation of income and

expenses, including detailed classification according to their functional purpose (operating, investing, and financing activities), as well as a clear distinction by source, including the recognition of revenue from contracts with customers in accordance with IFRS standards. This enables the assessment of the sustainability of profitability, its sources, and its sensitivity to market changes. Under national standards, classification is often simplified and does not reflect the substance of individual types of activity, which limits the analytical value of reporting for external users.

Particular attention should be devoted to the notes to the financial statements, which, within IFRS practice, constitute an integral component carrying substantial informational value. They contain not only numerical reconciliations to the primary statements, but also disclosures regarding accounting policies, significant professional judgements, estimation assumptions, and risk factors – ranging from currency risks to climate-related risks, which are especially relevant to the agricultural sector. In national practice, the notes are predominantly formal in nature and rarely extend beyond the repetition of information already presented. Consequently, within the context of decision-making by stakeholders, information

asymmetry increases significantly, while confidence in such reporting declines. From an economic perspective, the application of IFRS substantially improves the quality of financial analysis conducted both by internal users, such as management and owners, and by external users, including investors, auditors, and banking institutions. This, in turn, creates preconditions for reducing the cost of capital, improving a company's position in attracting financing, and enhancing its rating attractiveness on international financial platforms.

Thus, the transformation of financial reporting on the basis of IFRS should not be regarded merely as adaptation to technical requirements, but rather as a strategic change in the architecture of the enterprise's financial communication with the external environment. In the

case of Ukrainian agricultural enterprises, this is particularly relevant given their integration into export-oriented value-added chains, participation in global trading operations, and dependence on international capital and infrastructure donors. Accordingly, the implementation of IFRS may be considered an institutional prerequisite for the financial sustainability and competitiveness of the sector. In order to identify differences in reporting transparency and audit indicators, a comparative study of enterprises was conducted. Table 3 presents summarised data enabling comparison of the level of transparency, the depth of auditing, and the presence of key audit matters among the companies, as well as the identification of the principal differences in their practical application of IFRS and IAASB standards.

Table 3. Comparative analysis of financial reporting transparency and audit indicators

Indicator	LLC Agricultural Enterprise "NIBULON"	Kernel Holding S.A.	PJSC "MHP"	LLC "Agroprosperis Trade"	Conclusions on differences
Average transparency score (1-5)	4.3	4.6	4.5	3.9	The highest indicators were recorded for Kernel Holding and PJSC "MHP", while the lowest was observed in "Agroprosperis Trade".
Frequency of KAM identification (%)	85	92	90	78	Differences were identified in the disclosure of key audit matters; Kernel Holding was the leading company.
Depth of audit procedures (hours/year)	320	380	355	290	More time was allocated to auditing in Kernel Holding and PJSC "MHP", corresponding to their high level of transparency.
Correlation between transparency and KAM	0.68	0.75	0.71	0.62	A positive relationship was identified: more detailed disclosure of KAM corresponds to a higher level of transparency.

Source: the author's calculations based on data from the companies' public financial reports

The extended analysis demonstrated that enterprises devoting greater attention to the application of IFRS and IAASB standards exhibited higher levels of financial reporting transparency and more in-depth auditing, as confirmed by the frequency of KAM disclosures. Kernel Holding S.A. achieved the highest average transparency score of 4.6, with a KAM identification frequency of 92% and an audit depth of 380 hours per year, indicating a systematic approach to auditing and a high level of financial information detail. PJSC "Myronivsky Hliboproduct" obtained an average transparency score of 4.5, a KAM identification frequency of 90%, and an audit depth of 355 hours per year. This confirms the thoroughness of reporting preparation and the high level of reliability of the information for users. LLC Agricultural Enterprise "NIBULON" demonstrated an average transparency score of 4.3, a KAM identification frequency of 85%, and an audit depth of 320 hours per year. Although these indicators were slightly lower than those of Kernel Holding S.A. and PJSC "MHP", they nevertheless indicate a sufficiently high level of transparency and consistency in financial reporting. LLC "Agroprosperis Trade" received

the lowest average transparency score of 3.9, with a KAM identification frequency of 78% and an audit depth of 290 hours per year. This points to limited detail in reporting and potential risks regarding the completeness and accessibility of financial information for users. The correlation analysis confirmed a positive relationship between transparency and the frequency of KAM disclosure: the highest correlation was observed in Kernel Holding S.A. (0.75), followed by PJSC "MHP" (0.71), LLC Agricultural Enterprise "NIBULON" (0.68), and the lowest in LLC "Agroprosperis Trade" (0.62). This indicates that more detailed disclosure of key audit matters contributes to enhancing the transparency of financial reporting. For the purpose of further in-depth analysis of the transparency of enterprises' financial reporting, a content analysis of the 2023 annual reports was conducted in order to assess compliance with the key IFRS principles – transparency, completeness, reliability, neutrality, and comparability. Table 4 presents the results of the assessment of the enterprises' annual financial statements according to each principle, together with the average score on a five-point scale for each enterprise.

Table 4. Assessment of the compliance of annual financial statements with IFRS principles according to key indicators (2023)

Enterprise	Transparency	Completeness	Reliability	Neutrality	Comparability	Average score
LLC Agricultural Enterprise "NIBULON"	4	4	4	3	3	3.6
Kernel Holding S.A.	5	5	5	4	5	4.8
PJSC "MHP"	4	4	4	3	4	3.8
LLC "Agroprosperis Trade"	3	3	3	3	2	2.8

Source: author's own work based on publicly available financial reporting data from companies and the IFRS Foundation (2024)

The analysis demonstrates that Kernel Holding S.A. received the highest scores across all principles, indicating the systematic and comprehensive application of IFRS together with strict compliance with IAASB standards, thereby ensuring a high level of confidence among users of financial statements. PJSC "MHP" achieved moderate scores. This assessment indicates an overall high level of transparency, although with minor deviations in neutrality, which may affect users' perception of information relating to financial estimates. LLC Agricultural Enterprise "NIBULON" demonstrated a moderate level of transparency, reflecting a sufficient, though not maximum, level of detail and consistency in reporting. LLC "Agroprosperis Trade" received the lowest scores. Insufficient disclosure of KAM and notes, together with the low consistency of reporting forms, indicate the

need to improve the systematic application of IFRS and auditing procedures.

Overall, the results presented in the table make it possible to identify the strengths and weaknesses of the transparency of each enterprise's financial reporting and confirm that the systematic and comprehensive application of IFRS, combined with auditing in accordance with IAASB standards, is a key factor in enhancing the confidence of users of financial information. In order to assess the transparency of enterprises' financial reporting, it is appropriate to apply SWOT analysis, which enables a comprehensive comparison of internal and external factors influencing the quality of information disclosure. Strengths and weaknesses reflect the internal characteristics of the accounting and auditing system, whereas opportunities and threats relate to the external environment. The results of the analysis are summarised in Table 5.

Table 5. SWOT analysis of the transparency of financial reporting by agricultural enterprises

Strengths	Weaknesses
The use of IFRS ensures the international comparability of financial reporting	The presence of difficulties in the transition from National Accounting Standards (NAS) to IFRS
Conducting annual audits in accordance with IAASB standards	Insufficient detail in certain notes to the financial statements
Open access to key audit matters (KAM)	High dependence on external auditors
Opportunities	Threats
Attracting foreign investors through transparent financial reporting	Tightening regulatory requirements and penalty sanctions
Use of digital technologies for the automation of reporting processes	Risk of a formal approach to information disclosure
Harmonisation with the European capital market	Increasing costs of auditing and consultancy services

Source: author's own work

The results of the SWOT analysis indicate that the transparency of the financial reporting of agricultural enterprises was determined by a combination of internal factors related to the organisation of accounting and auditing, as well as external conditions within which the companies operated. Among the strengths, particular emphasis should be placed on the application of IFRS, which ensured unified approaches to the structuring of financial data and made reporting comparable with that of similar companies in global markets. Another advantage was the availability of audit opinions prepared in accordance with IAASB standards. Public access to KAM created additional value for users, as it enabled a better understanding of risks and the professional judgements made by auditors. At the same time, several weaknesses were

identified, particularly the difficulties arising during the transformation of financial reporting from NAS to IFRS. This process required substantial resources and increased the risk of technical errors. In addition, LLC "Agroprosperis Trade" and LLC Agricultural Enterprise "NIBULON" demonstrated insufficient detail within the notes to the financial statements, often limiting disclosures to the repetition of numerical indicators without deeper explanation of accounting policies, estimation judgements, and risks. This complicated the ability of users to conduct a comprehensive assessment of the enterprises' financial condition. Another limitation was the high dependence on external auditors: in cases of changes in audit firms or reductions in audit budgets, the transparency of reporting could decline.

Among the opportunities identified were the attraction of foreign investors and access to international capital markets. This is explained by the fact that international investors tend to favour companies with transparent reporting prepared in accordance with IFRS and audited under IAASB standards. The use of digital technologies in accounting and auditing was regarded as a promising direction capable of reducing the time and resources required for preparing financial statements, while also increasing the level of automation in data disclosure. An additional opportunity for enterprises was the harmonisation of reporting with the requirements of the European capital market, opening access to new financial resources and partnership opportunities. At the same time, threats to reporting transparency remained significant. In particular, increasing regulatory requirements could intensify the administrative burden on enterprises. There also exists a risk of a formal approach to information disclosure, whereby enterprises comply only with the minimum requirements of standards without ensuring sufficient analytical depth in reporting. Financial risks should also be highlighted separately: increasing costs associated with auditing, consultancy services, and preparation for inspections could reduce companies' motivation to comply fully and effectively with international requirements.

Based on a comparative analysis of financial reporting transparency and the results of a SWOT analysis, practical recommendations were developed to enhance the transparency of agricultural enterprises. It is necessary to ensure more detailed disclosure of information in the notes to the financial statements, particularly regarding accounting policies, accounting estimates and risks, which will help to increase user confidence. The systematic application of IFRS and IAASB standards within the internal processes of companies allows for improvements in the reliability and comparability of reporting, while the optimisation of audit procedures – particularly through increasing the depth of audits and the frequency of KAM disclosure – ensures a more accurate reflection of the financial position. The use of modern digital tools and automated systems for the collection and processing of data contributes to faster and more transparent publication of financial information. Furthermore, enterprises must manage external environmental risks by responding promptly to changes in legislation and regulatory requirements, thereby minimising negative impacts on reporting transparency. It is also necessary to improve the qualifications of personnel, particularly accountants and auditors, regarding modern international standards and best practices, ensuring the consistent and correct application of IFRS and IAASB requirements. The implementation of these measures makes it possible to enhance the transparency of financial reporting, strengthen the confidence of investors and creditors, and ensure effective management of financial information.

The mechanisms for enhancing transparency and confidence in financial reporting within the context of the agricultural enterprises under study were visualised in Figure 1.

It reflects a logical and sequential process: from the application of International Financial Reporting Standards and International Standards on Auditing to the improvement of reporting quality, ensured through the disclosure of KAM and in-depth audit procedures. Such visualisation makes it possible to clearly trace how international standards form the foundation for greater transparency and accountability in financial information.

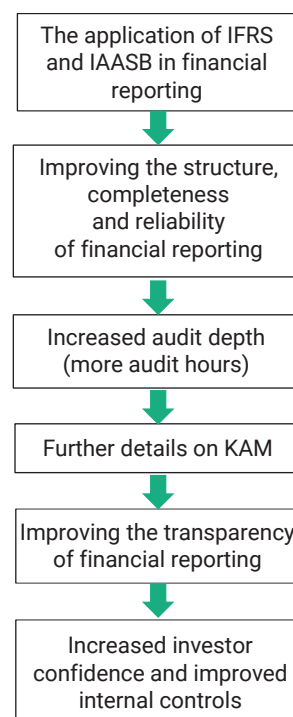


Figure 1. A logical model illustrating the relationship between audit, KAM disclosure and the transparency of financial reporting

Source: the author's own work

The analysis of the infographic demonstrates a consistent chain of influence of international standards on the quality of financial reporting. The application of IFRS encourages companies to increase the level of detail and reliability of information, which positively affects the depth of auditing. The extended duration of audit procedures and more detailed disclosure of KAM contribute to more transparent and reliable financial reporting. This, in turn, increases investor confidence and improves internal control mechanisms within enterprises. Thus, the model confirms the empirical results of the study and the theoretical assumptions regarding the effectiveness of implementing IFRS and IAASB standards within Ukraine's agricultural sector. Overall, the results indicate that the application of international standards has a direct impact on improving the transparency and quality of financial reporting, as well as the level of audit control in the companies under study. The conducted analysis demonstrated that the application of IFRS and IAASB significantly affects the transparency of the financial reporting of large agricultural enterprises.

The findings indicate that compliance with international standards creates conditions for more comprehensive and reliable information disclosure, increases the confidence of users of financial statements, and serves as a foundation for improving corporate practices in the field of accounting and auditing. At the same time, the differences identified between the companies indicate the necessity for further improvement of internal controls and auditing practices, taking into account the scale of business operations and the available resource base.

Discussion

The conducted study made it possible to comprehensively assess the impact of applying International Financial Reporting Standards and International Standards on Auditing on the quality of financial reporting among agricultural enterprises in Ukraine. Empirical evidence was obtained demonstrating statistically significant relationships between the depth of auditing, the frequency of disclosure of Key Audit Matters, and the level of reporting transparency, which confirms the practical effectiveness of international standards in enhancing the reliability of financial information. The identified advantages of structured IFRS reporting, more detailed notes, and higher transparency indicators confirm the effectiveness of regulatory convergence with international practice.

Financial management within the agricultural sector as a factor of economic sustainability was examined in the study by A.C.A. Sheyoputri (2024), which emphasised the necessity of integrating accounting practices into the national policy framework for agricultural development. This approach partially corresponds with the present study, which established that adaptation to IFRS requires not only technical changes, but also a strategic reconsideration of the information policy of agricultural enterprises. A similar theme was observed in the work of T. Lindby & S.F. Løken (2023), who investigated the consequences of transitioning from national standards to IFRS in Norway. Their analysis demonstrated a significant increase in both the volume and depth of disclosures following the implementation of the new standards. In the current study, similar tendencies were observed in the cases of Kernel Holding S.A. and PJSC "MHP", which achieved the highest transparency scores. The issue of the reliability and neutrality of reporting information was raised by M. Nurunabi (2021), who emphasised that these characteristics are decisive in forming trust in financial reporting. This emphasis is consistent with the findings obtained through the content analysis.

A thematically related study by R. Hoinaru *et al.* (2023) was devoted to assessing compliance of disclosures within the agricultural business sector with the requirements of the Global Reporting Initiative (n.d.) and International Accounting Standards (IFRS, n.d.). The authors identified a limited amount of data relating to biological assets, which complicated the assessment of enterprises' ecosystem impacts. Within the framework of the current study,

a sufficient depth of disclosure regarding this category was identified in the financial reporting of large agricultural enterprises, whereas less structured companies demonstrated a lower level of detail and organisation in information presentation. The resource-related challenges associated with the implementation of International Financial Reporting Standards were highlighted in the study by J.U. Akpan *et al.* (2023), which pointed to limited access to qualified personnel and technical infrastructure. The analysis of the financial statements of the enterprises under study revealed similar tendencies: the average assessment of the difficulty of securing resources for the implementation of standards amounted to 3.875 points, indicating the presence of organisational and technological constraints even among large agricultural companies.

The necessity of an appropriate corporate governance system for the effective implementation of IFRS was investigated by M. Kabwe *et al.* (2021). The authors demonstrated that companies with a high level of internal control exhibited better reporting quality. In the present study, a similar correlation was observed in the case of Kernel Holding S.A., where the effectiveness of management processes was confirmed by the structured nature of reporting documentation. A final perspective was presented by M.M. Saeed (2025), who analysed the relationship between the implementation of IFRS and the limitation of earnings management practices. According to his conclusions, increasing transparency through international standards significantly reduces opportunities for profit manipulation. This was partially confirmed within the current study as well: enterprises with the highest transparency scores demonstrated stable relationships between operating profit and net profit.

N.A.A. Effah (2024), in a bibliometric study, traced geographical and thematic shifts in research concerning compliance with international reporting standards across the continent. The author concluded that the majority of publications focused primarily on regulatory barriers rather than on the qualitative dimensions of transparency. This approach differs significantly from the present study, in which the principal emphasis was placed specifically on assessing the qualitative characteristics of reporting, including completeness, neutrality, timeliness, and related attributes. A similar issue was highlighted in the literature review by D. Dariyanti & E.M. Ahmed (2025), who analysed the impact of IFRS on the reporting of agricultural enterprises. The authors identified a low level of consistency in the interpretation of provisions relating to the valuation of biological assets. In the conducted analysis, these difficulties were likewise identified: companies with less detailed descriptions of accounting policies received lower scores according to the neutrality criterion. In another study, N. Van Hoa *et al.* (2022) examined the role of human capital and technological support in improving the quality of accounting and auditing within Vietnam's agricultural sector. The authors emphasised the necessity of systematic personnel training during the implementation

of International Financial Reporting Standards and International Standards on Auditing. The analysis of the practices of the Ukrainian enterprises under study demonstrated that organisational and staffing aspects remain key factors in the implementation of standards, particularly in ensuring professional judgement during the preparation and verification of financial statements.

Theoretical differences in the interpretation of biological assets were also addressed by R.D. Marrufo Garcia & A.M. Cano Morales (2021), who identified discrepancies between accounting practices across various Latin American countries. Primary attention was devoted to the issue of reliability in the valuation of standing crops. In the present study, a similar issue emerged in the difficulty of comparing transparency indicators between companies with differing agricultural profiles. At the same time, T.D. Wijesundara & S. Rashmika (2025) focused on the relationship between financial reporting and the financial sustainability of small enterprises within Sri Lanka's agricultural sector. In contrast to the analysis of large companies conducted in this study, the authors demonstrated that the absence of standardised procedures in accordance with IAASB requirements resulted in limited access to credit financing and low levels of transparency. This distinction highlights the role of enterprise scale in determining the level of reporting openness. Relevant aspects of managerial mechanisms were examined by N. Le *et al.* (2025), who identified corporate governance as one of the key factors influencing the quality of financial disclosures in public agricultural companies in Vietnam. The results of the conducted analysis confirmed this tendency: the highest transparency indicators were demonstrated precisely by those enterprises characterised by the presence of clear internal control procedures.

A completely different organisational model was examined in the study by C. Khadka *et al.* (2024), which analysed the experience of cooperatives in Nepal. The authors found that decentralised structures complicate the unification of accounting approaches, which in turn reduces the level of transparency. Although the focus of the present study was on large corporations, similar challenges concerning standardisation remain relevant within the Ukrainian context as well. Issues of reporting accountability within global agricultural supply chains were analysed by G. Medina & K. Thomé (2021), who examined the Brazilian soybean industry. Their concept of transparency as an element of business accountability corresponds with the approach implemented in the author's model, where explanatory notes to the financial statements constituted an important instrument for communicating information to stakeholders. Institutional conditions of corporate governance and their relationship with profitability and transparency were summarised in the review by M. Almashhadani (2021). The author characterised various governance models and their impact on the quality of non-financial information. The obtained results correspond with the findings of the present study: companies with centralised structures demonstrated higher values according to the criteria of neutrality and reliability.

Another aspect – the combination of financial and non-financial disclosure – was at the centre of the study conducted by J. Lin & M. Qamruzzaman (2023). They demonstrated that combining high-quality reporting with environmental disclosures contributes to improving the overall performance of companies. Although environmental aspects were not analysed within the scope of the present article, the proposed model allows for the future inclusion of such parameters as additional transparency criteria. A similar interdisciplinary approach was implemented by A. Buallay (2022), who investigated the impact of sustainability reporting on the efficiency of agricultural production in developing countries. The author found that transparency is not merely a formal attribute of compliance with standards, but also affects reputation and access to financial resources. This conclusion is consistent with the relationships identified within the author's indicative model, which combines financial and non-financial information for comprehensive assessment. The influence of non-financial factors on the development of reporting practices was analysed by S. Sisaye (2021), who examined the role of non-governmental organisations in shaping voluntary sustainability reporting rules. The study focused on the mechanisms of pressure and persuasion through which international institutions promoted the introduction of voluntary standards. In contrast to this macro-level perspective, the present study was based on an empirical assessment of the transparency of the reporting of specific agricultural enterprises, with particular emphasis on qualitative indicators.

Issues relating to the enhancement of financial reporting transparency in agricultural enterprises were addressed by R. Abiri *et al.* (2023), who investigated the application of technological solutions for optimising accounting processes. The authors noted that the automation of accounting and analytical tools can contribute to improving the accessibility and consistency of data for stakeholders. Within the author's model, these technological factors were considered as one of the aspects influencing the completeness and timeliness of financial information disclosure, without being distinguished as a separate variable. A similar emphasis on the systemic dimension of control was made by A. Quagli *et al.* (2021), who developed a composite indicator for assessing the quality of financial regulation at the national level. The researchers argued that the strength of the regulatory system directly influences the existence of financial controls and compliance with reporting requirements. Unlike this approach, the present study focused not on the country as a whole, but on four specific enterprises, enabling a qualitative comparative assessment of the internal transparency of reporting. The issue of manipulation of reporting information was examined by I.A. Abed *et al.* (2022), who established a relationship between so-called creative accounting and the level of data disclosure. The authors emphasised that excessive freedom in the selection of accounting policies is often used to distort results. This aspect received practical confirmation within the framework of the present study: companies with overly general

or vague notes to the financial statements received lower scores according to the neutrality criterion. The conducted analysis of the research results demonstrated that the application of International Financial Reporting Standards and International Standards on Auditing contributes to increasing the transparency, completeness, and reliability of the financial information of agricultural enterprises. The comparison of the activities of LLC Agricultural Enterprise "NIBULON", Kernel Holding S.A., PJSC "MHP", and LLC "Agroprosperis Trade" demonstrated that the structured implementation of standards, expanded disclosure of Key Audit Matters, and appropriate staffing support contribute to greater detail and consistency in reporting data.

Conclusions

The study demonstrated that the systematic application of International Financial Reporting Standards and International Standards on Auditing significantly enhances the transparency of the financial reporting of agricultural enterprises in Ukraine. The comparative analysis of companies showed that the detailed disclosure of key audit matters and the depth of audit procedures directly influence the quality and completeness of financial statements. The average transparency score of financial reporting was highest for Kernel Holding S.A. at 4.6, while PJSC "MHP" received 4.5, LLC Agricultural Enterprise "NIBULON" – 4.3, and LLC "Agroprosperis Trade" – 3.9. The frequency of KAM identification reflected similar trends: in Kernel Holding S.A. it reached 92%, in PJSC "MHP" – 90%, in LLC Agricultural Enterprise "NIBULON" – 85%, and in LLC "Agroprosperis Trade" – 78%. The depth of audit procedures varied from 290 to 380 hours per year, confirming a direct relationship between audit intensity and the level of transparency. The correlation between transparency indicators and KAM, ranging from 0.62 to 0.75, also demonstrated a moderately strong positive relationship: the more detailed the disclosure of key audit aspects, the greater the transparency of financial reporting.

The content analysis of the 2023 annual reports showed that the financial reporting of Kernel Holding S.A. was the most detailed and transparent, with an average score

of 4.8 according to the key IFRS principles, whereas PJSC "MHP" achieved 3.8, LLC Agricultural Enterprise "NIBULON" – 3.6, and LLC "Agroprosperis Trade" – 2.8. These results confirmed the conclusion regarding the direct relationship between the systematic application of IFRS, the depth of auditing, and the level of financial reporting transparency. The SWOT analysis identified the strengths of large enterprises, particularly the high level of reporting detail and compliance with international standards, as well as the weaknesses of smaller companies, including limited disclosure in the notes and less consistent application of standards. Opportunities for improving transparency are associated with the standardisation of reporting formats, the strengthening of internal controls, and the expansion of audit procedures, while potential threats include insufficient staff qualifications and limited resources for conducting audits. Thus, enhancing the transparency of financial reporting is possible only through the comprehensive implementation of standards, internal controls, and auditing. Practical recommendations include the systematic application of methodologies for transforming national reporting into international reporting standards, the improvement of internal control procedures and compliance with auditing standards, as well as the development of professional competencies among personnel to maintain a high level of transparency in financial data. Prospects for further research involve expanding the sample of agricultural enterprises, analysing the dynamics of financial reporting transparency in the context of accounting digitalisation, and assessing the impact of automated auditing systems and ESG reporting on the quality of financial information disclosure.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] Abed, I.A., Hussin, N., Haddad, H., Almubaydeen, T.H., & Ali, M.A. (2022). Creative accounting determination and financial reporting quality: The integration of transparency and disclosure. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(1), article number 38. doi: 10.3390/joitmc8010038.
- [2] Abiri, R., Rizan, N., Balasundram, S.K., Shahbazi, A.B., & Abdul-Hamid, H. (2023). Application of digital technologies for ensuring agricultural productivity. *Heliyon*, 9(12), article number e22601. doi: 10.1016/j.heliyon.2023.e22601.
- [3] Akpan, J.U., Akinadewo, I.S., & Osatuyi, Y.A. (2023). International Financial Reporting Standards (IFRS) and Small and Medium sized Enterprises (SMEs): Assessing the impact of IFRS adoption on SMEs. *World Journal of Finance and Investment Research*, 7(4), 34-56. doi: 10.56201/wjfir.v7.no4.2023.pg34.56.
- [4] Almashhadani, M. (2021). A brief review of corporate governance structure and corporate profitability in developed and developing economy: A review. *International Journal of Business and Management Invention*, 10(11), 42-46. doi: 10.35629/8028-1011024246.
- [5] Buallay, A. (2022). Sustainability reporting and agriculture industries' performance: Worldwide evidence. *Journal of Agribusiness in Developing and Emerging Economies*, 12(5), 769-790. doi: 10.1108/JADEE-10-2020-0247.

- [6] Dariyanti, D., & Ahmed, E.M. (2025). [The impact of International Accounting Standards \(IAS 41\) on agricultural financial reporting: A systematic literature review](#). In 4th Sivas international conference on scientific and innovation research (pp. 1461-1472). Sivas: Sivas University of Science and Technology.
- [7] Dubinina, M., Potryvaieva, N., Dovgal, O., Usykova, O., & Kuzoma, V. (2024). Integrated approach to accounting in agriculture in the context of sustainable development and circular economy. *Scientific Horizons*, 27(12), 153-167. [doi: 10.48077/scihor12.2024.153](#).
- [8] Effah, N.A.A. (2024). A bibliometric review of IFRS adoption and compliance research in Africa. *Journal of Business and Socio-economic Development*, 4(3), 193-209. [doi: 10.1108/JBSED-01-2023-0001](#).
- [9] Global Reporting Initiative. (n.d.). Retrieved from <https://www.globalreporting.org/>.
- [10] Golocialova, I., & Cojocaru, M. (2025). [The matrix of indicators for recognizing the agribusinesses ecosystem assets: Convergence of System of Environmental-Economic Accounting \(SEEA\) and International Financial Reporting Standards \(IFRS\)](#). *Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development*, 25(1), 429-437.
- [11] Hoinaru, R., Buda, D., Subić, J., & Jansen, A. (2023). [Financial and non-financial disclosures for agriculture: Is there any connection between GRI 13 and IAS 41?](#) *Revista de Management Comparat Internațional*, 24(2), 158-172.
- [12] Hubaryk, O. (2025). [International financial reporting and auditing standards as the basis of trust in accounting information in the agricultural sector](#). In H. Pavlova & N. Vasylieva (Eds.), *Accounting, financial, and economic support for sustainable development of the agricultural sector: Theoretical foundations and practical recommendations: Collective monograph* (pp. 98-117). Dnipro: Marsymovska Y.A.
- [13] iBuhgalter. (2025). *Financial results report: Let's fill it out together (Form No. 2)*. Retrieved from <https://surl.li/qmctij>.
- [14] IFRS Foundation. (2024). *IFRS Sustainability Licensing*. Retrieved from <https://surl.li/emxmey>.
- [15] IFRS. (n.d.). *IAS 41 Agriculture*. Retrieved from <https://surl.li/xgsaaf>.
- [16] International Auditing and Assurance Standards Board (IAASB). (n.d.). *2025 Handbook of International Quality Management, Auditing, Review, Other Assurance, and Related Services Pronouncements*. Retrieved from <https://www.iaasb.org/standards-pronouncements>.
- [17] Kabwe, M., Mwanaumo, E., & Chalu, H. (2021). Effect of corporate governance attributes on IFRS compliance: Evidence from a developing country. *Corporate Governance*, 21(1), 1-22. [doi: 10.1108/CG-03-2020-0103](#).
- [18] Kernel. (n.d.). Retrieved from <https://www.kernel.ua/ua/about/>.
- [19] Khadka, C., Pandey, G., Poudel, A., & Cudnilova, E. (2024). Assessing financial management practices and accounting mechanisms in agricultural cooperatives: A case study from Nepal. *Management Studies*, 12(3), 146-171. [doi: 10.17265/2328-2185/2024.03.002](#).
- [20] Le, N., Nguyen, L.Q., Nguyen, T.T.L., & Nguyen, V.C. (2025). Determinants of corporate governance on financial information transparency of listed agricultural companies in Vietnam. *IOP Conference Series: Earth and Environmental Science*, 1465(1), article number 012003. [doi: 10.1088/1755-1315/1465/1/012003](#).
- [21] Limited Liability Company "Agroprosperis Trade". (n.d.). Retrieved from <https://opendatabot.ua/c/36328597>.
- [22] Lin, J., & Qamruzzaman, M. (2023). The impact of environmental disclosure and the quality of financial disclosure and IT adoption on firm performance: Does corporate governance ensure sustainability? *Frontiers in Environmental Science*, 11, article number 1002357. [doi: 10.3389/fenvs.2023.1002357](#).
- [23] Lindby, T., & Løken, S.F. (2023). [The effects on the financial statement of adoption of IFRS from NGAAP: Evidence from Norway](#). (Master's thesis, Handelshøyskolen BI, Oslo, Norway).
- [24] Marrufo Garcia, R.D., & Cano Morales, A.M. (2021). Accounting treatment of biological assets and agricultural products. *Visión de Futuro*, 25(2), 63-80. [doi: 10.36995/j.visiondefuturo.2021.25.02R.002.en](#).
- [25] Medina, G., & Thomé, K. (2021). Transparency in global agribusiness: Transforming Brazil's soybean supply chain based on companies' accountability. *Logistics*, 5(3), article number 58. [doi: 10.3390/logistics5030058](#).
- [26] MHP. (n.d.). *You Control*. Retrieved from https://youcontrol.com.ua/catalog/company_details/25412361/.
- [27] Ministry of Finance of Ukraine. (2019). *Form No. 1 "Balance sheet (statement of financial position)"*. Retrieved from https://mof.gov.ua/storage/files/forma_1_ds.pdf.
- [28] Ministry of Finance of Ukraine. (n.d.). *Regulatory framework for accounting in the business sector*. Retrieved from <https://mof.gov.ua/uk/nacionalni-polozhennja1>.
- [29] LLC NIBULON. (n.d.). *You Control*. Retrieved from https://youcontrol.com.ua/catalog/company_details/14291113/.
- [30] Nurunnabi, M. (2021). Disclosure, transparency, and international financial reporting standards. In *International Financial Reporting Standards implementation: A global experience* (pp. 199-311). Leeds: Emerald Publishing. [doi: 10.1108/978-1-80117-440-420211005](#).
- [31] Quagli, A., Lagazio, C., & Ramassa, P. (2021). From enforcement to financial reporting controls (FRCs): A country-level composite indicator. *Journal of Management and Governance*, 25(2), 397-427. [doi: 10.1007/s10997-020-09518-w](#).
- [32] Rodriguez-Galindo, R., et al. (2024). Enhancing financial transparency in non-profit organisations: Challenges and integration of IFRS for SMEs, IFR4NPO, and GRI standards. *Journal of Infrastructure, Policy and Development*, 8(11), article number 7988. [doi: 10.24294/jipd.v8i11.7988](#).

- [33] Saeed, M.M. (2025). The impact of mandatory IFRS adoption on earnings management and its implications for the cost of debt in emerging economies. *International Journal of Disclosure and Governance*, 23, 348-364. doi: 10.1057/s41310-025-00312-4.
- [34] Shebanina, O., Burkovska, A., Petrenko, V., & Burkovska, A. (2023). Economic planning at agricultural enterprises: Ukrainian experience of increasing the availability of data in the context of food security. *Agricultural and Resource Economics: International Scientific E-Journal*, 9(4), 168-191. doi: 10.51599/are.2023.09.04.08.
- [35] Sheyoputri, A.C.A. (2024). Theoretical review: Financial management in the agribusiness sector and its implications for economic growth. *Atestasi: Applied Science & Innovation Journal*, 7(2), 828-851. doi: 10.57178/atestasi.v7i2.887.
- [36] Sisaye, S. (2021). The influence of non-governmental organizations (NGOs) on the development of voluntary sustainability accounting reporting rules. *Journal of Business and Socio-economic Development*, 1(1), 5-23. doi: 10.1108/JBSED-02-2021-0017.
- [37] Thijsel, A.M., Flayyih, H.H., & Faisal, G.M. (2025). *IFRS adoption and credit rating in Iraqi banks: The mediating role of governance and implications for agricultural finance*. *AgBioForum*, 27(1), 46-60.
- [38] Van Hoa, N., Duyen, N.T.H., Huyen, V.N., Quang, H.V., Tu, N.T.C., & Nguyet, B.T.M. (2022). *Impact of trained human resources, adoption of technology and international standards on the improvement of accounting and auditing activities in the agricultural sector in Vietnam*. *AgBioForum*, 24(1), 59-71.
- [39] Vasilic, M., & Savić, B. (2025). Accounting for agricultural activity: How transparent are Serbian companies? *Economics of Agriculture*, 72(2), 557-597. doi: 10.59267/ekoPolj2502577V.
- [40] Wijesundara, T.D., & Rashmika, S. (2025). *Financial reporting and sustainability of agribusiness SMEs: Evidence from Sri Lanka*. (Master's thesis, Umeå University, Umeå, Sweden).

Роль бухгалтерського обліку та аудиту у підвищенні прозорості фінансової звітності аграрних підприємств у контексті міжнародних стандартів

Євген Терехов

Кандидат економічних наук, доцент
Національний технічний університет Дніпровська політехніка
49005, просп. Дмитра Яворського, 19, м. Дніпро, Україна
<https://orcid.org/0000-0002-4816-6072>

Анотація. Метою дослідження було оцінити вплив міжнародних стандартів фінансової звітності та міжнародних стандартів аудиту на прозорість фінансової звітності великих аграрних підприємств України у період 2020-2024 років. Дослідження охопило діяльність чотирьох компаній: товариство з обмеженою відповідальністю сільськогосподарське підприємство «НІБУЛОН», Kernel Holding, приватне акціонерне товариство «Миронівський хлібопродукт» та товариство з обмеженою відповідальністю «Агропросперіс Трейд». У дослідженні було застосовано комплекс методів, зокрема контент-аналіз, порівняльний аналіз та SWOT-аналіз, що дозволило всебічно оцінити прозорість фінансової звітності аграрних підприємств. Результати показали, що найбільш прозорою фінансовою звітністю володіє Kernel Holding із середнім балом прозорості 4,6, а за нею йде приватне акціонерне товариство «Миронівський хлібопродукт» із показником 4,5. Товариство з обмеженою відповідальністю сільськогосподарське підприємство «НІБУЛОН» отримало 4,3, а товариство з обмеженою відповідальністю «Агропросперіс Трейд» – 3,9. Частота виявлення ключових аудиторських питань становила від 78 % у «Агропросперіс Трейд» до 92 % у Kernel Holding, а глибина аудиторської перевірки варіювала від 290 до 380 годин на рік відповідно. Аналіз структури звітності засвідчив значні відмінності між національними та міжнародними стандартами, зокрема більшу деталізацію активів, зобов'язань, доходів та розкриття облікової політики і ризиків за міжнародними стандартами. SWOT-аналіз показав, що основними можливостями для підвищення прозорості є уніфікація форматів звітності, посилення внутрішнього контролю та поглиблення аудиторських процедур, тоді як серед ключових загроз – обмежені ресурси для проведення аудиту та нестабільність зовнішнього середовища. Отримані результати мають практичне значення для керівників аграрних підприємств, аудиторських фірм та регуляторних органів, оскільки можуть бути використані для підвищення прозорості фінансової звітності, адаптації внутрішніх процедур до вимог міжнародних стандартів та вдосконалення аудиторських практик.

Ключові слова: сільськогосподарський бізнес; облікова політика; аудиторські практики; корпоративне управління; професійне судження

Theoretical and methodological foundations of delegating management powers in healthcare institutions

Olha Lytvynova

PhD in Medical Sciences, Associate Professor

I. Horbachevsky Ternopil National Medical University

46001, 1 Maidan Voli, Ternopil, Ukraine

<https://orcid.org/0000-0003-1039-3904>

Nataliia Slobodian*

PhD in Economics Sciences, Associate Professor

I. Horbachevsky Ternopil National Medical University

46001, 1 Maidan Voli, Ternopil, Ukraine

<https://orcid.org/0009-0000-6990-4188>

Abstract. The relevance of this study is driven by the specific nature of healthcare institutions, which are characterised by a high level of professional autonomy among medical personnel, substantial responsibility for patients' health and lives, as well as strict regulatory constraints. The combination of these factors makes the issue of delegating managerial authority particularly significant, yet insufficiently explored both in theoretical and applied dimensions. The purpose of this article was to substantiate the theoretical and methodological foundations of delegating managerial authority within healthcare institution management in order to enhance the efficiency and effectiveness of administrative activities. The research methodology included general scientific and specialised methods, in particular the analysis and synthesis of scholarly sources, systemic and structural functional approaches, comparative analysis, generalisation, and logical modelling of managerial processes in healthcare organisations. The study refined the conceptual essence of delegation in the management of a healthcare institution as a complex administrative process involving the transfer of tasks, authority, and responsibility while maintaining an appropriate level of control and accountability. The article highlighted the specific features of implementing line and functional authority in the management system of healthcare institutions and identifies their advantages and limitations. Particular attention was paid to identifying the major risks associated with delegation, including insufficient staff competence, loss of managerial control, communication barriers, psychological resistance to change, professional burnout, reduced standardisation of medical care, as well as legal and ethical threats. The practical significance of the research findings lies in their applicability for healthcare managers seeking to improve delegation mechanisms by enhancing staff training, standardising administrative procedures, clearly delineating responsibilities, and strengthening systems of control and feedback

Keywords: professional autonomy; managerial responsibility; delegation risks; management efficiency

Received: 08.01.2026, Revised: 23.04.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Lytvynova, O., & Slobodian, N. (2026). Theoretical and methodological foundations of delegating management powers in healthcare institutions. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 44-55. doi: 10.52566/msu-econ2.2026.44.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (slobodyanno@tdmu.edu.ua)

Introduction

Contemporary transformational processes within healthcare systems are increasing the demands placed on the effective management of healthcare facilities. In their research on organisational development, V.H. Alkema *et al.* (2023) highlighted the necessity of implementing modern managerial approaches that enhance adaptability. Under conditions of decentralisation and the autonomisation of healthcare institutions, O.O. Shevchenko *et al.* (2021) argued that rising competition and limited resources necessitate a rational distribution of managerial functions. Furthermore, according to the World Health Organization (2025), such a strategic redistribution across different management levels is vital for strengthening national health systems. Consequently, the delegation of managerial authority emerges as a crucial mechanism for improving both the efficiency and effectiveness of managerial activities. In the management of healthcare organisations, delegation is viewed not only as an organisational necessity but also as a complex managerial process that involves the transfer of authority, responsibility, and resources while simultaneously maintaining oversight and accountability. Ineffective or merely formal delegation leads to managerial overload, reduced quality of decision-making, staff demotivation, and disruptions in internal communication processes, thereby undermining the overall functioning of healthcare institutions.

Despite the considerable body of research in the field of general management, the issue of delegating managerial authority within healthcare institutions remains insufficiently systematised. This gap stems from the specific nature of medical practice, the societal significance of healthcare services, the high degree of professional autonomy among healthcare workers, and the regulatory constraints that shape managerial decisions. These factors underscore the need for a more comprehensive theoretical and methodological elaboration of delegation as an integral component of healthcare management systems. This necessity determines the relevance and purpose of the present study.

The issues of delegation and the strategic distribution of authority in healthcare continue to attract considerable scholarly attention. Contemporary studies demonstrate that ineffective delegation is closely associated with missed nursing care, disruptions in care continuity, and compromised patient safety, emphasising the importance of wellstructured authority distribution within healthcare teams (Papathanasiou *et al.*, 2024). Similarly, analyses of organisational performance reveal that inadequate staffing, unbalanced workloads, and insufficient clarity in delegated responsibilities create systemic risks that negatively influence patient outcomes and organisational stability (Oliveira *et al.*, 2024). The World Health Organization (2025) emphasised that modern healthcare transformations require a fundamental rethinking of managerial authority. Digitalisation is reshaping managerial functions, creating demand for new models of decisionmaking, coordination, and functional responsibility within healthcare institutions. Furthermore, governance-oriented studies

underscore the critical role of transparency, accountability, and multilevel coordination in improving managerial efficiency and strengthening the resilience of national health.

European scholars have increasingly focused on the critical link between managerial authority and organisational safety. In their recent analysis, A.-K.L. Hansen *et al.* (2024) demonstrated that an expanded span of control negatively affects a manager's capacity to ensure high-quality care, noting that increased workload stress often reduces supervisory effectiveness within complex hospital environments. Within the Ukrainian academic context, strategic documents emphasise ongoing reforms in healthcare governance. The Strategy for the Development of the Healthcare System of Ukraine until 2030 (2025) outlines modern approaches to coordination, distribution of authority, and strengthening managerial autonomy aligned with European integration processes. Analytical contributions further demonstrate that healthcare managers must increasingly reallocate routine operational responsibilities to focus on strategic decision-making, leadership development, and valuebased care (Sayyed *et al.*, 2024). Concurrently, recent scholarly interpretations of Mintzberg's work emphasise the necessity of collaborative rather than strictly hierarchical models of managerial interaction within healthcare organisations (Tian *et al.*, 2023).

Collectively, these studies form a contemporary theoretical framework that substantiates the need for systemic, evidencebased approaches to delegating managerial authority in healthcare organisations. Such approaches are essential for improving management performance, strengthening accountability, and enhancing the resilience and strategic capacity of healthcare systems. The aim of the article was to substantiate the theoretical and methodological principles of delegating managerial authority in healthcare management in order to enhance the overall efficiency and effectiveness of managerial activities.

Materials and Methods

The research was based on a comprehensive systematic approach and employed a combination of theoretical, analytical, and qualitative methods. The study was conducted in three interrelated stages to ensure the objectivity and reproducibility of results regarding the delegation of managerial authority in healthcare organisations (HCOs). The first stage involved an indepth documentary and theoretical analysis of the regulatory and conceptual framework of healthcare management. This included the study of national legislation, strategic governance documents, and international guidelines that outline the legal and managerial boundaries of authority distribution in healthcare. Key sources examined were the national regulatory framework shaped by public administration reforms in Ukraine (Shevchenko *et al.*, 2021) and contemporary WHO recommendations on strengthening health system governance (World Health Organization, 2025). The analysis focused on classical management principles such as the "scalar

chain” and “span of control”, tracing how formal authority is transferred from senior executives to middle and lower-level managers. Foundational management literature, including M.H. Mescon *et al.* (1988), and modern Ukrainian academic contributions (Alkema *et al.*, 2023), supported the refinement of the conceptual essence of delegation as a process involving the transfer of tasks while maintaining ultimate accountability.

The second stage applied structuralfunctional modeling and comparative analysis to distinguish the distribution of line and functional authority within multidisciplinary healthcare institutions. Particular attention was given to the practical implementation of delegation in clinical environments where functional authority – such as infection control, quality management, or clinical audit – intersects with linear administrative hierarchies. Spanofcontrol parameters were incorporated analytically based on findings of A.-K.L. Hansen *et al.* (2024), demonstrating how expanded managerial spans affect supervision quality, workload, and coordination processes in hospital management systems. Furthermore, the risks associated with delegation in clinical pathways and parallel authority structures were examined through recent international evidence on the managerial consequences of insufficiently defined responsibilities and their relationship to quality and safety (Papathanasiou *et al.*, 2024; Oliveira *et al.*, 2024).

The third stage relied on logical induction and qualitative risk identification to formulate managerial models for effective delegation under varying organisational conditions. Using fundamental management principles, particularly unity of command and parity between authority and responsibility (Mescon *et al.*, 1988), the study developed logical frameworks for delegating both routine operational tasks and critical, timesensitive clinical decisions. Qualitative synthesis enabled the identification of systemic barriers to effective delegation within HCOs, grouped into clinical risks (related to patient outcomes), legal risks (arising from shifts in responsibility), and psychological factors (such as lack of confidence, fear of liability, and burnout among staff). The analysis integrated recent crossdisciplinary findings on leadership effectiveness and managerial decision-making in modern healthcare systems (Sayyed *et al.*, 2024), as well as contemporary international perspectives on collaborative, nonhierarchical healthcare management models (Tian *et al.*, 2023). This triangulated methodological approach enabled the development of evidencebased recommendations for strengthening delegation practices through managerial training, standardised decisionmaking procedures, and enhanced feedback mechanisms in the context of ongoing healthcare decentralisation and governance reforms (The Ministry of Health of Ukraine, 2025).

Results and Discussion

Conceptual foundations of delegation in healthcare management

As was defined by I. Papathanasiou *et al.* (2024), delegation refers to the transfer of tasks and authority from a

manager to a subordinate who assumes responsibility for their execution. The effective functioning of the complex interaction system between managers and subordinates within a healthcare institution does not presuppose that a single manager performs all managerial functions. This is attributed to the multilevel structure of healthcare management, the diversity of functional tasks, and the high dynamism of the external environment. Concentrating managerial authority in one pair of hands leads to overload, reduced quality of managerial decisions, slower decision-making processes, and diminished responsiveness to environmental changes. Additionally, the inherent limitations of individual managerial resources – such as time, competencies, and cognitive capacity – objectively necessitate the distribution of managerial functions across different levels and actors within the organisation. Delegation of authority enables the engagement of the professional potential of healthcare personnel, increases staff responsibility and motivation, supports the development of managerial competencies, and contributes to the formation of an effective system of internal communication. Collectively, these factors enhance the performance and resilience of the organisation, as noted by M.H. Mescon *et al.* (1988).

An integral component of delegation is authority itself, understood as the bounded right to utilise organisational resources and guide the efforts of subordinate employees toward completing assigned tasks. For instance, in a multidisciplinary healthcare institution, the chief executive officer may delegate to the head of a clinical department the authority to organise diagnostic and treatment processes within that unit. This includes planning staff workflows, forming duty schedules, allocating material and technical resources, and coordinating physicians and nursing personnel to achieve established quality indicators of medical care. At the same time, this authority remains limited, as the department head operates within the approved budget, institutional policies, and standards of medical care. Strategic decisions regarding institutional development, financing, and human resource policy remain within the purview of senior management.

A functionally decisive component of delegation, as defined by V.H. Alkema *et al.* (2023), is responsibility – an obligation to complete assigned tasks and to be accountable for the quality of their execution. The chief executive officer assigns to the head of a clinical department responsibility for ensuring compliance with clinical protocols and quality indicators. The department head must organise the work of physicians and nursing staff to guarantee timely and high-quality medical services, minimise medical errors, and ensure proper maintenance of medical documentation. Regardless of the fact that tasks are completed by subordinate staff, the department head bears personal accountability for the unit's performance. It is important to emphasise that authority is delegated to a position, not the individual who occupies it. When an employee changes roles, the authority associated with the previous position is terminated and replaced by the authority inherent in the new one. Building on this understanding of responsibility and the formal

allocation of authority within organisational roles, V.H. Alkema *et al.* (2023) distinguished between line and functional

authority depending on the nature of delegation. The comparison of these types of authorities is summarised in Table 1.

Table 1. Comparison of line and functional authority in healthcare management

Criterion	Line authority	Functional authority
Nature	Hierarchical	Cross-functional
Decision-making	Direct, mandatory	Advisory or specialised
Scope	Within chain of command	Across departments
Example	Medical director → department head	Infection control service
Advantage	Clear accountability	Professional specialisation
Limitation	Rigidity	Potential conflicts

Source: developed by authors based on V.H. Alkema *et al.* (2023)

Line authority is transferred directly from a superior to a subordinate and then cascades to lower levels. It constitutes a legally sanctioned power enabling a manager to make decisions within the scope of their responsibilities without requiring additional approval from higher management. Delegation of line authority shapes the hierarchical structure of healthcare organisations – a scalar chain or chain of command. Modern healthcare leadership research emphasises that effective delegation requires clear delineation of administrative and clinical lines of authority, especially under conditions of organisational complexity (Spanos *et al.*, 2024). This aligns with contemporary views that leadership in healthcare must integrate collaborative, cross-functional, and adaptive decision-making to maintain quality and safety in dynamic clinical environments. An example of line authority in a healthcare institution is the managerial authority exercised by a medical director over departmental heads. The medical director has the right to issue mandatory directives regarding diagnostic and treatment organisation, staff scheduling, and adherence to internal policies and clinical standards. Department heads, in turn, exercise line authority over physicians, nursing staff, and junior personnel by assigning tasks, monitoring performance, and applying managerial measures within their competence. Thus, line authority establishes a clear vertical structure of governance within a healthcare institution, ensures unity of command, enables timely decisionmaking, and reinforces personal accountability for performance outcomes at each managerial level.

An example of line authority in a healthcare institution is the managerial authority exercised by a medical director over the heads of structural units. The medical director has the right to issue mandatory directives to department heads regarding the organisation of diagnostic and treatment processes, staff work schedules, and adherence to internal policies and standards of medical care. Department heads, in turn, exercise line authority over physicians, nursing staff, and junior medical personnel by assigning tasks, monitoring performance, and applying managerial measures within their scope of competence, as noted by

A.M. Malik & E.G. Elorrio (2023). Thus, line authority establishes a clear vertical structure of governance within a healthcare institution, ensures unity of command, enables timely decision making, and reinforces personal accountability for performance outcomes at each managerial level (Spanos *et al.*, 2024).

An example of functional authority within a healthcare institution, according to E. Tsapnidou *et al.* (2024), is the authority exercised by managers and specialists of specialised services who have the right to influence the activities of other departments within the scope of their professional competence, even though they are not part of their direct line of command. For instance, the medical director or the deputy director for clinical services is vested with functional authority regarding the implementation and monitoring of compliance with clinical treatment protocols across all departments of the institution. As noted by V. Loving (2025), individuals exercising functional authority have the right to provide methodological guidance, request adjustments to diagnostic and treatment processes, initiate internal audits of the quality of care, and suspend the use of treatment methods that do not comply with approved standards, regardless of the line subordination of department heads. Similarly, the chief nursing officer exercises functional authority over nursing services in all structural units by establishing standardised requirements for patient care, maintaining sanitary and epidemiological safety, and managing the use of medical products. Thus, functional authority ensures professional specialisation in management, standardisation of processes, and improvement in the overall quality of healthcare institution operations.

Delegation process and managerial model

Digital transformation in healthcare further complicates these structures, necessitating flexible delegation models. To clarify how authority operates in such settings, different types of functional authority can be distinguished. Table 2 presents the main types of functional authority, along with their descriptions and examples.

Table 2. Types of functional authority

Type of authority	Description	Example
Legitimate	Based on formal position	Director authority
Advisory	Provides recommendations	Clinical committee

Table 2, Continued

Type of authority	Description	Example
Mandatory coordination	Requires approval	New clinical pathways
Parallel	Independent but simultaneous decisions	Protocols vs scheduling

Source: developed by authors

Legitimate authority in a healthcare institution is exemplified by the powers of the director of a municipal non-profit enterprise. Under the Law of Ukraine “Fundamentals of Health Care Legislation of Ukraine” (1992), the institution’s charter, and the contract with the owner, the director has the right to independently issue orders concerning the organisation of the institution’s operations. The director may also approve job descriptions, establish work schedules for structural units, and appoint responsible individuals for occupational safety and infection control without requiring additional approval from higher-level authorities.

Advisory authority within a healthcare institution is exercised, for example, by a clinical expert committee or a medical director who does not issue mandatory directives but provides professional recommendations for physicians and department heads. Based on the analysis of clinical cases, the committee may propose improvements to treatment protocols, the appropriateness of diagnostic methods, or modifications in managing complex patients. Recommendations are considered in clinical decision making but are not mandatory unless specified in internal regulatory documents. Likewise, the infection control service may develop recommendations to improve sanitary practices, which serve as the basis for managerial decisions (Tsapnidou *et al.*, 2024).

Mandatory coordination authority arises in situations where a functional manager must seek agreement or approval from line managers before implementing decisions. For example, when the medical director plans to introduce new clinical pathways, such decisions must be coordinated with department heads, as their implementation directly affects workflows, staff load, and the use of resources. The chief nursing officer likewise must coordinate revised standards or schedules with department heads to ensure continuity of care and prevent conflicts (Spanos *et al.*, 2024).

Parallel authority refers to decisions made independently yet simultaneously by a functional manager and line managers within a healthcare institution. For example, a medical director may develop new clinical protocols for chronic disease management, while department heads organise the work of their units in accordance with internal schedules and staff distribution. The medical director’s decisions (regarding protocols) and those of the department heads (regarding operational organisation) function in parallel,

complementing one another to ensure high-quality care. Similarly, the chief nursing officer may establish standards of nursing care for all departments, while department heads organise the allocation of nurses and staff rotations. Their decisions coexist: the chief nursing officer oversees adherence to standards, while line managers ensure their implementation (Loving, 2025; Aljamal *et al.*, 2025). Thus, parallel authority allows the integration of specialised expert functions with operational line management, enhancing the efficiency of healthcare institution performance. Under a manager’s supervision, four types of units may operate (Fig. 1).

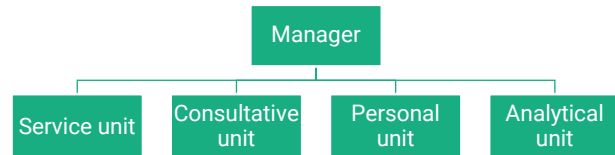


Figure 1. Types of specialised units in parallel authority
Source: compiled by the authors

A service unit is responsible for performing specific tasks (planning department, human resources department, labour and payroll department, accounting, procurement, etc.). A consultative unit consists of specially invited consultants working on a permanent or temporary basis. In healthcare institutions, this typically includes specialists who provide expert consultations to patients and recommendations to physicians across departments but are not engaged in continuous inpatient care. A personal unit includes employees who interact directly with the manager (secretary, assistant, aide, etc.). An information or information analytical unit provides the manager with essential communication and analytical support (Dougherty *et al.*, 2022).

Shortcomings in management often stem from a dual resistance: a manager’s reluctance to delegate authority and a subordinate’s unwillingness to assume responsibility. W. Newman (1955) identified specific barriers to effective delegation, which remain foundational to management theory. Building upon this framework, N. Baum (2025) further explored the psychological dimensions of these barriers, highlighting that managers often avoid delegation due to several internal factors. These multifaceted barriers can be systematically categorised into two perspectives: those originating from the supervisor and those originating from the subordinate (Table 3).

Table 3. Barriers to effective delegation in healthcare management

Factors leading to managers’ reluctance	Factors leading to subordinates’ resistance
Overestimation of capabilities	Fear of criticism and responsibility
Lack of confidence in managerial abilities	Low self-confidence in performing new or complex tasks

Table 3, Continued

Factors leading to managers' reluctance	Factors leading to subordinates' resistance
Distrust of subordinates' competence and reliability	Lack of necessary information, resources, or authority to complete tasks
Fear of risk and accountability for subordinates' errors	Excessive workload and inability to take on additional responsibilities
Absence of effective control mechanisms for monitoring delegated tasks	Lack of incentives or motivation for assuming additional responsibility
High-risk nature of healthcare decisions	Insufficient competence or experience in performing delegated tasks
Lack of clear standards, protocols, or regulatory support	Uncertainty in situations where procedures or guidance are not clearly defined
High level of legal and financial responsibility	Reluctance to assume responsibility associated with financial or legal consequences
Presence of conflicts of interest or political/organisational pressure	
Crisis or emergency situations requiring centralised decision-making	

Source: compiled by the authors based on W.H. Newman (1955), N. Baum (2025)

One primary reason is the “self-enhancement bias” – the belief that “I can do it better myself” – which leads to an overestimation of one’s own capabilities. Conversely, a lack of confidence in one’s managerial abilities or a fundamental distrust of subordinates can also inhibit the process. Additionally, N. Baum (2025) noted that a fear of risky decision-making and the absence of selective control mechanisms, which are necessary for the early detection of threats, further contribute to this reluctance. Healthcare managers may further avoid delegation in situations involving high stakes decisions – those directly affecting patient life and health, such as the assignment of complex or high-risk treatment procedures, surgical interventions, or the use of new techniques, where errors may carry severe consequences. Insufficient staff competence may also hinder delegation if subordinates lack the necessary knowledge, skills, or experience to make independent decisions within delegated authority. Delegation may also be avoided when clear standards or protocols are lacking, or when there are no regulatory or internal documents defining the task, meaning any mistake could lead to legal or clinical consequences. High levels of responsibility and risk – for instance, procurement of expensive medical equipment, contractual agreements, or licensing – can further limit managers’ willingness to delegate, as pointed by S. Khan (2024). Delegation is also withheld in situations involving conflicts of interest or political pressure, where personal involvement of the manager is required due to internal or external political, financial, or social factors. Finally, a chief executive officer will typically avoid delegation during transitional or crisis situations – such as epidemics, emergencies, or technical failures – when centralised and rapid decision making is more effective than distributed authority (Aljamal *et al.*, 2025).

Subordinates may also refuse to accept delegated authority. This most often occurs due to a lack of initiative and fear of addressing problems independently. Low

self-confidence and fear of criticism are likewise common reasons for declining delegated responsibilities. A lack of necessary information and resources, excessive workload, and an absence of additional incentives may also hinder effective delegation, as noted by A.M. Hassan *et al.* (2024). In a healthcare institution, subordinates may refuse delegated authority in situations of insufficient competence or experience. For example, a junior physician or nurse may decline to make independent decisions regarding the use of new and complex treatment methods if they have not completed appropriate training or clinical rotations. A senior nurse may refuse a request from the department head to coordinate activities across several units during equipment repairs when no approved procedures exist. A physician may also decline to sign procurement documents for expensive medical materials or pharmaceuticals due to the associated financial responsibility and managerial oversight. Excessive workload can likewise lead to refusal; for instance, a nurse may decline additional responsibilities for organising shift schedules for the entire department due to staff shortages and the impossibility of performing all duties effectively.

Principles of effective delegation

Following the systematisation of key barriers to effective delegation presented in Table 3, it is important to consider not only the factors that hinder delegation, but also the principles that ensure its successful implementation in practice. While the identified barriers reflect typical challenges faced by both managers and subordinates, overcoming them requires adherence to well-established management principles. Therefore, to complement the analysis of barriers, Figure 2 illustrates the key six principles of effective delegation in healthcare institutions, which serve as a conceptual framework for improving managerial practices and minimising the impact of the aforementioned limitations.

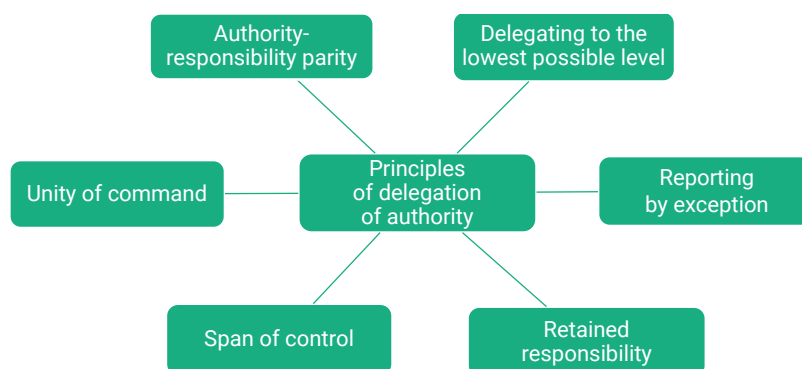


Figure 2. Key principles of effective management delegation in healthcare institutions

Source: compiled by the authors based on World Health Organization (2025)

According to the principle of unity of command, an employee should receive authority only from one superior and be accountable solely to that person. For example, a general practitioner in an outpatient clinic receives assignments related to patient management only from the head of the therapeutic department and reports exclusively to them, rather than simultaneously to the medical director or another department manager. Another principle underlying delegation is the principle of span of control. The span of control refers to the number of subordinates directly managed by a supervisor. At higher management levels, this number typically ranges from 4 to 8 employees, and at lower levels from 8 to 15 (Hansen *et al.*, 2024). For instance, the head of a surgical department supervises 10 physicians and 5 nurses, which corresponds to the span of control appropriate for mid-level management. The medical director does not assign the department head responsibility for an additional 20 physicians from other units to avoid excessive managerial burden.

The principle of retained responsibility means that only the superior of the delegating manager can relieve them of responsibility. Delegation is a process of distributing responsibility to subordinates, but delegating responsibility does not absolve the manager who delegated it. For example, if a subordinate forgets to complete a task, both the subordinate and the manager share accountability. If a chief physician delegate monitoring of surgical room sterility to a senior nurse, and a violation occurs leading to patient infection, responsibility lies both with the senior nurse and the department head who delegated the authority. The principle of authority-responsibility parity states that the scope of delegated authority must correspond to the assigned duties. If a manager assigns a task to a subordinate, they must provide adequate authority for task completion, including the right to use necessary human and financial resources. The principle of reporting by exception requires subordinates to report to their superior only actual or anticipated deviations from expected outcomes. The principle of delegating authority to the lowest possible level states that tasks, according to D.A. Radhakrishnan & M. Suresh (2025), should be assigned to the lowest organisational level capable of performing them effectively.

Delegation in management offers numerous advantages that contribute to more efficient organisational performance, staff development, and the achievement of strategic goals. In the management of healthcare institutions, delegation provides significant benefits for enhancing organisational efficiency and productivity (Sayyed *et al.*, 2024; Spanos *et al.*, 2024). Managers can concentrate on strategic and high priority tasks by delegating routine and operational responsibilities to subordinates, thereby optimising their use of time. For example, a hospital director may delegate to the senior nurse the supervision of shift schedules and daily staff assignments, allowing the director to focus on strategic planning for institutional development. Similarly, a department head may distribute the workload and delegate the organisation of routine patient examinations to junior physicians, enabling faster completion of appointments while preventing managerial overload.

Delegating tasks supports increased motivation, as employees feel trusted and responsible. Through delegation, staff gain opportunities to develop new skills and knowledge by performing unfamiliar tasks (Tsapnidou *et al.*, 2024; Cesilia *et al.*, 2025). For instance, a senior physician may delegate consultations involving new diagnostic methods to a junior colleague, providing them with valuable experience and contributing to professional development. A nurse may be assigned responsibility for organising preventive vaccinations within the department, increasing motivation by reinforcing trust and accountability. Delegation also strengthens teamwork and collaboration, fostering trust between managers and subordinates. For example, a department head may delegate to the senior nurse the responsibility of supervising other nurses' compliance with clinical procedures, demonstrating confidence in her competence. A surgeon may delegate the organisation of pre operative patient preparation to medical residents, enhancing interaction and coordination between clinical and academic staff (Loving, 2025; Samokishchuk, 2025). As previously emphasised, the purpose of delegation is the effective use of resources, optimisation of human capital, and consequently, improved productivity. For example, a senior nurse may delegate the collection of laboratory samples to junior nurses, ensuring optimal

utilisation of each staff member's skills. A laboratory manager may delegate routine analyses to technicians, allowing the manager to focus on more complex examinations and thereby improving overall departmental productivity (Hansen *et al.*, 2024; Augustyn *et al.*, 2026).

Delegation enables chief executives to enhance management and oversight by freeing up time for the development and implementation of strategic initiatives. For instance, a department head may delegate monitoring of sterility standards to nurses, allowing more focus on evaluating the effectiveness of treatment processes (Malik & Elorrio, 2023). Delegation encourages employees to propose new ideas and solutions, fostering innovation within the organisation. The distribution of tasks also helps identify inefficiencies and improve operational processes. For example, a laboratory manager may assign younger staff the task of exploring new methods for automating analyses, stimulating innovation (Dougherty *et al.*, 2022; Tsapnidou *et al.*, 2024). A department head may delegate oversight of patient examinations to nurses, enabling them to identify workflow delays and optimise processes. A multi-perspective approach to delegation allows a hospital director to assign the preparation of resource allocation options to both the financial and medical departments, thus obtaining diverse viewpoints to support sound decision making. Similarly, a department head may delegate the development of treatment protocols for complex patients to specialised experts (such as cardiologists or gastroenterologists), improving the quality of clinical decisions (Spanos *et al.*, 2024; Sayyed *et al.*, 2024).

Delegation enhances an organisation's ability to respond quickly to change and adapt to new circumstances. For example, a medical director may delegate to senior staff the task of adjusting work schedules during an epidemic, enabling timely responses to evolving conditions. The distribution of tasks and responsibilities also prevents dependency on a single individual and ensures organisational resilience – for instance, when a department head delegates the organisation of vaccination procedures to nurses, ensuring continuity of operations and reducing vulnerability to staff absences (Oliveira *et al.*, 2024; Augustyn *et al.*, 2026). Delegation of routine and operational tasks helps managers reduce stress and prevent burnout.

A hospital director may delegate the organisation of daily briefings to deputy directors, reducing personal workload and increasing the deputies' professional standing (Smirnova & Chabaniuk, 2021; Hansen *et al.*, 2024).

Delegation also enables employees to feel valued and significant, enhancing job satisfaction and loyalty. Staff gain new opportunities for career growth and advancement when, for example, a nurse who supervises departmental shifts through delegated authority acquires managerial experience and becomes eligible for promotion to a senior position (Layek & Koodamara, 2025; Samokishchuk, 2025). Thus, effective delegation of authority in management enhances organisational performance, supports employee development, increases motivation, and fosters favourable conditions for innovation and organisational growth (Spanos *et al.*, 2024; Cesilia *et al.*, 2025).

In summary, the application of clearly defined delegation principles, combined with an awareness of typical barriers, creates a coherent framework for improving managerial effectiveness in healthcare institutions. The integration of unity of command, appropriate span of control, retained responsibility, authority-responsibility parity, reporting by exception, and delegation to the lowest competent level ensures that tasks are distributed rationally while maintaining accountability and control. When these principles are consistently applied, delegation becomes not merely a managerial technique but a strategic tool that enhances organisational adaptability, optimises the use of human resources, and strengthens professional development. Ultimately, effective delegation contributes to sustainable organisational performance and supports the delivery of high-quality healthcare services.

Risks, associated with delegation of authority and possible consequences

Delegation of authority in the management of healthcare institutions is an important tool for enhancing the timeliness of managerial decisions and ensuring the continuity of clinical and diagnostic processes. At the same time, this managerial mechanism is associated with a number of risks that may negatively affect the quality of medical services, organisational efficiency, and patient safety, which are summarised in Table 4.

Table 4. The risks of delegation of authority and possible consequences

Risk category	Description	Consequence
Clinical	Errors due to low competence	Patient safety issues
Organisational	Loss of control	Inefficiency
Communication	Misinterpretation of tasks	Delays
Psychological	Burnout, resistance	Low motivation
Legal	Undefined responsibility	Liability risks

Source: developed by authors

One of the key limitations is the insufficient level of professional competence among personnel to whom managerial or clinical-organisational functions are delegated. Assigning authority to employees who lack adequate

qualifications, experience, or training increases the likelihood of errors in decision making, disruption of patient care pathways, and deviations from approved clinical standards (Hassan *et al.*, 2024; Augustyn *et al.*, 2026). The

absence of continuous professional development, clear job descriptions, and internal protocols further complicates effective implementation of delegated tasks. A significant risk is the loss of managerial and clinical control. When the boundaries of responsibility between administrators, physicians, and nursing staff are not clearly defined, functions may be duplicated or “zones of irresponsibility” may emerge. This negatively affects compliance with treatment standards, sanitary and epidemiological requirements, and managerial procedures (Smirnova & Chabaniuk, 2021; Hansen *et al.*, 2024).

Communication inconsistencies within the institution also play a critical role. Insufficient information exchange between administrative and clinical staff during the delegation process may lead to misinterpretation of assigned tasks, delays in service provision, and increased organisational errors. The lack of systematic feedback prevents timely adjustment of managerial decisions and contributes to the accumulation of structural problems (Malik & Elorrio, 2023; Spanos *et al.*, 2024).

Another important category of limitations is formed by psychological factors and staff resistance. In healthcare practice, delegation is often perceived as an additional burden without corresponding financial or professional incentives. Increased responsibility for treatment outcomes and the potential medico legal consequences of errors may cause reluctance among staff to accept new functions or participate in managerial decision making (Smirnova & Chabaniuk, 2021; Samokishchuk, 2025).

Psychological overload and professional burnout are also common outcomes of irrational task distribution. Concentrating a large number of tasks among a small group of specialists reduces work capacity, worsens performance quality, and decreases staff motivation (Hansen *et al.*, 2024; Layek & Koodamara, 2025). Ignoring individual strengths, specialisation, and experience negatively affects employee engagement. A particularly serious risk is the reduction of standardisation in medical care. Poorly implemented delegation may lead to variability in the execution of identical functions, contradicting the principles of evidence-based medicine and standardised clinical protocols (Dougherty *et al.*, 2022).

Delegation may also become a source of internal organisational conflict, especially between departments or professional groups. Competition for resources, influence over decision making, and status within the management system can harm the psychological climate and impede interprofessional collaboration (Spanos *et al.*, 2024; Cesilia *et al.*, 2025). Another critical limitation arises from legal and ethical risks. Assigning authority without proper regulatory grounding may result in violations of legislation, licensing requirements, and professional standards. Delegating decisions that directly influence diagnosis, treatment, and patient safety is particularly risky, as it increases the likelihood of medical errors and legal disputes (Augustyn *et al.*, 2026). In summary, irrational distribution of managerial and functional authority within healthcare institutions

leads to imbalanced workloads, inefficient use of human resources, and deteriorating institutional performance. Therefore, delegation should be implemented based on clearly defined competence criteria, regulatory documentation, and systematic oversight (Malik & Elorrio, 2023; Layek & Koodamara, 2025).

To minimise the disadvantages of delegation, several measures must be considered. First, employees must receive the necessary training and skill development prior to delegation (Augustyn *et al.*, 2026). For example, in a paediatric clinic, a nurse may complete advanced training in injections and patient management so that, after training, the physician can safely delegate certain procedures. Clear instructions and expectations must also be defined for delegated tasks. In a surgical ward, for instance, a physician may prepare a step-by-step operating room preparation protocol for junior staff to ensure clarity and prevent errors (Smirnova & Chabaniuk, 2021).

In family medicine clinics, department heads may conduct weekly meetings with nurses to review work results, correct mistakes, and provide guidance on delegated responsibilities, thus ensuring regular monitoring and feedback, as pointed out by R. Samokishchuk (2025). Tasks should be delegated considering employees' abilities, qualifications, and interests. For example, in a dental clinic, an assistant with a strong interest in orthodontics may be assigned to assist with bracket placement, aligning tasks with competencies and enhancing motivation (Cesilia *et al.*, 2025). Building trusting relationships also enhances delegation effectiveness. For instance, in a therapeutic outpatient clinic, the department head may organise team-building activities and regular meetings where employees can discuss challenges, fostering trust and enabling safe delegation of complex tasks (Spanos *et al.*, 2024; Loving, 2025). Modern reforms in the healthcare delivery system – driven by decentralisation, digitalisation, growing competition, and limited resources – objectively increase the importance of effective management within healthcare institutions. Under these conditions, the delegation of managerial authority emerges not as an auxiliary tool, but as a key mechanism for ensuring managerial effectiveness, organisational resilience, and the quality of medical services.

The specific nature of the healthcare sector, which is defined by high professional autonomy among medical staff, significant societal expectations, and strict regulatory requirements, necessitates adapting general management approaches to the unique characteristics of the field. Consequently, delegation must be grounded in systematic, evidence-based principles that take into account both organisational and clinical dimensions of healthcare activities. Thus, the delegation of managerial powers in the healthcare system should be viewed as a strategic management instrument aimed at optimising resource use, improving the effectiveness of managerial decisions, ensuring the quality and safety of medical services, and strengthening the institutional capacity and resilience of the healthcare system as a whole.

The findings of this study demonstrate that the delegation of managerial authority in Ukrainian healthcare institutions is a multifaceted process that significantly influences organisational performance. The analysis confirms that effective delegation enhances managerial efficiency by enabling leaders to concentrate on strategic development, which is particularly relevant in the context of the ongoing healthcare reform in Ukraine (Shevchenko *et al.*, 2021). Unlike a routine redistribution of tasks, the proposed competence-based approach ensures that professional autonomy is balanced with strict accountability.

The study reveals that the coexistence of line and functional authority creates a unique management environment. The importance of line authority for ensuring unity of command is evident; however, as shown in the authors' results, functional authority plays a crucial role in standardising clinical processes. This aligns with the global trends identified by S. Spanos *et al.* (2024), who emphasise that navigating complexity in modern healthcare requires leaders to possess advanced competencies in cross-functional coordination. The authors' data supports the argument that hierarchical structures must become more flexible to respond to operational disruptions.

A critical aspect identified in the research is the impact of delegation on staff motivation and the risks of professional burnout. It was found that unclear division of responsibilities often leads to "zones of irresponsibility" and psychological resistance. This correlation is further supported by the work of K. Smirnova & A. Chabaniuk (2021), who highlighted that staff demotivation in modern conditions is frequently a consequence of poor organisational communication and emotional overload. By integrating human resource development into the delegation model, healthcare managers can mitigate these risks and enhance institutional resilience. Furthermore, the results emphasise that delegation is not merely an administrative technique but a strategic tool for ensuring the quality of medical care. The identified connection between structured delegation and adherence to clinical standards reinforces the idea that delegation must be strictly regulated. This perspective expands upon the management theories discussed in work of B.W.C.A. Tian *et al.* (2023), suggesting that the "myths of healthcare management" can be overcome through transparent oversight and robust feedback systems.

In conclusion, the identified risks and limitations associated with the delegation of authority highlight the necessity of its careful and structured implementation within healthcare institutions. While delegation offers substantial benefits in terms of efficiency, flexibility, and staff development, its improper application may lead to clinical errors, organisational dysfunction, communication breakdowns, and legal vulnerabilities. Therefore, a balanced approach that combines clearly defined competencies, regulatory support, effective communication, and continuous monitoring is essential. By aligning delegation practices with both managerial principles and the specific requirements of the healthcare sector, institutions can mitigate potential risks while

preserving the advantages of decentralised decision making. Ultimately, well-regulated delegation serves not only as a mechanism for task distribution but also as a strategic instrument for ensuring patient safety, organisational stability, and the sustainable development of healthcare systems.

Conclusions

The study has established that the delegation of authority is an essential management tool in healthcare institutions, aimed at enhancing managerial efficiency, rationalising the distribution of functions, and ensuring continuity of clinical and diagnostic processes. It has been determined that delegation in healthcare organisations is a complex process that involves not only the transfer of tasks but also the assignment of corresponding authority and responsibility, with managerial control necessarily retained. The effectiveness of this process depends on the level of professional competence of the staff, the clarity of regulatory frameworks, and the quality of internal communication.

The research has shown that the use of line and functional authority within healthcare management systems ensures a balance between timely decisionmaking and adherence to standards of medical practice. However, this requires clear delineation of areas of responsibility among managers, physicians, and nursing staff. It also has been substantiated that violations of the principles of authority – responsibility parity, unity of command, optimal span of control, and accountability lead to reduced effectiveness of managerial decisions, increased complexity in coordinating staff activities, and heightened organisational risks. The study also has identified that delegation in healthcare institutions is accompanied by specific risks, including insufficient staff training, loss of managerial and clinical control, communication inconsistencies, psychological resistance among employees, professional burnout, decreased standardisation of medical care, emergence of internal conflicts, as well as legal and ethical violations. It has been demonstrated that these risks are systemic in nature and can negatively affect not only organisational efficiency but also the quality and safety of medical services.

Prospects for further research in this area include the development of effective delegation models that account for the organisational maturity of healthcare institutions, the type of facility (primary, secondary, or tertiary care), and specific human resource capacities. Additionally, the evaluation of delegation effectiveness requires further study, particularly through the development of a system of quantitative and qualitative indicators. Such indicators would allow for determining the impact of delegation on the quality of medical services, managerial risk levels, and staff satisfaction.

Acknowledgements

The authors express their gratitude to the administration of the I.Ya. Horbachevsky Ternopil National Medical University for the technical support and access to the information resources of the Department of Public Health and Healthcare Management, which facilitated this research.

Funding

None.

Conflict of Interest

None.

References

- [1] Aljamal, B.A., Nimer, M., Zroog, S.A., & Alkhaldi, M. (2025). Leadership styles in health crisis management. *International Journal of Science and Research Archive*, 16(1), 226-233. doi: [10.30574/ijrsra.2025.16.1.1541](https://doi.org/10.30574/ijrsra.2025.16.1.1541).
- [2] Alkema, V.H., Sumets, O.M., & Kyrychenko, O.S. (2023). *Management of a healthcare institution: A textbook*. Kyiv: University of Economics and Law "KROK".
- [3] Augustyn, R., Demkiv, I., & Omelchenko, Yu. (2026). Improving the management of human resources potential in healthcare institutions. *Herald of Khmelnytskyi National University. Economic Sciences*, 350(1), 532-538. doi: [10.31891/2307-5740-2026-350-73](https://doi.org/10.31891/2307-5740-2026-350-73).
- [4] Baum, N. (2025). The road less traveled: The route to effective delegation. *Healthcare Administration Leadership & Management Journal*, 3(2), 86-89. doi: [10.55834/halmj.6382704810](https://doi.org/10.55834/halmj.6382704810).
- [5] Cesilia, R., Paramarta, V., & DeSousa Guterres, A. (2025). Analysis of transformational leadership relationships, work motivation, and employee performance in healthcare facilities. *MORFAI Journal*, 5(1), 22-28. doi: [10.54443/morjai.v5i1.2526](https://doi.org/10.54443/morjai.v5i1.2526).
- [6] Dougherty, S., Lorenzoni, L., Marino, A., & Murtin, F. (2022). The impact of decentralisation on the performance of health care systems: A non-linear relationship. *The European Journal of Health Economics*, 23, 705-715. doi: [10.1007/s10198-021-01390-1](https://doi.org/10.1007/s10198-021-01390-1).
- [7] Hansen, A.-K.L., Jacobsen, C.B., & Dalgaard, V.L. (2024). Span of control and well-being outcomes among hospital frontline managers: Too much to handle? *BMJ Leader*, 9(1), 31-35. doi: [10.1136/leader-2024-000978](https://doi.org/10.1136/leader-2024-000978).
- [8] Hassan, A.M., et al. (2024). *The role of nursing leadership delegation in managing workload and staff shortage during crisis: A systematic review*. *International Journal of Medical Toxicology & Legal Medicine*, 27(3), 182-189.
- [9] Khan, S. (2024). *Effective delegation of authority: A cornerstone for operational excellence in healthcare business*. Retrieved from <https://www.linkedin.com>.
- [10] Law of Ukraine No. 2801-XII "Fundamentals of Health Care Legislation of Ukraine". (1992, November). Retrieved from <https://zakon.rada.gov.ua/laws/show/2801-12#Text>.
- [11] Layek, D., & Koodamara, N.K. (2025). Motivation on contextual performance in healthcare settings: The influence of work engagement and transformational leadership. *International Journal of Healthcare Management*, 1-14. doi: [10.1080/20479700.2025.2520945](https://doi.org/10.1080/20479700.2025.2520945).
- [12] Loving, V. (2025). Optimising doctor-administrator leadership dyads in healthcare organisations. *BMJ Leader*. doi: [10.1136/leader-2024-001127](https://doi.org/10.1136/leader-2024-001127).
- [13] Malik, A.M., & Elorrio, E.G. (2023). Governance and management in healthcare organizations: Their different roles in driving safety and quality. *International Journal for Quality in Health Care*, 35(3), article number mzad046. doi: [10.1093/intqhc/mzad046](https://doi.org/10.1093/intqhc/mzad046).
- [14] Mescon, M.H., Albert, M., & Khedouri, F. (1988). *Management (3rd ed.)*. New York: Harper & Row.
- [15] Newman, W.H. (1955). *Administrative action: The techniques of organization and management*. Englewood Cliffs: Prentice-Hall.
- [16] Oliveira, R., Santinha, G., & Sá Marques, T. (2024). The impacts of health decentralization on equity, efficiency, and effectiveness: A scoping review. *Sustainability*, 16, article number 386. doi: [10.3390/su16010386](https://doi.org/10.3390/su16010386).
- [17] Papathanasiou, I., Tzenetidis, V., Tsaras, K., Zyga, S., & Malliarou, M. (2024). Missed nursing care; prioritizing the patient's needs: An umbrella review. *Healthcare*, 12(2), article number 224. doi: [10.3390/healthcare12020224](https://doi.org/10.3390/healthcare12020224).
- [18] Radhakrishnan, D.A., & Suresh, M. (2025). *Leadership during crisis in healthcare: A systematic literature review*. In *Information systems for intelligent systems* (Vol. 430) (pp. 535-544). Singapore: Springer.
- [19] Samokishchuk, R. (2025). Models of motivation of medical workers in modern conditions. *Economy and Society*, 78. doi: [10.32782/2524-0072/2025-78-147](https://doi.org/10.32782/2524-0072/2025-78-147).
- [20] Sayyed, A., Sahu, S., Kanyal, D., & Sable, S. (2024). Effective leadership strategies in healthcare: A narrative review. *Multidisciplinary Reviews*, 8(3), article number 2025090. doi: [10.31893/multirev.2025090](https://doi.org/10.31893/multirev.2025090).
- [21] Shevchenko, O.O., Rabotnikov, S.P., & Heiko, O.V. (2021). Improving the mechanism of public governance of the healthcare system in Ukraine: Issues of public policy in the context of reform. *State and Regions*, 4(74), 99-104. doi: [10.32840/1813-3401.2021.4.15](https://doi.org/10.32840/1813-3401.2021.4.15).
- [22] Smirnova, K., & Chabaniuk, A. (2021). Causes, consequences and ways to overcome staff demotivation in modern conditions. *Economy and Society*, 32. doi: [10.32782/2524-0072/2021-32-30](https://doi.org/10.32782/2524-0072/2021-32-30).
- [23] Spanos, S., Leask, E., Patel, R., Datyner, M., Loh, E., & Braithwaite, J. (2024). Healthcare leaders navigating complexity: A scoping review of key trends in future roles and competencies. *BMC Medical Education*, 24, article number 720. doi: [10.1186/s12909-024-05689-4](https://doi.org/10.1186/s12909-024-05689-4).
- [24] The Ministry of Health of Ukraine. (2025). *Strategy for the development of the healthcare system of Ukraine for the period up to 2030*. Retrieved from <https://healthstrategy2030.com.ua>.

- [25] Tian, B.W.C.A., Catena, F., Agnoletti, V., Lusenti, C., Bravi, F., & Carradori, T. (2023). Book review: Managing the myths of health care by Henry Mintzberg. *Discover Health Systems*, 2, article number 18. doi: 10.1007/s44250-023-00030-0.
- [26] Tsapnidou, E., Kelesi, M., Rovithis, M., Katharakis, G., Gerogianni, G., Dafogianni, C., Toyli, G., Fasoi, G., & Stavropoulou, A. (2024). Transformational leadership – quality achievements and benefits for healthcare organizations: A scoping review. *Hospitals*, 1, 87-103. doi: 10.3390/hospitals1010008.
- [27] World Health Organization. (2025). *Strengthening health systems governance*. Retrieved from <https://www.who.int>.

Теоретико-методологічні засади делегування управлінських повноважень у менеджменті закладів охорони здоров'я

Ольга Литвинова

Кандидат медичних наук, доцент

Тернопільський національний медичний університет імені І. Я. Горбачевського

46001, Майдан Волі, 1, м. Тернопіль, Україна

<https://orcid.org/0000-0003-1039-3904>

Наталія Слободян

Кандидат економічних наук, доцент

Тернопільський національний медичний університет імені І. Я. Горбачевського

46001, Майдан Волі, 1, м. Тернопіль, Україна

<https://orcid.org/0009-0000-6990-4188>

Анотація. Актуальність даного дослідження зумовлена специфікою діяльності закладів охорони здоров'я, які характеризуються високим рівнем професійної автономії медичного персоналу, значною відповідальністю за здоров'я та життя пацієнтів, а також жорсткими нормативно-правовими обмеженнями. Сукупність цих чинників робить проблему делегування управлінських повноважень особливо значущою та водночас недостатньо дослідженою як у теоретичному, так і в прикладному аспектах. Метою статті було обґрунтування теоретико-методологічних засад делегування управлінських повноважень у менеджменті закладів охорони здоров'я для підвищення ефективності та результативності управлінської діяльності. У процесі дослідження було використано загальнонаукові та спеціальні методи, зокрема аналіз і синтез наукових джерел, системний та структурно-функціональний підходи, порівняльний аналіз, узагальнення, а також логічне моделювання управлінських процесів у закладах охорони здоров'я. У результаті дослідження уточнено сутність делегування в менеджменті закладу охорони здоров'я як складного управлінського процесу, що передбачає передачу завдань, повноважень і відповідальності із збереженням належного рівня контролю та підзвітності. Розкрито особливості реалізації лінійних і функціональних повноважень у системі управління закладами охорони здоров'я, визначено їхні переваги та обмеження. Особливу увагу приділено ідентифікації основних ризиків делегування, серед яких недостатня компетентність персоналу, втрата управлінського контролю, комунікаційні бар'єри, психологічний опір змінам, професійне вигорання, зниження рівня стандартизації медичної допомоги, а також юридичні й етичні загрози. Практична цінність отриманих результатів полягає у можливості їх використання керівниками закладів охорони здоров'я для вдосконалення механізмів делегування шляхом підвищення рівня професійної підготовки персоналу, стандартизації управлінських процедур, чіткого розмежування відповідальності та посилення системи контролю й зворотного зв'язку.

Ключові слова: професійна автономія; управлінська відповідальність; ризики делегування; ефективність управління

The economic implications of shadow AI in Georgia's public sector

Irakli Manvelidze*

Doctor of Public Administration, Professor
Shota Rustaveli State University of Batumi
6010, 35/32 Ninoshvili Str., Batumi, Georgia
<https://orcid.org/0000-0001-6422-2049>

Abstract. The purpose of this study was to systematically investigate the scale, drivers, and economic implications of Shadow AI in Georgia's public sector, and to propose evidence-informed policy interventions for enhancing AI readiness, workforce productivity, and fiscal risk mitigation. Although over 70% of public servants globally use AI tools, systematic empirical research on unauthorised "Shadow AI" in Georgia is lacking. To address this gap, a convergent mixed-methods design was employed, including a survey of 322 public servants, 15 semi-structured interviews, a three-round Delphi panel with 12 experts, a Ministry of Internal Affairs case study, and systematic document analysis. Quantitative survey data, qualitative interviews, and Delphi panel inputs were integrated to achieve methodological triangulation. Findings showed that 52.8% of public servants use AI tools (17.4% daily), while 42.9% engage in Shadow AI. Institutional readiness is limited: only 14.3% have a formal AI policy, 61.5% received no AI training, and 54% enter sensitive data into AI platforms. Thematic analysis identified five patterns: Silent Innovation, Double Standard, Training Desert, Data Fear, and Lack of Trust. Logistic regression shows that perceived productivity gains ($OR = 2.34, p < .01$) and absence of formal policy ($OR = 3.12, p < .001$) are significantly associated with Shadow AI adoption. These findings suggested coexisting productivity gains and unmitigated institutional risks, including inefficiencies from unmanaged AI use, uneven human capital development, and fiscal exposure from data breaches or algorithmic errors. The study suggested a contextual adaptation of the Unified Theory of Acceptance and Use of Technology (UTAUT), providing evidence that in transition economies perceived usefulness may outweigh absent facilitating conditions. For policymakers and public administrators, the research proposes four actionable interventions: mandatory AI literacy programs, a regulatory sandbox for controlled experimentation, AI Champions networks for peer support, and revised performance evaluation systems. These recommendations are designed to enhance economic efficiency, mitigate fiscal risks, and promote responsible governance in Georgia and comparable post-Soviet transition economies

Keywords: digital transformation; generative AI; institutional readiness; data privacy; UTAUT model; administrative efficiency; transition economies

Received: 18.12.2025, Revised: 16.04.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Manvelidze, I. (2026). The economic implications of shadow AI in Georgia's public sector. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 56-67. doi: 10.52566/msu-econ2.2026.56.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (irakli.manvelidze@bsu.edu.ge)

Introduction

AI is increasingly transforming public sector operations worldwide, reshaping workforce productivity, administrative efficiency, and service delivery models. While global adoption of AI tools among public servants is accelerating, institutional readiness for their effective governance remains uneven, particularly in transition economies. This growing gap between individual-level adoption and organisational capacity raises important concerns regarding economic efficiency, fiscal risk, and administrative accountability.

Existing evidence suggests that AI use in the public sector is already widespread, with over 70% of public servants globally reporting engagement with AI tools in their daily work, according to Mission Square Research Institute (2025). However, institutional readiness remains limited, as many governments lack the capacity to effectively regulate and integrate these technologies (Barcelona Provincial Council, 2025). In Georgia, this challenge is particularly pronounced. Although AI diffusion has reached 18.2% of the workforce in 2025 (Microsoft, 2025), the country still ranks 87th in the Government AI Readiness Index (Oxford Insights, 2025), indicating a structural imbalance between technological adoption and institutional preparedness. This divergence may result in inefficiencies, uneven human capital development, and fiscal risks associated with unmanaged AI use. Institutional assessments confirm these limitations. IDFI (2021) indicated that formal AI governance frameworks in Georgia remain underdeveloped, with limited regulatory definitions and weak oversight mechanisms. Although Georgia has engaged with international governance initiatives, including the Council of Europe's AI Convention, implementation gaps remain significant (IDFI, 2024a).

At the workforce level, capacity constraints are also evident. A large proportion of public servants have not received formal AI-related training, and only a small share operates within institutions that have established AI governance policies, as was noted by E. Tskhvariashvili (2025). This increases the likelihood of informal or unregulated AI use in public administration. Importantly, discrepancies between official data and actual practice have been identified by national oversight institutions. The Public Defender of Georgia (2025) reported significant gaps between officially reported AI usage and actual practices within public institutions, suggesting that the true scale of AI adoption may be underestimated in formal statistics.

A growing concern in this context is the phenomenon of "Shadow AI", defined by R. Farrell (2025) as the unsanctioned or unregulated use of AI tools within organisational settings. While this phenomenon has been widely discussed in advanced economies, empirical evidence from transition contexts, such as Georgia, remains limited. Shadow AI presents a dual dynamic, simultaneously contributing to productivity gains while introducing risks related to data security, accountability, and decision transparency. The phenomenon of Shadow AI is not unique to Georgia but reflects a broader regional challenge. A

large-scale study in Latvia (N = 1,557) revealed that more than half of public sector employees express limited trust in AI-generated information, with only seven participants out of 1,557 fully trusting AI. Furthermore, G. Lāma & A. Lastovska (2025) found that employees who received formal AI training rated their competence significantly higher than those without training. Given these challenges, there is a need to better understand how AI is adopted in Georgia's public sector, what competencies are required for its responsible use, and how institutions should adapt to emerging technological realities.

However, existing literature on Shadow AI presents two unresolved debates. First, while some studies such as J. Waters-Lynch *et al.* (2024) emphasise organisational control and formal governance as necessary responses, others, such as R. Farrell (2025), suggest that informal adoption may drive innovation that formal channels suppress. Second, evidence from advanced economies dominates the field, with limited attention to how weak institutional environments – characterised by absent policies, fragmented governance, and low AI literacy – shape Shadow AI dynamics. This study engages with both debates by examining a transition economy context where institutional constraints may paradoxically accelerate informal adoption while magnifying associated risks. The purpose of this study was to systematically investigate the scale, drivers, and economic implications of Shadow AI in Georgia's public sector, and to propose evidence-informed policy interventions for enhancing AI readiness, workforce productivity, and fiscal risk mitigation. Accordingly, this study addressed the following research questions: what is the scale of AI diffusion in Georgia's public sector, and how can Shadow AI be empirically conceptualised; what competencies are required for the effective and responsible use of AI among public servants; how do institutional factors influence patterns of AI adoption and governance in the public sector and what policy measures could enhance AI readiness and economic efficiency in Georgia's public administration.

Materials and Methods

This study adopted a convergent parallel mixed-methods design, following the methodological frameworks proposed by J.W. Creswell (2014) and A. Bryman (2016). Quantitative survey data, qualitative interview data, and Delphi panel inputs were integrated to achieve methodological triangulation across multiple sources of evidence. The research design was structured to address four inter-related research questions concerning the scale of AI diffusion, the prevalence of Shadow AI, workforce competencies, administrative adaptation, and policy instruments in Georgia's public sector.

A survey of 322 public servants was conducted between September and November 2025 using a stratified random sampling approach. The sampling frame encompassed all public institutions in Georgia, with an estimated total public sector workforce of approximately 32,000 employees.

Stratification was based on three dimensions: institution type (central government ministries, local government municipalities, and independent agencies), geographic location (Tbilisi metropolitan area, regional centres, and rural areas), and hierarchical level (senior management, middle management, and frontline staff). The sample composition was compared against available population parameters, showing reasonable alignment on institutional type but overrepresentation of Tbilisi-based respondents relative to regional distribution. Consequently, findings are best interpreted as indicative rather than statistically representative of the entire public sector workforce.

The survey instrument consisted of 25 items measured on five-point Likert scales (1 = strongly disagree to 5 = strongly agree), covering five domains: demographic characteristics; frequency and purposes of AI use; training experiences and needs; institutional readiness and policy environment; and Shadow AI behaviours alongside risk awareness. Pilot testing with 20 public servants yielded a Cronbach's alpha coefficient of $\alpha = 0.87$, indicating a high level of internal consistency across the instrument. Data

were collected using Google Forms, achieving an overall response rate of 65.8% following three follow-up reminders. A brief non-response bias check compared early versus late respondents across key demographic variables (institution type, geographic location); no statistically significant differences were detected ($p > 0.10$ for all comparisons), suggesting that non-response does not substantially distort the findings. All surveys and parts of research, involving people, were conducted in accordance with ethical research principles, including voluntary participation, informed consent, confidentiality, and anonymity of respondents, in line with the principles of the Declaration of Helsinki (World Medical Association, 1964).

Statistical analysis was conducted using SPSS version 28. The analytical strategy included descriptive statistics, independent-samples t-tests, one-way analysis of variance (ANOVA), chi-square tests of independence, Pearson correlation analysis, and binary logistic regression, following established guidelines (Field, 2018). Table 1 presents the theoretical framework linking each research question to its corresponding conceptual foundation.

Table 1. Theoretical framework correspondence to research questions

Research Question	Theoretical Component
1. Scale of AI diffusion and Shadow AI	Shadow IT/AI (Waters-Lynch <i>et al.</i> , 2024; Farrell, 2025)
2. New skills and competencies	TAM/UTAUT (Davis, 1989; Venkatesh <i>et al.</i> , 2003; OECD, 2026)
3. Adaptation of administrative system	Diffusion of Innovations (Rogers, 2003); Digital Era Governance (Dunleavy <i>et al.</i> , 2006)
4. Policy instruments for Georgia	Digital Era Governance + EU AI Act (IDFI, 2024a); Council of Europe Convention (IDFI, 2024b)

Note: the table presents the conceptual linkage between the study's research questions and the theoretical frameworks applied. Shadow AI is interpreted as an extension of Shadow IT literature; TAM/UTAUT explain technology adoption behaviour; Digital Era Governance and Diffusion of Innovations inform institutional adaptation; and policy instruments are derived from European regulatory frameworks and governance models

Source: compiled by author

Fifteen semi-structured interviews were conducted online via Zoom, each lasting between 45 and 90 minutes. Participants were selected through purposive sampling to ensure diversity of perspectives and included agency heads ($n = 3$), information technology managers ($n = 4$), human resource specialists ($n = 3$), and frontline AI users ($n = 5$). The interview protocol covered five thematic areas: current AI use practices and tools; perceived benefits and risks; training experiences and needs; perspectives on governance and policy requirements; and barriers to responsible AI use. Data saturation was systematically assessed and reached after the twelfth interview, with no substantially new themes emerging in the remaining three interviews. Transcripts were analysed using thematic analysis in accordance with V. Braun & V. Clarke's (2006) six-phase framework, resulting in the identification of five principal themes: Silent Innovation, Double Standard, Training Desert, Data Fear, and Lack of Trust.

A three-round Delphi panel involving 12 experts was conducted to validate empirical findings and to develop consensus-based policy recommendations. Experts were

selected based on predefined inclusion criteria: a minimum of five years of professional experience in public administration ($n = 6$), academic expertise in AI ethics or digital governance ($n = 4$), or experience in public sector training and capacity development ($n = 2$). In the first round, participants were presented with preliminary findings and asked to evaluate their significance on a five-point scale. The second round provided anonymised feedback and invited participants to revise their assessments. The third round aimed to achieve consensus, which was defined a priori as at least 70% of experts assigning a rating of 4 or 5 on the five-point importance scale.

A case study of Georgia's Ministry of Internal Affairs examined an AI-based automated document processing system in operation since 2023. The analysis focused on compliance with relevant international frameworks, including the EU AI Act (IDFI, 2024a) and the Council of Europe Framework Convention on Artificial Intelligence (IDFI, 2024c). Key dimensions of assessment included: the presence of risk assessment procedures; transparency and disclosure mechanisms; audit trail requirements; and the existence of human oversight.

Systematic document analysis complemented the primary data collection. Sources included reports and policy documents from IDFI (2021), the Government of Georgia (2024), Microsoft (2025), Oxford Insights (2025), E. Tskhvariashvili (2025), the European Commission (2025), the Public Defender of Georgia (2025) and relevant institutional policies where available. The study received ethical approval from the Research Ethics Committee of Shota Rustaveli State University of Batumi. All participants provided informed consent and were assured of anonymity and confidentiality. Participation was voluntary, and respondents retained the right to withdraw at any stage without penalty.

Several limitations should be acknowledged when interpreting the findings. First, the sample ($N = 322$) represents approximately 1% of the total public sector workforce in Georgia, which limits the statistical generalisability of quantitative results. The findings are therefore best understood as indicative rather than definitively representative. Nevertheless, the stratified sampling design – based on institution type, geographic location, and hierarchical level – enhances representativeness within the constraints of a single-country study, and methodological triangulation strengthens the robustness of qualitative insights. Second, the cross-sectional design captures data

at a single point in time; longitudinal research would be required to assess temporal dynamics in AI adoption and any causal relationships. Third, self-reported data may be subject to response bias, particularly in relation to unauthorised AI use, where underreporting is possible. Fourth, the size of the Delphi panel ($n = 12$), while consistent with established methodological practice, remains relatively limited, and the ROI estimates derived from it should be treated as expert-informed illustrations rather than precise economic forecasts.

Results and Discussion

The survey results indicate that 52.8% of Georgian public servants use AI tools, with ChatGPT, Microsoft Copilot, and Google Gemini identified as the most frequently used platforms. Among these users, 17.4% report daily use, 35.4% weekly use, and the remainder report monthly or occasional use. Document summarisation represents the most common application (78.2%), followed by email and report drafting (65.9%), data analysis (41.2%), and idea or budget generation (35.3%). These usage patterns are broadly consistent with international evidence reported by the Mission Square Research Institute (2025) and the Barcelona Provincial Council (2025). Table 2 summarises the principal indicators of AI use and associated risks.

Table 2. Main indicators of AI use and associated risks

Aspect	Data (%)	Theoretical interpretation	Main risk
Scale of AI use	52.8	TAM – perceived usefulness	-
Shadow AI	42.9	Shadow AI (Farrell, 2025)	Data leakage; reduced accountability
Daily AI use	17.4	UTAUT – performance expectancy	-
Document summarisation (users)	78.2	TAM – perceived ease of use	Hallucinations (67% do not verify outputs)
Email/report writing	65.9	UTAUT – social influence	Personal data exposure (54%)
Data analysis	41.2	Lack of facilitating conditions	Analytical inaccuracies (38% report low trust)
Idea/budget generation	35.3	Diffusion of innovations – early adopters	Informal use practices
Written AI policy	14.3	Absence of facilitating conditions	Governance gap
No AI training	61.5	OECD (2026) – skills barrier	Inconsistent and potentially unsafe use

Note: TAM = Technology Acceptance Model; Percentages are based on the survey sample ($N = 322$). Risk indicators reflect self-reported behaviours (e.g., lack of verification of AI outputs, input of personal data, and low trust in analytical accuracy) and are interpreted in relation to existing theoretical frameworks on technology adoption and governance. “Absence of facilitating conditions” refers to the lack of organisational support structures such as formal policies, training, and oversight mechanisms

Source: calculated by author based on survey data

The predominance of document summarisation and report drafting suggests that AI is primarily used for routine information-processing tasks that traditionally require substantial time investment. Interview data indicate that users may save approximately 2-3 hours per day through these applications. Economic productivity estimation: sensitivity and scenario analysis. Based on a conservative baseline estimate, in which 52.8% of public servants save an average of 1.5 hours per day, the aggregate productivity gain is estimated at approximately 25,000-30,000 labour hours per day across the public sector. Assuming an average public sector wage of approximately GEL 15 per hour

(≈USD 5.50) (Geostat, 2025), this corresponds to an estimated daily productivity value of GEL 375,000-450,000 (≈USD 135,000-165,000), or approximately GEL 100-120 million annually (≈USD 36-44 million). To address the inherent uncertainty in these estimates, a scenario analysis was conducted using three variants (Table 3). The pessimistic scenario assumes that self-reported time savings are overestimated by 50% due to social desirability bias. The optimistic scenario assumes that underreporting of AI use (qualitative evidence suggested reluctance to disclose) means actual savings are 50% higher. The baseline scenario represents the direct calculation from survey

data. Across all three scenarios, even the pessimistic estimate suggests substantial productivity gains (GEL 50-60 million annually), while the optimistic estimate reaches

GEL 150-180 million. This range (GEL 50-180 million) should be understood as the plausible interval rather than a precise point estimate.

Table 3. Sensitivity analysis of estimated annual productivity gains

Scenario	Assumption (hours saved per user)	Annual productivity value (GEL million)
Pessimistic (lower bound)	0.75 (50% of baseline)	50-60
Baseline (central estimate)	1.5	100-120
Optimistic (upper bound)	2.25 (150% of baseline)	150-180

Source: author's calculations based on Table 2 indicators and Geostat (2025)

Uncertainty and methodological caveats. These estimates should be interpreted as illustrative and indicative, not as precise fiscal accounts, for five reasons. First, they rely on self-reported data, which may be subject to recall bias and social desirability bias (particularly for unauthorised AI use). Second, the assumption of GEL 15 per hour average wage is a simplification that does not account for variation across job grades, institution types, or geographic locations. Third, the estimate assumes that saved hours translate directly into productive work – an assumption that may not hold uniformly across all roles. Fourth, the cross-sectional design captures a single point in time; productivity effects may change as AI tools evolve. Fifth, because much of this activity occurs outside formal governance structures, these productivity gains are not systematically captured, measured, or reinvested at the institutional level.

This reliance on self-reported data reflects a deeper institutional reality documented by UNESCO (2026): Georgia remains at a foundational governance stage with no dedicated AI law, regulatory authority, or national strategy. UNESCO identifies a “dual bottleneck” – institutional constraints alongside technological gaps – which explains why objective, system-level data on AI-driven productivity do not yet exist. In the absence of centralised monitoring, self-reported data constitute the only feasible source. Triangulation with interviews and Delphi panel ($\alpha = 0.87$) partially mitigates subjectivity. Moreover, because much of this activity occurs outside formal governance structures, these productivity gains are not systematically captured, measured, or reinvested at the institutional level.

When asked specifically about using AI without formal authorisation or approval from information technology departments, 42.9% of respondents answered affirmatively. This figure aligns closely with findings reported by E. Tskhvariashvili (2025), providing cross-study validation. Qualitative evidence suggests that actual levels of unauthorised use may be higher, as several interview participants (P7, P11, P13) indicated reluctance to disclose such practices in formal survey settings. From a risk management perspective, this proportion corresponds to approximately 13,700 public servants operating outside formal governance frameworks.

Indicators of institutional readiness reveal substantial limitations. Only 14.3% of respondents reported the existence of a formal AI policy within their organisation,

while 61.5% indicated that they had received no AI-related training. Additionally, 54% of respondents acknowledged entering personal or sensitive data (including citizen information and internal documents) into AI platforms without formal guidance or authorisation. These findings suggest the presence of a governance and training gap with potential economic implications. Each instance of personal data input into unregulated AI systems may represent a compliance risk under emerging regulatory frameworks. While enforcement mechanisms in Georgia are still evolving, alignment with European regulatory standards implies potential exposure to financial liabilities in the future. At the same time, the absence of structured training indicates that AI-related human capital is developing informally, without standardisation or quality assurance mechanisms.

A binary logistic regression analysis was conducted to examine factors associated with Shadow AI use (coded as 1 = yes, 0 = no). Independent variables included perceived productivity gain, AI training (binary), presence of a written policy (binary), and supervisor support. The results indicate that perceived productivity gain (OR = 2.34, 95% CI [1.58, 3.47], $p < .01$) and absence of a written policy (OR = 3.12, 95% CI [1.95, 4.99], $p < .001$) are significantly associated with Shadow AI adoption. In contrast, AI training (OR = 0.89, $p = .42$) and supervisor support (OR = 1.12, $p = .31$) were not statistically significant. The model as a whole was statistically significant ($\chi^2(4) = 38.47$, $p < .001$), with a Nagelkerke pseudo R^2 of 0.31 and an overall classification accuracy of 74.3%. These associations should be interpreted as correlational rather than causal, given the cross-sectional design.

Interpreting these regression findings, individual-level productivity incentives and the absence of formal institutional frameworks emerge as the primary factors associated with Shadow AI use. This pattern suggests a partial divergence from the Unified Theory of Acceptance and Use of Technology (UTAUT), which posits that facilitating conditions – such as organisational support, training, and infrastructure – directly influence technology adoption (Venkatesh *et al.*, 2003). While the absence of a formal AI policy is significantly associated with Shadow AI use (OR = 3.12), variables such as training and supervisor support were not statistically significant. This indicates that in contexts characterised by weak institutional frameworks, perceived usefulness – operationalised as productivity gains (OR = 2.34) – may play a dominant

role in shaping user behaviour. Public servants appear to adopt AI tools primarily based on their perceived efficiency benefits, rather than organisational encouragement or formal support structures.

This finding suggests a contextual adaptation of UTAUT: in transition economy contexts, perceived usefulness may partially substitute for absent facilitating conditions. However, this substitution is not neutral in its effects. It introduces a divergence between individual-level incentives and organisational-level risk management. From an economic perspective, this dynamic can be interpreted through a principal-agent framework. Individual public servants (agents) maximise private benefits (time savings), while potential risks – such as data breaches or accountability failures – are externalised to the state (principal). This creates a form of negative externality, whereby privately rational behaviour may lead to suboptimal outcomes at the organisational or systemic level. Accordingly, technology acceptance models applied to public sector contexts may benefit from incorporating considerations of incentive alignment, institutional constraints, and risk externalities.

Turning to the qualitative evidence, thematic analysis of interview data identified five principal themes with distinct organisational and economic implications. The first theme, Silent Innovation, reflects the widespread informal use of AI tools without formal approval. Ten out of twelve AI-using interviewees reported engaging in such practices. One participant (P11) noted: “I use ChatGPT to summarise all my reports... it saves me two to three hours a day. I am hesitant to disclose this because there is no formal policy”. This pattern suggests that productivity gains are realised at the individual level but are not systematically integrated into organisational processes.

The second theme, Double Standard, captures ambiguity in managerial responses to AI use. Leaders neither formally endorse nor explicitly prohibit AI adoption, resulting in unclear accountability structures. This dynamic may increase organisational exposure to risk while simultaneously allowing productivity gains to continue informally. The findings indicate a notable discrepancy between managerial support (22.4%) and actual AI use (42.9%), suggesting a gap between formal leadership positions and employee practices. From a governance perspective, such ambiguity may weaken accountability structures and limit the effectiveness of risk management processes. Standard frameworks, such as ISO 31000, emphasise the importance of explicit risk identification, assessment, and acceptance. In the absence of clear policy direction, risks may remain unarticulated and unmanaged. This situation may also generate agency costs, including reduced monitoring capacity, limited enforceability of standards, and potential misalignment between organisational objectives and individual behaviour. In economic terms, the decentralised capture of productivity benefits alongside the socialisation of risks resembles a common-pool resource problem, where incentives for individual optimisation may lead to collectively suboptimal outcomes.

The third theme, Training Desert, reflects the widespread absence of formal training opportunities. The majority of respondents rely on self-directed learning, which may lead to uneven skill development and inconsistent application of AI tools. The coexistence of high AI usage (52.8%) and limited training provision (61.5% without training) indicates that informal learning mechanisms are operating at scale. However, such learning processes are inherently uneven and may not align with best practices in data protection, ethical use, or output validation. For example, the finding that a substantial proportion of users do not systematically verify AI-generated outputs highlights potential risks associated with overreliance on automated systems. This is consistent with international evidence on AI hallucinations and user overconfidence (Hall, 2025). From a human capital perspective, this situation can be interpreted as a coordination problem in skills investment. While individuals invest time in acquiring AI-related competencies, the absence of institutional frameworks reduces the overall efficiency and reliability of this investment. Formal training programmes could enhance the social return on these skills by ensuring standardisation, risk awareness, and knowledge diffusion across the workforce. Moreover, the distributional dimension of this skills gap warrants attention, as qualitative evidence suggests that access to informal AI learning opportunities may vary across demographic and professional groups, potentially reinforcing existing inequalities.

The “Training Desert” phenomenon identified in Georgia is consistent with findings from Latvia, where a survey of 1,557 public servants demonstrated that AI training significantly increases self-assessed AI competence. Notably, more than half of Latvian respondents expressed limited trust in AI-generated information, with only 0.45% (seven participants) reporting complete trust in AI (Lāma & Lastovska, 2025). This corroborates current finding that the absence of structured training (61.5% of Georgian respondents) may directly contribute to both low competence and low trust, creating a barrier to responsible AI adoption.

The fourth theme, Data Fear, highlights awareness of data protection risks among users, which does not necessarily prevent AI use. Participants demonstrated partial understanding of risks but often prioritised efficiency under time constraints. The fifth theme, Lack of Trust, emerged primarily among non-users, who expressed concerns about the reliability and accuracy of AI outputs. This scepticism may limit broader adoption and reduce potential productivity gains.

These concerns are not unique to Georgia. As T. Canens (2025) argued, the distrust in generative AI within public administrations stems from its limited explainability, which fundamentally restricts its appropriate use in the public sector. The risks surrounding confidentiality, the marking of AI outputs, and the potential for errors require both technical and cultural responses, pushing the boundaries of our instrumental conceptions of machines. Moreover, the transformative impact of GenAI on the

intellectual production of the state raises fears of the replacement, or rather “enslavement”, of civil servants to machines. T. Cantens (2025) therefore advocated for the development of critical thinking as a specific skill for civil servants who must learn to think with an eclectic machine.

While the potential benefits of generative AI in the public sector are widely recognised (Aryfiyanto & Alamsyah, 2024), the case study of the Ministry of Internal Affairs’ automated document processing system indicates that the system operates without several key governance mechanisms, including formalised risk assessment procedures, transparency disclosures, audit trails, and clearly defined human oversight. Under the EU AI Act framework (IDFI, 2024a), such systems would likely be classified as high-risk and subject to specific regulatory requirements. The absence of these mechanisms may increase operational and compliance risks, although precise financial implications cannot be determined without further data.

A recent survey of 576 public managers across seven EU countries found that the unregulated or ‘shadow’ use of generative AI tools is widespread, particularly in contexts where formal governance mechanisms are still in their early stages (Tangi *et al.*, 2026). While earlier research has developed taxonomies to understand the phenomenon of Shadow IT (Kopper & Westner, 2016), shadow AI” acquires particular importance in the context of public administration, as it is associated not only with technological but also with institutional, ethical, and governance challenges (Silic & Back, 2014). M. Silic *et al.* (2025) noted that the “generative, opaque, and autonomous” nature of generative AI has turned Shadow AI into a “sociotechnical governance failure”. The authors emphasise that AI tools such as ChatGPT and Microsoft Copilot are often used outside the boundaries of organisational IT control, creating a so-called “governance drift zone” – a situation where formal policies and regulations exist nominally but do not function effectively in practice.

The prevalence of Shadow AI, supported by both quantitative (42.9%) and qualitative evidence, suggests that it should be understood not as isolated individual behaviour

but as a systemic organisational phenomenon. The identified themes – particularly Silent Innovation and Double Standard – indicate the emergence of an informal equilibrium in which AI use is tacitly tolerated but not formally regulated. This configuration may generate several economic implications. First, productivity gains remain decentralised and difficult to scale. While individual users report time savings, the absence of institutional coordination limits the ability to replicate and standardise successful use cases across agencies. Second, cumulative risk exposure may increase over time. The widespread input of potentially sensitive data into AI systems without formal safeguards introduces compliance and operational risks. While precise financial implications remain uncertain, alignment with international regulatory frameworks suggests the potential for future fiscal exposure. Third, informal learning pathways may lead to uneven human capital development. Fourth, the absence of institutional mechanisms for knowledge sharing may limit innovation spillovers.

The eight countries in Table 4 were selected to ensure representative geographic and institutional coverage of the post-Soviet space while maintaining comparability and avoiding excessive table size. Selection followed three principles. First, one country was chosen from each major post-Soviet subregion: the Baltics (Estonia), Eastern Europe (Ukraine, Moldova, Belarus – capturing variation in EU alignment), the South Caucasus (all three countries – Georgia, Azerbaijan, Armenia – included to enable intra-regional comparison), and Central Asia (Kazakhstan as the regional leader). Second, the selection spans the full range of AI readiness from Estonia (rank 21) to Belarus (rank 121), allowing systematic comparison of high, medium, and low performers. Third, the inclusion of EU candidate states (Ukraine, Moldova) alongside non-candidate states (Belarus, Azerbaijan) enables tentative observation of whether European institutional alignment is associated with higher AI governance capacity. All selected countries share a common Soviet administrative legacy but have diverged in their post-1991 governance reforms, digital transformation pathways, and international integration trajectories.

Table 4. Georgia in comparative perspective with post-Soviet states

Country	Subregion	Rank	Strategy	Capacity	Infrastructure	Governance	Public Sector Adoption
Estonia	Baltics	21	54.29	90.00	99.63	46.01	64.38
Ukraine	Eastern Europe (EU candidate)	41	52.40	83.00	80.24	40.34	58.21
Moldova	Eastern Europe (EU candidate)	71	61.50	56.67	82.33	22.40	61.06
Kazakhstan	Central Asia	58	53.88	64.63	73.59	39.85	37.38
Azerbaijan	South Caucasus	69	51.45	60.00	66.97	36.08	56.35
Georgia	South Caucasus	87	49.35	74.17	47.44	27.24	34.63
Armenia	South Caucasus	103	41.02	56.75	57.40	24.37	27.75
Belarus	Eastern Europe (non-EU)	121	12.00	43.38	24.03	24.62	36.88

Source: Oxford Insights (2025), Government AI Readiness Index (2025)

The data reveal several important patterns. Estonia (rank 21) leads the region across all pillars, particularly in Infrastructure (99.63) and Capacity (90.00), reflecting its

long-standing digital governance investments. This aligns with the “AI Leap” initiative, which systematically builds AI competencies across the workforce. Ukraine (rank 41)

demonstrates remarkable resilience, with high Infrastructure (80.24) and Public Sector Adoption (58.21) scores despite ongoing conflict. Ukraine's Diia.AI platform – the world's first national AI assistant for government services – validates this institutional capacity, processing over 200 public services with 70% of legal work handled by AI before human review (Sampson, 2025).

Moldova (rank 71) presents an interesting case. Despite a relatively low Governance score (22.40) – similar to Georgia's Governance (27.24) – Moldova achieves a much higher Public Sector Adoption score (61.06), second only to Estonia in this comparison. This pattern suggests that Moldova's ongoing EU accession process and its FAIMA AI Antenna initiative (providing access to EU supercomputing infrastructure) may be accelerating public sector AI adoption even in the absence of strong domestic governance frameworks. However, this interpretation remains tentative given the cross-sectional nature of the index data.

Kazakhstan (rank 58) and Azerbaijan (rank 69) show moderate performance, with Azerbaijan outperforming Georgia notably in Public Sector Adoption (56.35 vs 34.63). This suggests that despite similar regional constraints, Azerbaijan may have achieved greater diffusion of AI tools across its public workforce, though causal mechanisms cannot be established from these data. Georgia (rank 87) presents a distinctive profile. Its Infrastructure score (74.17) is relatively strong – second only to Estonia among the eight countries. However, Georgia's Strategy score (49.35) and Governance score (27.24) are among the lowest in the comparison group. More strikingly, Georgia's Public Sector Adoption score (34.63) is the lowest among all eight countries – even below Belarus (36.88) and Armenia (27.75, which is lower but Armenia ranks 103 overall). This pattern independently corroborates the central finding of current survey. The Oxford Insights data confirm that while Georgia has built reasonable digital infrastructure (74.17), it lacks the strategic frameworks (49.35) and governance mechanisms (27.24) to translate this infrastructure into actual public sector AI adoption (34.63). This aligns with the “dual bottleneck” identified in current qualitative analysis – the themes of Silent Innovation and Double Standard emerge from weak governance, not from technological gaps.

Belarus (rank 121) ranks lowest among the eight countries, with very low Strategy (12.00) and Infrastructure (24.03). However, its Public Sector Adoption score (36.88) slightly exceeds Georgia's (34.63), suggesting that even under autocratic governance and with minimal strategic frameworks, some degree of AI diffusion may occur – albeit likely in an unregulated “Shadow AI” pattern

similar to Georgia. Armenia (rank 103) ranks second lowest overall but shows a more balanced profile, with Governance (24.37) and Public Sector Adoption (27.75) more closely aligned with its Strategy (41.02) than in Georgia's case. This suggests that Armenia's lower overall ranking reflects broader capacity constraints, whereas Georgia's underperformance is specifically concentrated in governance and adoption.

From a policy perspective, these findings suggest that Georgia's priority could be governance reform and strategic framework development, rather than additional infrastructure investment. Estonia's example demonstrates that high governance quality (46.01) – not just infrastructure – enables effective AI adoption. Conversely, Moldova's case suggests that EU integration and access to shared AI infrastructure may accelerate adoption even when domestic governance remains weak – a potential pathway for Georgia to consider. Evidence from the Public Defender of Georgia (2025) supports this interpretation, highlighting discrepancies between officially reported and actual AI use across public institutions. The finding that only a small number of agencies formally acknowledge AI usage, despite evidence of broader implementation, suggests the presence of institutional blind spots in governance and reporting mechanisms. From an economic perspective, this configuration reflects a dual dynamic: the coexistence of latent productivity gains and unmitigated institutional risk exposure.

The findings highlight three interrelated areas requiring policy attention. First, the development of AI-specific competencies is essential. Transitioning from general digital literacy to AI literacy – including skills such as prompt design, critical evaluation, and ethical awareness – may enhance both productivity and risk mitigation. Second, the establishment of formal governance frameworks is necessary to reduce uncertainty and manage risks. This includes the development of policies addressing data use, accountability, transparency, and oversight mechanisms. Third, leadership capacity could be strengthened to ensure that AI adoption is aligned with organisational objectives. This involves clarifying responsibilities, integrating AI into performance management systems, and fostering a culture of responsible innovation. Based on the empirical findings and validated through the Delphi panel process, four integrated policy recommendations are proposed. Each recommendation is grounded in an economic rationale linking the intervention to potential improvements in workforce productivity, human capital development, and fiscal risk mitigation (Table 5). These recommendations should be understood as evidence-informed possibilities rather than definitive policy prescriptions.

Table 5. Estimated potential economic impact of recommendations (expert-informed illustration)

Recommendation	Estimated cost	Estimated potential benefit	Illustrative horizon
Mandatory AI literacy	\$50-100 per employee	~\$500 per employee/year (based on Estonia)	6-12 months
Regulatory sandbox	\$50,000-100,000	Risk reduction; potential productivity gains	12-18 months

Table 5, Continued

Recommendation	Estimated cost	Estimated potential benefit	Illustrative horizon
AI Champions network	\$500-1,000 per Champion	Faster adoption; reduced errors	~6 months
Revised performance metrics	Minimal	Potential productivity improvement (20-30%)	3-6 months

Note: estimates are based on Delphi panel consensus (n = 12 experts) and economic productivity analysis. These figures are expert-informed illustrations rather than precise empirical forecasts. The ROI estimates should be interpreted as indicative ranges, not as guaranteed outcomes. Estonia's AI literacy investment figures are drawn from M. Voog (2025)

Source: compiled by author

Recommendation 1. Mandatory AI literacy for all public servants. Compulsory AI literacy training could be introduced for all public servants within a 12-month implementation horizon. The training curriculum could include foundational AI concepts, prompt engineering, critical evaluation of AI outputs, hallucination recognition, data ethics, bias detection, security protocols, and relevant legal frameworks, including the EU AI Act and the Council of Europe Convention. A structured training programme (estimated at 8-12 hours per employee) may contribute to reducing error rates associated with unverified AI outputs, improving data handling practices, and enhancing efficiency through more effective use of AI tools. Comparative evidence from Estonia suggests that an investment of approximately USD 50 per employee in training may be associated with productivity gains of around USD 500 per employee annually (Voog, 2025). However, these figures are context-specific and may not be directly transferable to the Georgian context.

Recommendation 2. Regulatory sandbox for controlled experimentation. A regulatory sandbox for AI experimentation could be established to provide a controlled and legally compliant environment for AI use within the public sector. The sandbox framework should clearly define categories of prohibited data and permitted data. With a current Shadow AI prevalence of 42.9%, the introduction of a sandbox mechanism may help formalise existing practices by offering a structured alternative to unauthorised use. International experience, such as the Delaware AI Sandbox initiative, suggests that sandbox approaches could reduce informal AI usage while preserving productivity benefits (State of Delaware News, 2025).

Recommendation 3. AI champions network for peer support. A cross-agency AI Champions network could be established to support the diffusion of AI capabilities and promote responsible use practices. Champions would receive advanced training beyond foundational literacy and act as internal facilitators. Each AI Champion (estimated ratio: one per 50-100 employees) would require approximately 40 hours of advanced training (costing approximately \$500-1,000 per Champion), while providing ongoing support to a broader group of users at relatively low marginal cost.

Recommendation 4. Revised performance metrics. Existing performance evaluation systems could be updated to reflect the realities of AI-enabled work environments. Revised metrics might include indicators such as AI

literacy certification, demonstrated critical evaluation of AI outputs, effective reallocation of time toward higher-value activities, and adherence to ethical and data protection standards. Aligning performance metrics with AI-enabled workflows may help mitigate unintended disincentives for adoption and encourage more efficient use of technology. While Georgia currently experiences a "Shadow AI" phenomenon characterised by unregulated individual adoption, neighbouring Ukraine has pioneered a different trajectory – the "agentic state". Ukraine's Diia.AI (n.d.), recognised as the world's first national AI assistant for government services, serves 23 million citizens and processes over 200 public services, with 70% of legal work within the Ministry of Digital Transformation handled by AI before human review (Sampson, 2025). This suggests that the evolution from unmanaged AI use to institutionalised AI integration is possible, but would require strategic investment in digital infrastructure and governance capacity – areas where Georgia's Government AI Readiness Index ranking of 87th indicates considerable room for improvement.

The study contributes to the literature in three main ways. Empirically, it provides one of the first systematic mixed-methods analyses of AI use and Shadow AI in Georgia's public sector. Theoretically, it suggests a contextual adaptation of the Unified Theory of Acceptance and Use of Technology (UTAUT) by providing evidence on how institutional readiness constraints shape technology adoption in transition economies. Practically, it offers evidence-informed policy recommendations aimed at strengthening AI governance, workforce capacity, and public sector efficiency.

Conclusions

This study provides the first systematic empirical evidence on the use of artificial intelligence and the prevalence of Shadow AI within a post-Soviet public sector. The findings reveal that a majority of Georgian public servants use AI tools, with approximately 40% engaging in unauthorised use. A substantial majority lack formal training, and written AI policies exist in only a small minority of organisations. Complementary evidence suggests that officially reported AI usage substantially understates actual practice, highlighting gaps in institutional visibility and governance.

Taken together, these results point to a structural imbalance between rapid technological adoption and comparatively limited institutional readiness. From an economic perspective, this imbalance may reduce the efficiency and

sustainability of AI adoption in the public sector. The regression analysis identifies perceived productivity gain and absence of formal policy as factors significantly associated with Shadow AI use – both with odds ratios exceeding two – suggesting that individual efficiency incentives may outweigh institutional constraints in shaping behaviour. This finding suggests a contextual adaptation of the UTAUT framework, indicating that perceived usefulness may support technology adoption even when facilitating conditions are weak. However, given the cross-sectional design, these associations should not be interpreted as causal.

The absence of structured training may limit the long-term development of human capital and reduce the overall efficiency of AI utilisation. At the same time, informal and unregulated use practices may increase exposure to risks associated with data handling, accountability, and decision-making processes. While the magnitude of potential fiscal impacts remains uncertain, the findings indicate that unmanaged AI adoption may limit productivity gains while increasing operational and fiscal risks.

The findings provide new empirical grounding on Shadow AI in transition economies, extend UTAUT for contexts with limited institutional support, and offer actionable policy directions. Investing proactively in governance, skills, and organisational systems may boost productivity and reduce institutional vulnerabilities. Georgia's experience illustrates a broader dynamic relevant to many transition economies: rapid technological uptake can outpace institutional adaptation. Bridging this

gap is essential for sustainable and effective public sector AI adoption.

Subsequent studies should prioritise four directions. First, longitudinal research is needed to track Shadow AI dynamics as institutional frameworks mature and to assess whether formal policies are associated with reduced unauthorised use over time. Second, comparative analyses across post-Soviet transition economies would help assess the generalisability of the proposed UTAUT adaptation. Third, quantitative risk assessment models should be developed to estimate potential fiscal exposure from data breaches, algorithmic errors, and non-compliance with emerging regulatory frameworks such as the EU AI Act. Fourth, experimental or quasi-experimental studies evaluating the effectiveness of specific interventions – including regulatory sandboxes, AI Champions networks, and mandatory literacy programs – would provide more definitive causal evidence to guide policy decisions. Future comparative research should examine the applicability of the proposed UTAUT adaptation in neighbouring transition economies, including Latvia.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] Aryfiyanto, H., & Alamsyah, A. (2024). Public service with generative AI: Exploring features and applications. In *2024 7th international conference of computer and informatics engineering (IC2IE)* (pp. 1-7). Bali: Institute of Electrical and Electronics Engineers. doi: 10.1109/IC2IE63342.2024.10747963.
- [2] Barcelona Provincial Council. (2025). *Public personnel positively value the use of AI in their day-to-day work*. Retrieved from <https://www.aoc.cat>.
- [3] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. doi: 10.1191/1478088706qp063oa.
- [4] Bryman, A. (2016). *Social research methods* (5th ed.). Oxford: Oxford University Press.
- [5] Cantens, T. (2025). How will the state think with ChatGPT? The challenges of generative artificial intelligence for public administrations. *AI & Society*, 40, 133-144. doi: 10.1007/s00146-023-01840-9.
- [6] Creswell, J.W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: SAGE Publications.
- [7] Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319-340. doi: 10.2307/249008.
- [8] Dunleavy, P., Margetts, H., Bastow, S., & Tinkler, J. (2006). *Digital era governance: IT corporations, the state, and e-government*. Oxford: Oxford University Press. doi: 10.1093/acprof:oso/9780199296194.001.0001.
- [9] European Commission. (2025). *Georgia 2025 report (SWD(2025) 757 final)*. Retrieved from <https://www.eeas.europa.eu>.
- [10] Farrell, R. (2025). *The silent risk in government AI: Shadow models are already at work*. Retrieved from <https://www.govloop.com>.
- [11] Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). London: SAGE Publications.
- [12] Geostat. (2025). *Average monthly earnings of employees by economic activity*. Retrieved from <https://www.geostat.ge>.
- [13] Government of Georgia. (2024). *Digital governance strategy of Georgia 2025-2030*. Retrieved from <https://matsne.gov.ge>.
- [14] Hall, I. (2025). *GenAI on the rise: UK public sector's AI appetite and attitudes revealed in survey*. Retrieved from <https://www.globalgovernmentforum.com>.

- [15] IDFI. (2021). *Use of artificial intelligence systems in Georgia: Legislation and practice*. Retrieved from <https://idfi.ge>.
- [16] IDFI. (2024a). *EU AI Act*. Retrieved from <https://idfi.ge>.
- [17] IDFI. (2024b). *Council of Europe convention on AI*. Retrieved from <https://idfi.ge>.
- [18] IDFI. (2024c). *Global index on responsible artificial intelligence and Georgia's outcomes*. Retrieved from <https://idfi.ge>.
- [19] Kopper, A., & Westner, M. (2016). *Towards a taxonomy for shadow IT*. In *Proceedings of the 22nd Americas conference on information systems (AMCIS 2016)* (pp. 1-10). San-Diego: Association for Information Systems.
- [20] Lāma, G., & Lastovska, A. (2025). AI competence and sentiment: A mixed-methods study of attitudes and open-ended reflections. *Frontiers in Artificial Intelligence*, 8, article number 1658791. doi: 10.3389/frai.2025.1658791.
- [21] Microsoft. (2025). *AI diffusion report 2025-H2*. Retrieved from <https://www.microsoft.com>.
- [22] Mission Square Research Institute. (2025). *AI adoption in state and local government: What drives success and employee confidence?* Retrieved from <https://icma.org>.
- [23] OECD. (2026). *Building an AI-ready public workforce*. Paris: OECD Publishing. doi: 10.1787/b89244c7-en.
- [24] Oxford Insights. (2025). *Government AI readiness index 2025*. Retrieved from <https://oxfordinsights.com>.
- [25] Public Defender of Georgia. (2025). *AI and human rights*. Retrieved from <https://www.ombudsman.ge>.
- [26] Rogers, E.M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.
- [27] Sampson, C. (2025). *Ukraine AI nation initiative*. Retrieved from <https://www.kyivpost.com/post/63986>.
- [28] Silic, M., & Back, A. (2014). Shadow IT – A view from behind the curtain. *Computers & Security*, 45, 274-283. doi: 10.1016/j.cose.2014.06.007.
- [29] Silic, M., Silic, D., & Kind-Trüller, K. (2025). From Shadow IT to Shadow AI: Threats, risks and opportunities for organizations. *Strategic Change*, 34(5), 291-304. doi: 10.1002/jsc.2682.
- [30] State of Delaware News. (2025). *Delaware launches AI sandbox initiative*. Retrieved from <https://news.delaware.gov>.
- [31] Tangi, L., Rodriguez Müller, A.P., & Combetto, M. (2026). A silent partner: The shadow presence of generative artificial intelligence in public administrations. In S. Hofmann et al. (Eds.) *Lecture notes in computer science* (Vol. 15978). Cham: Springer. doi: 10.1007/978-3-032-02515-9_5.
- [32] Tskhvariashvili, E. (2025). Artificial intelligence and public governance: Innovative approaches in health policy in the context of gender equality and social insurance. *Vectors of Social Sciences*, 10. doi: 10.51895/VSS.
- [33] UNESCO. (2026). *Key insights: Georgia – artificial intelligence governance*. Retrieved from <https://www.unesco.org/ethics-ai/en>.
- [34] Venkatesh, V., Morris, M.G., Davis, G.B., & Davis, F.D. (2003). User acceptance of IT. *MIS Quarterly*, 27(3), 425-478. doi: 10.2307/30036540.
- [35] Voog, M. (2025). *Kallas at the Tallinn Digital Summit: Estonia's true leap is to learn to think with artificial intelligence, not instead of it*. Retrieved from <https://hm.ee>.
- [36] Waters-Lynch, J., Allen, D.W.E., Potts, J., & Berg, C. (2024). Managing generative AI in firms: The theory of shadow user innovation. SSRN. doi: 10.2139/ssrn.4754950.
- [37] World Medical Association. (1964). *Declaration of Helsinki*. Retrieved from <https://www.wma.net>.

Економічний вплив «тіньового ШІ» на кадровий потенціал державного сектору Грузії

Іраклі Манвелідзе

Доктор публічного управління, професор
Державний університет імені Шота Руставелі в Батумі
6010, вул. Ніношвілі, 35/32, м. Батумі, Грузія
<https://orcid.org/0000-0001-6422-2049>

Анотація. Метою цього дослідження було проаналізувати економічний вплив штучного інтелекту (ШІ) на робочу силу державного сектору Грузії, зосереджуючись на прирості продуктивності, ризиках для зайнятості та інституційній адаптації. Хоча понад 70 % державних службовців у світі використовують інструменти ШІ, систематичні емпіричні дослідження несанкціонованого використання «тіньового ШІ» (Shadow AI) у Грузії відсутні. Для заповнення цієї прогалини застосовано конвергентний змішаний дизайн дослідження, який включає опитування 322 державних службовців, 15 напівструктурованих інтерв'ю, трьоххвилинну експертну панель Delphi (12 експертів), кейс-стаді Міністерства внутрішніх справ та систематичний аналіз документів. Кількісні дані опитування, якісні інтерв'ю та результати Delphi-панелі були інтегровані для забезпечення методологічної триангуляції. Результати показують, що 52,8 % державних службовців використовують інструменти ШІ (17,4 % – щоденно), тоді як 42,9 % залучені до практик Shadow AI. Рівень інституційної готовності є обмеженим: лише 14,3 % установ мають формальну політику щодо ШІ, 61,5 % не проходили жодного навчання з ШІ, а 54 % вводять конфіденційні дані в AI-платформи. Тематичний аналіз виявив п'ять ключових патернів: «мовчазні інновації», «подвійні стандарти», «навчальна пустеля», «страх даних» і «дефіцит довіри». Логістична регресія показує, що сприйняття підвищення продуктивності ($OR = 2.34, p < .01$) та відсутність формальної політики ($OR = 3.12, p < .001$) суттєво пов'язані з використанням Shadow AI. Отримані результати свідчать про одночасне існування зростання продуктивності та нерегульованих інституційних ризиків, включаючи неефективність через неконтрольоване використання ШІ, нерівномірний розвиток людського капіталу та фінансові ризики, пов'язані з витоками даних або алгоритмічними помилками. Дослідження пропонує контекстуальну адаптацію Уніфікованої теорії прийняття і використання технологій (UTAUT), демонструючи, що в перехідних економіках сприйнята корисність може переважати відсутність сприятливих умов. Для політиків і публічних адміністраторів запропоновано чотири практичні інтервенції: обов'язкові програми з AI-грамотності, регуляторна «пісочниця» для контрольованого експериментування, мережі AI-чемпіонів для взаємної підтримки та перегляд систем оцінювання ефективності. Ці рекомендації спрямовані на підвищення економічної ефективності, зниження фінансових ризиків та розвиток відповідального управління в Грузії та аналогічних пострадянських перехідних економіках.

Ключові слова: цифрова трансформація; генеративний ШІ; інституційна готовність; конфіденційність даних; модель UTAUT; адміністративна ефективність; перехідні економіки

Models for technical and economic justification of the feasibility of reconstruction in the construction industry

Oleksandr Pidodnia*

Postgraduate Student

Ukrainian State University of Science and Technologies

49010, 2 Lazarian Str., Dnipro, Ukraine

<https://orcid.org/0009-0006-2156-0682>

Abstract. The study aimed to develop a system of models for the technical and economic justification of the feasibility of reconstructing enterprises in the construction industry, considering technical, investment, resource and energy, life-cycle and risk parameters. As a result, normative-methodological, parametric, structural, scenario-based and calculation-integral models for evaluating refurbishment decisions were developed. It was established that the feasibility of renovation cannot be determined solely by the estimated cost or payback period, as it depends on the interplay of technical suitability, economic impact, investment performance, resource and energy sustainability, and risk exposure. The scenario-based model made it possible to compare alternatives not only in terms of initial costs, but also in terms of long-term effect, energy efficiency, life-cycle cost and risk level. A comparison of the scenarios showed that maintaining the current status quo has the lowest capital expenditure index – 0.15 – but is characterised by the lowest operational benefit – 0.05 – low energy efficiency – 0.20 – and the highest risk level – 0.78. The scenario involving comprehensive refurbishment with a digital and energy component demonstrated the highest methodological feasibility: the technical renewal index was 0.92, the operational benefit index – 0.86, the energy efficiency index – 0.89, the life-cycle cost index was 0.76, the net present value index was 0.39, and the risk load fell to 0.34. Integral ranking confirmed the superiority of this scenario, which received a reconstruction feasibility index of 0.54. This demonstrated that the most sound scenario is one in which technical modernisation is combined with digital control, energy management, reduced life-cycle costs and a managed level of risk uncertainty. The practical significance is determined by the possibility of using the proposed system of models for the preliminary selection of a feasible reconstruction scenario for enterprises in the construction industry of Ukraine

Keywords: life-cycle cost; return on investment; risk exposure; integrated ranking; payback period

Introduction

The renovation of enterprises in the construction sector has become a strategic priority in the context of increasing

requirements for resource efficiency, environmental sustainability and the resilience of production systems. Unlike

Received: 03.01.2026, Revised: 21.05.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Pidodnia, O. (2026). Models for technical and economic justification of the feasibility of reconstruction in the construction industry. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 68-83. doi: 10.52566/msu-econ2.2026.68.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (oleksandrpododnia@outlook.com)

conventional refurbishment projects aimed solely at restoring the technical condition of facilities, contemporary renovation involves the comprehensive modernisation of buildings and engineering infrastructure, the integration of energy-efficient technologies and digital tools, and the optimisation of long-term operating performance. Under conditions of economic uncertainty and post-war recovery, the justification of renovation decisions requires integrated approaches capable of balancing technical, economic, environmental and risk-related considerations. The urgency of renovating Ukraine's building stock is underscored by the scale of the renovation needs: according to a World Bank estimate (2026), Ukraine's total renovation and reconstruction needs for the period 2026-2035 amount to USD 588 billion. An additional factor is the introduction in Ukraine, from 1 April 2025, of requirements for nearly zero-energy buildings, which highlights the need to incorporate energy-efficient solutions when planning renovations (State Agency on Energy Efficiency and Energy Saving of Ukraine, 2025).

The issue of the economic effectiveness of innovative solutions in the activities of construction companies was examined by O. Malykhina *et al.* (2023), who demonstrated the correlation between the choice of innovation strategy and the economic performance of a company's operational system. This approach demonstrated that the restructuring of a construction enterprise cannot be assessed solely based on the volume of capital investment, as its feasibility is linked to the impact of restructuring measures on production productivity, the stability of the operational system, process costs and long-term economic returns. The environmental dimension of modernising enterprises in the construction industry was explored by U. Andrusiv *et al.* (2024), where environmental modernisation is interpreted as an innovative production and management technology. This provides grounds for including in the technical and economic justification not only financial indicators but also parameters of resource conservation, energy efficiency, environmental impact and the reduction of production's impact on the environment. Digital approaches to evaluating renovation decisions are actively developing in connection with the use of Building Information Modelling (BIM). O. Doukari *et al.* (2023) proposed a BIM-oriented technical and economic framework for comparing building renovation strategies, which was used to assess options in terms of cost, timeframes, energy efficiency and operational parameters. For companies in the construction sector, this approach is particularly relevant, as the refurbishment of production and ancillary facilities requires not only cost estimates but also digital validation of refurbishment scenarios. K. Lu *et al.* (2023) systematised the relationship between building life-cycle cost analysis and BIM, demonstrating that the combination of these tools enhances the soundness of decisions during the planning, design, operation and renovation stages of a facility. This has reinforced the need to incorporate life-cycle indicators into renovation assessment models for construction industry enterprises.

In the study by M. Gubert *et al.* (2023), traditional and industrialised scenarios for deep renovation were compared, demonstrating the differences between renovation options in terms of costs, technological complexity and expected outcomes. This approach is relevant for developing the scenario-based logic of a technical and economic justification, within which renovation can be viewed not as a single fixed project, but as a set of alternatives: minimal refurbishment, partial modernisation, comprehensive renovation, or renovation incorporating digital and energy-efficient solutions. Y. Alsalem *et al.* (2023), using the example of the modernisation of an engineering system, demonstrated the importance of technical and economic evaluation in determining the effectiveness of reconstruction measures. Their findings confirmed that decisions regarding the upgrading of equipment or engineering infrastructure should be based on a comparison of the initial investment, operating costs, energy efficiency and payback period.

The multi-criteria nature of selecting renovation solutions was explored by Y. Shi *et al.* (2024), where energy-efficient renovation strategies were evaluated based on energy, economic and comfort parameters. Although the study targeted buildings with a different functional purpose, its methodological logic is relevant for enterprises in the construction sector, as the renovation of industrial facilities also requires a balance between costs, technical performance, operating conditions and long-term effects. D. Macek & S. Vitásek (2024) focused on risk analysis in building renovation and strategies for investors, which is particularly relevant for technical and economic justification in conditions of uncertainty. In the renovation of construction industry facilities, risks may be associated with cost overruns, changes in material costs, delays in work completion, insufficient return on investment, technical limitations of existing facilities, and incomplete input data. Approaches to sustainable building renovation are increasingly based on a combination of economic, environmental and social criteria. M. Caruso *et al.* (2024) proposed an updated multi-criteria decision-making method for sustainable renovation, which incorporates environmental, economic and social life-cycle metrics. This logic implies that the model for justifying a plant refurbishment must go beyond simple payback and encompass a broader set of criteria relating to the durability, resource efficiency, operational stability and adaptability of the production system. In a critical review of methods for analysing the costs and benefits of sustainable building renovations, S. Sharbaf & P. Schneider-Marín (2024) demonstrated that the financial assessment of renovation requires consideration not only of direct investment but also of future savings, operational effects, maintenance costs and long-term benefits. This is directly consistent with the need to develop a technical and economic model capable of demonstrating not only the cost of refurbishment but also its viability over a longer time horizon.

An analysis of academic literature has shown that the renovation of buildings and industrial facilities is examined

through the interplay of an enterprise's innovation strategy, environmental modernisation, digital modelling, life-cycle cost analysis, scenario comparison, technical and economic evaluation of engineering systems, multi-criteria selection and risk analysis. At the same time, in the existing literature, these areas are mostly considered separately: some studies focus on digital modelling, others on life-cycle costs, energy efficiency, risks or the sustainability of renovation solutions. An integrated model for technical and economic justification remains underdeveloped; such a model would be suitable specifically for assessing the feasibility of refurbishing enterprises in the construction sector and would combine the technical condition of the facility, the scale of investment, operating costs, energy efficiency, risks, payback period, life cycle and the strategic effectiveness of the refurbishment.

The study aimed to develop a system of models that provides a comprehensive technical and economic justification for the feasibility of renovating enterprises in the construction sector, considering the technical condition of the facilities, investment returns, resource and energy efficiency, life-cycle costs and risk exposure. Achieving this aim involved the development of normative-methodological and parametric models for the technical and economic justification of reconstruction; the construction of structural and scenario-based models of the interaction between technical, economic, investment, resource-energy and risk parameters; the development of a computational-integral model for ranking scenarios for the reconstruction of enterprises in the construction industry based on a reconstruction feasibility index.

Materials and Methods

The study was theoretical and modelling-based, combining an analytical review of regulatory and methodological sources with scenario-based, calculation- and assessment-based, and risk-oriented modelling. The material basis of the study consisted of cost, design, construction, energy, life-cycle, environmental and risk-oriented sources, which were processed using various methods in accordance with their hierarchy and functional purpose. In Order of the Ministry of Community and Territorial Development of Ukraine No. 281 (2021), a regulatory-cost analysis was applied, which made it possible to determine the role of the cost estimate base in shaping initial investment costs, the structure of reconstruction costs and the financial prerequisites for technical and economic evaluation. DBN A.2.2-3:2014 (2014) was examined using the normative-design analysis method, as this document defines the composition of design documentation, initial data, technical specifications and the stages of preparing reconstruction solutions. DBN V.2.2-9:2018 (2018) was analysed using a functional and planning analysis to consider the requirements for administrative, auxiliary, service and production support components of enterprises in the construction industry.

The energy module of the model was developed through energy audits and structural-functional analysis.

DSTU EN 16247-3:2015 (2015) was used to determine the baseline energy consumption parameters of industrial processes, identify potential losses, and establish performance indicators for energy modernisation. ISO 50001:2018 (2018) was used as a basis for addressing energy consumption management, monitoring energy performance and reducing operational losses. ISO 15686-5:2017 (2017) was used within the framework of life-cycle analysis, as this standard provides a basis for considering not only initial costs but also operational, ongoing, discounted and final costs over the calculation horizon. ISO 14044:2006 (2006) was applied using the environmental and resource analysis method to incorporate resource efficiency parameters, reduce environmental impact and assess the consequences of technical upgrades throughout the life cycle. ISO 31000:2018 (2018) was used within the framework of risk-based analysis to categorise cost, schedule, technical, market and regulatory risks that may affect the cost, implementation timeline, return on investment and overall viability of the refurbishment scenario.

The structural-systemic method was applied to identify five interrelated groups of parameters for the technical and economic feasibility study: technical suitability, economic impact, investment effectiveness, resource and energy sustainability, and risk exposure. Technical suitability covered physical wear and tear, obsolescence, structural reliability, the condition of engineering networks, technological compatibility of equipment, and the ability to adapt buildings to new production needs. Economic effect included capital expenditure, changes in production costs, expected resource savings, productivity gains, and reductions in operational losses. Investment performance was determined by payback period, net present value, discounted cash flows, and the sensitivity of the result to changes in the cost of works or the expected effect. Resource and energy sustainability covered energy efficiency, reduced resource consumption, controllability of energy processes, and a reduction in life-cycle impact. Risk exposure considered cost, technical, schedule, market, and regulatory risks.

Comparative and scenario-based methods were used to compare alternative options for the restructuring of a hypothetical production and construction system at a construction industry enterprise. The study did not analyse a specific enterprise; the model was developed for an enterprise whose activities are related to construction production, storage of materials, operation of repair areas, administrative and amenity premises, engineering networks and energy infrastructure. Within the framework of scenario modelling, four hypothetical reconstruction scenarios were identified: maintaining the current state, partial modernisation, comprehensive reconstruction, and comprehensive reconstruction with a digital-energy component. These were selected as typological options reflecting varying degrees of reconstruction intervention, ranging from no systematic renewal to local, comprehensive, and comprehensive digital-energy renewal of the production and construction system.

A normalised model scale ranging from 0 to 1 was used to quantitatively compare the renovation scenarios. The indices were calculated using the following algorithm: first, the parameters to be assessed were determined for each scenario, specifically technical upgrades, capital expenditure, operational benefits, life-cycle cost, net present value, energy efficiency and risk exposure; next, each parameter was assigned a level of manifestation on a scale of 0.00-0.20 (minimum), 0.21-0.40 (low), 0.41-0.60 (moderate), 0.61-0.80 (high), and 0.81-1.00 (very high). For positive parameters, an increase in the index indicated a greater contribution to the feasibility of the refurbishment, whereas for capital expenditure, life-cycle costs and risk exposure, it indicated higher costs or a greater level of constraints. As the study was not tied to a specific enterprise, the normalised values were used as model calculation and assessment indicators to demonstrate the algorithm for the preliminary comparison of refurbishment scenarios.

The calculation and evaluation method was used to formalise the indicators used to determine the financial and operational viability of the refurbishment scenario. The input data for calculating the payback period, life-cycle cost and net present value are the initial investment costs, projected cash flows or cost savings following refurbishment, operating costs, the discount rate, the duration of the calculation horizon and costs in the final period. In practical application, these data can be determined based on a preliminary refurbishment estimate, project documentation, energy audit results, the enterprise's financial plan, a forecast of operating costs, and assumptions regarding the cost of capital. Within the scope of this study, these indicators were used as model calculation parameters for comparing hypothetical refurbishment scenarios, rather than as actual data for a specific enterprise. The payback period for the refurbishment project was defined as the ratio of the initial investment costs to the average annual increase in cash flow or cost savings following the refurbishment (1):

$$PP = \frac{I_0}{\Delta CF}, \quad (1)$$

where PP – payback period for the refurbishment; I_0 – initial investment costs, covering the costs of construction and installation works, upgrading of utility networks, equipment, project preparation and supervision of the refurbishment; ΔCF – the average annual increase in cash flow or cost savings following refurbishment, resulting from reduced energy consumption, operational losses and maintenance costs, and improved production efficiency.

Life-cycle costs were used to estimate the total costs associated with the construction and subsequent operation of the refurbished facility (2):

$$LCC = C_0 + \sum_{t=1}^n \frac{C_t}{(1+r)^t} + \frac{C_d}{(1+r)^n}, \quad (2)$$

where LCC – cost of a lifecycle; C_0 – initial renovation costs; C_t – operating costs during the period t , in particular, costs relating to energy, upkeep, repairs, maintenance and the management of the facility; r – discount rate, reflecting the cost of capital and the time value of money; C_d – costs incurred during the final period relating to the dismantling, disposal, replacement of equipment or final refurbishment; n – duration of the projection horizon.

The investment performance of the refurbishment solution was assessed using the net present value (3):

$$NPV = \sum_{t=1}^n \frac{CF_t}{(1+r)^t} - I_0, \quad (3)$$

where NPV – net present value; CF_t – cash flow during the period t ; r – discount rate; I_0 – initial investments. The values obtained for PP, LCC and NPV were incorporated into the composite index K_{rec} by normalising the relevant calculated indicators on a scale of 0-1. The payback period and net present value formed the investment component of the model, as they reflected the rate of return on investment and the financial performance of the refurbishment. The life-cycle cost was used in the resource-energy and operational components, as it showed not only the initial costs but also the long-term financial burden following the implementation of the refurbishment scenario. A lower value of PP and LCC after normalisation corresponded to a higher feasibility of the scenario, whilst a higher value of NPV increased the investment rating.

To summarise the technical, economic, investment, resource and energy, and risk parameters, a comprehensive index of the feasibility of the refurbishment was developed (4):

$$K_{rec} = w_T T + w_E E + w_I I + w_S S - w_R R, \quad (4)$$

where K_{rec} – comprehensive feasibility index for reconstruction; T – technical suitability of the property for renovation; E – economic effect; I – return on investment; S – resource and energy sustainability; R – risk load; w_T, w_E, w_P, w_S, w_R – weighting factors for relevant blocks. As part of the model-based ranking of scenarios, an equilibrium distribution of weighting coefficients was applied: $w_T = w_E = w_I = w_S = w_R = 0.2$. This approach was used to demonstrate the basic logic of an integrated comparison of scenarios without prioritising any particular evaluation component.

A risk-based analysis was used to refine the constraints of the integrated model and to determine the risk exposure index. Risks were grouped into five categories: cost, schedule, technical, market and regulatory. For each risk group, a standardised scale from 0 to 1 was used, where 0.00-0.20 indicated minimal risk, 0.21-0.40 – low, 0.41-0.60 – moderate, 0.61-0.80 – high, and 0.81-1.00 – critical risk levels. Cost risk reflected the probability of exceeding the planned cost of the refurbishment; schedule risk – a possible deviation from the implementation deadlines; technical risk – incomplete information about the actual condition of

structures, utility networks and equipment; market risk – changes in demand, resource costs or the company's operating conditions; regulatory risk – changes in requirements for design, operation, energy efficiency and environmental safety. The overall risk load index was determined as the weighted average of the five risk components (5):

$$R = w_c R_c + w_t R_t + w_{\text{tech}} R_{\text{tech}} + w_m R_m + w_{\text{reg}} R_{\text{reg}}, (5)$$

where R – overall risk exposure index; R_c – budget risk; R_t – calendar risk; R_{tech} – technical risk; R_m – market risk; R_{reg} – regulatory risk; $w_c, w_t, w_{\text{tech}}, w_m, w_{\text{reg}}$ – weighting factors for the relevant risk groups. In the baseline model assessment, equal weighting was applied, with each risk group assigned a weight of 0.20. The resulting value was included in the overall index of the feasibility of reconstruction as a limiting factor; consequently, an increase in this value reduced the scenario's overall score.

To facilitate decision-making within the conceptual model, threshold criteria for scenario selection were established. A renovation scenario was considered methodologically acceptable if the technical suitability index was at least 0.40, as a lower value indicated that the facility lacked sufficient structural, engineering or technological suitability for refurbishment. An acceptable level of risk was defined as up to 0.60; for a value of $R > 0.60$, the scenario required further review of the budget, timelines, technical solutions or

organisational conditions for implementation. The integrated reconstruction feasibility index K_{rec} was used as the final ranking criterion: a value below 0.30 indicated low feasibility of the scenario, 0.30-0.49 – conditional acceptability, 0.50-0.69 – sufficient feasibility, and a value of 0.70 and above – a high level of technical and economic justification. A limitation of the study is that the proposed scenarios, normalised indices and calculated indicators are of a model nature and are not based on empirical data from a specific enterprise, the actual reconstruction cost estimate or real cash flows.

Results

The regulatory, methodological and parametric framework for the technical and economic justification of the refurbishment

An analysis of the regulatory and methodological framework has shown that the technical and economic justification for the refurbishment of enterprises in the construction sector has a multi-component structure and encompasses cost, design, spatial planning, energy, life-cycle, environmental and risk-oriented parameters. This approach makes it possible to evaluate a reconstruction decision not only in terms of initial investment costs, but also in terms of technical feasibility, expected operational benefits, energy consumption management, changes in life-cycle costs and the level of risk exposure. The functional breakdown of these components is presented in Table 1.

Table 1. Regulatory and methodological sources for developing a model for the technical and economic justification of the reconstruction of enterprises in the construction industry

Regulatory and methodological basis	Scope of regulation	Section on the technical and economic feasibility study	Outcome for assessing the feasibility of the refurbishment
Order of the Ministry of Community and Territorial Development of Ukraine No. 281	Cost standards for the construction industry in Ukraine	Asset and investment unit	Determining the initial cost of the refurbishment, the cost structure and the basis for further investment appraisal
DBN A.2.2-3:2014	Composition and content of the project documentation	Design and documentation unit	Alignment of the renovation proposal with the initial data, technical specifications, design stages and the scope of design documentation
DBN V.2.2-9:2018	Requirements for public buildings and structures	Spatial planning unit	Consideration of structural and functional constraints for the administrative, ancillary, service and public-industrial components of the enterprise
DSTU EN 16247-3:2015	Energy audits of industrial processes	Energy audit unit	Determining baseline energy data, identifying energy losses and identifying areas for improving energy efficiency
ISO 50001:2018	Energy management systems	Energy management and performance monitoring	Incorporating energy performance indicators into the model and ensuring that energy consumption can be managed following the refurbishment
ISO 15686-5:2017	Life-cycle cost of buildings and structures	Life-cycle module	Assessing not only the initial cost, but also the operational, ongoing and final costs over the forecast period
ISO 14044:2006	Life cycle environmental assessment	Environmental unit	Consideration of the resource, energy and environmental implications of the refurbishment solution
ISO 31000:2018	Risk management	Risk-based module	Adjustment of the final valuation to account for uncertainties regarding value, timing, technical condition, market conditions and regulatory conditions

Source: compiled by the author

The data in Table 1 demonstrate that the regulatory and methodological framework for technical and economic justification has a hierarchical structure. Its basic level is formed by cost estimates and design requirements, as it is impossible to proceed to the investment appraisal of the refurbishment without determining the cost of the works, the composition of the documentation and the technical specifications. The second level consists of spatial planning and energy requirements, which correlates the renovation with the functional adaptation of buildings, the condition of engineering systems and the potential for reducing energy consumption. The third level encompasses life-cycle, environmental and risk assessments, which can be used to analyse the renovation not only as a one-off investment project, but as a long-term change to the production and construction system. The systematisation revealed the functional distribution of regulatory sources within the integrated model. Order of the Ministry of Community and Territorial Development of Ukraine No. 281 (2021) establishes the cost estimation and valuation framework for renovation; DBN A.2.2-3:2014 (2014) defines design and documentation requirements; DBN V.2.2-9:2018 (2018) specifies the spatial planning and functional constraints for the administrative, auxiliary and service components of the enterprise; DSTU EN 16247-3:2015 (2015) and ISO 50001:2018 (2018) provide the energy assessment section; ISO 15686-5:2017 (2017) is used for life-cycle cost assessment, ISO 14044:2006 (2006) – for accounting for resource and environmental impacts, and ISO 31000:2018 (2018) – for the risk-oriented module of the model. The budgetary framework defines the initial financial scope of the refurbishment; the design framework establishes the link between economic decisions and technical implementation; the energy framework demonstrates the potential for reducing energy losses; the life-cycle framework broadens the scope of assessment; the environmental framework takes resource implications into account; and the risk-oriented framework adjusts the overall feasibility to account for uncertainty. This provided the basis for a transition from a prescriptive list to a structural model of parameters,

in which each source is linked to a corresponding group of indicators. Thus, the results of the normative and methodological systematisation have made it possible to establish that the model for the technical and economic justification of the reconstruction of enterprises in the construction industry should be structured as an integrated system, in which estimated cost, project preparation, spatial and planning constraints, energy efficiency, life-cycle cost, environmental impact and risk exposure are considered as interrelated components. This framework facilitates the transition to the further systematisation of five groups of parameters for the feasibility of reconstruction: technical suitability, economic effect, investment performance, resource and energy sustainability, and risk exposure.

The technical and economic feasibility of renovating enterprises in the construction sector has been structured into five components, with each group of parameters reflecting a separate aspect of the decision-making process regarding renovation. Technical suitability determines the feasibility of upgrading existing buildings, utility networks and technological equipment; economic effect characterises the expected change in costs, productivity and operational losses; investment performance indicates the financial return on investment over the forecast horizon; resource and energy sustainability reflects the ability of the refurbishment to reduce resource consumption and maintain the manageability of energy processes; risk exposure identifies constraints that may reduce the expected outcome due to uncertainty regarding cost, timing, technical condition or market conditions. The resulting framework showed that the feasibility of refurbishment cannot be determined by a single dominant indicator. A low estimated cost does not guarantee the rationality of a scenario if it does not eliminate technical constraints, reduce operating costs or ensure an acceptable level of resource and energy sustainability. At the same time, a scenario with higher initial investment may receive a better overall assessment due to a longer economic effect, lower life-cycle costs, greater adaptability of the facility and a lower risk burden. The relationship between these groups of parameters is presented in Table 2.

Table 2. Groups of parameters relating to the technical and economic feasibility of renovating enterprises in the construction sector

Parameter group	Assessment content	Key indicators	Impact on the comprehensive index of the feasibility of reconstruction
Technical suitability	Determines the feasibility and practicality of refurbishment based on the current condition of the buildings, utility networks, technical equipment and spatial layout	Physical wear and tear; obsolescence; structural integrity; condition of utility networks; technological compatibility of equipment; adaptability of buildings to new operational requirements	Increases the index provided the property is sufficiently suitable for refurbishment; reduces the feasibility if the property is heavily worn or cannot be adapted
Economic impact	Describes the expected changes in costs, productivity and operational performance following the refurbishment	Capital expenditure; changes in production costs; resource savings; productivity gains; reduction in operational losses; lower maintenance costs	Increases the index when there is an improvement in cost savings, productivity and a reduction in operating costs; decreases the index when the operational impact is insufficient

Table 2, Continued

Parameter group	Assessment content	Key indicators	Impact on the comprehensive index of the feasibility of reconstruction
Investment performance	Reflects the financial viability of the refurbishment over the forecast period and the project's ability to generate a return on investment	Payback period; net present value; discounted cash flows; sensitivity to changes in the cost of works, the discount rate and the expected return	Improves the index in terms of positive return on investment, an acceptable payback period and the resilience of the results to changes in initial conditions
Resource and energy sustainability	Assesses the long-term ability of a refurbishment solution to reduce resource consumption, energy costs and the company's operational dependence	Energy efficiency; reduced resource consumption; controllability of energy processes; lower life-cycle costs; stability of operating parameters	Improves performance by reducing energy consumption, lowering resource usage and enhancing operational control
Risk exposure	Determines the degree of uncertainty that may reduce the expected impact of the redevelopment or complicate the implementation of the chosen scenario	Cost risks; technical risks; schedule risks; market risks; regulatory risks; uncertainty regarding the actual condition of the facility	Has a negative impact on the index; reduces the overall viability of the scenario where there is a high probability of cost overruns, delays or failure to achieve the intended effect

Source: developed by the author based on the estimated cost, design, energy, life-cycle and risk-based approaches to evaluating the refurbishment

The data in Table 2 show that the parameters of the technical and economic feasibility of the refurbishment affect the final assessment differently. Technical feasibility serves as a prerequisite for the model, since even an economically attractive scenario cannot be justified if there is no structural, engineering or technological possibility of its implementation. Economic impact and investment performance form the financial core of the assessment, yet they have different focuses: economic impact captures expected changes in costs and productivity, whilst investment performance indicates whether these changes can offset the initial investment within the projection horizon. Resource and energy sustainability extends the assessment beyond short-term savings, as it considers the long-term manageability of energy consumption, the reduction in resource costs, and the impact of the refurbishment on the enterprise's future operations. In this context, what is relevant is not only the reduction in energy costs, but also the enterprise's ability to maintain controlled operational parameters after the refurbishment is complete. In contrast to other factors, risk does not increase the feasibility of refurbishment but serves a corrective function. Its inclusion in the model demonstrates that the overall effectiveness of a refurbishment scenario depends not only on expected benefits but also on the likelihood of cost overruns, implementation delays, technical complications, or changes in market and regulatory conditions. High technical viability without sufficient economic benefits does not justify the investment, and a positive net present value may lose its significance if there is a high implementation risk or high life-cycle costs. The systematisation of parameters has made it possible to develop the internal structure of a model for assessing the technical and economic feasibility of renovating enterprises in the construction sector. The study established that such a model must combine an assessment of technical condition, expected economic benefit, financial performance,

resource and energy sustainability, and risks. This provides the basis for constructing a structural model for justifying reconstruction, in which these groups of parameters interact with one another and form a final decision regarding the choice of a scenario for the enterprise's modernisation.

A structural-scenario model for evaluating reconstruction alternatives

The structure of the technical and economic feasibility study revealed that the feasibility of renovating a construction company is determined not by isolated indicators, but by the interaction of several functionally linked components, which collectively influence the final decision. At the heart of this system lies an integrated assessment of the feasibility of reconstruction, which synthesises technical, economic, investment, resource-energy and risk parameters into a single analytical framework. This approach treats reconstruction not as a separate construction project, but as a comprehensive management and investment decision formed at the intersection of the technical condition of the facility, the expected benefits of the refurbishment, and implementation constraints. The structural model of the technical and economic justification for the feasibility of reconstructing a construction industry enterprise is presented in Figure 1. As shown in Figure 1, at the centre of the model lies an integrated decision regarding the feasibility of renovating a construction industry enterprise. This decision is formed through the interaction of five parametric blocks: technical suitability, economic impact, investment effectiveness, resource and energy sustainability, and risk exposure. Within the model, technical suitability reflects the actual condition of buildings, engineering networks, technological equipment and spatial planning structure, and also sets the technical limits of the reconstruction decision, considering the requirements for the composition of project documentation in accordance

with DBN A.2.2-3:2014 (2014). The economic effect reflects the expected reduction in costs, increase in productivity, reduction in operational losses and the formation of the cost estimate basis for the renovation in accordance with Order of the Ministry of Community and Territorial

Development of Ukraine No. 281 (2021). Investment performance shows the relationship between the volume of investment and the expected financial return, and is therefore linked to the payback period, discounted cash flows and net present value.

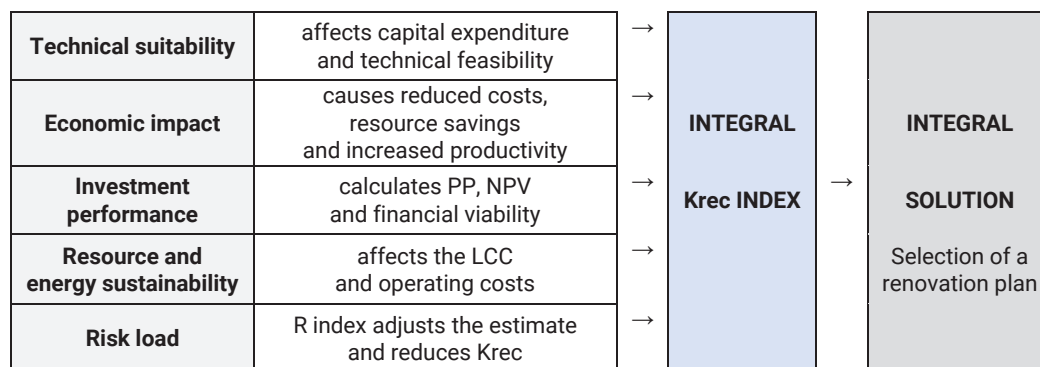


Figure 1. Structural model for the technical and economic justification of the feasibility of a construction company's refurbishment

Source: compiled by the author based on a systematisation of cost, design, energy, life-cycle, environmental and risk-based parameters of the refurbishment

Resource and energy sustainability refers to the ability of a refurbishment project to reduce energy consumption, resource use and life-cycle costs. This module combines the results of energy audits of industrial processes, energy management and life-cycle assessment, in accordance with the provisions of DSTU EN 16247-3:2015 (2015), ISO 15686-5:2017 (2017) and ISO 50001:2018 (2018). The environmental dimension of this part of the model relates to the resource and energy impacts of the refurbishment solution throughout its life cycle, following ISO 14044:2006 (2006). The risk factor serves a corrective function, as it accounts for the probability of cost overruns, delays, technical complications, market changes or regulatory requirements; this logic is consistent with the risk-based approach of ISO 31000:2018 (2018). All blocks of the model form a closed-loop assessment system, within which a change in one parameter affects other components of technical and economic feasibility. For example, a high level of technical wear and tear may increase capital expenditure, extend the payback period and heighten implementation risks, whilst improving resource and energy sustainability can enhance the economic impact, reduce life-cycle costs and improve investment performance. The structural model shows that the choice of a refurbishment scenario should not be based on a single dominant criterion, but rather on a balance between technical feasibility, economic benefits, return on investment, energy stability and an acceptable level of risk. The presented structural model for assessing the feasibility of reconstructing a construction industry enterprise reflects an interrelated system of parameters, in which technical suitability determines the possibility of reconstruction, economic effect and investment performance determine its financial feasibility, resource and energy sustainability characterise the long-term operational effect,

and the risk burden adjusts the final assessment. The output of the model is the selection of a reconstruction scenario that best meets the criteria of technical and economic feasibility and ensures a balance between investment returns, operational stability and a controlled level of uncertainty.

A scenario-based comparison of refurbishment alternatives has shown that the choice of the most appropriate option for upgrading a construction industry enterprise cannot be based solely on minimising initial capital expenditure. Each scenario involves a different level of technical complexity and has a different impact on operating costs, energy efficiency, return on investment and risk exposure. Therefore, maintaining the current state, partial modernisation, comprehensive refurbishment and comprehensive refurbishment with a digital-energy component differ not only in the scale of construction and technical changes, but also in the enterprise's long-term ability to reduce costs, maintain productivity and manage risks. The summarised results of the scenario comparison are presented in Table 3. The data in Table 3 show that the "maintain current status" scenario has the lowest capital expenditure index – 0.15, but is characterised by the lowest operational efficiency – 0.05, low energy efficiency – 0.20, a zero-payback index and the highest risk load – 0.78. This indicates that reducing the initial investment does not eliminate technical, energy and operational constraints. Partial modernisation yields intermediate values: the technical upgrade index is 0.45, the operational effect is 0.38, energy efficiency is 0.48, the normalised payback index is 0.56, and the risk load is reduced to 0.52. This scenario provides a local effect but does not comprehensively transform the production and construction system. Comprehensive reconstruction increases the technical renewal index to 0.78, the operational efficiency index to 0.72 and the energy efficiency index to

0.71, although it has a higher capital intensity of 0.76 and a lower normalised payback index of 0.48. The comprehensive refurbishment scenario with a digital-energy component has the highest values for technical renewal – 0.92, operational efficiency – 0.86, and energy efficiency – 0.89; the lowest LCC index – 0.76; the highest NPV index – 0.39;

and the lowest risk load – 0.34. Thus, the scenario comparison demonstrated that the feasibility of the refurbishment is determined not by the minimum initial costs, but by the balance between technical modernisation, operational efficiency, energy efficiency, life-cycle costs, investment performance and risk.

Table 3. A scenario-based comparison of alternatives for the restructuring of a construction company

Scenario	Technical update index	Capital expenditure index	Operational effect index	Standardised payback period	LCC index	NPV index	Energy efficiency index	Risk exposure index	Methodological appropriateness of the application
Saved current status	0.10	0.15	0.05	0.00	1.00	0.00	0.20	0.78	Base scenario for comparison; does not provide a system update
Partial modernisation	0.45	0.42	0.38	0.56	0.92	0.18	0.48	0.52	Suitable for locally addressing technical limitations
Comprehensive refurbishment	0.78	0.76	0.72	0.48	0.84	0.31	0.71	0.44	Suitable for the systematic modernisation of the industrial and construction infrastructure
Comprehensive refurbishment with a digital and energy component	0.92	0.88	0.86	0.43	0.76	0.39	0.89	0.34	Suitable for strategic renewal and long-term sustainability

Source: developed by the author as a standardised model for evaluating reconstruction scenarios on a 0-1 scale, using formulas (1-3) and considering cost, design, energy, life-cycle and risk frameworks

Calculational and integrative assessment and ranking of reconstruction scenarios

The results of the functional comparison showed that each indicator has a distinct zone of analytical sensitivity. The payback period is most informative for scenarios with a relatively rapid return on investment, but may underestimate long-term operational losses. Life-cycle cost highlights

the difference between scenarios with low initial costs and those with higher initial investments but lower subsequent costs. Net present value reflects financial performance over time, whilst the integrated index can be used to compare financial indicators with technical, energy and risk components. The generalised role of these indicators in the feasibility model for the refurbishment is presented in Table 4.

Table 4. The functional role of calculation indicators in the model for justifying the feasibility of reconstruction

Indicator	Evaluated aspect	Management significance	Scenarios in which the indicator is critical
Payback period, PP	Payback period based on increased cash flow or cost savings	Can be used to determine the rate of return on investment and compare scenarios in terms of short- and medium-term financial attractiveness	Partial modernisation; comprehensive refurbishment; comprehensive refurbishment with a digital and energy component
Life-cycle cost, LCC	Total costs for implementation, operation and the final phase over the forecast period	Can be used for a shift from assessing the initial cost to assessing the total cost of ownership of a refurbished production and construction system	Comprehensive refurbishment; comprehensive refurbishment with a digital and energy component
Net present value, NPV	Discounted financial result of the reconstruction scenario, incorporating the initial investment	Indicates the investment performance of the scenario and its ability to generate a positive economic return over the forecast period	Partial modernisation; comprehensive refurbishment; comprehensive refurbishment with a digital and energy component
Comprehensive reconstruction feasibility index, Krec	Overall assessment of technical suitability, economic impact, investment performance, resource and energy sustainability, and risk exposure	Ranks scenarios and selects the option that offers the best balance of effectiveness, cost, sustainability and risk	All scenarios, including the baseline scenario of maintaining the current status quo

Source: compiled by the author based on the calculation and estimation logic of the technical and economic justification for the reconstruction, using equations (1-4)

The data in Table 4 showed that each calculated indicator served a specific management purpose. The payback

period was used for a quick comparison of scenarios in terms of the time taken to recoup the investment, but did

not incorporate subsequent costs after the payback period had ended. Therefore, the scenario with the shortest payback period was not necessarily the most appropriate in the long term. This situation could arise when a local upgrade required lower initial costs but did not eliminate systemic operational losses. The life-cycle cost indicator expanded the assessment, as it can be used to consider costs not only during the implementation phase of the refurbishment but also during the subsequent operational period. This indicator revealed the difference between scenarios with a lower initial cost and those with higher capital intensity, but which ensured cost reductions over a longer period. Net present value complemented this logic with an investment dimension, as it showed whether a scenario generated a financial return after accounting for initial investments and discounting future cash flows.

The comprehensive index of the feasibility of reconstruction served as a summary indicator for the model, as it combined parameters that could not be fully captured by payback period, life cycle or net present value alone. Its significance stemmed from the fact that it was used for the simultaneous consideration of the technical suitability of the facility, economic impact, investment performance, resource and energy sustainability, and risk exposure. In this context, the risk component served as a corrective factor and could lower the final assessment even when the scenario demonstrated positive economic indicators. A

comparison of the functions of the indicators showed that the isolated use of a single calculation criterion did not provide a complete assessment of the refurbishment. A short payback period did not always mean the best long-term viability, and a lower initial cost could be accompanied by higher operating costs, a weaker resource and energy efficiency, or higher implementation risks. Therefore, the calculation and evaluation model demonstrated the need to combine the PP, LCC, NPV and K_{rec} indicators into a single system, where each indicator performs a separate function, and the final decision is formed through their mutual interpretation.

An integrated ranking of the scenarios showed that the overall feasibility of the refurbishment did not vary in proportion to the level of initial expenditure, but depended on the balance between technical suitability, economic impact, investment performance, resource and energy sustainability, and risk exposure. Within the model assessment, scenarios involving a greater extent of technical upgrading achieved better rankings only when the increase in capital expenditure was offset by lower life-cycle costs, higher energy efficiency, better investment performance and reduced risks during the subsequent operational period. The integrated ranking of scenarios was performed using formula (4), in which the risk burden had a negative impact on the final index. Table 5 presents the model ranking of the four refurbishment scenarios.

Table 5. Model-based ranking of reconstruction scenarios using the K_{rec} integral index

Scenario	T – technical suitability	E – economic impact	I – investment performance	S – Resource and energy sustainability	R – Risk exposure	K _{rec}	Relevancy rank
Saved current status	0.10	0.05	0.00	0.20	0.78	-0.09	IV
Partial modernisation	0.45	0.38	0.18	0.48	0.52	0.19	III
Comprehensive refurbishment	0.78	0.72	0.31	0.71	0.44	0.42	II
Comprehensive refurbishment with a digital and energy component	0.92	0.86	0.39	0.89	0.34	0.54	I

Source: calculated by the author using the integrated model for the technical and economic feasibility study of the reconstruction, in accordance with equations (4-5)

The data in Table 5 showed that the “maintain current status” scenario received the lowest overall score – K_{rec} = -0.09. This result was explained by the fact that the minimal current costs did not compensate for the low technical suitability, lack of investment returns, weak resource and energy efficiency, and the highest risk load – 0.78. The obtained value indicated that foregoing reconstruction may appear less costly only in the short term; however, in the longer term, it exacerbates the enterprise’s technical, operational and energy constraints. The partial modernisation scenario received an integral index of K_{rec} = 0.19 and a third-place ranking in terms of feasibility. It demonstrated better values compared to the baseline option in terms of technical suitability, economic effect and resource-energy sustainability, but remained limited due to the localised nature of the upgrade. A risk load of 0.52 indicated that partial modernisation reduces certain technical and

operational risks but does not eliminate the systemic constraints of the production and construction system. Comprehensive reconstruction was ranked second with a K_{rec} value of 0.42. Its advantage was determined by higher values for technical suitability (0.78), economic efficiency (0.72) and resource and energy sustainability (0.71). This scenario provided for a more comprehensive refurbishment of buildings, utility networks, equipment and the spatial layout. At the same time, the risk score of 0.44 remained significant due to the greater complexity of implementation, the larger scope of work and the need to coordinate several of the enterprise’s subsystems. The highest overall score was awarded to the scenario involving comprehensive refurbishment with a digital-energy component – K_{rec} = 0.54, which secured it first place in terms of feasibility. Its advantage was linked to the highest values for technical feasibility – 0.92, economic effect – 0.86, and

resource and energy sustainability – 0.89. The inclusion of digital monitoring, energy management and control of operational parameters enhanced the scenario's ability to reduce life-cycle costs and maintain the enterprise's manageability after the completion of the reconstruction. The lower risk load – 0.34 – indicated that, in the long term, the digital-energy component not only improves operational performance but also reduces the uncertainty of managing the reconstructed system. A comparison of the scenarios demonstrated that the overall feasibility of modernising enterprises in the construction sector was not determined by a single indicator. The scenario with the lowest initial costs had the worst overall outcome due to weak economic and resource-energy effects and a high-risk load. Partial modernisation brought about local improvements but did not ensure sufficient systematicity. Comprehensive refurbishment yielded the highest technical and economic performance, whilst comprehensive refurbishment incorporating a digital and energy component demonstrated the best balance between technical modernisation, economic benefits, investment returns, resource and energy sustainability, and risk management. The results of the integrated ranking made it possible to refine the overall logic behind the choice of reconstruction scenario. The most comprehensive assessment was provided by a combination of cost, design, energy, life-cycle, investment and risk-oriented logic. The K_{rec} integrated index made it possible to compare scenarios not only in terms of costs, but also in terms of their ability to ensure the long-term sustainability of the enterprise, reduce operational burden and maintain an acceptable level of risk. Therefore, the scenario in which technical modernisation was combined with energy management, life-cycle cost control and the reduction of risk uncertainty was deemed to have the highest methodological merit.

A summary of the findings showed that the technical and economic justification for the feasibility of renovating enterprises in the construction sector should be viewed as a system of interrelated models: regulatory and methodological, parametric, structural, scenario-based, and computational-integral. The normative-methodological model defined the assessment framework by combining cost, design, energy, life-cycle, environmental and risk-oriented requirements. The parametric model made it possible to identify five key factors determining the feasibility of reconstruction: technical suitability, economic impact, investment performance, resource and energy sustainability, and risk exposure. A scenario comparison showed that minimal initial costs do not guarantee the best outcome, as the “maintain current status” scenario had the highest risk load and the lowest long-term effect. Calculated-integral ranking demonstrated the advantage of a comprehensive refurbishment with a digital-energy component, which received the highest K_{rec} index due to the combination of technical upgrading, energy management, life-cycle cost control, and reduced risk uncertainty. The results confirmed that the choice of renovation scenario should be based not on a single indicator, but on a balanced combination of cost, return

on investment, operational sustainability, energy efficiency and an acceptable level of risk.

Discussion

A comparison of the results obtained with current research showed that the proposed system of models expanded the traditional interpretation of renovation as a standalone investment or cost-estimation decision. In the present study, the feasibility of renovation was demonstrated through the interaction of regulatory-methodological, parametric, structural, scenario-based, and computational-integral models. This result was consistent with the findings of S. Cova *et al.* (2021), who, when assessing economically optimal investments in building retrofits, demonstrated the importance of combining the cost of measures with long-term outcomes. At the same time, the resulting model differed in its broader scope, as it transferred the logic of investment feasibility from the level of an individual building to the level of the construction industry as a production-construction system. A similar temporal dimension of renovation was evident in the study by I. Maia *et al.* (2021), where a step-by-step retrofit model was proposed, incorporating the optimal timing for implementing measures. The results presented complemented this approach, as they showed that the choice of scenario depended not only on the timing of implementation but also on a combination of technical feasibility, economic impact, investment performance, resource and energy sustainability, and risk exposure. The findings of P. Palma *et al.* (2021), which emphasised the cost of energy-efficient refurbishment of the housing stock, were also consistent with the conclusions reached: in the presented model, the initial cost did not act as an independent criterion of optimality, as the “maintain current state” scenario had the lowest capital expenditure index of 0.15, but received the worst overall ranking due to its poor operational performance and high-risk burden. The life-cycle logic of the results obtained was consistent with the direction of research in which renovation was considered in terms of total costs, environmental impacts and long-term operational performance. O. Fahlstedt *et al.* (2024), in a review of studies on building refurbishment and life-cycle assessment, demonstrated that the benefits of refurbishment cannot be accurately determined without considering the consequences throughout the entire period of the building's use. This was consistent with the result obtained, according to which the life cycle cost index became one of the key indicators in the scenario comparison. The conclusions of G. Maselli *et al.* (2024) regarding the use of Life Cycle Costing in structural analysis and design were consistent with the finding that, in the calculation and evaluation model, the life cycle cost indicator was used for the short-term cost-effectiveness of a scenario to be distinguished from its long-term viability. A similar issue regarding the limits of applying Life Cycle Costing in decision-making processes was examined by S. Gil *et al.* (2025). The results obtained confirmed their conclusion that the life-cycle approach must be integrated into a

broader assessment framework, as it does not independently address technical suitability, return on investment and implementation risks. The findings of L. Gustavsson & C. Piccardo (2022) regarding the optimisation of energy retrofits across different materials, economic scenarios and energy supply systems were also consistent with a scenario-based model, in which the top ranking was not awarded to the cheapest option, but to the scenario offering the best balance of energy efficiency, life-cycle costs and risk manageability. The conclusions of H. Zhang *et al.* (2021) on the application of Pareto optimisation in the assessment of energy retrofits using life-cycle logic were similar to the integral ranking obtained, as in both cases optimality was determined not by a single indicator but by a balance between several criteria. The review by M. Papangelopoulou *et al.* (2025), dedicated to the financial evaluation of energy retrofits, confirmed the importance of combining investment and technical indicators, as reflected in the combination of payback period, net present value, life-cycle cost and the integrated retrofit feasibility index.

The parametric and scenario-based components of the results obtained were conceptually similar to studies in which renovation solutions were evaluated using multi-criteria models. J. Amorcho & T. Hartmann (2022) proposed a multi-criteria approach to the renovation of residential buildings using pairwise comparisons and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method. The obtained results were consistent with this logic, as the parametric model also involved comparing several groups of indicators, but was adapted to enterprises in the construction industry and supplemented with a risk module. The study by P. Spüdys *et al.* (2025), in which payback was combined with embodied carbon costs and stakeholder priorities, supported the study's conclusion that renovation cannot be assessed solely based on the payback period. In the study's model, a shorter payback period did not guarantee higher overall feasibility if the scenario retained high risks or failed to ensure resource and energy sustainability. K. Theilig *et al.* (2025), comparing multi-criteria decision-making methods for energy renovation, showed that the ranking result depends on the structure of the criteria and the method of their weighting. This was directly relevant to the integrated ranking in this study, where the balanced distribution of weighting coefficients made it possible to demonstrate the underlying logic of scenario selection without reference to the priorities of a specific enterprise. At the same time, the obtained results expanded upon the approaches outlined by incorporating not only energy and financial parameters, but also technical suitability, operational resilience and risk exposure. A separate section of the comparison focused on the digitalisation of renovation solutions. S. Jiang *et al.* (2023) identified gaps and requirements for the application of automated architectural design in building renovation. The study's findings aligned with this direction, as the comprehensive renovation scenario with a digital-energy component received the highest overall rating precisely due to the combination of

technical upgrades, digital monitoring of operational parameters and energy management. The bibliometric review by S. Adekunle *et al.* (2021) demonstrated the growing role of digital transformation in the construction industry, which was consistent with the results obtained: the digital-energy component reduced the risk load to 0.34 and enhanced resource and energy sustainability to 0.89. The conclusions of R. Charef & S. Emmitt (2020) regarding the use of BIM to overcome barriers to the circular economy were also relevant to the structural model obtained. In the study, digital support was not considered merely as a design tool, but was incorporated into a broader assessment system, where it influenced operational manageability, life-cycle cost control and the reduction of uncertainty in the refurbishment scenario. Thus, the findings complemented previous research in that digitalisation was linked not only to design accuracy but also to the overall feasibility of the plant's refurbishment. A comparison with works on the circular economy and sustainability in the construction sector showed that the proposed system of models corresponded to the broader trend of moving from one-off refurbishment solutions to long-term, balanced renewal strategies. B. Guerra & F. Leite (2021) identified stakeholders' awareness, barriers and factors influencing the implementation of the circular economy in construction, which aligned with the conclusion that it is necessary to take into account not only technical and financial parameters, but also organisational and risk-related factors. E. Gasparri *et al.* (2023) highlighted gaps in research on the circular economy in construction, particularly regarding the need for new integrated research frameworks. The resulting normative-methodological and parametric models partially met this need, as they combined cost, design, energy, life-cycle and risk logic within a single assessment framework. B. Dams *et al.* (2023) showed in an analysis of the scaling of bio-oriented construction that sustainable solutions require simultaneous consideration of technical capabilities, the market, resources and regulatory constraints. A similar pattern emerged in the present study: a high level of resource and energy sustainability would not provide an overall advantage without technical suitability, investment efficiency and controlled risk. This confirmed that the restructuring of enterprises in the construction sector should be assessed as a multi-factor process, rather than as a set of individual modernisation measures. The risk-oriented set of results was consistent with contemporary research on risk management in sustainable construction. R. Almashhour *et al.* (2025) examined the transition from traditional to sustainable risk management in the construction industry, which corresponded to the study's conclusion regarding the corrective role of risk exposure in the integrated model. In the present study, risk was not an external add-on to financial calculations, but directly reduced the final feasibility index of the refurbishment. Therefore, the "maintain current state" scenario received the lowest score of $K_{rec} = -0.09$ with a high-risk load of 0.78, despite a low capital expenditure index. A systematic review by F. Wang *et al.* (2025) on risk management in

sustainable construction projects also confirmed the need to link risks to environmental, economic and technical parameters. The obtained results built on this logic by establishing a scenario ranking, in which a reduction in risk exposure became one of the criteria favouring a comprehensive refurbishment incorporating a digital and energy component. Thus, the risk module in the model served not a descriptive function but a computational and corrective one, thereby strengthening the rationale for selecting the refurbishment scenario.

A summary of the results showed that the proposed model system was consistent with the main trends in contemporary research on renovation, whilst at the same time expanding upon them by shifting the focus from an individual building, energy measure or financial indicator to the construction industry as a whole, viewed as an integrated production and construction system. Unlike approaches focused primarily on retrofit costs, energy renovation, life-cycle assessment or multi-criteria selection, this study combined regulatory-methodological, parametric, structural, scenario-based and integrated logic. The results obtained showed that the scenario of comprehensive renovation with a digital-energy component had the highest methodological feasibility, as it provided the best balance between technical modernisation, economic effect, investment performance, resource and energy sustainability, and risk exposure. This provided grounds for considering the integrated reconstruction feasibility index as a tool for the preliminary ranking of alternatives, which can be further refined based on actual data from specific enterprises in the construction industry in Ukraine.

Conclusions

The study has resulted in the development of a system of models for the technical and economic justification of the feasibility of renovating enterprises in the construction sector. It has been established that reconstruction cannot be assessed solely based on estimated cost, payback period or individual energy efficiency. Its feasibility is determined through the interaction of normative-methodological, parametric, structural, scenario-based and calculation-integral models. The normative-methodological systematisation made it possible to identify seven interrelated assessment dimensions: cost, design, spatial planning, energy, life cycle, environmental and risk-oriented. This facilitated a shift from viewing renovation as a separate

cost-intensive measure to interpreting it as a comprehensive management and investment decision. The parametric model covered five key blocks: technical suitability, economic effect, investment performance, resource and energy sustainability, and risk exposure. The study determined that technical suitability determines the feasibility of reconstruction, economic effect and investment performance form financial viability, resource and energy sustainability reflect long-term operational effect, and risk exposure adjusts the final assessment. A comparison of the scenarios showed that the lowest initial costs do not guarantee the best outcome. The “maintain current status” scenario had the lowest capital expenditure index – 0.15 – but was characterised by the lowest operational benefit – 0.05, low energy efficiency – 0.20 – and the highest risk load – 0.78. The most balanced scenario was the comprehensive refurbishment with a digital-energy component: the technical upgrade index was 0.92, the operational benefit index – 0.86, energy efficiency was 0.89, LCC was 0.76, NPV was 0.39, and the risk load fell to 0.34. Integral ranking based on the K_{rec} index confirmed the superiority of comprehensive refurbishment with a digital-energy component, which received the highest Krec value of 0.54. Comprehensive refurbishment was second with Krec = 0.42, partial modernisation third with Krec = 0.19, whilst maintaining the current state received the lowest rating – $K_{rec} = -0.09$. The main limitation of the study is the theoretical nature of the standardised indices, which demonstrate the logic of the technical and economic justification without reference to the actual financial statements of a specific enterprise. Further research should verify the model on real enterprises in Ukraine’s construction sector, refine the weighting coefficients for different types of enterprises, incorporate actual data on energy consumption, capital expenditure, cash flows and risks, and expand renovation scenarios to account for digital monitoring, BIM support and energy management systems.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] Adekunle, S.A., Aigbavboa, C.O., Ejohwomu, O., Adekunle, E.A., & Thwala, W.D. (2021). Digital transformation in the construction industry: A bibliometric review. *Journal of Engineering Design and Technology*, 22(1), 130-158. [doi: 10.1108/jedt-08-2021-0442](https://doi.org/10.1108/jedt-08-2021-0442).
- [2] Almashhour, R., Al-Mhdawi, M., Daghfous, A., Qazi, A., & Ojiako, U. (2025). Traditional to sustainable risk management in the construction industry: A systematic literature review. *International Journal of Managing Projects in Business*, 18(3), 528-565. [doi: 10.1108/ijmpb-01-2025-0021](https://doi.org/10.1108/ijmpb-01-2025-0021).
- [3] Alsalem, Y., Ayadi, O., & Asfar, J.A. (2023). Techno-economic assessment of retrofitting heating, ventilation, and air conditioning system – case study. *Journal of Ecological Engineering*, 24(3), 153-168. [doi: 10.12911/22998993/158383](https://doi.org/10.12911/22998993/158383).

- [4] Amoroch, J.A.P., & Hartmann, T. (2022). A multi-criteria decision-making framework for residential building renovation using pairwise comparison and TOPSIS methods. *Journal of Building Engineering*, 53, article number 104596. doi: [10.1016/j.jobbe.2022.104596](https://doi.org/10.1016/j.jobbe.2022.104596).
- [5] Andrusiv, U., Zelinska, H., & Lagodienko, V. (2024). Ecological modernization at construction industry enterprises as an innovative production and management technology. *Ukrainian Journal of Applied Economics and Technology*, 9(2), 22-27. doi: [10.36887/2415-8453-2024-2-3](https://doi.org/10.36887/2415-8453-2024-2-3).
- [6] Caruso, M., Buttazzoni, M., Passoni, C., Labò, S., Marini, A., & Pinho, R. (2024). An updated multi-criteria decision-making method for the sustainable renovation of buildings including environmental, economic and social life-cycle metrics. *Journal of Building Engineering*, 98, article number 110967. doi: [10.1016/j.jobbe.2024.110967](https://doi.org/10.1016/j.jobbe.2024.110967).
- [7] Charef, R., & Emmitt, S. (2020). Uses of building information modelling for overcoming barriers to a circular economy. *Journal of Cleaner Production*, 285, article number 124854. doi: [10.1016/j.jclepro.2020.124854](https://doi.org/10.1016/j.jclepro.2020.124854).
- [8] Cova, S., Andrade, C., Soares, O., & Lopes, J. (2021). Evaluation of cost-optimal retrofit investment in buildings: The case of Bragança Fire Station, Portugal. *International Journal of Strategic Property Management*, 25(5), 369-381. doi: [10.3846/ijspm.2021.15082](https://doi.org/10.3846/ijspm.2021.15082).
- [9] Dams, B., Maskell, D., Shea, A., Allen, S., Cascione, V., & Walker, P. (2023). Upscaling bio-based construction: Challenges and opportunities. *Building Research & Information*, 51(7), 764-782. doi: [10.1080/09613218.2023.2204414](https://doi.org/10.1080/09613218.2023.2204414).
- [10] DBN A.2.2-3:2014. (2014). *Composition and content of design documentation for construction*. Retrieved from https://e-construction.gov.ua/laws_detail/3192355188719486804.
- [11] DBN V.2.2-9:2018. (2018). *Public buildings and structures. Basic provisions*. Retrieved from https://e-construction.gov.ua/laws_detail/3199648113669179181?doc_type=2.
- [12] Doukari, O., Scoditti, E., Kassem, M., & Greenwood, D. (2023). A BIM-based techno-economic framework and tool for evaluating and comparing building renovation strategies. *Journal of Information Technology in Construction*, 28, 246-265. doi: [10.36680/j.itcon.2023.012](https://doi.org/10.36680/j.itcon.2023.012).
- [13] DSTU EN 16247-3:2015. (2015). *Energy audits. Part 3. Processes*. Retrieved from https://online.budstandart.com/ua/catalog/doc-page.html?id_doc=68400.
- [14] Fahlstedt, O., Rasmussen, F.N., Temeljotov-Salaj, A., Huang, L., & Bohne, R.A. (2024). Building renovations and life cycle assessment – a scoping literature review. *Renewable and Sustainable Energy Reviews*, 203, article number 114774. doi: [10.1016/j.rser.2024.114774](https://doi.org/10.1016/j.rser.2024.114774).
- [15] Gasparri, E., Arasteh, S., Kuru, A., Stracchi, P., & Brambilla, A. (2023). Circular economy in construction: A systematic review of knowledge gaps towards a novel research framework. *Frontiers in Built Environment*, 9, article number 1239757. doi: [10.3389/fbuil.2023.1239757](https://doi.org/10.3389/fbuil.2023.1239757).
- [16] Gil, S.D., Pacheco, G.R., & de los Ríos, S.A. (2025). Life-cycle cost assessment in real estate decision-making processes: Scope, limits and shortages of current practices – an integrative review. *Sustainability*, 17(12), article number 5577. doi: [10.3390/su17125577](https://doi.org/10.3390/su17125577).
- [17] Gubert, M., Avesani, S., Ngoyaro, J.A., Gutierrez, M.J., Pinotti, R., & Brandolini, D. (2023). Comparative cost analysis of traditional and industrialised deep retrofit scenarios for a residential building. *Journal of Facade Design and Engineering*, 11(2), 145-168. doi: [10.47982/jfde.2023.2.a3](https://doi.org/10.47982/jfde.2023.2.a3).
- [18] Guerra, B.C., & Leite, F. (2021). Circular economy in the construction industry: An overview of United States stakeholders' awareness, major challenges, and enablers. *Resources Conservation and Recycling*, 170, article number 105617. doi: [10.1016/j.resconrec.2021.105617](https://doi.org/10.1016/j.resconrec.2021.105617).
- [19] Gustavsson, L., & Piccardo, C. (2022). Cost optimized building energy retrofit measures and primary energy savings under different retrofitting materials, economic scenarios, and energy supply. *Energies*, 15(3), article number 1009. doi: [10.3390/en15031009](https://doi.org/10.3390/en15031009).
- [20] ISO 14044:2006. (2006). *Environmental management – life cycle assessment – requirements and guidelines*. Retrieved from <https://www.iso.org/ru/standard/38498.html>.
- [21] ISO 15686-5:2017. (2017). *Buildings and constructed assets – service life planning. Part 5: Life-cycle costing*. Retrieved from <https://www.iso.org/ru/standard/61148.html>.
- [22] ISO 31000:2018. (2018). *Risk management – guidelines*. Retrieved from <https://www.iso.org/standard/65694.html>.
- [23] ISO 50001:2018. (2018). *Energy management systems – requirements with guidance for use*. Retrieved from <https://www.iso.org/ru/standard/69426.html>.
- [24] Jiang, S., Wang, M., & Ma, L. (2023). Gaps and requirements for applying automatic architectural design to building renovation. *Automation in Construction*, 147, article number 104742. doi: [10.1016/j.autcon.2023.104742](https://doi.org/10.1016/j.autcon.2023.104742).
- [25] Lu, K., Deng, X., Jiang, X., Cheng, B., & Tam, V.W.Y. (2023). A review on life cycle cost analysis of buildings based on building information modeling. *Journal of Civil Engineering and Management*, 29(3), 268-288. doi: [10.3846/jcem.2023.18473](https://doi.org/10.3846/jcem.2023.18473).
- [26] Macek, D., & Vitásek, S. (2024). Risk analysis in building renovations: Strategies for investors. *Buildings*, 14(7), article number 2219. doi: [10.3390/buildings14072219](https://doi.org/10.3390/buildings14072219).

- [27] Maia, I., Kranzl, L., & Müller, A. (2021). New step-by-step retrofitting model for delivering optimum timing. *Applied Energy*, 290, article number 116714. doi: [10.1016/j.apenergy.2021.116714](https://doi.org/10.1016/j.apenergy.2021.116714).
- [28] Malykhina, O., Ananko, E., Movseyan, A., Sargsyan, V., & Vovkovich, Y. (2023). Scientific and applied components of assessing the impact of measures on the implementation of the selected innovative strategy on the economic productivity of the operating system of a construction enterprise. *Ways to Improve Construction Efficiency*, 2(52), 286-306. doi: [10.32347/2707-501x.2023.52\(2\).286-306](https://doi.org/10.32347/2707-501x.2023.52(2).286-306).
- [29] Maselli, G., Ascione, F., & Nesticò, A. (2024). Life cycle costing for structural analysis and design. *Procedia Structural Integrity*, 64, 1743-1751. doi: [10.1016/j.prostr.2024.09.179](https://doi.org/10.1016/j.prostr.2024.09.179).
- [30] Order of the Ministry of Community and Territorial Development of Ukraine No. 281 "On Approval of Estimated Norms of Ukraine in Construction". (2021, November). Retrieved from <https://zakon.rada.gov.ua/rada/show/v0281914-21#Text>.
- [31] Palma, P., Gouveia, J.P., & Barbosa, R. (2021). How much will it cost? An energy renovation analysis for the Portuguese dwelling stock. *Sustainable Cities and Society*, 78, article number 103607. doi: [10.1016/j.scs.2021.103607](https://doi.org/10.1016/j.scs.2021.103607).
- [32] Papangelopoulou, M.D., Alexakis, K., & Askounis, D. (2025). Assessment methods for building energy retrofits with emphasis on financial evaluation: A systematic literature review. *Buildings*, 15(14), article number 2562. doi: [10.3390/buildings15142562](https://doi.org/10.3390/buildings15142562).
- [33] Sharbaf, S.A., & Schneider-Marin, P. (2024). Cost-benefit analysis of sustainable upgrades in existing buildings: A critical review. *Energy and Buildings*, 328, article number 115142. doi: [10.1016/j.enbuild.2024.115142](https://doi.org/10.1016/j.enbuild.2024.115142).
- [34] Shi, Y., Wang, R., & Chen, P. (2023). Multi-criteria decision-making approach for energy-efficient renovation strategies in hospital wards: Balancing energy, economic, and thermal comfort. *Energy and Buildings*, 298, article number 113575. doi: [10.1016/j.enbuild.2023.113575](https://doi.org/10.1016/j.enbuild.2023.113575).
- [35] Spūdys, P., Jarmalavičiūtė, D., & Klumbytė, E. (2025). Embodied carbon meets payback: Stakeholder-driven MCDM for selecting renovation scenarios. *Transformations and Sustainability*, 1(3), 212-224. doi: [10.63775/3ph1qs36](https://doi.org/10.63775/3ph1qs36).
- [36] State Agency on Energy Efficiency and Energy Saving of Ukraine. (2025). *New energy efficiency requirements for buildings have been introduced in Ukraine – the NZEB standard is now in effect*. Retrieved from <https://saee.gov.ua/en/news/new-energy-efficiency-requirements-for-buildings-have-been-introduced-in-ukraine-the-nzeb-standard-is-now-in-effect>.
- [37] Theilig, K., Vollmer, M., Lang, W., & Albus, J. (2025). Multi-criteria decision-making for energy building renovation: Comparing exterior wall structures with the AHP, ANP, utility analysis, and TOPSIS. *Building and Environment*, 280, article number 113075. doi: [10.1016/j.buildenv.2025.113075](https://doi.org/10.1016/j.buildenv.2025.113075).
- [38] Wang, F., Antwi-Afari, M.F., Anwer, S., Umer, W., & Mehmood, I. (2025). Risk management in sustainable building projects: A systematic literature review and scientometric analysis. *Cleaner Production Letters*, 9, article number 100111. doi: [10.1016/j.clpl.2025.100111](https://doi.org/10.1016/j.clpl.2025.100111).
- [39] World Bank. (2026). *Ukraine fifth rapid damage and needs assessment: February 2022 – December 2025*. Retrieved from <http://documents.worldbank.org/curated/en/099022026094036395>.
- [40] Zhang, H., Hewage, K., Prabatha, T., & Sadiq, R. (2021). Life cycle thinking-based energy retrofits evaluation framework for Canadian residences: A Pareto optimization approach. *Building and Environment*, 204, article number 108115. doi: [10.1016/j.buildenv.2021.108115](https://doi.org/10.1016/j.buildenv.2021.108115).

Моделі техніко-економічного обґрунтування доцільності реконструкції підприємств будівельної галузі

Олександр Підодня

Аспірант

Український державний університет науки і технологій

49010, вул. Лазаряна, 2, м. Дніпро, Україна

<https://orcid.org/0009-0006-2156-0682>

Анотація. Метою дослідження було розроблення системи моделей техніко-економічного обґрунтування доцільності реконструкції підприємств будівельної галузі з урахуванням технічних, інвестиційних, ресурсно-енергетичних, життєво-циклових і ризикових параметрів. У результаті сформовано нормативно-методичну, параметричну, структурну, сценарну та розрахунково-інтегральну моделі оцінювання реконструкційних рішень. Встановлено, що доцільність реконструкції не може визначатися лише кошторисною вартістю або строком окупності, оскільки вона залежить від взаємодії технічної придатності, економічного ефекту, інвестиційної результативності, ресурсно-енергетичної стійкості та ризикового навантаження. Сценарна модель дала змогу зіставити альтернативи не лише за початковими витратами, а й за довгостроковим ефектом, енергоефективністю, вартістю життєвого циклу та рівнем ризику. Сценарне порівняння показало, що збереження поточного стану має найнижчий індекс капітальних витрат – 0,15, але характеризується мінімальним експлуатаційним ефектом – 0,05, низькою енергоефективністю – 0,20 і найвищим ризиковим навантаженням – 0,78. Найвищу методичну доцільність продемонстрував сценарій комплексної реконструкції з цифрово-енергетичним компонентом: індекс технічного оновлення становив 0,92, експлуатаційного ефекту – 0,86, енергоефективності – 0,89, індекс вартості життєвого циклу – 0,76, індекс чистої приведеної вартості – 0,39, а ризикове навантаження знизилося до 0,34. Інтегральне ранжування підтвердило перевагу цього сценарію, який отримав індекс доцільності реконструкції 0,54. Це засвідчило, що найбільш обґрунтованим є сценарій, у якому технічне оновлення поєднується з цифровим контролем, енергоменеджментом, зниженням життєво-циклових витрат і керованим рівнем ризикової невизначеності. Практична значущість полягає у можливості використання запропонованої системи моделей для попереднього вибору доцільного сценарію реконструкції підприємств будівельної галузі України

Ключові слова: вартість життєвого циклу; інвестиційна результативність; ризикове навантаження; інтегральне ранжування; строк окупності

**Business environment for jobs, investments and exporting:
The real effects of EU green transitions on developing countries**

Nigar Gulmaliyeva*

Postgraduate Student

"ABB" Open Joint Stock Company

AZ1005, 67 Nizami Str., Baku, Azerbaijan

<https://orcid.org/0009-0004-1724-7509>

Rahman Babayev

PhD Student

Azerbaijan State University of Economics (UNEC)

AZ1001, 6 Istiqlaliyyat Str., Baku, Azerbaijan

<https://orcid.org/0009-0008-7698-6917>

Gulzar Ismayilzada

Postgraduate Student, Lecturer

Academy of Public Administration under the President of the Republic of Azerbaijan

AZ1001, 74 Lermontova Str., Baku, Azerbaijan

<https://orcid.org/0009-0001-3892-6488>

Lamiya Huseynova

PhD in Economic Sciences, Lecturer

Azerbaijan State University of Economics (UNEC)

AZ1001, 6 Istiqlaliyyat Str., Baku, Azerbaijan

<https://orcid.org/0000-0003-4633-6493>

Elnur Isayev

Postgraduate Student, Lecturer

Azerbaijan State University of Economics (UNEC)

AZ1001, 6 Istiqlaliyyat Str., Baku, Azerbaijan

<https://orcid.org/0000-0002-8240-7482>

Abstract. The aim of this study was to assess the impact of the EU's environmental transformation on the economic development of developing countries in the context of employment, investment activity and foreign trade. The research

Received: 11.01.2026, Revised: 20.04.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Gulmaliyeva, N., Babayev, R., Ismayilzada, G., Huseynova, L., & Isayev, E. (2026). Business environment for jobs, investments and exporting: The real effects of EU green transitions on developing countries. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 84-100. doi: 10.52566/msu-econ2.2026.84.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (n_gulmaliyeva@hotmail.com)

methodology was based on comparative, statistical and scenario analysis, as well as methods of analysis and generalisation. The results showed that carbon dioxide emissions in the United Kingdom decreased by almost 29% and in Germany by 28%, while in Vietnam they increased by 106%, in Indonesia by 63% and in India by almost 49%, indicating a shift of carbon-intensive production to emerging markets. Exports from Africa to the EU increased from EUR 136 billion in 2019 to EUR 189 billion in 2024, while imports from Central Asia reached EUR 35.1 billion. Scenario analysis showed that export losses could exceed EUR 7.5 billion for Africa and EUR 1.4 billion for Central Asia under the pessimistic scenario. Renewable energy capacity in Africa could reach 96-99 gigawatts by 2030, while in Kazakhstan it could increase to almost 4 gigawatts. The study found that the European Green Deal increased trade risks for carbon-intensive sectors while stimulating renewable energy development and low-carbon industrial modernisation. The practical significance of the study is the possibility of using the results by public authorities, exporters, industrial enterprises and investors for assessing the risks of the Carbon Border Adjustment Mechanism and planning low-carbon industrial modernisation

Keywords: Carbon Border Adjustment Mechanism; foreign direct investment; decarbonisation; industrialisation; climate policy; global value chains

Introduction

The intensification of EU climate policy transforms international trade, investment flows and industrial regulation, increasingly affecting developing countries. The implementation of the European Green Deal, the Carbon Border Adjustment Mechanism (CBAM) and decarbonisation requirements creates new conditions for access to the European market and changes the competitive environment for exporters from developing economies. The EU's green transition increases the need to assess its economic consequences for developing countries, particularly in employment, export competitiveness and industrial modernisation. R.R. Dadashli (2024) analysed the EU's support for Azerbaijan's transition to a green economy within the EU4Environment and EU4Climate programmes. The study found that cooperation with the EU contributed to renewable energy legislation, energy efficiency standards, green infrastructure and renewable energy exports to European markets.

The growing role of green energy corridors and environmental modernisation projects in strengthening economic interaction between Azerbaijan and the EU was also identified. The impact of the green transition on economic growth, innovative development, energy efficiency and investment processes was studied by G.H. Popescu *et al.* (2025), who analysed the relationship between green investments, renewable energy, environmental policy and the competitiveness of EU economies. The results obtained showed that investments in green infrastructure, research and development (R&D), energy efficiency and renewable energy contribute to technological modernisation and circular economy development.

Economic decarbonisation, environmental regulation and the transition to low-carbon development models create challenges for countries dependent on industrial production, fossil fuels and foreign investment. P. Mitić *et al.* (2024) studied the relationship between carbon dioxide emissions, industrialisation, financial development and electricity generation in Central and Eastern Europe during 1995-2021. The results obtained showed a long-term relationship between industrialisation and CO₂ emissions,

while industrial growth and dependence on fossil fuels increase the environmental burden and complicate decarbonisation. The specifics of implementing the green transition within the EU cohesion policy were studied by L. Tijanić & I. Kersan-Škabić (2025), who analysed financing mechanisms through the European Structural and Investment Funds (ESIFs), as well as investments in the low-carbon economy, energy efficiency, renewable energy and climate adaptation. The study showed that investments in green infrastructure and ecological modernisation contributed to energy efficiency, greenhouse gas emission reduction, renewable energy expansion and structural transformation of EU economies.

The growing role of the service sector in the international economy and the spread of ecological transformation create new conditions for the economic development of developing countries, especially in employment, investment, digitalisation and integration into global value chains. The relationship between the development of the service sector, the green economy and the structural transformation of developing economies was studied by P. Ström (2024), who analysed the role of digital services, servitisation, global production networks and knowledge-intensive services in ensuring sustainable economic development. The relationship between innovative activity, the green economy and sustainable development was studied by A. Kwilinski *et al.* (2025), who analysed the impact of innovation, research and development (R&D) spending, high-tech trade and patent activity on the green economic growth of the Visegrad Group countries in 2007-2022. The results obtained showed that investments in research and development, high-tech exports, digitalisation and environmental technologies contribute to increasing energy efficiency, renewable energy development and economic competitiveness.

Environmental trade regulation and sustainable development standards create new conditions for the global economy, affecting investment activity, export competitiveness and transformation of developing countries. S. Mubin & A.H.A. Putri (2025) analysed the role of CBAM, environmental trade standards and mechanisms for spreading

environmental norms in the global trading system. The results obtained showed that the European Green Deal contributes to international trade transformation through stricter environmental import requirements, low-carbon supply chains, green industrialisation and investments in clean technologies. The impact of the European Investment Bank's environmental and social standards on green projects outside the EU was studied by S. de Simone *et al.* (2025), who analysed the role of the European Investment Bank (EIB) in promoting a just transition through Environmental and Social Impact Assessments (ESIAs) within the European Green Deal. The study showed that environmental and social financing criteria increase attention to environmental justice, inclusiveness, social protection and assessment of infrastructure projects' impact on local communities.

At the same time, insufficient attention has been paid to assessing the impact of the EU's green transition on employment, export competitiveness, international investment flows and the adaptation of the business environment in developing countries. The aim of this study was to determine the effects of the EU's green transition mechanisms on export competitiveness, investment processes and employment transformation in developing countries. To achieve this goal, the following tasks were defined: to analyse the main mechanisms of the EU's green transition and their impact on international economic relations; to assess the impact of the EU's environmental trade and investment requirements on export competitiveness, investment transformation and the adaptation of the business environment in developing countries.

Materials and Methods

The study was predominantly theoretical in nature with the use of individual empirical analysis elements. The main time period of the study covered the years 2019-2025. The period 2019-2024 was chosen to analyse the dynamics of trade between Africa and the EU due to the availability of statistical data, the possibility of covering the period before the active implementation of the European Green Deal, the consequences of the COVID-19 pandemic and the further strengthening of environmental regulation of the EU. The period 2020-2024 was used to analyse trade and economic cooperation between the EU and the countries of Central Asia, since it was after the COVID-19 pandemic that the region observed a gradual recovery of trade flows and an increase in the impact of CBAM and EU environmental standards on export-orientated sectors. The time period 2014-2024 was used to analyse the dynamics of CO₂ emissions, which made it possible to assess long-term changes in the global distribution of carbon-intensive production and the processes of transferring industrial production to emerging markets. Separate statistical and forecast indicators for 2025 were used to assess current trends in the development of renewable energy infrastructure, green industrial projects and scenario consequences of the European Green Deal for developing countries.

The analysis of regulatory and analytical documents of the EU, including The European Green Deal (n.d.), Regulation (EU) No. 2021/1119 of the European Parliament and of the Council (2021) and European Union Emissions Trading System (EU ETS, n.d.), was used to study the transformation of international economic policy, global trade regulation and the development of a low-carbon economy. The method of analysis and systematisation was also applied to examine Regulation (EU) No. 2024/1735 of the European Parliament and of the Council (2024), Regulation (EU) No. 2024/1252 of the European Parliament and of the Council (2024) and the Green Deal Industrial Plan (EUR-Lex, 2023)/Clean Industrial Deal (n.d.) according to the criteria of main objectives, key instruments and influence on international economic relations to determine their impact on international trade, investment flows and adaptation to low-carbon standards. The same method was used to study the Carbon Border Adjustment Mechanism (n.d.), Regulation on Deforestation-free Products (EUDR) (n.d.) and EU Taxonomy for Sustainable Activities (2026) to determine their influence on environmental regulation of international trade and global value chains.

The method of analysis of statistical and analytical sources was used to study the transformation of global value chains, changes in CO₂ emissions in 2014-2024, the transfer of carbon-intensive production to emerging markets and the transformation of investment flows in African countries under the influence of the EU's green transition. Statistical sources, reports of international organisations and project documents were used to determine the impact of environmental regulation on international production, supply chains, renewable energy development and low-carbon industrial transformation (International Renewable Energy Agency, 2025; Velyka, 2026; Jowett, 2026). Analysis of analytical documents of the World Trade Organization (WTO) (2025), the Organisation for Economic Co-operation and Development (OECD, 2025) and the United Nations Conference on Trade and Development (UNCTAD, 2025) was used to study approaches to the coordination of trade, environmental and investment policies in the context of the low-carbon transformation of the world economy. The method of analysis and generalisation was applied to assess the impact of the CBAM on export competitiveness, adaptation of carbon-intensive industries, renewable energy development and the spread of cleaner production technologies in international trade. Analytical and project materials related to renewable energy, geothermal energy, green hydrogen initiatives and the Noor Ouarzazate I Concentrated Solar Power Independent Power Project (NOORo I CSP IPP) were used to identify directions of low-carbon industrial modernisation and renewable energy infrastructure development in African countries (NOORo I CSP IPP, n.d.; UNCTAD, 2021).

Country and sectoral analytical materials were also used to assess the impact of the green transition on renewable energy development, green infrastructure, and climate finance and clean technologies in Africa and Central Asia.

The method of analysis and generalisation was applied to identify changes in the structure of investment, industrial production and export competitiveness, as well as risks for energy-intensive industries and sectors dependent on fossil fuels in Central Asia and Africa. Kazakhstan and Azerbaijan were selected for a more detailed analysis due to the significant role of carbon-intensive exports in their trade relations with the EU (Park *et al.*, 2023; World Bank, n.d.). Separate country analytical materials were used to assess changes in the structure of energy exports and international investment flows in Azerbaijan (World Bank, 2022). Turkmenistan, Uzbekistan, Kyrgyzstan and Tajikistan were considered at a general review level to identify common regional risks related to fossil-fuel dependence and carbon-intensive production (EU and Central Asia, n.d.). South Africa, Egypt, Morocco, Kenya, Ethiopia, Namibia, Mauritius and Tunisia were also reviewed to illustrate regional trends in renewable energy development, green industrialisation and sustainable infrastructure projects (Freitas & Mwaniki, 2024; Ebatamehi, 2025). The comparative analysis method was used to examine the transformation of export-orientated sectors and the investment environment under the influence of the EU Green Transition and the CBAM. The analysis was conducted according to the criteria of carbon intensity, exposure to EU environmental requirements, investment adaptation mechanisms and directions of industrial modernisation. Particular attention was paid to metallurgy, aluminium production, fertilisers, energy, renewable energy and low-carbon manufacturing. Uzbekistan, South Africa, Morocco, Egypt and the least developed countries of Africa were additionally considered at a general review level to illustrate broader regional differences in adaptation to low-carbon standards, climate finance and green investments.

The analysis and synthesis method were applied to analytical and project documents related to renewable energy and sustainable infrastructure projects in Central Asia. For Kazakhstan, renewable energy facilities, the Mirny (TotalEnergies, n.d.) wind farm and investments in battery storage systems were studied to determine the impact of EU environmental standards on energy modernisation and investment transformation (Hernandez & Rabiega, 2026). For Kyrgyzstan, the Kambarata-1 Hydropower Project (n.d.) and international financing mechanisms for energy infrastructure were analysed to assess the development of sustainable infrastructure projects in the region (George *et al.*, 2025).

The analysis of international cooperation programmes, strategic initiatives and analytical documents, including “Enhanced Partnership and Cooperation Agreement between the European Union and its Member States, of the one part, and the Republic of Kazakhstan, of the other part” (EPCAs) (2015), Strategy – Global Gateway (n.d.) and The European Green Deal (n.d.), was used to explore opportunities for infrastructure modernisation, renewable energy development and export diversification in Central Asian countries. The method of analysis and generalisation was

also applied to analytical materials on green finance and investment risk reduction to determine the role of EU environmental standards in the development of low-carbon logistics corridors, sustainable infrastructure and climate-orientated financing in Central Asia and Eastern Partnership countries (EU4Environment, 2025).

The method of statistical analysis was applied to analytical sources on trade dynamics between Africa and the EU in 2019-2024 based on indicators of exports from Africa to the EU, imports from the EU to Africa, total trade volumes and changes in the trade balance in order to determine changes in foreign trade relations, the level of dependence of African economies on the European market and the potential impact of EU environmental requirements on export-orientated sectors (Ehl & Padros, 2026). The period 2019-2024 was selected due to the availability of statistical data and the possibility of covering the period before the active implementation of the European Green Deal, the post-pandemic recovery of international trade and the strengthening of environmental regulation of the EU. The same method was used to analyse analytical materials on trade dynamics between the EU and the countries of Central Asia in 2020-2024 to determine changes in the structure of trade flows, the role of industrial exports and the development of economic cooperation in the context of strengthening EU environmental standards (Economic Cooperation between..., n.d.; The EU and Central Asia, n.d.). The period 2020-2024 was chosen due to the availability of statistical data for the countries of Central Asia after the COVID-19 pandemic and the possibility of analysing trade dynamics in the context of strengthening the influence of the CBAM and EU environmental standards.

The scenario analysis method was used to study the possible economic consequences of the European Green Deal and CBAM for the countries of Africa and Central Asia under optimistic, baseline and pessimistic scenarios to assess the impact of different levels of production decarbonisation, industrial modernisation, development of renewable energy infrastructure and access to green finance on export competitiveness, foreign direct investment, renewable energy capacity and export losses in the context of strengthening environmental standards of the EU. To build the scenarios, indicators of exports to the EU, dynamics of renewable energy capacity, share of renewables in the national electricity mix, potential Gross Domestic Product (GDP) losses and projected changes in carbon-intensive sectors, in particular metallurgy, aluminium production, cement and fertilisers, which were already mentioned in the study, were used.

Results

EU green transition and external economic effects

The European Green Deal (n.d.) has transformed international economic policy and the global trade regulation system, making environmental and climate requirements a key factor in market access, international competitiveness and investment attractiveness. The EU's policy is increasingly

based on the principles of decarbonisation, circular economy, resource efficiency and low-carbon development. The European Climate Law (Regulation (EU) No. 2021/1119 of the European Parliament and of the Council, 2021) has set the target of achieving climate neutrality by 2050, while reducing emissions by at least 55% by 2030 has become one of the basic benchmarks for the EU's economic transformation. The EU's investment mechanisms play an important role in implementing the green transition, including over EUR 275 billion in clean investments, the Just Transition Fund of

almost EUR 20 billion and the expansion of the EU ETS (n.d.), which has already provided over EUR 200 billion in revenues for environmental and social programmes. In these conditions, environmental criteria are integrated into the mechanisms of industrial, trade, investment and financial policies, which contributes to the transformation of global value chains, the development of low-carbon technologies and the change in the structure of international trade. The main initiatives of the European Green Deal and their impact on international economic relations are given in Table 1.

Table 1. Key initiatives of the European Green Deal and their influence on international economic relations

Initiative	Main objective	Key instruments	Influence on international economic relations
Net-Zero Industry Act	Increasing European manufacturing capacity for net-zero technologies and strengthening the competitiveness of the clean technology sector.	Simplified permitting procedures; Single Points of Contact; Net-Zero strategic projects; public procurement and renewable energy auction criteria; Net-Zero Acceleration Valleys; Net-Zero Europe Platform.	Establishes a target for net-zero manufacturing capacity to meet at least 40% of the EU's annual deployment needs by 2030; strengthens investment attractiveness and market access for clean technologies; promotes international net-zero industrial partnerships and restructuring of global supply chains toward low-carbon technologies.
European Critical Raw Materials Act	Ensuring secure, sustainable and diversified supply of critical raw materials for the green and digital transition in the EU.	Development of extraction, processing and recycling capacities; strategic partnerships with third countries; diversification of supply chains; support for research, innovation and recycling; monitoring of supply chain resilience.	Establishes benchmarks by 2030 for 10% domestic extraction, 40% processing and 25% recycling of strategic raw materials in the EU; limits dependence on a single third country supplier to no more than 65%; expands trade and investment cooperation with emerging markets and developing economies through strategic partnerships, WTO cooperation and sustainable investment agreements.
Green Deal Industrial Plan/Clean Industrial Deal	Strengthening EU competitiveness and decarbonisation through support for clean manufacturing, energy transition and circular economy.	Low-carbon procurement requirements; InvestEU support; Innovation Fund; Industrial Decarbonisation Bank; Clean Trade and Investment Partnerships.	Mobilises over EUR 100 billion to support clean manufacturing and industrial decarbonisation; introduces investment conditions for non-EU companies controlling more than 40% of global manufacturing capacity in strategic sectors; strengthens CBAM and promotes diversification of supply chains through Clean Trade and Investment Partnerships.
CBAM	Ensuring a fair carbon price for carbon-intensive goods entering the EU and preventing carbon leakage.	CBAM certificates; embedded emissions reporting; carbon price adjustment based on EU ETS; authorised CBAM declarants; annual emissions declarations.	Applies to cement, iron and steel, aluminium, fertilisers, electricity and hydrogen; covers more than 50% of emissions in ETS-covered sectors after full implementation; requires EU importers exceeding 50 tonnes of CBAM goods to purchase CBAM certificates from 2026; strengthens decarbonisation incentives and aligns international trade with EU climate objectives and WTO rules.
Regulation on Deforestation-free Products (EUDR)	Reducing greenhouse gas emissions and biodiversity loss by ensuring that products consumed in the EU do not contribute to deforestation or forest degradation.	Due diligence requirements; traceability systems; country benchmarking by deforestation risk; EUDR Information System; EU observatory on deforestation and forest degradation.	Covers commodities such as cattle, wood, cocoa, soy, palm oil, coffee, rubber and derived products; aims to reduce carbon emissions linked to EU consumption by at least 32 million tonnes annually; strengthens sustainability requirements and traceability standards in global agricultural and commodity value chains; supported by a EUR 70 million Team Europe Initiative for deforestation-free value chains.
EU Taxonomy for Sustainable Activities	Creating an EU-wide classification system for environmentally sustainable economic activities aligned with net zero objectives by 2050.	Technical screening criteria; Taxonomy Regulation; delegated and implementing acts; sustainable finance disclosure requirements.	Establishes a common definition of sustainable economic activities for financial and non-financial companies; supports scaling up sustainable investments; reduces greenwashing and market fragmentation; redirects international capital flows toward projects aligned with the European Green Deal and EU climate objectives.

Source: compiled by authors based on Regulation on Deforestation-free Products (n.d.), Clean Industrial Deal (n.d.), Carbon Border Adjustment Mechanism (n.d.), EUR-Lex (2023), Regulation (EU) No. 2024/1735 of the European Parliament and of the Council (2024), Regulation (EU) No. 2024/1252 of the European Parliament and of the Council (2024), EU taxonomy for sustainable activities (2026)

The initiatives presented demonstrate the gradual transformation of environmental standards into one of

the central mechanisms of international economic regulation. The strengthening of climate, investment and trade

requirements of the EU affects the structure of international trade, global value chains, investment flows and the competitiveness of export-orientated industries. As a result, access to the European market increasingly depends on the ability of countries and companies to adapt production processes, infrastructure and environmental control systems to low-carbon standards and the requirements of sustainable development. The spread of environmental regulation results in the transformation of global value chains. Strengthening climate requirements stimulates international companies to transfer individual stages of production to countries with more developed green infrastructure, access to renewable energy sources and a lower carbon footprint. At the same time, there is a regionalisation of individual segments of global supply chains to reduce logistics costs, reduce emissions and simplify control over compliance with environmental standards. In these conditions, digital monitoring systems, environmental certification, traceability of products and emission control within supply chains become important. At the same time, emission reductions in developed countries are increasingly accompanied by the transfer of carbon-intensive production to Asian countries and other emerging markets. In 2014-2024, CO₂ emissions in the UK decreased by almost 29%, in Germany by 28%, and in the USA by 11%, while in Vietnam they increased by 106%, in Indonesia by 63%, and in India by almost 49%. Even with relatively lower growth rates in China (+23.2%), the absolute increase in emissions was about 2.3 billion tonnes of CO₂, which exceeds the annual emissions of most countries in the world. This indicates the formation of a model of global redistribution of carbon-intensive production, in which some developed economies reduce domestic emissions by transferring industrial capacity to countries with lower environmental requirements and cheaper production resources (Velyka, 2026).

In these conditions, international organisations, in particular the World Trade Organization (2025), the OECD (2025) and the UNCTAD (2025), emphasise the need to coordinate trade, environmental and investment policies. The WTO considers international trade as a tool for the dissemination of low-carbon technologies and environmental innovations but emphasises the importance of the non-discriminatory nature of environmental trade measures. The OECD emphasises the need to coordinate trade and climate policies to support a circular economy, sustainable food systems and the development of green technologies. UNCTAD emphasised the risks of increasing inequality between countries due to different levels of readiness to meet new environmental requirements and the need for financial and technical support for developing countries.

For developing countries, the new environmental requirements of the EU create both additional restrictions and opportunities for economic modernisation. Manufacturers of carbon-intensive products face increasing costs for decarbonisation, certification and adaptation of

production to new environmental standards. According to the UNCTAD (2025), the introduction of the CBAM with a price of USD 44 per tonne of embedded CO₂ emissions could reduce developing countries' exports in carbon-intensive sectors by 1.4%, and at prices of USD 88, by 2.4%. Producers of cement, steel, aluminium, fertilisers, chemical products and oil refining will be most affected. According to UNCTAD calculations, at a carbon price of USD 44 per tonne, developed countries' incomes could increase by USD 2.5 billion, while developing countries' incomes could decrease by USD 5.9 billion (UNCTAD, 2021).

An additional challenge is the high concentration of exports of carbon-intensive products in countries whose economies are largely dependent on metallurgy, fertilisers, cement and energy. Among the countries most dependent on CBAM-sensitive sectors are China, Turkey, Ukraine, India and South Korea. In these conditions, export competitiveness increasingly depends not only on production costs but also on the level of carbon intensity of products, access to clean technologies and the ability of enterprises to confirm compliance with international environmental standards. At the same time, companies that are able to adapt to new requirements are given the opportunity to integrate into green global value chains, access to premium segments of the European market and attract green investments. Strengthening environmental requirements stimulates the development of renewable energy, digitalisation of production and the introduction of energy-efficient technologies. At the same time, UNCTAD emphasises that the effect of CBAM for reducing global emissions remains limited, since the mechanism can potentially reduce only about 0.1% of global CO₂ emissions. As a result, mechanisms for green finance, international technical assistance and the dissemination of cleaner production technologies are gaining particular importance to support the adaptation of developing countries to a new low-carbon model of international trade (UNCTAD, 2021).

Thus, the European Green Deal is gradually transforming environmental standards, decarbonisation and climate requirements into one of the key mechanisms of international economic regulation, affecting the structure of world trade, investment flows and global value chains. The introduction of CBAM, strengthening requirements for sustainable production and the development of green financing create both additional barriers for carbon-intensive industries and incentives for technological modernisation and integration into low-carbon supply chains. For developing countries, export competitiveness increasingly depends on the level of carbon intensity of products, access to clean technologies, green investments and the ability to adapt production to international environmental standards. As a result, the effectiveness of adaptation to the new model of international trade will be largely determined by the level of international technical support, the development of green infrastructure, and the coordination of trade, investment, and climate policies.

Impact of the EU green transition on developing countries

The impact of the European Green Deal and CBAM on Central Asian and African countries is manifested through increased competitive pressure on exporters of carbon-intensive products, changes in the conditions of access to the European market and the transformation of the structure of export-orientated sectors. The introduction of CBAM creates additional costs for producers of products with a high level of embedded CO₂ emissions, which gradually changes the structure of international competitiveness in favour of producers with lower carbon intensity, more developed systems of environmental monitoring and more effective Monitoring, Reporting and Verification (MRV) (n.d.) systems. The greatest impact is felt by such carbon-intensive sectors as iron and steel, aluminium, cement, fertilisers, electricity generation, chemicals, the mining industry and energy-intensive manufacturing, whose competitiveness increasingly depends not only on the cost of production but also on the level of decarbonisation, transparency of supply chains and the ability to confirm the environmental characteristics of products (UNECE, 2026).

The most vulnerable country in Central Asia to the impact of CBAM is Kazakhstan, which has the largest volume of industrial exports to the EU and a significant concentration of carbon-intensive industries. The main sectors at risk remain iron and steel, aluminium, cement, fertilisers, electricity and petroleum-linked products. According to World Bank (n.d.) estimates, if CBAM is extended, the share of Kazakhstani exports covered by new environmental requirements may exceed 3% of the country's total exports, while by 2035, iron and steel exports to the EU may decrease by 38% and, under a broader CBAM scenario, by more than 65%. At the same time, the implementation of decarbonisation policies, the development of renewable energy and the introduction of MRV systems can partially reduce the negative impact of new environmental requirements on the country's export competitiveness.

For Azerbaijan, the key risks are primarily related to the reduction in the EU's demand for fossil fuels and the change in the structure of international investment flows. The country's economy is largely dependent on oil and gas exports, and the EU remains one of the main markets for energy resources. In the baseline scenario of the impact of the European Green Deal, Azerbaijan's oil-related exports could decrease by approximately USD 2.5 billion by 2035 (World Bank, 2022). For Turkmenistan, the main risks are related to fertilisers, energy-related exports and low levels of economic diversification, while for Uzbekistan, Kyrgyzstan and Tajikistan, the impact is mainly sector-specific and concerns aluminium production, electricity-intensive industries and industrial goods with a high level of energy intensity. A common feature for most Central Asian countries remains the high dependence of industry and energy on fossil-fuel-based power generation, which increases the carbon intensity of export-orientated sectors.

At the same time, the deepening of cooperation between the EU and the countries of Central Asia through the Enhanced Partnership and Cooperation Agreement between the EU and its Member States, of the one part, and the Republic of Kazakhstan, of the other part (2015), the strategy – “Global Gateway” (n.d.) and the European Green Deal (n.d.) creates opportunities for the modernisation of infrastructure systems, the development of green technologies and the diversification of exports. The development of transport corridors, renewable energy infrastructure, digital trade systems and sustainable industrial projects is gradually becoming one of the key areas of economic cooperation between the EU and the region. In these conditions, the competitiveness of the countries of Central Asia increasingly depends on the ability to adapt industrial production, logistics systems and export-orientated sectors to low-carbon standards of international trade. Similar transformation processes are observed in African countries, for which the European Green Deal and CBAM create both risks for carbon-intensive export sectors and incentives for the modernisation of production and the development of low-carbon technologies. Africa remains one of the EU's key trading partners: in 2019, Africa-EU trade reached approximately EUR 280 billion, while the EU absorbed about 28% of Africa's total exports. At the same time, the structure of African exports remains largely raw material and carbon-intensive, as a significant share of supplies to the EU falls on crude oil, gas, metals, minerals, fertilisers and other primary commodities. According to estimates by the African Climate Foundation & London School of Economics and Political Science (2023), CBAM could reduce African exports to the EU of aluminium by up to 13.9%, iron and steel by 8.2%, fertiliser by 3.9% and cement by 3.1%, while in some scenarios, the African continent's GDP could decrease by approximately 0.91%, equivalent to about USD 25 billion.

Least developed countries (LDCs), a significant part of which are located in Africa, are particularly vulnerable. Africa covers 33 of the 46 global least developed countries, and if CBAM were extended to a wider range of products, individual countries could lose more than 1.5% of GDP, while in some scenarios the losses could reach 8.4%. An additional risk factor is the insufficient development of carbon monitoring systems and carbon markets in most African countries, which increases the likelihood of applying higher default emissions values and increasing the actual CBAM burden for exporters. The mining industry, agriculture, cement production and energy sectors remain the most sensitive sectors, which form a significant part of employment and export revenues in many African economies. A high level of vulnerability is observed in agriculture, where new requirements for traceability, sustainable production and deforestation-free supply chains for cocoa, coffee, palm oil, soy, rubber, cattle and wood products increase costs for smallholders, exporters and agricultural producers

(African Climate Foundation & London School of Economics and Political Science, 2023).

At the same time, the green transition stimulates the development of renewable energy, green infrastructure, climate finance and clean technologies in Africa. The significant potential of solar, wind and hydropower resources creates the prerequisites for the development of renewable energy projects and attracting green investments. The volume of climate finance for African countries increased from USD 29.5 billion in 2019-2020 to USD 43.7 billion in 2021-2022. Green bonds, blended finance, public-private partnerships and international investment programmes are increasingly used to modernise renewable energy, transport infrastructure, water systems and cleaner industrial production. As a result, the modernisation of industrial production is increasingly taking place through the introduction of cleaner machinery, energy-efficient technologies, digital monitoring systems and climate-related standards, while the employment structure is gradually shifting from traditional carbon-intensive sectors to renewable energy, sustainable agriculture, emissions monitoring, digital traceability systems and green industrial services (Freitas & Mwaniki, 2024).

Under the influence of the EU's environmental requirements, the structure of international investment in African and Central Asian countries is gradually shifting from carbon-intensive industries to renewable energy, low-carbon manufacturing and sustainable infrastructure projects. As a result, international investors are increasingly focusing on projects that involve the integration of renewable energy, energy-efficiency modernisation, emissions monitoring systems and compliance with EU-aligned environmental standards. For African economies, these processes are having a heterogeneous impact on export-orientated sectors. Countries exporting steel, aluminium, fertilisers and minerals to the EU are facing increasing carbon trade risks. At the same time, the EU's climate finance mechanisms, including the Global Gateway initiatives and the Green Industry Partnership, are stimulating the development of renewable energy, green hydrogen and low-carbon production. Africa is gradually strengthening its position in the field of green industrialisation through investments in renewable energy, sustainable manufacturing and green infrastructure. The industrial sector in Africa is expected to grow by around 20% annually, and its share in GDP could increase from 13% to 32% by the end of 2025. South Africa, Egypt and Morocco show the greatest potential for attracting investment in renewable energy through the development of solar and wind power, as well as green hydrogen projects. Morocco is integrating green hydrogen production into industrial zones; Egypt is developing environmentally friendly cement production and renewable infrastructure; and South Africa is modernising the mining, automotive and chemical sectors using renewable power. Kenya and Ethiopia are strengthening their positions through the development of geothermal energy and low-carbon industrial parks.

Namibia is developing solar-powered refining plants and green hydrogen projects for the EU market. Mauritius and Tunisia are focusing on low-carbon manufacturing, sustainable textile production, green steel manufacturing and circular economy practices within export-orientated industries (Ebatamehi, 2025).

In Central Asian countries, the EU's environmental requirements most affect metallurgy, ferroalloys, aluminium, chemical products and other energy-intensive industries. According to the Asian Development Bank, the most vulnerable to the CBAM in the region are aluminium production in Kazakhstan and the fertiliser sector in Georgia. For Kazakhstan, about 42.15% of aluminium exports are aimed at the EU market, making the country one of the most dependent on carbon trade restrictions in Central Asia. As a result, the investment attractiveness of enterprises is increasingly determined by the ability to integrate renewable energy sources, emission monitoring systems and environmentally friendly production technologies. The expected level of carbon border tax for basic metallurgy could reach 68.16% of exports to the EU for South Africa, 38.8% for India and 22.05% for Vietnam (Park *et al.*, 2023). This indicates an increase in investment risks for industries that do not carry out technological modernisation or do not implement emission reduction technologies. As a result, the structure of foreign direct investment is gradually changing: carbon-intensive industries are becoming less attractive for traditional investments in production capacity, while investors are increasingly focused on modernisation of industrial enterprises, the integration of renewable energy and increasing the carbon efficiency of production.

Green financing and investment risk reduction mechanisms are increasingly being used in Central Asia and the Eastern Partnership countries. The OECD notes that green investments in these countries face political, financial and geopolitical risks, including high capital costs, exchange rate volatility and underdeveloped financial markets. To reduce risks, concessional loans, guarantees, blended finance mechanisms, currency hedging and technical assistance programmes are used. Through green credit lines, international financial institutions have channelled more than EUR 3 billion to the region over the past twenty years. The EU's environmental standards are also influencing the modernisation of industrial production and logistics infrastructure in Central Asia. European transport and infrastructure initiatives are stimulating the development of low-carbon logistics corridors, electrified railway systems, multimodal transport hubs and environmentally friendly production technologies. As a result, compliance with the EU's environmental standards is gradually becoming not only a trade requirement but also a necessary condition for access to European investment programmes and climate-orientated financing (EU4Environment, 2025). The main directions of transformation of export-orientated sectors and the investment environment in the countries of Africa and Central Asia are given in Table 2.

Table 2. Impact of EU green transition on export-oriented sectors and investment environment in Africa and Central Asia

Region/ Country	Main carbon-intensive sectors	Main EU environmental risks	Investment transformation	Main adaptation directions
Kazakhstan	Iron and steel, aluminum, fertilizers, electricity	CBAM exposure, high carbon intensity, dependence on EU exports	Shift from brownfield FDI to green modernisation	Renewable energy, MRV systems, cleaner production
Azerbaijan	Oil and gas, petrochemicals	Declining EU fossil fuel demand	Diversification of investment flows	Green energy corridors, renewable infrastructure
Uzbekistan	Aluminum, electricity-intensive industries	Carbon-related trade risks	Sector-specific green investments	Energy efficiency, industrial modernisation
African LDCs	Agriculture, mining, cement	Traceability requirements, CBAM, EUDR	Increased role of climate finance	Sustainable agriculture, emissions monitoring
South Africa	Mining, metals, automotive	High CBAM exposure in metallurgy	Growth of renewable-linked industrial investments	Green hydrogen, renewable-powered industry
Morocco/ Egypt	Cement, manufacturing, energy	Sustainability and ESG requirements	Expansion of green industrial clusters	Solar/wind projects, low-carbon manufacturing

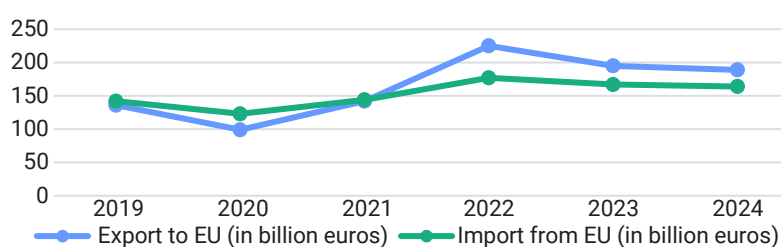
Source: compiled by authors based on World Bank (2022, n.d.), African Climate Foundation & London School of Economics and Political Science (2023), S. Ebatamehi (2025), European Commission (n.d.)

The data presented show that the impact of the EU's environmental requirements is differentiated depending on the structure of exports, the level of carbon intensity of production and the degree of integration of countries into international value chains. Carbon-intensive industries, in particular metallurgy, the fertiliser industry, cement production and energy, are most affected. At the same time, the development of renewable energy, green financing and low-carbon industrial modernisation creates the prerequisites for the structural transformation of the economy and attracting new investments. Thus, the European Green Deal, CBAM and broader environmental standards of the EU are shaping the long-term transformation of investment mechanisms in the countries of Africa and Central Asia. Industries dependent on fossil fuels and carbon-intensive production are gradually losing

their investment attractiveness without modernisation and decarbonisation, while renewable energy, low-carbon production, green industrial clusters and sustainable infrastructure are becoming priority areas of international investment flows.

Economic effects of the EU green transition on developing countries

The dynamics of trade between Africa and the EU indicate a gradual strengthening of economic interaction and the growing role of the European market for African exporters. After a reduction in trade figures in 2020 due to the COVID-19 pandemic, mutual trade volumes began to recover rapidly, which was accompanied by an increase in exports of raw materials and energy-intensive products to the EU (Fig. 1).

**Figure 1.** Dynamics of trade between Africa and the EU in 2019-2024

Source: compiled by authors based on D. Ehl & A.M. Padros (2026)

The dynamics of trade between Africa and the EU indicate the growing importance of the European market for African exporters. According to Eurostat, exports from Africa to the EU increased from EUR 136 billion in 2019 to EUR 189 billion in 2024. Exports dropped to EUR 99 billion in 2020 as a result of the COVID-19 pandemic, but they rebounded rapidly and reached a high of EUR 225 billion in 2022. At the same time, imports from the EU to Africa increased from EUR 142

billion in 2019 to EUR 164 billion in 2024. A significant part of African exports to the EU are oil, gas, metals and other raw materials, which increases the sensitivity of export-orientated sectors to EU environmental standards and the CBAM. Similar trends are observed in the countries of Central Asia, where, after a reduction in trade indicators during the COVID-19 pandemic, there was a gradual increase in mutual trade volumes with the EU (Fig. 2).

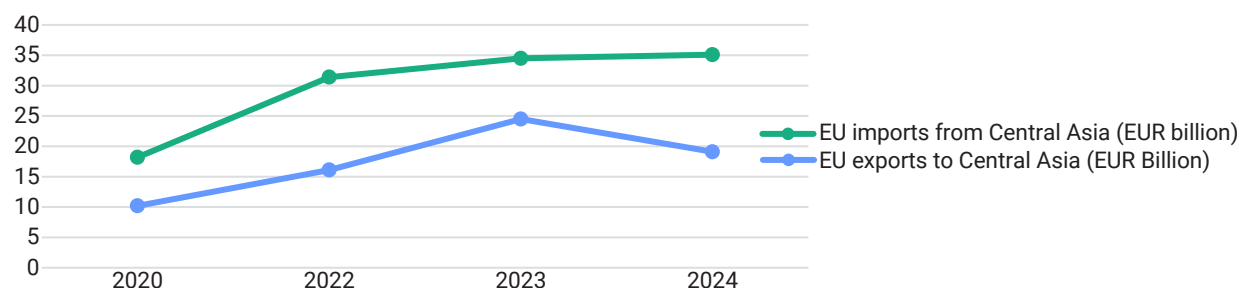


Figure 2. Dynamics of trade between the EU and Central Asia in 2020-2024

Source: compiled by authors based on Eurasian Research Institute (n.d.), European Commission (n.d.), The EU and Central Asia (n.d.), EU-Central Asia trade (n.d.)

Trade and economic cooperation between the EU and the countries of Central Asia is characterised by a gradual increase in trade and investment interaction. In 2020, the volume of exports from Central Asian countries to the EU decreased to USD 18.2 billion, which was the lowest figure in the last decade. At the same time, exports from the EU to the countries of Central Asia during this period amounted to USD 10.2 billion. In 2022, imports from the EU to the countries of Central Asia amounted to EUR 31.4 billion, while exports from the EU to the region reached EUR 16.1 billion. As a result, the trade balance for the EU remained negative at around EUR -15.3 billion, which indicates the predominance of raw material exports from the countries of Central Asia to the European market. In 2023, the share of trade with the EU was 22.6% of the total foreign trade of the Central Asian countries, and the total volume of trade in goods and services between the parties exceeded EUR 59 billion. In particular, the EU's imports from Central Asia amounted to EUR 32.5 billion in goods and about EUR 2 billion in services, while the EU's exports to Central Asia reached EUR 20.2 billion in goods and EUR 4.3 billion in services. In 2024, the EU's imports from Central Asia reached approximately EUR 35.1 billion, while the EU's exports to the region amounted to approximately EUR 19.1 billion, resulting in a negative trade balance for the EU of approximately EUR -16 billion.

The assessment of investment and infrastructure development dynamics in Africa and Central Asia shows that the impact of the EU's green transition is gradually going beyond trade regulation and increasingly affecting the structure of investment, the modernisation of production and the development of low-carbon infrastructure. In recent years, developing countries have witnessed a gradual increase in investment in renewable energy, green industrial projects and energy-efficient infrastructure. These processes are most noticeable in countries with high dependence on exports to the EU and significant vulnerability to CBAM-sensitive sectors.

In Africa, the transformation of investment flows is primarily associated with the development of renewable energy infrastructure and low-carbon industrial projects. South Africa remains one of the regional leaders in renewable energy, with installed renewable energy capacity

exceeding 10 GW and an estimated 1.6 GW of new capacity added by 2025 (Jowett, 2026). Morocco has become one of the largest solar power hubs in Africa with the NOOR Ouarzazate CSP IPP (n.d.) complex, which provides electricity to over 1 million households and supports the development of low-carbon industrial infrastructure. Egypt is actively developing renewable energy and green hydrogen projects, while Kenya and Ethiopia are strengthening their positions through the development of geothermal energy and low-carbon industrial parks. In 2024, Africa's installed renewable energy capacity reached 67 GW, up 4.2 GW or 6.7% year-on-year. The main growth was driven by Egypt, Ethiopia and South Africa, reflecting the region's growing role in developing low-carbon energy infrastructure (International Renewable Energy Agency, 2025). The impact of the EU's environmental standards on investment dynamics is increasingly evident in Central Asian countries. Kazakhstan has demonstrated the highest level of renewable energy modernisation. In 2024, the country had 148 renewable energy facilities with a total capacity of about 2.9 GW, including solar, wind and small hydropower plants. In 2025, the number of renewable facilities increased to 162, while the share of renewables in the national electricity mix reached about 7%. One of the largest infrastructure projects in the region is the Mirny (TotalEnergies, n.d.) wind farm in Kazakhstan, which envisages the creation of about 1 GW of wind capacity and a battery storage system with a capacity of 600 MWh with a total investment of approximately USD 1.2 billion (Hernandez & Rabiega, 2026). Infrastructure modernisation in the region is also associated with the implementation of large hydropower projects, in particular the Kambarata-1 Hydropower Project (n.d.) in Kyrgyzstan with a capacity of 1,860 MW supported by international financial institutions (George *et al.*, 2025). The observed investment dynamics indicate a gradual transformation of the business environment in developing countries under the influence of the EU's green transition. Investment flows are increasingly concentrated in renewable energy, energy-efficient modernisation of industry, low-carbon manufacturing and sustainable transport infrastructure, while carbon-intensive sectors with a low level of decarbonisation face increasing investment constraints. In these conditions, the competitiveness of export-orientated industries

increasingly depends on the ability to integrate renewable energy technologies, emissions monitoring systems, sustainable logistics infrastructure, and environmental reporting standards into production processes and international supply chains.

The scenario analysis showed that the economic impacts of the European Green Deal and CBAM for African and Central Asian countries depend to a large extent on the level of decarbonisation of production, the pace of industrial modernisation and access to green finance. The calculations were based on export figures to the EU in 2024, the dynamics of renewable energy capacity, the share of renewable energy in the national electricity balance and the projected changes in carbon-intensive sectors already analysed in the study. The baseline for Africa was EUR 189 billion in exports to the EU in 2024, and for Central Asia, the EU's imports from the region were EUR 35.1 billion. The optimistic scenario assumed active decarbonisation, the development of renewable energy, cleaner production technologies and the implementation of monitoring, reporting and verification (MRV) systems. The baseline scenario reflected partial adaptation to the EU's environmental standards, while the pessimistic scenario assumed slower industrial modernisation, limited access to green finance, and a broader expansion of CBAM requirements. In the optimistic scenario, the decline in developing countries' exports to the EU remains at around 1.4%. For Africa, this corresponds to potential export losses of around EUR 2.65 billion compared to exports to the EU of EUR 189 billion in 2024, while for Central Asia, the losses could amount to around EUR 0.49 billion compared to exports of EUR 35.1 billion. At the same time, this scenario maintains the positive dynamics of green investment and renewable energy infrastructure. Assuming an annual growth rate of renewable energy capacity in Africa of 6.7%, installed capacity could grow from 67 GW in 2024 to around 96-99 GW by 2030. For Kazakhstan, the implementation of the 1 GW Mirny project could increase the country's renewable energy capacity from around 2.9 GW to almost 4 GW, and the share of renewable energy sources in the national electricity balance could potentially increase from 7% to around 10-12%.

The baseline scenario assumes partial adaptation of export-orientated sectors to new environmental requirements while maintaining significant dependence on carbon-intensive industries. In this scenario, the reduction in exports could reach around 2.4%. For Africa, this is equivalent to a potential loss of around EUR 4.54 billion in exports to the EU and for Central Asia, around EUR 0.84 billion. In this case, the metallurgy, aluminium, cement and fertiliser production will be most negatively affected. In particular, for Kazakhstan, exports of iron and steel to the EU could potentially decline by about 38% by 2035, while for Africa, exports of aluminium could decline by 13.9%, iron and steel by 8.2%, and fertiliser by 3.9%. At the same time, the growth rate of renewable energy infrastructure remains moderate: installed renewable energy capacity in

Africa in this scenario could grow to about 85-88 GW by 2030 and the share of renewables in Kazakhstan's electricity mix to about 8-9%.

The pessimistic scenario assumes a large-scale extension of CBAM and other environmental standards to a wider range of goods while industrial modernisation slows down and decarbonisation rates remain low. Under these conditions, the potential reduction in exports could exceed 4%. For Africa, this corresponds to a loss of over EUR 7.5 billion in exports to the EU and, for Central Asia, over EUR 1.4 billion. For some African least developed countries, GDP losses may exceed 1.5% and, in some scenarios, reach 8.4%. In this case, a significant part of foreign direct investment is gradually reoriented from carbon-intensive industries to low-carbon manufacturing and renewable energy projects in other regions. In the pessimistic scenario, the pace of development of renewable energy infrastructure remains insufficient to compensate for trade losses: renewable energy capacity in Africa by 2030 may grow only to about 75-78 GW, while the share of renewables in Kazakhstan's electricity mix will remain around 7-8%. The results obtained indicate that the scale of economic losses for developing countries will largely depend on the speed of technological modernisation, the development of renewable energy, access to climate finance and the ability of enterprises to adapt to the environmental standards of the EU.

Thus, the European Green Deal is gradually transforming the business environment in the countries of Africa and Central Asia, creating new conditions for international competitiveness, investment activity and the development of export-orientated production. Integration into low-carbon global value chains increasingly depends on the development of renewable energy, industrial modernisation, sustainable infrastructure and the ability of enterprises to adapt to the environmental standards of the EU.

Discussion

The EU's green transition is accompanied by a large-scale transformation of the economic, investment and trade system, which changes the conditions for the functioning of international markets, the structure of employment and global supply chains. In the study by S. Reither *et al.* (2025), the EU's green transition was considered primarily as a result of the strengthening of the role of state regulation, climate policy and financial mechanisms in the transformation of the economy. An analysis of 57 Commission Communications for 2009-2023 showed a gradual transition of the EU to more active state intervention in the processes of decarbonisation and industrial modernisation. A similar logic was traced in this study through the analysis of CBAM, the European Climate Law and the Net-Zero Industry Act. At the same time, the emphases of the studies differed. While S. Reither *et al.* focused mainly on the internal evolution of the EU's economic policy, this study focused mainly on the external consequences of the green transition for the countries of Central Asia and Africa. In particular, the risks of a 1.4-2.4% reduction in developing

countries' exports were analysed, as well as a possible 13.9% reduction in aluminium exports from Africa to the EU.

The topic of employment and economic restructuring became common for the study by E. Cappa *et al.* (2024). The authors proved that one megawatt of renewable energy capacity created about 40 jobs over seven years, mainly in construction and agriculture. In this study, the development of renewable energy infrastructure and green industrial projects was also considered as a factor in the modernisation of production and the transformation of the employment structure. However, E. Cappa *et al.* analysed the internal regional effects of investments in renewable energy in European countries, while this study focused on the impact of the European Green Deal and CBAM on exports, investments and competitiveness of African and Central Asian countries.

A similar division between internal and external effects of the green transition was observed when comparing it with the work of N. Chatzistamoulou & P. Koundouri (2024). The authors analysed the EU-28 countries in 2010-2019 and focused on the relationship between eco-innovation, renewable energy, green taxation and environmental efficiency. Their study focused on the internal macroeconomic transformation of the EU, resource efficiency and the circular economy. This work similarly considered decarbonisation mechanisms, the development of clean technologies and regulatory instruments, but the main focus shifted to the external economic consequences of EU environmental policy for developing countries.

The debated nature of the green transition was particularly evident in the work of D. Villani *et al.* (2025), who questioned traditional approaches to measuring green jobs and concluded that 24 European countries experienced almost no net growth in green employment during 2011-2022. In contrast, this study considered renewable energy projects, green finance and industrial modernisation as drivers of new employment opportunities. Similar labour market transformations were analysed by A. Javed & N. Usman (2025), who found that stricter environmental policies and the transition to renewable energy increased demand for high-skilled labour while reducing demand for low-skilled workers in Italy's traditional energy sectors. However, their focus remained on internal labour market changes, whereas this study examined the impact of the European Green Deal on export competitiveness and investment processes in African and Central Asian countries.

The infrastructural and geopolitical dimensions of the green transition were more clearly reflected in the works of S. Tagliapietra (2024). In his 2024 study, Global Gateway was presented as a tool for developing sustainable infrastructure, renewable energy and EU cooperation with partner countries, particularly in Africa. Similar trends were identified in this study through the analysis of renewable energy infrastructure, sustainable transport corridors and green industrial projects in Africa and Central Asia. At the same time, S. Tagliapietra focused more on geopolitical competition between the EU and the Belt and Road

Initiative, while this study concentrated on the trade and investment effects of CBAM and decarbonisation.

In later research, S. Tagliapietra *et al.* (2025) examined electric vehicles, battery supply chains and the EU's dependence on Chinese investments and critical raw materials. Likewise, this study considered stricter environmental standards and CBAM as factors increasing risks for carbon-intensive sectors and raw-material-exporting economies. However, S. Tagliapietra *et al.* focused mainly on EU industrial policy and strategic autonomy, whereas this study analysed the adaptation of business environments in developing countries to new low-carbon standards. The role of green finance in economic transformation was explored by B. Fu *et al.* (2025) and W. Xu *et al.* (2025). Their studies showed that green finance policies in China stimulated employment growth, accelerated energy transition and supported cleaner technologies. Similarly, this study emphasised the importance of green investments, cleaner production technologies and digital monitoring systems for industrial modernisation and supply chain adaptation. Nevertheless, the Chinese studies focused on domestic policy mechanisms, while this research analysed the external economic effects of EU climate regulation on Africa and Central Asia.

Comparable conclusions were presented by X. Li & M. Du (2025), who analysed China's green industrial policy through the lens of international trade law and WTO norms. Both studies recognised that decarbonisation and clean technologies were reshaping global supply chains and trade relations. However, X. Li & M. Du focused on state support for electric vehicle and solar technology producers in China, whereas this study examined the external implications of the European Green Deal, CBAM and EUDR for developing countries. A similar distinction appeared in A. Khalique *et al.* (2025), who examined environmental regulation and climate investment within the EU-22. In contrast, this study focused on the emergence of new trade barriers for developing countries and the risks of carbon leakage to less regulated markets.

The social dimension of the green transition was addressed in the works of A. Hassel & K. Weil (2023) and Z.J. Im *et al.* (2025). A. Hassel & K. Weil analysed the role of social partners, trade unions and employers in ensuring a just transition for European workers, while Z.J. Im *et al.* compared social and industrial responses to decarbonisation in Denmark, Germany, Spain and Poland. These studies coincided with this work in that the green transition was interpreted as a process that changed the structure of employment, created additional costs for business and required compensation mechanisms. At the same time, the main focus of these authors was on the internal models of social protection, collective bargaining and industrial policy in the EU. This study examined socio-economic risks more broadly, through the impact of CBAM, EUDR, and other EU standards on employment, investment, and export opportunities in African and Central Asian countries, where institutional resources for adaptation were much

more limited. The closest foreign-economic perspective was presented by I. Valiyeva & K. Garashli (2025), who analysed the impact of environmental policies, CBAM and certification requirements on global trade and supply chains. Both studies emphasised the risks of uneven distribution of environmental burdens and the relocation of carbon-intensive industries to less regulated markets. However, I. Valiyeva & K. Garashli considered these processes globally, while this study focused specifically on the consequences of EU regulation for Africa and Central Asia.

A similar issue was raised by F.M. Hoffart & F. Holz (2024), who examined the risks of energy asset stranding in resource-dependent countries caused by declining demand for fossil fuels. While their study focused on losses related to oil, gas and coal assets, this work analysed the external pressure of EU regulatory instruments such as CBAM and EUDR on trade, production and investment in developing economies. The political and distributional dimensions of the green transition were explored by S. Baute (2025) and D. Plehwe *et al.* (2025). S. Baute showed that support for climate reforms depended on perceptions of fairness and the “polluter pays” principle, whereas this study focused on unequal effects between the EU and developing countries. D. Plehwe *et al.* highlighted political resistance to renewable energy and green jobs from fossil-fuel-related networks, while this study emphasised the economic consequences of EU regulation, including new trade barriers, rising adaptation costs and risks of carbon leakage to less regulated regions.

The analysis showed that modern studies of the green transition mainly focus on the decarbonisation of the economy, the development of renewable energy, green finance, labour market transformation and changes in international trade. Most of the work confirmed that environmental regulation and climate investments stimulate the modernisation of production and the development of low-carbon technologies. At the same time, it was found that the strengthening of EU environmental standards and the implementation of CBAM and EUDR create new risks for export competitiveness, investment climate and employment in African and Central Asian countries. There was also a trend towards the transfer of carbon-intensive production to less regulated regions, indicating the uneven global impact of the green transition.

Conclusions

The study found that CBAM, EUDR and other environmental mechanisms of the EU are transforming the international economic environment, affecting trade, investment and the competitiveness of developing countries. The competitiveness of export-orientated sectors increasingly depends on carbon intensity, environmental monitoring systems and cleaner production technologies. In 2014-2024, CO₂ emissions in the UK decreased by almost 29%

and in Germany by 28%, while in Vietnam they increased by 106%, in Indonesia by 63% and in India by almost 49%, indicating the transfer of carbon-intensive production to emerging markets. The greatest impact of CBAM concerns metallurgy, aluminium, cement, fertilisers and other energy-intensive industries. The mechanism at a carbon price of USD 44 per tonne of embedded CO₂ emissions could reduce developing countries' exports by 1.4%, while at USD 88 the reduction could reach 2.4%.

Scenario analysis showed that the economic consequences for African and Central Asian countries depend on the level of decarbonisation and industrial modernisation. Under the optimistic scenario, Africa's exports to the EU could decrease by about EUR 2.65 billion, while Central Asia's exports could decline by about EUR 0.49 billion. If renewable energy capacity in Africa continues to grow by 6.7% annually, installed capacity could increase from 67 GW in 2024 to 96-99 GW by 2030. In Kazakhstan, the 1 GW Mirny project could increase renewable energy capacity to almost 4 GW and raise the share of renewables in the electricity mix to 10-12%.

The baseline scenario assumes export losses of around EUR 4.54 billion for Africa and EUR 0.84 billion for Central Asia. Kazakhstan's iron and steel exports to the EU could decrease by about 38% by 2035, while African aluminium exports could decline by 13.9%, iron and steel by 8.2% and fertiliser by 3.9%. The pessimistic scenario assumes export reductions exceeding 4%, corresponding to losses of more than EUR 7.5 billion for Africa and EUR 1.4 billion for Central Asia. For some African least-developed countries, GDP losses could exceed 1.5% and reach 8.4%. At the same time, the green transition stimulates renewable energy and low-carbon manufacturing. Climate finance for Africa increased from USD 29.5 billion in 2019-2020 to USD 43.7 billion in 2021-2022. In South Africa, about 1.6 GW of new renewable capacity was commissioned in 2025, while in Kazakhstan the number of renewable energy facilities increased to 162. A limitation of this study is its focus mainly on macroeconomic and foreign trade effects without detailed analysis of individual enterprises and local production chains. Further research should focus on econometric analysis of the impact of CBAM, climate finance and renewable energy investments on export competitiveness and decarbonisation in developing countries.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] African Climate Foundation & London School of Economics and Political Science. (2023). *Implications for African countries of a Carbon Border adjustment mechanism in the EU*. Retrieved from <https://africanclimatefoundation.org>.

- [2] Baute, S. (2025). The distributive politics of the green transition: A conjoint experiment on EU climate change mitigation policy. *Journal of European Public Policy*, 32(1), 52-80. doi: 10.1080/13501763.2024.2304609.
- [3] Cappa, E., Lamperti, F., & Pallante, G. (2024). Creating jobs out of the green: The employment effects of the energy transition. *LEM Papers Series 2024/21*. doi: 10.57838/ssa/7y6y-8z23.
- [4] Carbon Border Adjustment Mechanism. (n.d). Retrieved from <https://taxation-customs.ec.europa.eu>.
- [5] Chatzistamoulou, N., & Koundouri, P. (2024). Is green transition in Europe fostered by energy and environmental efficiency feedback loops? The role of eco-innovation, renewable energy and green taxation. *Environmental and Resource Economics*, 87(6), 1445-1472. doi: 10.1007/s10640-024-00849-y.
- [6] Clean Industrial Deal. (n.d). Retrieved from <https://commission.europa.eu>.
- [7] Dadashli, R.R. (2024). *EU-Azerbaijan collaboration in green economy transition*. In XXVII republican scientific conference of doctoral students and young researchers (NASCO XXVII) conference materials (pp. 331-336). Sumgayit: Sumgayit State University.
- [8] de Simone, S., Nicolò, M., & Parks, L. (2025). Exporting the just transition? The European Investment Bank, the European Green Deal and environmental and social rules for green projects outside the EU. *International Environmental Agreements: Politics, Law and Economics*, 25, 285-301. doi: 10.1007/s10784-025-09664-2.
- [9] Ebatamehi, S. (2025). *Top 10 African countries leading in green industrialization in 2025*. Retrieved from <https://www.africanexponent.com>.
- [10] Ehl, D., & Padros, A.M. (2026). *How Africa gets shortchanged in trade with Europe*. Retrieved from <https://www.dw.com>.
- [11] Enhanced Partnership and Cooperation Agreement between the European Union and its Member States, of the one part, and the Republic of Kazakhstan, of the other part. (2015). Retrieved from <https://www.consilium.europa.eu>.
- [12] EU ETS: EU emissions trading system. (n.d). Retrieved from <https://climate.ec.europa.eu>.
- [13] EU taxonomy for sustainable activities. (2026). Retrieved from <https://finance.ec.europa.eu>.
- [14] EU4Environment. (2025). *De-risking green investments in the EU Eastern Partnership and in Central Asia*. Retrieved from <https://www.eu4environment.org>.
- [15] EU-Central Asia trade. (n.d). Retrieved from <https://www.consilium.europa.eu>.
- [16] Eurasian Research Institute. (n.d). *Economic cooperation between Central Asia and the European Union*. Retrieved from <https://www.eurasian-research.org>.
- [17] EUR-Lex. (2023). *Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions "A green deal industrial plan for the Net-Zero Age"*. Retrieved from <https://eur-lex.europa.eu>.
- [18] European Commission. (n.d). *Central Asia: EU trade relations with Central Asia. Facts, figures and latest developments*. Retrieved from <https://policy.trade.ec.europa.eu>.
- [19] Freitas, A.S., & Mwaniki, G. (2024). *Climate finance in Africa: An overview of climate finance flows, challenges and opportunities*. New York: United Nations Development Programme.
- [20] Fu, B., Zhang, Y., Maani, S., & Wen, L. (2025). Green finance and job creation: Analyzing employment effects in China's manufacturing industry within green finance innovation and reform pilot zones. *Energy Economics*, 141, article number 108090. doi: 10.1016/j.eneco.2024.108090.
- [21] George, L., Strohecker, K., & Jessop, S. (2025). *EBRD could lend up to \$1.5 billion for Central Asia hydro plant*. Retrieved from <https://www.reuters.com>.
- [22] Global Gateway. (n.d). Retrieved from <https://commission.europa.eu>.
- [23] Hassel, A., & Weil, K. (2023). Social partners in the green transition of the EU. *Quarterly Journal of Economic Research*, 92(4), 15-34. doi: 10.3790/vjh.2023.334383.
- [24] Hernandez, A., & Rabiega, M. (2026). *TotalEnergies approves Kazakh renewable project despite disputes*. Retrieved from <https://www.reuters.com>.
- [25] Hoffart, F.M., & Holz, F. (2024). Energy asset stranding in resource-rich developing countries and the just transition – a framework to push research frontiers. *Frontiers in Environmental Economics*, 3, article number 1273315. doi: 10.3389/frevc.2024.1273315.
- [26] Im, Z.J., de la Porte, C., Heins, E., Prontera, A., & Szelewa, D. (2025). A green but also just transition? Variations in social and industrial policy responses to industrial decarbonisation in EU member states. *Global Social Policy*, 25(1), 64-85. doi: 10.1177/14680181241246763.
- [27] International Renewable Energy Agency. (2025). *Renewable capacity highlights*. Retrieved from <https://www.irena.org>.
- [28] Javed, A., & Usman, N. (2025). Skill-biased labour market effects of environmental policy and green energy transition in Italy. *Energy Policy*, 207, article number 114833. doi: 10.1016/j.enpol.2025.114833.
- [29] Jowett, P. (2026). *South Africa adds 1.6 GW of solar in 2025*. Retrieved from <https://www.pv-magazine.com>.
- [30] Kambarata-1 Hydropower Project. (n.d). Retrieved from <https://kambarata1.org/en>.

- [31] Khalique, A., Wang, Y., & Ahmed, K. (2025). Europe's environmental dichotomy: The impact of regulations, climate investments, and renewable energy on carbon mitigation in the EU-22. *Energy Policy*, 198, article number 114498. doi: [10.1016/j.enpol.2025.114498](https://doi.org/10.1016/j.enpol.2025.114498).
- [32] Kwilinski, A., Dacko-Pikiewicz, Z., Szczepanska-Woszczyna, K., Lyulyov, O., & Pimonenko, T. (2025). The role of innovation in the transition to a green economy: A path to sustainable growth. *Journal of Open Innovation: Technology, Market, and Complexity*, 11(2), article number 100530. doi: [10.1016/j.joitmc.2025.100530](https://doi.org/10.1016/j.joitmc.2025.100530).
- [33] Li, X., & Du, M. (2025). China's green industrial policy and world trade law. *East Asia*, 42, 261-278. doi: [10.1007/s12140-025-09447-1](https://doi.org/10.1007/s12140-025-09447-1).
- [34] Mitić, P., Fedajev, A., Radulescu, M., Hudea, O.S., & Streimikiene, D. (2024). Fostering green transition in Central and Eastern Europe: Carbon dioxide emissions, industrialization, financial development, and electricity nexus. *Technological and Economic Development of Economy*, 30(4), 1009-1036. doi: [10.3846/tede.2024.20630](https://doi.org/10.3846/tede.2024.20630).
- [35] Monitoring, reporting and verification. (n.d). Retrieved from <https://climate.ec.europa.eu>.
- [36] Mubin, S., & Putri, A.H.A. (2025). The European Union Green Deal and global trade: A constructivist perspective on sustainability norms. *Journal of World Trade Studies*, 10(1), 46-59. doi: [10.22146/jwts.v10i1.18729](https://doi.org/10.22146/jwts.v10i1.18729).
- [37] NOORo I CSP IPP. (n.d). Retrieved from <https://acwapower.com>.
- [38] OECD. (2025). Harnessing trade and environmental policies to accelerate the green transition. *OECD Net Zero+ Policy Papers No. 5*. doi: [10.1787/0b4d893f-en](https://doi.org/10.1787/0b4d893f-en).
- [39] Park, C.-Y., Yamamoto, Y., & Doong, M.A.L. (2023). European Union Carbon Border Adjustment Mechanism: Economic impact and implications for Asia. doi: [10.22617/BRF230561-2](https://doi.org/10.22617/BRF230561-2).
- [40] Plehwe, D., Moreno, J.A., & Neujeffski, M. (2025). Challenging energy transition and green jobs: Climate policy obstruction across borders. *Critical Policy Studies*, 19(4), 614-636. doi: [10.1080/19460171.2024.2447248](https://doi.org/10.1080/19460171.2024.2447248).
- [41] Popescu, G.H., Fortea, C., Nica, E., Antohi, V.M., Andrei, J.V., & Szpilko, D. (2025). Investments in the green transition and their impact on economic growth and competitiveness in the European Union. *Copernican Economy*, 16(4), 1665-1725. doi: [10.24136/oc.3963](https://doi.org/10.24136/oc.3963).
- [42] Regulation (EU) No. 2021/1119 of the European Parliament and of the Council "Establishing the Framework for Achieving Climate Neutrality and Amending Regulations (EC) No. 401/2009 and (EU) 2018/1999 ("European Climate Law")". (2021, June). Retrieved from <https://eur-lex.europa.eu>.
- [43] Regulation (EU) No. 2024/1252 of the European Parliament and of the Council "Establishing a Framework for Ensuring a Secure and Sustainable Supply of Critical Raw Materials and Amending Regulations (EU) No. 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020 (Text with EEA relevance)". (2024, April). Retrieved from <https://eur-lex.europa.eu>.
- [44] Regulation (EU) No. 2024/1735 of the European Parliament and of the Council "On Establishing a Framework of Measures for Strengthening Europe's Net-Zero Technology Manufacturing Ecosystem and Amending Regulation (EU) 2018/1724 (Text with EEA Relevance)". (2024, June). Retrieved from <https://eur-lex.europa.eu>.
- [45] Regulation on Deforestation-free Products. (n.d). Retrieved from <https://environment.ec.europa.eu>.
- [46] Reither, S., Radulova, E., & Spendzharova, A. (2025). Steering the green transition in the European Union? Analysis of the European Commission's strategic communication. *Regulation & Governance*. doi: [10.1111/rego.70107](https://doi.org/10.1111/rego.70107).
- [47] Ström, P. (2024). Services and the green transition in developing countries. In E. Scheja & K.B. Kim (Eds.), *Rethinking economic transformation for sustainable and inclusive development: Turning a corner?* (pp. 123-142). Cheltenham: Edward Elgar Publishing. doi: [10.4337/9781035348466.00010](https://doi.org/10.4337/9781035348466.00010).
- [48] Tagliapietra, S. (2024). The European Union's Global Gateway: An institutional and economic overview. *The World Economy*, 47(4), 1326-1335. doi: [10.1111/twec.13551](https://doi.org/10.1111/twec.13551).
- [49] Tagliapietra, S., Trasi, C., & Sebastian, G. (2025). *A smart European strategy for electric vehicle investment from China*. Retrieved from <https://www.bruegel.org>.
- [50] The EU and Central Asia. (n.d). Retrieved from <https://eu-cai.org/the-eu-and-central-asia>.
- [51] The European Green Deal. (n.d.). *The European Green Deal: Striving to be the first climate-neutral continent*. Retrieved from <https://commission.europa.eu>.
- [52] Tijanić, L., & Kersan-Škabić, I. (2025). Tracking the green transition in the European Union within the framework of EU cohesion policy: Current results and future paths. *Economies*, 13(2), article number 37. doi: [10.3390/economies13020037](https://doi.org/10.3390/economies13020037).
- [53] TotalEnergies. (n.d.). *Mirny: A giant onshore wind project in Kazakhstan*. Retrieved from <https://totalenergies.com>.
- [54] UNECE. (2026). *UNECE report assesses implications of EUCarbon Border Adjustment Mechanism on Central Asia*. Retrieved from <https://unece.org/media/press/411503>.
- [55] UNCTAD. (2021). *A European Union Carbon Border Adjustment Mechanism: Implications for developing countries*. Retrieved from <https://unctad.org>.
- [56] UNCTAD. (2025). *Trade policies to advance national climate plans: Guide for policymakers*. Retrieved from <https://unctad.org>.

- [57] Valiyeva, I., & Garashli, K. (2025). Environmental policy and the green transition: Impact on global trade and supply chains. *Grassroots Journal of Natural Resources*, 8(1), 847-873. doi: 10.33002/nr2581.6853.080136.
- [58] Velyka, H. (2026). *Europe is reducing its emissions at the expense of Asian countries – visual capitalist*. Retrieved from <https://ecopolitic.com.ua>.
- [59] Villani, D., Vázquez, I.G., & Fernández-Macías, E. (2025). *Green jobs: A critique of the occupational approach to measure the employment implications of the green transition*. Seville: European Commission.
- [60] World Bank. (2022). *Azerbaijan: Towards green growth – issues note*. doi: 10.1596/38073.
- [61] World Bank. (n.d.). *Kazakhstan: Country climate and development report. Background note 1. EU CBAM: Modelling the impacts on Kazakhstan's economy*. Retrieved from <https://documents1.worldbank.org>.
- [62] World Trade Organization. (2025). *WTO annual report 2025*. Retrieved from <https://www.wto.org>.
- [63] Xu, W., Yuan, Q., Chen, N., & Ye, J. (2025). Green finance and energy structure transition: Evidence from China. *Sustainability*, 17(11), article number 4838. doi: 10.3390/su17114838.

Бізнес-середовище для робочих місць, інвестицій та експорту: реальний вплив зелених переходів ЄС на країни, що розвиваються

Нігар Гульталієва

Аспірант

Відкрите акціонерне товариство "АВВ"
AZ1005, вул. Нізамі, 67, м. Баку, Азербайджан
<https://orcid.org/0009-0004-1724-7509>

Рахман Бабаєв

Докторант

Азербайджанський державний економічний університет (UNEC)
AZ1001, вул. Істікляльят, 6, м. Баку, Азербайджан
<https://orcid.org/0009-0008-7698-6917>

Гультзар Ісмаїлзада

Аспірант, викладач

Академія державного управління при Президентові Азербайджанської Республіки
AZ1001, вул. Лермонтова, 74, м. Баку, Азербайджан
<https://orcid.org/0009-0001-3892-6488>

Ламія Гусейнова

Кандидат економічних наук, викладач

Азербайджанський державний економічний університет (UNEC)
AZ1001, вул. Істікляльят, 6, м. Баку, Азербайджан
<https://orcid.org/0000-0003-4633-6493>

Ельнур Ісаєв

Аспірант, викладач

Азербайджанський державний економічний університет (UNEC)
AZ1001, вул. Істікляльят, 6, м. Баку, Азербайджан
<https://orcid.org/0000-0002-8240-7482>

Анотація. Метою цього дослідження було оцінити вплив екологічної трансформації ЄС на економічний розвиток країн, що розвиваються, в контексті зайнятості, інвестиційної активності та зовнішньої торгівлі. Методологія дослідження базувалася на порівняльному, статистичному та сценарному аналізі, а також методах аналізу та узагальнення. Результати показали, що викиди вуглекислого газу у Великій Британії зменшилися майже на 29 %, у Німеччині – на 28 %, тоді як у В'єтнамі вони зросли на 106 %, в Індонезії – на 63 % та в Індії – майже на 49 %, що свідчить про переміщення вуглецевого виробництва до ринків, що розвиваються. Експорт з Африки до ЄС зріс зі 136 млрд євро у 2019 році до 189 млрд євро у 2024 році, тоді як імпорт з Центральної Азії досяг 35,1 млрд євро. Сценарний аналіз показав, що втрати від експорту можуть перевищити 7,5 млрд євро для Африки та 1,4 млрд євро для Центральної Азії за песимістичним сценарієм. Потужність відновлюваної енергетики в Африці може досягти 96-99 гігават до 2030 року, тоді як у Казахстані вона може зрости майже до 4 гігават. Дослідження показало, що Європейська зелена угода збільшила торговельні ризики для вуглецевих секторів, одночасно стимулюючи розвиток відновлюваної енергетики та низьковуглецеву модернізацію промисловості. Практичне значення дослідження полягає в можливості використання результатів органами державної влади, експортерами, промисловими підприємствами та інвесторами для оцінки ризиків Механізму вуглецевого коригування на кордоні та планування низьковуглецевої модернізації промисловості

Ключові слова: механізм вуглецевого коригування на кордонах; прямі іноземні інвестиції; декарбонізація; індустріалізація; кліматична політика; глобальні ланцюги створення вартості

Scientific Bulletin of Mukachevo State University

Series

Economics

Volume 13, No. 2, 101-113

Journal homepage: <https://economics-msu.com.ua/en>

UDC 336.763:502.131.1(477)

DOI: 10.52566/msu-econ2.2026.101

ISSN 2313-8114

E-ISSN 2518-1254

Green bonds as a financing instrument for environmental projects in Ukraine

Yuliia Kryvenko*

*PhD in Economics, Associate Professor
Hryhorii Skovoroda University in Pereiaslav
08401, 30 Sukhomlynskyi Str., Pereiaslav, Ukraine
<https://orcid.org/0000-0003-0473-8101>*

Anatolii Ovsienko

*Senior Lecturer
Hryhorii Skovoroda University in Pereiaslav
08401, 30 Sukhomlynskyi Str., Pereiaslav, Ukraine
<https://orcid.org/0000-0001-9808-8028>*

Abstract. The aim of the study was to substantiate the mechanisms underpinning the functioning of the global green bond market and to identify the conditions for their effective utilisation in financing environmental projects in Ukraine. The methodological foundation of the research comprised systemic, structural-functional, comparative, and institutional approaches, alongside content analysis of scholarly sources, analytical reports, and regulatory documents. The study analysed issuance volumes, documenting the global market's growth beyond USD 4 trillion and highlighting the energy sector's dominance in fund allocation. The research findings established that the development of green bonds is determined by the interplay of regulatory requirements, institutional infrastructure, and the level of market transparency, which collectively shape the conditions for capital attraction and the degree of investor confidence. Based on the market dynamics analysis, it was determined that the key parameters of the instrument's effectiveness are the earmarked use of proceeds, the availability of verification procedures, and the capacity to deliver a measurable environmental impact. It was estimated that implementing a programme for developing Ukraine's decentralised energy system based on renewable generation and energy storage systems requires between USD 15.5 billion and USD 23 billion in initial investment, while simultaneously securing a 5.6% reduction in the energy system's annual operating costs. It was established that the adoption of international reporting and certification standards contributes to reducing information asymmetry, whereas their incomplete implementation constrains the market's development opportunities in Ukraine. The analytical synthesis facilitated the identification of the structural peculiarities of the national segment, characterised by a limited number of issuances and dependence on external sources of financing, as substantiated by the implementation of discrete instruments totalling EUR 325 million and EUR 50 million. The study formulated a conceptual model linking regulatory conditions, issuance mechanisms, and fund utilisation efficiency through green bonds

Keywords: sustainable development; energy efficiency; information transparency; institutional conditions; energy security

Received: 19.12.2025, Revised: 14.04.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Kryvenko, Yu., & Ovsienko, A. (2026). Green bonds as a financing instrument for environmental projects in Ukraine. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 101-113. doi: 10.52566/msu-econ2.2026.101.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (yuliyagorodnichenko@gmail.com)

Introduction

The evolution of financial instruments oriented towards environmental objectives reflects a transformation in capital mobilisation mechanisms amidst increasingly stringent requirements for the environmental performance of investments. Within this context, green bonds serve as an instrument that combines financial parameters with the targeted allocation of funds towards the implementation of environmentally-focused projects. For Ukraine, this issue acquires particular significance due to the necessity of financing infrastructure restoration, enhancing energy efficiency, and ensuring energy security. Concurrently, the development of the green bond market is accompanied by constraints linked to institutional immaturity, the insufficient level of financial market development, and regulatory environment uncertainty, which necessitates a comprehensive analysis of both the opportunities and barriers associated with the utilisation of this instrument. In the work of O. Cheberyako (2025), green financing is examined as an instrument for ensuring sustainable development and the post-war recovery of Ukraine's economy. The author demonstrated that environmentally-oriented financial mechanisms are capable of mobilising resources for infrastructure modernisation and improving the efficiency of energy resource utilisation. The study analysed the dynamics of green financing development globally and established that over 50 countries actively employ green financing instruments within their national economies. The researcher substantiated the role of green instruments in shaping long-term investment flows, which permits their consideration as an element of restorative economic policy. Within the context of forming the green bond market in Ukraine, it is essential to characterise the barriers to its development, among which key constraints are delineated in the work of A. Dubko (2022). The author identified the insufficient level of regulatory framework, limited awareness among market participants, and the absence of developed infrastructure as factors inhibiting the development of this segment. Simultaneously, the potential of green bonds in financing environmental projects was highlighted, allowing them to be regarded as a promising instrument for capital mobilisation. The global dimension of the green bond market's development was revealed through the prism of crisis phenomena in the work of N.V. Dunas (2021), which demonstrated that even under conditions of economic instability, the market maintains a growth trajectory. The author emphasised that after 2020, the global green bond market surpassed USD 1 trillion in cumulative issuance volume. The author characterised the role of international initiatives in shaping national markets. In the study by B. Lutsiv *et al.* (2023), the banking sector is identified as a key element of green financing, manifested in the transformation of lending and investment approaches by integrating environmental criteria. The authors proved that the integration of such approaches into the activities of financial institutions facilitates the formation of new financial instruments and alters the structure of the financial

market, creating preconditions for the development of green bonds as a component of the sustainable finance system. In particular, a rise in the share of ESG-oriented financial products within the structure of banking services and a strengthening of the role of environmental criteria in risk assessment processes were established. At the level of territorial communities, the utilisation of green bonds is linked to the possibility of financing local environmental projects, notably in the areas of energy efficiency and infrastructure. According to I. Sokoliuk (2024), this instrument can facilitate the mobilisation of resources for modernising communal service facilities; however, its effectiveness depends on access to financial resources and the development of local financial institutions.

The issue of investor confidence in green financing instruments is becoming of decisive importance for the formation of a fully-fledged market, as it fundamentally determines the potential for scaling up issuances and attracting long-term capital. The research by R. Zvarych & O. Masna (2025) demonstrated that the level of trust directly depends on the quality of information disclosure, adherence to reporting standards, and the availability of verified environmental impact evidence for the financed projects. The authors underscore that the global green bond market surpassed USD 4 trillion as of 2025, and that further expansion of the segment directly depends on the quality of verification mechanisms and the transparency of fund utilisation. Such an approach allows transparency and accountability to be regarded not as formal requirements, but as instruments for reducing information asymmetry between issuers and investors. In this context, it is precisely the reliability of data concerning fund utilisation and project implementation outcomes that shapes the investment attractiveness of green bonds, as it enables the assessment not only of financial parameters but also of the environmental performance of investments. In the work of Y. Petlenko (2024), it is substantiated that the development of the energy sector requires the attraction of substantial investment resources directed towards infrastructure modernisation and reducing dependence on fossil energy sources. Under these conditions, green bonds constitute an alternative capital mobilisation mechanism that combines financial viability with the achievement of environmental objectives. The author emphasises that the implementation of energy transition programmes requires multi-billion-dollar investments in the modernisation of energy infrastructure and the development of renewable energy sources. Their utilisation ensures the targeted channelling of resources towards projects related to the advancement of renewable energy sources. The level of development of sustainable finance instruments is determined by the institutional capacity of the financial system, which establishes the conditions for the effective attraction and allocation of investment resources. A study by A. Koldovskyi (2025) emphasises that the quality of financial infrastructure plays a key role, particularly the ability to ensure transparency of

operations, accessibility of financial instruments, and stability of capital flows. The author underscores that countries with developed financial infrastructure demonstrate significantly higher volumes of capital attraction in the sustainable finance segment compared to markets where institutional mechanisms remain fragmented. At the same time, institutional constraints associated with the insufficient development of market mechanisms and infrastructure restrain issuer activity and diminish the potential for attracting investment into environmental projects.

Scholarly research has elucidated specific aspects of green finance development, notably the role of financial instruments in ensuring sustainable development, the functioning of the banking system, and the barriers to the formation of the green bond market. However, the works examined predominantly analyse individual elements of this process, whereas the question of systemic interaction between the regulatory environment, institutional infrastructure, and the mechanisms governing the functioning of green bonds remains insufficiently explored. Equally under-researched is the potential for deploying this instrument within the context of Ukraine's economic transformation and the possibilities for its integration into the national financial system based on a holistic model. The aim of the study was to identify the specific features of the green bond market's functioning, to determine the factors driving its development, and to substantiate the possibilities of utilising this instrument to finance environmental projects in Ukraine. To achieve the stated aim, the following objectives were defined: to analyse the emergence and dynamics of the global green bond market; to investigate the specificities of market formation in Ukraine and the parameters of the inaugural issuances, to assess the potential for green bond utilisation; and to develop a model for attracting financing through green bonds within the conditions of the national economy.

Materials and Methods

The study was theoretical and analytical in nature. The methodological foundation of the research was based on the application of systemic, structural-functional, comparative, and institutional approaches, which enabled a comprehensive investigation into the mechanisms of the green bond market's functioning and the interaction among its key participants. During the study, scholarly publications, international reports, and market data were analysed to trace the instrument's evolution, highlight key trends, and summarise project reporting, verification, and certification requirements, such as R. Rodrigues Loiola *et al.* (2025), Climate Bonds Initiative (2025) and Organisation for Economic Co-operation and Development (OECD, 2025). The case study method was employed to investigate the Ukrainian market, including regulatory documents and examples of the initial issuances (IFC, 2025). The temporal scope of the study encompassed the period from 2007 to 2025, from the emergence of the first green bond issuances to the formation of a fully-fledged

segment of the global sustainable finance market. The selection of this period was dictated by the necessity to trace the instrument's evolution from the initial emissions by international financial institutions to the current stage of large-scale capital attraction and market institutionalisation. For analysing contemporary trends, market structure, and institutional investors, data from 2023-2025 were used to characterise the current green bond segment. The global market was examined using a historical-economic approach with time series analysis based on Climate Bonds Initiative (2025). Structural analysis was applied to determine the composition of market participants and their functional roles (Moro & Zaghini, 2025; Kansoy & Stasiulaitis, 2025; Giacometti *et al.*, 2025).

The selection of sources was carried out according to the criteria of scholarly relevance, timeliness, and availability of empirical data. The analysis incorporated scholarly articles, analytical reports from international financial organisations, and regulatory documents, predominantly published between 2019 and 2025. The search was performed using the keywords "green bonds", "sustainable finance", "ESG investing", "green finance", "climate finance", "Ukraine green bonds", "energy transition financing" in international scientometric and analytical databases, including Scopus, Web of Science, OECD iLibrary, Climate Bonds Initiative, International Energy Agency, and the International Capital Market Association (ICMA). The analysis of the emergence of the green bond market in Ukraine was carried out by applying institutional and content analysis through a combination of the normative and practical dimensions of its formation. Analytical materials from the National Bank of Ukraine (2025) and A.A. Olenyuk (2025) were processed. A comparative analysis was used to identify market development specifics, comparing initial green bond issuances with international sustainable finance practices by capital structure, instrument type, sector, financing scale, market integration, and functional role. Based on a comparative case analysis, which involved juxtaposing the parameters of two green finance instruments according to criteria such as instrument type, source of capital, financing sector, project scale, level of integration into the financial market, and functional role, Table 1 was formulated. Investor requirements for green bonds were investigated through the application of content analysis of international standards and a comparative analysis of approaches to assessing instrument quality and conditions for capital access. To this end, research and reports by the ICMA (2025) and Climate Bonds Initiative (2025) were analysed, focusing on instrument structure, use of proceeds, project selection, financial management, and information disclosure. In the process of analysis, these elements were correlated with one another as interconnected components of a single mechanism. A comparative analysis was used to contrast international practice with Ukrainian conditions, assessing the standardisation of green bond requirements, verification and reporting procedures, institutional infrastructure, investor participation, and transparency mechanisms.

The potential for utilising green bonds in Ukraine was assessed through the application of structural-functional and comparative analysis. In the study, scholarly approaches to green financing, as presented by M. Babic (2024) and A. Frolov (2024), were compared with the economy's environmental needs to identify key application areas, including renewable energy, energy efficiency, infrastructure, transport, and waste management. In the process of analysis, these areas were examined from the perspective of their investment attractiveness, capital intensity, and the potential for achieving a measurable environmental effect. A structural-functional approach was employed to systematise these interconnections, within which the market was regarded as a system with input parameters, a functioning mechanism, and outcomes. The architecture of the conceptual model (Fig. 3) was formulated based on the structural-functional approach and the operational logic of sustainable finance markets. The delineation of the model's four blocks (input parameters, functioning mechanism, impact moderators, and outcomes) was necessitated by the need to reflect the sequence of formation and implementation of the capital attraction mechanism through green bonds. The input parameters encompass the regulatory and institutional conditions that form the basis for market functioning. The functioning mechanism covered the processes of issuance, verification, placement, and monitoring of the instrument. The impact moderators included risks, the level of investor confidence, and macroeconomic conditions, which determine the efficacy of market functioning. The outcomes block reflected the volumes of attracted financing and the environmental effect of the implemented projects.

Results and Discussion

The emergence of the global green bond market occurred as a response by the financial system to the need to mobilise capital for financing projects aimed at mitigating negative environmental impact. Conceptually, this instrument is grounded in the principle of the earmarked use of proceeds, which distinguishes it from conventional debt instruments and shapes a new logic of interconnection between financial flows and environmental outcomes (Rodrigues Loiola *et al.*, 2025). M. Migliorelli (2021) emphasises that sustainable finance does not constitute a separate market segment but rather represents a transformation of the operating logic of the financial system. Within this logic, investment is assessed not only against financial parameters but also by its capacity to generate a measurable environmental effect. This defines the place of green bonds within the sustainable finance system. Historically, the formation of the global market is linked to the activities of international financial institutions, which undertook the first attempts to integrate environmental objectives into debt financing mechanisms. The inaugural issuances were carried out in 2007-2008 by the European Investment Bank and the World Bank, laying the foundation for the application of the principle of targeted allocation of funds and creating a model that subsequently became the benchmark for the entire market (On

the origin of green bonds, 2023). This stage was characterised by a limited circle of participants and the absence of standardised approaches to assessing environmental effect, which constrained the scaling up of the instrument. The subsequent development of the market in 2009-2015 was accompanied by a sharp increase in issuance volumes and a transition from isolated offerings to the formation of a systemic segment of the financial market. Whereas in 2007 the market volume amounted to less than USD 1 billion, by 2014 it had reached USD 37 billion, and by 2016, USD 80 billion (Climate Bonds Initiative, 2019; Ballester *et al.*, 2024). Such dynamics were driven by the simultaneous growth in demand from investors and the expansion of supply from issuers, including financial institutions, corporations, and government entities. Since 2015, market development has been shaped by the strengthening of climate policy and international agreements that stimulate the mobilisation of private capital to finance environmental transformations. The study by J. Demski *et al.* (2025) underscores that, following the adoption of the Paris Climate Agreement, the market has exhibited exponential growth dynamics, manifested both in increased issuance volumes and in the diversification of participants and financing sectors. The geographical expansion of the market has been accompanied by the emergence of sovereign green bonds, notably the first government issuance in Poland in 2016, signifying the instrument's transition to the level of public financial policy.

Gradually, the market is moving from a phase of quantitative growth towards structural sophistication, manifested in the formation of a system of standards, verification mechanisms, and reporting. In the initial stages, green bond issuance was characterised by a low level of transparency regarding environmental outcomes; however, with the expansion of the market, the role of certification and verification of the use of proceeds has grown, thereby enhancing market transparency, as noted by Z. Zhang (2024) and J. Demski *et al.* (2025). This drives the market's transformation from an instrument based on declarative environmental goals to a mechanism operating on the basis of formalised assessment criteria. Starting from 2017, market development has been characterised by a high level of integration of green bonds into global financial markets (Schoenmaker & Schramade, 2018). As of 2025, the volume of the global market has exceeded USD 4 trillion, reflecting a transition from a niche market instrument to a fully-fledged segment of the global debt market (The evolution of green bonds, 2025; LSEG, 2025; TechSci Research, 2026). This transformation is accompanied by the strengthening of regulation, the growing role of institutional investors, and heightened reporting requirements. Thus, the evolution of the green bond market is determined by the interplay of financial mechanisms, climate policy, and institutional changes, which ensure the systematic channelling of capital towards the environmental transformation of the economy. The initial stage of the global green bond market's development was accompanied by limited placement volumes; however, over the last decade, a significant acceleration in the pace of development has occurred (Fig. 1).

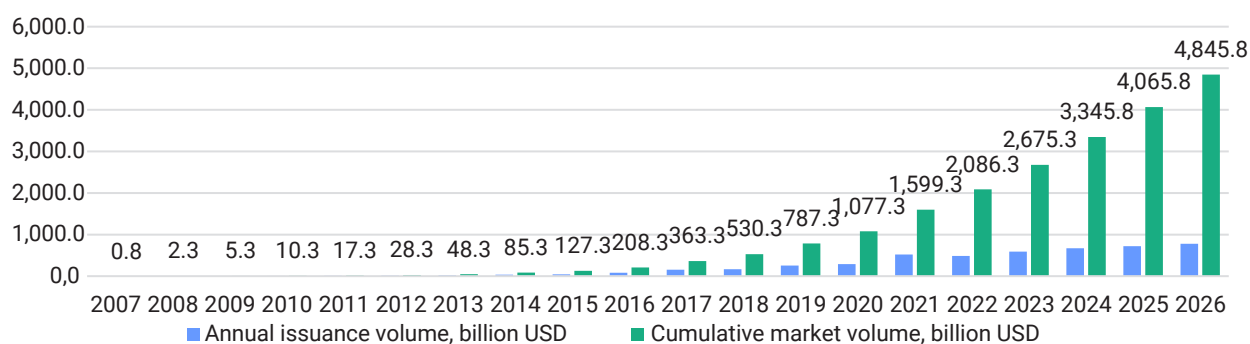


Figure 1. Dynamics of the global green bond market in 2007-2026

Source: compiled by the authors based on D. Schoenmaker & W. Schramade (2018), Climate Bonds Initiative (2025), LSEG (2025), TechSci Research (2026)

The volume of green bond issuance in 2023 amounted to USD 589.5 billion, while in 2024 it exceeded USD 670 billion, reflecting the growing demand for instruments financing environmental projects. The cumulative market volume surpassed USD 4 trillion in 2025, indicating its integration into global financial flows. The further expansion of the market is accompanied by an increase in the share of institutional investors and a strengthening of the role of regulatory mechanisms. According to OECD (2025), over 70% of global investments in the sustainable debt instrument segment are formed with the participation of institutional investors, including pension funds, insurance companies, and investment funds, which attests to the high level of integration of green bonds into the structure of professional asset management. The growth in issuance volumes is accompanied by an increase in market liquidity and an expansion of the toolkit, enabling capital to be raised for a broad spectrum of projects. At the same time, growth rates demonstrate a dependence on macroeconomic conditions and the regulatory environment, which is manifested in fluctuations in annual issuance volumes. Moreover, the regional structure of the market is characterised by the concentration of issuance in developed financial centres with a high level of institutional development. Leading positions are held by the USA and China, which account for more than half of the global placement volume, a situation driven by the active implementation of climate policy and the development of the regulatory framework (Ibrić *et al.*, 2024; Yue & Nedopil, 2025). This is supported by Sustainable bond market reaches new highs (2025),

which highlights the USA as one of the largest market segments owing to a substantial volume of corporate issuances. Concurrently, the work of Y. Xia *et al.* (2024) characterises the Chinese market, where a specific development model exists, within which green bonds occupy a relatively small share of the domestic debt market but play a role in financing infrastructure projects. The share of green bonds in the total issuance volume of debt instruments in EU countries reaches 7%, while the aggregate volume of the European green debt market segment has already exceeded USD 1 trillion, reflecting the high level of integration of this instrument into the financial system (Green bonds in Europe, n.d.; LSEG, 2025).

The sectoral structure of the market is determined by the direction of financing towards projects linked to the environmental transformation of the economy. The largest share falls on the energy sector, including the development of renewable energy sources and the enhancement of energy efficiency, which aligns with the strategic objectives of decarbonisation. Financing is also directed towards transport infrastructure, particularly the development of electric transport and the modernisation of logistics systems. A distinct segment is formed by financing the construction and renovation of buildings with enhanced energy efficiency standards, reflecting a change in approaches to infrastructure development (OECD, 2025). The formalisation of project selection criteria is carried out in accordance with international standards, ensuring the alignment of financial and environmental parameters. The sectoral structure of the use of proceeds from green bonds is clearly presented in Figure 2.

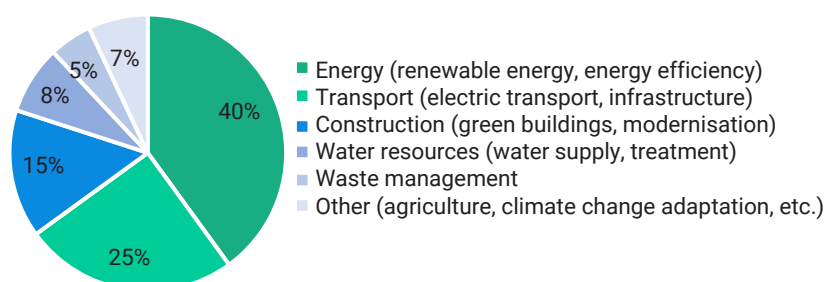


Figure 2. Sectoral structure of green bond proceeds utilisation as of 2025

Source: compiled by the authors based on OECD (2025), Climate Bonds Initiative (2025)

Analysis of the sectoral structure indicates the predominance of energy projects, which is attributable to their high capital intensity and direct impact on emissions reduction. At the same time, the transport and construction sectors account for a significant share, reflecting the expanding scope of green bond application. The functioning of the green bond market is determined by the interaction of three groups of participants, each of which performs a specific role in the process of mobilising and allocating financial resources for environmentally oriented projects (Moro & Zaghini, 2025; Rodrigues Loiola *et al.*, 2025). The category of issuers comprises sovereign states, corporate structures, and development finance institutions, whose activities ensure the formation of supply in this market segment. Sovereign issuers establish the normative foundation and set the operational parameters of the market through the issuance of sovereign bonds, thereby enabling the integration of environmental priorities into financial policy. The corporate sector employs this instrument as a mechanism for attracting long-term capital to modernise production and reduce environmental impact, which signals a shift in companies' strategic orientations.

The formation of demand in the market is primarily linked to the activities of institutional investors, for whom the integration of environmental, social, and governance (ESG) criteria into the investment decision-making process is becoming an integral component of portfolio policy. This transformation alters traditional approaches to asset valuation, as, alongside financial indicators, the quality of non-financial characteristics reflecting the degree of issuers' alignment with sustainable development principles is taken into account, according to F. Kansoy & D. Stasiulaitis (2025). As a result, capital is gradually being reallocated in favour of those instruments capable of delivering a combination of financial returns and a verified environmental impact. According to Climate bonds released provisional... (2025), the volume of assets managed under ESG criteria has exceeded USD 30 trillion globally, indicating the strengthening role of institutional investors in the development of the sustainable finance market. This drives the growing role of specialised investment funds focused on sustainable development and shapes a new demand structure in which transparency and the reliability of information concerning the use of proceeds occupy a central position (Giacometti *et al.*, 2025). A distinct function in ensuring market efficiency is performed by intermediaries, notably rating agencies, independent verifiers, and auditors, who assess the alignment of financed projects with established environmental criteria. Their involvement helps to reduce information asymmetry between issuers and investors by verifying the reliability of reporting and monitoring the earmarked use of funds. The presence of external verification formalises the environmental parameters of investments and ensures their comparability, which enhances confidence in the instrument and creates preconditions for market expansion. At the same time, S. Yiqun & Y. Hao (2025) are convinced that, within such

a system, intermediaries perform not only a control function but also an institutional one, since it is through their activities that a mechanism for reconciling the interests of all market participants is formed. The development of the green bond market is accompanied by the progressive institutionalisation of financing approaches grounded in the consideration of environmental, social, and governance criteria. The integration of such approaches into the financial system signifies a transition from the episodic use of environmental instruments to their systematic application in capital-raising processes (Rodrigues Loiola *et al.*, 2025; Walker & Gramlich, 2026).

Further transformation of the market is associated with the strengthening role of the regulatory environment, which defines the rules for classifying environmentally oriented activities and establishes the criteria for their compliance. In this context, the European Union Taxonomy occupies a prominent position, representing a unified system for identifying economic activities that align with environmental objectives (Chalavon *et al.*, 2025; Treglia, 2026). Its implementation ensures consistency in approaches to project assessment and reduces the risk of ambiguous interpretation of their environmental orientation, thereby influencing the conditions of market functioning and the level of trust in it. In parallel, the standardisation of issuance procedures and reporting is underway, envisaging the establishment of uniform requirements for the use of proceeds, their monitoring, and information disclosure. The introduction of the European Green Bond Standard (n.d.) is aimed at unifying the rules governing market operation and enhancing the transparency of investment processes, which ensures the comparability of financial instruments and reduces the costs associated with assessing their quality. Simultaneously, the problem persists of a discrepancy between the declared environmental characteristics of projects and the actual outcomes of their implementation, which manifests in practices of so-called "greenwashing". The use of environmental rhetoric without adequate substantiation of real impact creates risks of information distortion and reduces market confidence. The findings obtained regarding the risks of non-compliance and greenwashing practices align with the critical approaches to assessing the green bond market presented in the research of S. Bracking (2024). Within this approach, the existence of a contradiction between the financial returns and the environmental value of the instruments is emphasised, which creates preconditions for formal compliance with standards without ensuring a genuine environmental effect. In this regard, the significance of verification, control, and information disclosure procedures is amplified, as they allow for ensuring that financing corresponds to the declared environmental objectives and for increasing the reliability of information on the market (Yiqun & Hao, 2025; Treglia, 2026).

When examining the problem of green bond market formation in the context of Ukraine, it is expedient to proceed from the combination of normative consolidation of the instrument and limited practice of its use, which

determines the specific features of this financial market segment's emergence. The introduction of a legislative definition of green bonds in 2021 established the basic conditions for their use as an instrument for financing environmental projects, setting out the requirement for the earmarked direction of proceeds and the necessity of disclosing information on the results of their utilisation (National Bank of Ukraine, 2025). This regulatory model is oriented towards ensuring the transparency of financial flows and creates preconditions for aligning the national approach with international practice, which gradually influences the market structure (Olenyuk, 2025). The practice of using green bonds in Ukraine is characterised by a limited number of issuances and concentration within the corporate sector, reflecting the early stage of market development (National Bank of Ukraine, 2025). The placement parameters, notably the currency denomination and orientation towards international investors, indicate the limited capacity of the domestic capital market to provide the necessary volumes of financing and constrain the participation of local financial institutions in the development of this segment. At the same time, the normative environment is being shaped

under the influence of harmonisation processes with European approaches to regulating sustainable finance, which is manifested in the consideration of the provisions of the Taxonomy for Sustainable Activities, the International ICMA (2025) recommendations regarding the Green Bond Principles, and the European Green Bond Standard (n.d.), aimed at unifying approaches to structuring issuances, project selection, and information disclosure. The development of financing practices for Ukrainian environmental projects is also taking place through the use of adjacent instruments, which form the institutional foundation for the expansion of the green bond market. The attraction of financing in the amount of EUR 50 million in 2025 within the framework of sustainable development support programmes aimed at implementing projects in the sphere of energy efficiency and renewable energy demonstrates the gradual formation of demand for green finance instruments and creates preconditions for their further dissemination (IFC, 2025). Given the limited number of practical cases, it is appropriate to systematise the parameters of the first green finance instruments in Ukraine and their functional characteristics (Table 1).

Table 1. Comparative characteristics of the parameters of the first green financing instruments in Ukraine

Parameter	DTEK renewables green Eurobonds	Sustainable financing programmes (IFC and partners)
Year of launch	2019	2025
Financing volume	EUR 325 million	EUR 50 million
Type of instrument	Debt instrument (Eurobonds)	Credit and investment mechanism
Source of capital	International investors	International financial institutions
Currency	EUR	EUR
Financing sector	Renewable energy	Energy efficiency, sustainable energy
Scale of projects	Large infrastructure facilities	Small and medium-sized enterprises
Level of market integration	Full integration into the international capital market	Indirect integration through financial intermediaries
Functional role	Formation of the green bond market segment	Formation of demand for green financing
Limitations	Dependence on external investors	Absence of a direct debt instrument

Source: compiled by the authors based on IFC (2025), National Bank of Ukraine (2025)

The generalisation has enabled the delineation of the structural configuration of market formation, within which isolated corporate issues and mechanisms of international financial support are combined. The existence of a single, fully-fledged debt instrument with a volume of EUR 325 million indicates a high level of market concentration and its dependence on individual issuers. Concurrently, financing within the framework of programmes amounting to EUR 50 million generates demand for environmental projects, yet it does not translate into the development of a domestic debt instrument market. Such a structure reflects an asymmetry between institutional support and issuance practice, which constrains market depth and determines its reliance on external sources of capital. Expanding the spectrum of financial instruments in the field of sustainable finance establishes the preconditions for a gradual transition from isolated issuances to a more systematic use of green bonds (Kidwell *et al.*, 2025). The combination

of international financial resources with national support mechanisms produces an institutional multiplier effect, within which the development of adjacent instruments stimulates the formation of a market for environmentally-oriented debt instruments. This makes it possible to compensate for limitations associated with the insufficient level of development of the domestic capital market and ensures a gradual expansion of financing opportunities for environmental projects. The emergence of the green bond market in Ukraine is characterised by a gap between the regulatory formalisation of the instrument and the limited practice of its use. The selection of projects for financing through green bonds involves the application of specialised assessment procedures that ensure coherence between environmental objectives and the financial parameters of investments. Such procedures are oriented towards determining the environmental impact of projects, the efficiency of resource use, and compliance with established

sustainable development criteria, forming the basis for investment decision-making (Frolov, 2024). At the same time, the absence of established assessment methodologies and the limited experience of their application restrain the activity of issuers and reduce the instrument's attractiveness for investors. The shaping of investor requirements for green bonds occurs within a gradual shift from evaluating exclusively financial parameters towards a comprehensive consideration of transparency, accountability, and environmental performance characteristics.

Access to capital is determined not only by the issuer's creditworthiness but also by the ability to ensure project compliance with established sustainable finance standards, which alters the structure of the investment process and elevates the role of non-financial information (Rodrigues Loiola *et al.*, 2025; OECD, 2025). The institutional basis for shaping such requirements is provided by international standards, which ensure the unification of approaches to green bond issuance and define the criteria for project assessment. The Green Bond Principles, developed by the ICMA (2025), establish general requirements for the use of proceeds, project selection procedures, resource management, and disclosure, shaping the fundamental architecture of market functioning. In parallel, a system of sector-specific criteria is emerging, developed within the framework of the Climate Bonds Initiative (2025), which specifies the requirements for the environmental orientation of projects and ensures their comparability across different sectors of the economy. The evolution of the European Green Bond Standard is aimed at further detailing these requirements and integrating them into the regulatory environment, thereby increasing the level of market formalisation and creating conditions for reducing information uncertainty (Treglia, 2026; European Green Bond Standard, n.d.). Investor requirements are structured around four interconnected components that determine the quality of the instrument and the level of trust in it (Frolov, 2024). The first component relates to the targeted use of proceeds, envisaging their allocation exclusively to financing projects with a clearly defined environmental effect. The second component encompasses project selection procedures, which ensure investment compliance with established criteria and involve the assessment of their environmental impact. The third component includes mechanisms for the management of proceeds, which guarantee their targeted use and control over the flow of financial resources. The fourth component pertains to reporting, which ensures the disclosure of information on project implementation results and enables investors to assess the efficiency of the capital raised (ICMA, 2025; OECD, 2025). The aggregate of these elements forms a systemic model for evaluating green bonds, within which financial and environmental parameters are integrated into a single investment decision-making process. Ensuring the instrument's compliance with established requirements presupposes the use of verification and certification mechanisms, which allow for the confirmation of the credibility of declared characteristics (Yiqun

& Hao, 2025; Demski *et al.*, 2025). A prominent place is occupied by external audit, which ensures the verification of information regarding the use of proceeds and the compliance of projects with established criteria. It is also common practice to engage independent expert assessments, which form an additional layer of quality confirmation for the instrument and reduce the risks of information uncertainty. Within this cycle, trust is built through a sequence of stages that include defining the targeted use of proceeds, selecting projects, ensuring control over their implementation, and disclosing results. Each of these stages is linked to corresponding verification mechanisms, which allows for the minimisation of information asymmetry and ensures that financing corresponds to the stated environmental objectives. The presence of information asymmetry between issuers and investors complicates the project assessment process and increases uncertainty regarding their environmental effectiveness, which may lead to a decrease in the investment attractiveness of green bonds (Ballester *et al.*, 2024; Zhang, 2024).

A comparison of international practice with the Ukrainian market demonstrates the existence of gaps in the level of compliance with established requirements. In the global context, the functioning of the market is based on a developed system of standards, verification, and reporting, which ensures a high level of transparency and investor confidence. In Ukraine, these mechanisms are at the formative stage, which is manifested in the limited experience of applying standards and the insufficient development of institutional infrastructure (Cheng, 2022; Piskunov *et al.*, 2025). This situation necessitates the further improvement of the regulatory environment and the adaptation of international practices to national conditions. Investor requirements for green bonds form a comprehensive system of criteria that covers all stages of the instrument's life cycle – from project selection to the assessment of their results. The level of compliance with these requirements determines the degree of trust in the market and directly influences the possibilities for attracting financial resources, which confirms the dependence of access to capital on the level of transparency and the effectiveness of control mechanisms. The areas of application of green bonds in Ukraine are shaped with consideration for the structure of environmental challenges and the specificities of the economy. The most influential area remains renewable energy, which requires significant investment in the modernisation of energy infrastructure and allows for the direct reduction of emissions. According to estimates by the International Energy Agency, implementing a scenario for the development of Ukraine's decentralised energy system based on renewable generation and energy storage systems requires between USD 15.5 and 23 billion in initial investment, depending on the structure of the energy balance (IEA, 2024). At the same time, such a scenario is viewed as more economically efficient in the long term, as it allows for a reduction in the annual costs of the energy system by approximately 5.6% owing to decreased fuel costs and electricity imports. Alongside this,

significant potential is concentrated in the sphere of energy efficiency, where financing is directed towards the modernisation of the housing stock, industrial enterprises, and communal infrastructure. The transport sector constitutes a separate segment for the instrument's application, linked

to the development of electric transport and the renewal of logistics systems, while waste management opens opportunities for financing recycling and resource recovery projects. Potential directions for financing environmental projects through green bonds in Ukraine are presented in Table 2.

Table 2. Potential directions for financing environmental projects through green bonds in Ukraine

Direction of financing	Content of financing	Environmental effect	Implementation specifics
Renewable energy	Financing the construction and modernisation of solar, wind, and bioenergy facilities	Ensures a direct reduction in greenhouse gas emissions and decreased dependence on fossil fuels	Requires significant capital expenditure and long-term investment, which stipulates dependence on international financing
Energy efficiency	Modernisation of the housing stock, industrial enterprises, and communal infrastructure	Contributes to reduced energy consumption and enhanced resource use efficiency	Implemented through a combination of state support programmes and private investment
Transport infrastructure	Development of electric transport, modernisation of logistics systems, and urban mobility	Reduces air pollution levels and emissions within the transport sector	Requires a comprehensive approach to infrastructure renewal and substantial investment in technologies
Construction and real estate	Financing the construction and reconstruction of buildings with enhanced energy efficiency standards	Reduces energy consumption and emission levels in the construction sector	Necessitates compliance with international certification standards and heightened requirements for design quality
Waste management	Creation and modernisation of systems for recycling, utilisation, and reuse of resources	Reduces waste volumes and negative environmental impact	Characterised by an insufficient level of infrastructure development and requires institutional support
Water resources	Financing water purification projects and the modernisation of water supply and drainage systems	Ensures the conservation of water resources and improvement of water quality	Requires significant investment and a lengthy implementation period
Climate change adaptation	Implementation of projects aimed at increasing infrastructure resilience to climate risks	Reduces the economy's vulnerability to the adverse consequences of climate change	Demands the integration of state policy and long-term strategic planning

Source: compiled by the authors

The generalisation made it possible to identify that the potential for using green bonds is concentrated in sectors with high capital intensity and a clearly measurable environmental effect, which ensures their attractiveness to investors. At the same time, the implementation of such projects is associated with the necessity of combining private and public financing, which determines the complexity of their scaling. The results related to determining the potential of green bonds for financing environmental projects correlate with the conclusions of M. Babic (2024), in which the green finance market is regarded as a key instrument for transforming the energy sector and infrastructure. The development of the green bond market in Ukraine is determined by a set of factors that shape the conditions for its functioning and influence its ability to attract financial resources. Institutional factors are linked to the level of development of the financial infrastructure and the capacity to ensure the transparency and accountability of financing processes. Financial factors reflect the availability of capital and the cost of resources, which characterises the instrument's attractiveness for issuers. Regulatory factors shape the rules of market functioning and influence the level of investor confidence, while investment factors are associated with investors' willingness to incorporate environmental criteria into their decision-making process. Alongside the development factors, there exists a set of barriers that limit the use of green bonds as a financing instrument.

Macroeconomic instability reduces the predictability of financial flows and complicates long-term investment planning. War-related risks heighten the level of uncertainty and deter investor participation, while the weakness of the environmental infrastructure and the limited development of the environmental effect assessment system reduce the potential for project implementation. The restricted participation of institutional investors and the insufficient development of the domestic financial market further constrain the scaling of the instrument, which creates structural limitations for its use. The formation of a model for attracting financing through green bonds involves a generalisation of the interconnections between the key elements of market functioning. Within the framework of the structural-functional approach, the market is viewed as a system encompassing input parameters, a functioning mechanism, moderators of influence, and outcomes. The input parameters are determined by the quality of the regulatory environment, the level of development of environmental standards, and the institutional capacity of market participants. The functioning mechanism includes a sequence of stages of issuance, verification, placement, and monitoring that ensure the implementation of the financial instrument. Moderators reflect the influence of risks, investor confidence, and macroeconomic conditions, which can either amplify or attenuate the mechanism's effectiveness. The outcome of the model's functioning is the volume of attracted financing

and the achieved environmental effect, which influences the efficiency of the instrument's use (Fig. 3).

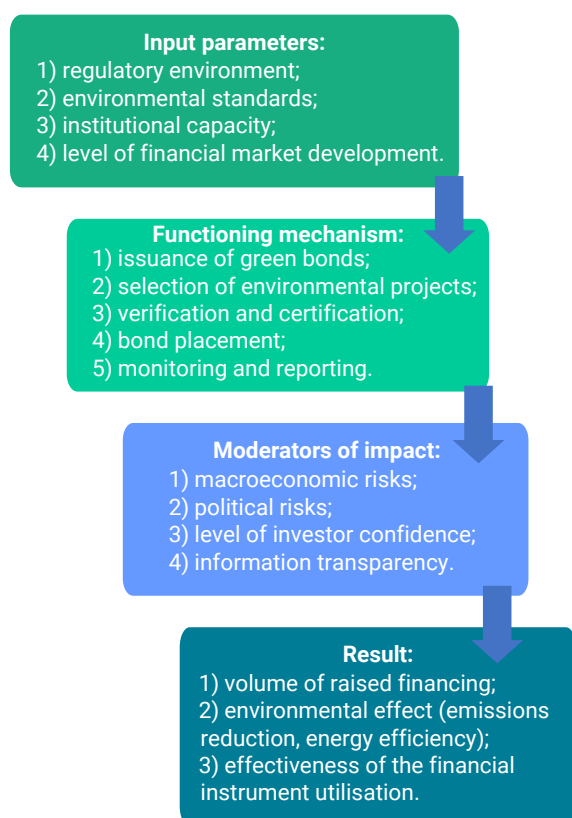


Figure 3. Conceptual model for attracting financing through green bonds

Source: developed by the authors

The interpretation of the model indicates that the efficiency of market functioning depends on the coherence among its components. Improving the quality of the regulatory environment and developing institutional infrastructure contribute to increased investor confidence and larger volumes of financing. At the same time, the negative influence of risk factors can neutralise positive effects, which necessitates a comprehensive approach to market development. Thus, the potential of green bonds as an instrument for financing environmental projects in Ukraine is determined not only by the availability of relevant areas of application but also by the capacity to ensure coherence among the institutional, financial, and regulatory conditions of their use. The developed model allows for the systematisation of these interconnections and the identification of key directions for enhancing the efficiency of market functioning.

Conclusions

The study has substantiated that the use of green bonds forms a distinct segment of the financial market, within which the

financial and environmental parameters of investment are combined. Its economic essence lies in the targeted attraction of capital for the implementation of projects with a measurable environmental effect, which alters the traditional logic of debt instrument functioning. The total market volume exceeded USD 4 trillion as of 2025. This indicates the transition of green bonds from a niche instrument to a fully developed segment of the global debt market. The dominance of the energy sector is driven by its capital intensity and direct effect on emission reductions, while the increasing role of the transport and construction sectors reflects the broader application of the instrument. The study found that the development of this financial market segment in Ukraine is marked by a gap between regulatory consolidation of the instrument and its limited practical use. The existence of DTEK renewables' green Eurobonds in the amount of EUR 325 million and sustainable financing programmes worth EUR 50 million attests to the market's dependence on external sources of capital and the insufficient level of development of the domestic debt instrument market. It has been established that the potential for using green bonds in Ukraine is most significant in the sectors of renewable energy, energy efficiency, transport, construction, and waste management. It has been revealed that market functioning is based on the interaction of issuers, investors, and intermediaries, who ensure the formation of supply, demand, and quality control of financing. It has been substantiated that the key factor in attracting investment is the level of transparency and reliability of information. The significance of this factor is reinforced by the fact that over 70% of global investments in the sustainable debt instrument segment are formed with the participation of institutional investors, and the volume of assets managed under ESG criteria exceeds USD 30 trillion. A cause-and-effect relationship has been identified: compliance with reporting standards, the presence of verification procedures, and confirmation of environmental impact directly influence the investment attractiveness of green bonds. A structural-functional model for financing has been proposed, reflecting the interconnection between input parameters, the implementation mechanism, and the outcomes of the instrument's use. The model's efficiency depends on regulatory coherence, investor confidence, institutional quality, and macroeconomic factors, enabling systematisation of capital attraction and optimisation of environmental project financing.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] Babic, M. (2024). Green finance in the global energy transition: Actors, instruments, and politics. *Energy Research & Social Science*, 111, article number 103482. doi: 10.1016/j.erss.2024.103482.

- [2] Ballester, L., González-Urteaga, A., & Shen, L. (2024). Green bond issuance and credit risk: International evidence. *Journal of International Financial Markets, Institutions and Money*, 94, article number 102013. doi: [10.1016/j.intfin.2024.102013](https://doi.org/10.1016/j.intfin.2024.102013).
- [3] Bracking, S. (2024). Green bond market practices: Exploring the moral “balance” of environmental and financial values. *Journal of Cultural Economy*, 17(3), 279-296. doi: [10.1080/17530350.2024.2312864](https://doi.org/10.1080/17530350.2024.2312864).
- [4] Chalavon, T., Klint, C., & Rapantova, B. (2025). *The EU Taxonomy in practice: Driving energy efficiency investments? Mapping insights from stakeholders*. Paris: Sciences Po Paris.
- [5] Cheberyako, O. (2025). *Green finance as a tool for sustainable development and post-war recovery in Ukraine*. *University Economic Journal*, 20(1), 8-18.
- [6] Cheng, L. (2022). *Supporting green bond development for Ukraine*. New York, NY: UNDP.
- [7] Climate Bonds Initiative. (2019). *Green bonds global state of the market 2019*. Retrieved from <https://www.climatebonds.net/files/documents/publications/Green-Bonds-Global-State-of-the-Market-2019.pdf>.
- [8] Climate Bonds Initiative. (2025). *Sustainable debt global state of the market 2024*. Retrieved from <https://www.climatebonds.net/data-insights/publications/global-state-market-2024>.
- [9] Climate bonds released provisional 2024 GSS+ debt market figures. (2025). Retrieved from <https://greenfinancelac.org/resources/news/climate-bonds-released-provisional-2024-gss-debt-market-figures/>.
- [10] Demski, J., Dong, Y., McGuire, P., & Mojon, B. (2025). *Growth of the green bond market and greenhouse gas emissions*. *BIS Quarterly Review*, March 2025, 53-71.
- [11] Dubko, A. (2022). Prospects and barriers to the development of the green bonds market in Ukraine. *Baltic Journal of Legal and Social Sciences*, 2, 58-64. doi: [10.30525/2592-8813-2022-2-10](https://doi.org/10.30525/2592-8813-2022-2-10).
- [12] Dunas, N.V. (2021). Global trends and initiatives in the development of Ukraine's green bond market amid the COVID-19 pandemic. *Problems of Economics*, 2(48), 4-16. doi: [10.32983/2222-0712-2021-2-4-16](https://doi.org/10.32983/2222-0712-2021-2-4-16).
- [13] European Green Bond Standard. (n.d.). Retrieved from <https://eur-lex.europa.eu/EN/legal-content/summary/european-green-bond-standard.html>.
- [14] Frolov, A. (2024). Project evaluation and selection system for the green bonds market. *Finance of Ukraine*, 11, 85-100. doi: [10.33763/finukr2024.11.085](https://doi.org/10.33763/finukr2024.11.085).
- [15] Giacometti, R., Torri, G., Bonomelli, M., & Lauria, D. (2025). Market-implied sustainability: Insights from funds' portfolio holdings. *arXiv*. doi: [10.48550/arXiv.2510.20434](https://doi.org/10.48550/arXiv.2510.20434).
- [16] Green bonds in Europe. (n.d.). Retrieved from <https://www.eea.europa.eu/en/analysis/indicators/green-bonds-8th-eap>.
- [17] Ibrić, M., Kozarević, E., & Mešković, A. (2024). The rise of green bonds: Global context and European insights. *Journal of Economics, Law, and Society*, 1(1), 55-71. doi: [10.70009/jels.2024.1.1.4](https://doi.org/10.70009/jels.2024.1.1.4).
- [18] ICMA. (2025). *The green bond principles*. Retrieved from <https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/>.
- [19] IEA. (2024). *Empowering Ukraine through a decentralised electricity system*. Paris: International Energy Agency.
- [20] IFC. (2025). *IFC and OTP leasing launch €50 million facility to boost Ukraine's private sector and sustainable energy solutions*. Retrieved from <https://www.ifc.org/en/pressroom/2025/ifc-and-otp-leasing-launch-50-million-facility-to-boost-ukraine-s-private-sector-a>.
- [21] Kansoy, F., & Stasiulaitis, D. (2025). Green shields: The role of ESG in uncertain time. *arXiv*. doi: [10.48550/arXiv.2506.02143](https://doi.org/10.48550/arXiv.2506.02143).
- [22] Kidwell, D.S., Mazzola, P., Brimble, M., Docherty, P., Basu, A., & Khan, H. (2025). *Financial markets, institutions and money*. Hoboken, NJ: John Wiley & Sons.
- [23] Koldovskyi, A. (2025). Sustainable development in Ukraine: Enhancing financial sector infrastructure. *Green Economics*, 3(1), 17-36. doi: [10.62476/ge.3.117](https://doi.org/10.62476/ge.3.117).
- [24] LSEG. (2025). *Green debt market passes \$3 trillion milestone*. Retrieved from <https://www.lseg.com/en/insights/green-debt-market-passes-3-trillion-milestone>.
- [25] Lutsiv, B., Mayorova, T., & Lutsiv, P. (2023). “Green finance” in the paradigm of sustainable banking development of the economy of Ukraine. *World of Finance*, 3(76), 64-76. doi: [10.35774/sf2023.03.064](https://doi.org/10.35774/sf2023.03.064).
- [26] Migliorelli, M. (2021). What do we mean by sustainable finance? Assessing existing frameworks and policy risks. *Sustainability*, 13(2), article number 975. doi: [10.3390/su13020975](https://doi.org/10.3390/su13020975).
- [27] Moro, A., & Zaghini, A. (2025). *Cui prodest? The heterogeneous impact of green bonds on companies' ESG score*. Rome: Bank of Italy.
- [28] National Bank of Ukraine. (2025). *NBU sustainable finance development policy*. Retrieved from https://bank.gov.ua/admin/uploads/article/Policy_rozvytok-stalogo-finansuvannja_2025_en.pdf.
- [29] OECD. (2025). *Sustainable bonds: Trends and policy recommendations*. Paris: OECD Publishing. doi: [10.1787/26726c68-en](https://doi.org/10.1787/26726c68-en).
- [30] Olenyuk, A.A. (2025). The development of legal regulation of green bonds in Ukraine. *Scientific Notes of the National University of Kyiv-Mohyla Academy. Legal Sciences*, 14, 57-65. doi: [10.18523/2617-2607.2024.14.57-65](https://doi.org/10.18523/2617-2607.2024.14.57-65).

- [31] On the origin of green bonds. (2023). Retrieved from <https://www.environmental-finance.com/content/analysis/on-the-origin-of-green-bonds.html>.
- [32] Petlenko, Y. (2024). Financing green energy for enhancing energy security in Ukraine. *Financial and Credit Activity: Problems of Theory and Practice*, 2(55), 161-179. doi: 10.55643/fcaptop.2.55.2024.4299.
- [33] Piskunov, R., Moskalenko, O., Daudova, G., Peniak, Y., & Shubina, S. (2025). The role of green finance in ensuring sustainable economic development of Ukraine in the context of European integration. *Financial and Credit Systems: Prospects for Development*, 2(17), 143-155. doi: 10.26565/2786-4995-2025-2-12.
- [34] Rodrigues Loiola, R., Kimura, H., & Melo Souza, L.D. (2025). Sustainable finance, green bonds and financial performance-a literature review. *International Journal of Financial Studies*, 13(4), article number 233. doi: 10.3390/ijfs13040233.
- [35] Schoenmaker, D., & Schramade, W. (2018). *Principles of sustainable finance*. Oxford: Oxford University Press.
- [36] Sokoliuk, I. (2024). Green bonds as a tool for financing environmentally sustainable initiatives in the context of post-war reconstruction of amalgamated hromadas. *The Economics of Systems Development*, 6(2), 84-90. doi: 10.32782/2707-8019/2024-2-12.
- [37] Sustainable bond market reaches new highs. (2025). Retrieved from <https://www.marketsmedia.com/sustainable-bond-market-reaches-new-highs/>.
- [38] TechSci Research. (2026). *Green bond market – global industry size, share, trends, opportunity, and forecast, 2021-2031F*. Retrieved from <https://www.techsciresearch.com/report/green-bond-market/27016.html>.
- [39] The evolution of green bonds: From niche to mainstream. (2025). Retrieved from <https://www.climatealigned.co/blog/green-bonds-evolution>.
- [40] Treglia, C. (2026). Enhancing green bond regulation in the EU: Strengthening oversight, market growth, and climate justice. *European Papers*, 11(1), 315-340. doi: 10.15166/2499-8249/871.
- [41] Walker, T., & Gramlich, D. (Eds.). (2026). *The Palgrave handbook of sustainable finance*. Cham: Springer Nature. doi: 10.1007/978-3-031-98736-6.
- [42] Xia, Y., Luo, L., Ji, K., Huang, C., Wan, F., & Wang, Z. (2024). The impact of green finance and local regulations on industrial green innovation efficiency in China. *Environmental Science and Pollution Research*, 31(2), 1980-1994. doi: 10.1007/s11356-023-31314-w.
- [43] Yiqun, S., & Hao, Y. (2025). Green bonds and corporate environmental performance: The role of third-party certification. *International Review of Economics & Finance*, 104, article number 104621. doi: 10.1016/j.iref.2025.104621.
- [44] Yue, M., & Nedopil, C. (2025). *China green finance status and trends 2024-2025*. Brisbane: Griffith Asia Institute.
- [45] Zhang, Z. (2024). The development of green bonds: Current issues and solutions. *Highlights in Business, Economics and Management*, 24, 722-730. doi: 10.54097/3mfb8p84.
- [46] Zvarych, R., & Masna, O. (2025). Green bonds as a tool for financing sustainable development in Ukraine. *World of Finance*, 2(83), 150-162. doi: 10.35774/sf2025.02.150.

Зелені облігації як інструмент фінансування екологічних проєктів в Україні

Юлія Кривенко

*Кандидат економічних наук, доцент
Університет Григорія Сковороди в Переяславі
08401, вул. Сухомлинського, 30, м. Переяслав, Україна
<https://orcid.org/0000-0003-0473-8101>*

Анатолій Овсієнко

*Старший викладач
Університет Григорія Сковороди в Переяславі
08401, вул. Сухомлинського, 30, м. Переяслав, Україна
<https://orcid.org/0000-0001-9808-8028>*

Анотація. Мета дослідження полягала в обґрунтуванні механізмів функціонування глобального ринку «зелених» облігацій та визначенні умов їх ефективного використання для фінансування екологічних проєктів в Україні. Методологічною основою дослідження стали системний, структурно-функціональний, порівняльний та інституційний підходи, а також контент-аналіз наукових джерел, аналітичних звітів і нормативних документів. У роботі проаналізовано обсяги емісії, зафіксовано зростання світового ринку понад 4 трлн дол. та підкреслено домінування енергетичного сектору у розподілі коштів. Результати дослідження показали, що розвиток «зелених» облігацій визначається взаємодією нормативних вимог, інституційної інфраструктури та рівня прозорості ринку, що в сукупності формує умови для залучення капіталу та ступінь довіри інвесторів. На основі аналізу динаміки ринку встановлено, що ключовими параметрами ефективності цього фінансового інструменту є цільове використання залучених коштів, наявність процедур верифікації та здатність забезпечити вимірюваний екологічний ефект. Оцінено, що реалізація програми розвитку децентралізованої енергетичної системи України на базі відновлюваних джерел і систем накопичення енергії потребує від 15,5 до 23 млрд дол. початкових інвестицій та водночас забезпечує зниження річних експлуатаційних витрат енергосистеми на 5,6 %. Встановлено, що запровадження міжнародних стандартів звітності та сертифікації сприяє зменшенню інформаційної асиметрії, тоді як їх неповне впровадження обмежує можливості розвитку ринку в Україні. Аналітичний синтез дозволив виявити структурні особливості національного сегмента, що характеризується обмеженою кількістю емісій та залежністю від зовнішніх джерел фінансування, що підтверджується реалізацією окремих інструментів на суму 325 млн євро та 50 млн євро. Дослідження сформулювало концептуальну модель, яка пов'язує нормативні умови, механізми емісії та ефективність використання коштів через «зелені» облігації

Ключові слова: сталий розвиток; енергоефективність; інформаційна прозорість; інституційні умови; енергетична безпека

Export challenges caused by blockade of ports and shift to overland and alternative routes

Rostyslav Osadchuk*

Postgraduate Student

National University of Life and Environmental Sciences of Ukraine

03041, 15 Heroiv Oborony, Kyiv, Ukraine

<https://orcid.org/0009-0005-6422-899X>

Abstract. This article investigated the challenges facing Ukrainian exports due to the blockade of seaports under martial law, and substantiated the main directions for redirecting logistics flows towards overland, river, and multimodal routes. The study was based on a systems approach, comparative analysis, statistical generalisation, structural and logical analysis, and economic interpretation. Information sources included statistical data from Ukraine's State Statistics Service, materials published by government authorities, analytical reports by international organisations, and academic studies on transport logistics, foreign trade, and Ukraine's export infrastructure in wartime. The impact of the port blockade on Ukraine's export logistics was analysed, and the role of alternative transport routes in maintaining the resilience of foreign trade was identified. The study provided a comprehensive evaluation of how Ukraine's export logistics had changed as a result of the seaport blockade between 2021 and 2025. The share of maritime transport in export logistics was found to have declined from 72% in 2021 to 38% in 2023, a decrease of 34 percentage points. Conversely, the share of rail transport increased from 15% to 31%, while the share of Danube ports rose from 5% to 18%. Additionally, the share of road transport increased from 8% to 13%. Redirecting export flows enabled Ukraine to maintain some of its foreign trade. However, a substantial increase in logistics costs was also observed: the cost of rail transport was found to have risen by 25-30%, road transport by 30-40%, and river transport via the Danube by 15-20%. Alternative logistics routes were found to be viable for sustaining exports of agricultural products, mining and metallurgical products, and raw materials. Nevertheless, the capacity of these routes has not yet been sufficient to compensate for pre-war maritime transport volumes fully. The practical significance of the findings lies in the formulation of recommendations regarding the development of multimodal transport, the modernisation of border infrastructure, the expansion of capacity at Danube ports, the integration of the Ukrainian transport system into the TEN-T network, and the enhancement of the resilience of the national export logistics system in the face of wartime and post-war risks

Keywords: transport logistics; multimodal transport; Danube ports; rail transport; foreign trade

Received: 23.01.2026, Revised: 24.04.2026, Accepted: 25.05.2026, Published: 29.05.2026

Suggested Citation: Osadchuk, R. (2026). Export challenges caused by blockade of ports and shift to overland and alternative routes. *Scientific Bulletin of Mukachevo State University. Series "Economics"*, 13(2), 114-121. doi: 10.52566/msu-econ2.2026.114.



Copyright © The Author(s). This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (<https://creativecommons.org/licenses/by/4.0/>)

*Corresponding author (rostosadchuk@gmail.com)

Introduction

Transport logistics is one of the key factors determining the competitiveness of a national economy within the international trading system. For Ukraine, a traditional leading exporter of agricultural products and raw materials, efficient export logistics determine the stability of foreign-exchange earnings and the country's position in global markets. In 2022, Russia invaded and then blocked seaports in the Black Sea and the Sea of Azov. This put the whole foreign trade system at risk. It was vital to find alternative transport routes for exports.

In recent years, the operation of Ukraine's export logistics has become particularly relevant. This is because of the conditions of military hostilities. The operation of Ukraine's export logistics has been the subject of numerous academic studies. O. Onyshchenko & V. Shyshkin (2025) investigated the specific features of managerial decision-making in international transport logistics. They looked at this under conditions of armed conflict and economic sanctions. They emphasised that transport logistics in a wartime environment should be based on the principles of flexibility, route diversification, and rapid response to changes in the external environment. I. Dashko & L. Mykhailichenko (2024) examined the impact of the war on the development of freight transport in Ukraine. They stressed that rail, road and river transport had become much more important following the blockade of the seaports. L. Lebedieva & D. Shkuropadska (2024) analysed the resilience of transport logistics in Ukraine and the EU, demonstrating that integrating Ukrainian transport corridors into the European logistics system is key to maintaining foreign trade. T. Luchnykova *et al.* (2023) discussed the challenges associated with operating rail transport amid turbulent foreign trade flows. Rail transport had become one of the main ways of making up for the loss of maritime routes, the authors noted. However, its effectiveness is constrained by the capacity of border crossings, differences in railway gauges, and rolling stock shortages.

K.V. Mazur *et al.* (2023) investigated the organisation of Ukrainian agricultural exports under martial law. The study emphasised that the stability of transport infrastructure is crucial for agricultural exports, as grain and oilseed crops require large volumes to be transported at a relatively low cost. N.I. Mykhailyk (2024) examined the main challenges facing transport logistics during the war, emphasising the need for multimodal logistics centres. O.P. Podtserkovnyi (2023) investigated the legal framework governing the port industry under wartime conditions, highlighting the need to adapt legislation and regulatory frameworks to the new operating conditions of the maritime business. The challenges and opportunities associated with the development of Ukraine's maritime sector during the post-war period were analysed by L. Trachenko (2025). He emphasised the importance of restoring port infrastructure, attracting investment and developing public-private partnerships. The current state, challenges and development prospects of maritime freight transport in Ukraine and worldwide were

examined by O. Shevchuk & N. Hayvanovych (2023). They demonstrated that maritime transport would remain strategically important for Ukraine, even with the development of alternative routes, because of its ability to support large-scale export deliveries at a lower cost.

Despite the large number of recent studies, most have looked at individual parts of the transport system in Ukraine under martial law. These include rail transport, agricultural exports and seaport activities. At the same time, there has been a lack of focus on a thorough quantitative analysis of the structural change in Ukraine's export logistics after the seaport blockade, the shifts in the role of different transport modes, the extent of the rise in logistics costs, and the creation of practical recommendations for growing multimodal transport networks. It was the need to address this research gap that determined the selection of the topic and the logic of the study. The investigation's objective was twofold: firstly, to conduct a thorough examination of the repercussions of the seaport blockade on Ukraine's export logistics, and secondly, to evaluate the structural transformation of transport flows between 2021 and 2025.

Materials and Methods

The study employed a combination of general scientific and specialised methods. The relationships between the blockade of ports, changes in the structure of export flows and the increase in logistics costs were determined using systems analysis. Comparative analysis was used to compare Ukraine's pre-war and wartime export logistics models. Statistical analysis was used to generalise indicators relating to changes in transport volumes across alternative transport routes. Structural and logical analyses were used to identify the main challenges and directions for restructuring export infrastructure. The conclusions and practical recommendations were formulated with the application of economic generalisations. A comparative analysis of pre-war and wartime tariff rates was used to assess the increase in logistics costs associated with alternative routes. This analysis was based on publicly available industry data, including materials published by R. Bandura *et al.* (2024) and the United Nations Conference on Trade and Development (2024).

The empirical basis of the study consisted of official statistical data from 2021 to 2025. These data enabled a comparative analysis of Ukraine's export logistics operation during the pre-war period, the full-scale blockade of seaports and the gradual adaptation of the transport system to new foreign trade conditions. To ensure the representativeness of the study, official national statistical reports (State Statistics Service of Ukraine, 2022; Ukrainian Sea Ports Authority, 2025; State Customs Service of Ukraine, 2026) were used together with analytical materials produced by international financial institutions (Echeverria *et al.*, 2025). The study focused on the main categories of Ukrainian exports that are most dependent on seaport operations, including grain and oilseed crops, sunflower oil, ferrous metals and

iron ore, as well as other mining and metallurgical products. Traditionally, these product categories accounted for the largest share of Ukraine's export freight flows, representing the bulk of maritime transport prior to the onset of full-scale war.

The study analysed maritime, rail, road, river and multimodal transport operations. When assessing the effectiveness of alternative logistics routes, particular attention was paid to transport volume trends, transport flow structure, changes in the share of individual transport modes, logistics costs, transport infrastructure throughput capacity, freight delivery times, congestion levels at border crossings and the impact of these factors on the competitiveness of Ukrainian exports. The study has certain limitations. First, official statistics concerning the operation of Ukrainian seaports under martial law were only available in aggregated form or were subject to restricted access for reasons of national security. Furthermore, the 2024-2025 statistical indicators were provisional and subject to change once the respective reporting periods are finalised. The study was carried out at the macroeconomic level and did not cover the individual logistics indicators of specific enterprises. This limitation emphasises the necessity for additional research at the microeconomic level, employing corporate statistics and data supplied by transport operators.

Results and Discussion

Since the start of 2022, Ukraine has faced significant challenges in international trade due to Russia's aggression. The blockade of Ukraine's seaports is one of the most destructive consequences of the conflict. These ports were the main transport gateway for exports of agricultural products, metallurgical goods, coal, ore and other important commodities. Losing access to the ports of the Black Sea and the Sea of Azov, including Odesa, Mykolaiv and Kherson, has had a critical impact on the Ukrainian economy. These ports handled the majority of the country's export shipments, and their blockade has resulted in a substantial decline in export volumes, as well as complicating the transportation of goods due to the absence of adequate alternatives (Onyshchenko & Shyshkin, 2025).

Traditionally, Ukraine's seaports have played a key role in the global supply of grain, oilseeds, metals, and other raw materials. They functioned as major logistics hubs. They also constituted a principal artery of the national economy. Following the outbreak of hostilities, some of these facilities were destroyed or fell under the control of the aggressor, resulting in the closure or severe restriction of maritime routes. This crisis has created an urgent need to restructure foreign trade and logistics routes. The European Commission (2025, 2026) has reported a 60% decrease in Ukrainian grain exports following the blockade of the ports. This had a negative impact on global prices and meant that importers had to look for other suppliers. Rail, road and river transport became alternative means of sustaining export activity. However, Ukraine was confronted with new challenges, such as establishing and modernising

transport corridors, introducing new multimodal routes, and integrating them into the international logistics system. At the same time, the increase in overland freight volumes put considerable pressure on existing infrastructure, necessitating the reconstruction of current transport links and the development of new ones (Prasad, 2025).

Due to the blockade of ports and restricted access to maritime routes, Ukraine redirected a significant portion of its exports towards its western borders, primarily through Poland, Romania, and Moldova, as well as southwards via the Danube River. These alternative routes have become crucial to maintaining exports, particularly grain exports. However, unlike maritime transport, overland and river routes require significant investment in transportation, infrastructure adaptation, and logistics. To ensure the effectiveness of these alternatives, rail and road transport must be modernised and new multimodal hubs established to ensure the rapid and secure transportation of goods to European markets.

The expansion of river transport, especially via the Danube, which has become one of the most important alternatives to maritime routes, should be given particular attention. However, navigating the Danube is challenging for several reasons. Some sections have insufficient water depth, shipping capacity is limited, and there are infrastructure constraints. Despite these limitations, the Danube has become a vital transport artery for grain and other agricultural exports following the seaports' blockade. In addition, the rising cost of transporting goods by overland and river routes became a serious challenge for Ukrainian enterprises. The loss of efficient maritime transport has impacted the competitiveness of Ukrainian goods in international markets. In addition, the logistics restructuring necessitated considerable investment in infrastructure modernisation and the establishment of new facilities for freight storage and transportation. Therefore, ensuring the flexibility and resilience of transport systems under the new conditions, as well as attracting investment to support these initiatives, became particularly important.

Another key factor is the importance of international assistance and cooperation with partners such as the European Union and the United States. These partners have contributed to the development of new logistics corridors and provided financial and technical support for infrastructure modernisation. A number of initiatives were initiated between 2022 and 2024. Among these were projects to restore and expand railway lines, construct new logistics centres, improve river routes and develop multimodal transport services. These measures enabled Ukraine to reduce the impact of the port blockade. They also enabled Ukraine to continue exporting strategically important goods (Antonovych, 2024). A full assessment of the economic and social consequences of logistics restructuring and Ukraine's cooperation with international partners is required in order to make such changes. It is important to understand how these new routes can be integrated into global trade and the effect they will have on the stability of

the national economy. It is also crucial to evaluate the role of government support in fostering these processes and its impact on the national economy's development.

The blockade of Ukraine's seaports forced the country to restructure its logistics routes quickly, with the focus now on rail, road and river transport. This enabled some of the goods that had previously been shipped through seaports to be redirected towards the western border and the Danube. Rail transport played a key role in restoring foreign trade. However, it should be noted that the western border encountered numerous difficulties during the initial stages of the war. Congestion at border crossings, insufficient freight

wagons and coordinating logistics processes with European partners were among the main challenges. Nevertheless, Ukrainian authorities and businesses addressed these issues promptly, increasing rail freight volumes by 30-35% compared to pre-war levels (Bandura *et al.*, 2024). River transport along the Danube became another important export route. Ukrainian companies developed river-based logistics, using ports in Romania, Bulgaria, and Moldova to transport goods to international markets. Although river transport is subject to certain constraints, including the limited depth of navigable channels in some sections, it enabled substantial increases in export volumes, particularly for grain (Table 1).

Table 1. Changes in freight volumes transported via alternative transport routes, 2022-2023

Transport route	Freight volume, million tonnes	Change compared with 2021
Rail transport	16.2	+30%
River transport via the Danube	7.8	+45%
Road transport	3.5	+20%

Source: State Statistics Service of Ukraine (2022), Ukrainian Sea Ports Authority (2025)

These factors had an adverse effect on the price competitiveness of Ukrainian products in international markets. The lack of affordable and speedy shipping options led to higher prices for Ukrainian goods. As a result, Ukraine lost some of its export markets, as competitors from other countries with access to less expensive and more efficient transport routes were able to offer their products at lower prices. Therefore, the increase in logistics costs became not only an operational problem for individual exporting enterprises, but also a systemic factor that reduced the price competitiveness of Ukrainian goods in foreign markets. The agricultural sector was particularly severely affected, as the low profit margins associated with agricultural products mean that logistics costs are crucial to the profitability of export deliveries. The findings indicate that, when used independently, none of the alternative routes provides economic efficiency comparable to that of pre-war maritime logistics. This demonstrates the need to develop a comprehensive multimodal model for organising export transportation.

The results of the analysis suggest that Ukraine's export logistics should be further developed based on the principle of transport route diversification. Priority areas include modernising border crossings along the western border, as these represent the main infrastructure constraint affecting rail corridors. Other priorities include expanding the terminal capacity of Danube ports. They also include reducing

customs barriers. This would increase the throughput capacity of transport corridors. It would also lower logistics costs for exporters. Integrating Ukraine's transport system into the Trans-European Transport Network (TEN-T) is a strategic objective that requires standardising railway gauges along key international corridors. Eliminating these technical differences is essential, as they are a systemic source of additional freight transshipment costs. Investment in railway infrastructure, river ports and multimodal terminals is required to address this issue (Echeverría *et al.*, 2025).

The implementation of these priorities is dependent on systematic government support for transport operators through preferential lending and subsidies. It is also dependent on the mobilisation of international financing under reconstruction programmes implemented by the World Bank and the European Bank for Reconstruction and Development. To provide a more detailed assessment of the consequences of the seaport blockade, changes in transport volumes and the transformation of the structure of Ukraine's export logistics must be examined. Prior to the onset of full-scale warfare, the country's export model was predominantly centred on seaports, which handled substantial consignments of agricultural products, metallurgical goods, and raw materials. However, the blockade of port infrastructure has necessitated a rapid transition to alternative routes, particularly rail and road transport, as well as Danube ports (Table 2).

Table 2. Structure of Ukrainian exports by principal logistics route, %

Transport route	2021	2023	Change, percentage points
Seaports	72	38	-34
Rail transport	15	31	+16
Danube ports	5	18	+13
Road transport	8	13	+5

Source: E.E. Echeverría *et al.* (2025), State Customs Service of Ukraine (2026)

As shown in Table 2, there has been a significant shift in the logistics model of Ukrainian exports. While seaports handled around 72% of export flows in 2021, this figure had fallen to 38% by 2023. This decline was due to the blockade of several ports, infrastructure damage, increased security risks, and the requirement for more intricate transport arrangements. Conversely, the share of rail transport increased from 15% to 31% over the same period, confirming its pivotal role in ensuring the continuity of foreign trade operations. The growing importance of Danube ports is particularly notable, indicating the emergence of a new strategic export route that has partially compensated for the loss of traditional maritime routes. Road transport also

increased its share. However, its potential remains limited. This is due to high transport costs, border crossing queues and lower carrying capacity. This is when compared with rail and maritime transport.

The redirection of exports towards alternative routes was also accompanied by rising logistics costs. This has become one of the main factors reducing the competitiveness of Ukrainian products in global markets. The largest cost increases were observed in rail and road transport. The root causes of these issues were identified as congestion at border infrastructure, additional transshipment operations, longer delivery times and the need to use combined transport arrangements (Table 3).

Table 3. Estimated impact of alternative routes on exporters' logistics costs

Mode of transport	Principal advantage	Principal limitation	Estimated increase in costs during the war, %
Rail transport	Ability to transport large consignments	Limited throughput capacity at border crossings	25-30
Danube ports	Access to European and global markets via river routes	Insufficient depth and limited port capacity	15-20
Road transport	Flexibility and rapid route adjustment	High cost and queues at border crossings	30-40
Multimodal transport	Risk diversification and combination of different routes	Complex coordination and the need for logistics hubs	10-20

Source: compiled and calculated by the author on the basis of data from R. Bandura *et al.* (2024) and United Nations Conference on Trade and Development (2024)

The data confirm that, in terms of scale, cost and speed of transport, none of the alternative routes can fully replace maritime logistics. Rail transport became the foundation of the export redirection process, although how effective it is depends a lot on the throughput capacity of border crossings, the availability of railway wagons, the speed of customs clearance and coordination with European operators. Danube ports have substantial potential, but require further modernisation and expansion of terminal capacity, as well as the dredging of navigation channels and development of access infrastructure. Although road transport offers the greatest flexibility, it is the most expensive option for bulk export cargoes. Therefore, it should primarily be used for products with a higher added value or as part of a multimodal arrangement. The most promising approach is the development of multimodal transport, which combines the advantages of different modes of transport and reduces exporters' dependence on a single logistics channel. Therefore, the analysis confirms that the seaport blockade not only caused short-term losses for exporters, but also catalysed the structural transformation of Ukraine's transport system. In these new conditions, the efficiency of exports depends on the state and businesses' ability to develop a flexible, diversified and integrated logistics model that combines rail, road, river and multimodal routes.

Overall, the findings confirm the conclusions of recent studies that transport infrastructure plays a critical role in maintaining the resilience of Ukraine's foreign trade in wartime. At the same time, however, they provide a

considerably more detailed assessment of the scale of the structural transformation of export logistics. Unlike previous studies, which primarily focused on individual aspects of the transport system, this study provides a comprehensive analysis of changes in export transportation structure, logistics costs, the role of alternative routes, and how they adapt to new international trade conditions.

The findings are consistent with the conclusions of R. Bandura *et al.* (2024), who emphasise that transport logistics should be based on route diversification and rapid responses to changes in the external environment under conditions of military conflict. The present analysis confirmed that transport route diversification was one of the key factors in ensuring the continuity of Ukrainian exports following the blockade of the seaports. However, the findings also demonstrate that the substantial increase in the use of rail, road and river transport did not fully compensate for the loss of maritime logistics.

The findings also support the conclusions of I.V. Davydova & S.V. Reznichenko (2022) that the role of rail transport has significantly strengthened since the start of the full-scale war. While previous studies primarily identified increased pressure on railway infrastructure, the present analysis reveals specific quantitative changes. Notably, the share of rail transport in Ukraine's export logistics increased from 15% to 31%, and freight volumes transported across the western border surpassed pre-war levels by around 30%. These results demonstrate the high degree of adaptability of Ukraine's transport system, even in the face of large-scale wartime challenges.

Comparing the findings with the research of I. Shevchenko & I. Klius (2023) suggests that integrating Ukrainian transport corridors into the European logistics system was key to supporting export activity. The findings confirm that closer cooperation with EU countries, increased use of border infrastructure, and active development of the Danube transport route enabled foreign trade operations to continue despite partial disruption to maritime transport. However, the findings differ somewhat from those of certain earlier studies concerning the economic efficiency of alternative routes (Lysenko, 2016; Miroshnyk & Bahlai, 2022). Rail and river transport are regarded by some authors as complete substitutes for maritime transport. However, the present analysis shows that neither mode can fully replace maritime logistics. This is due to substantially higher transport costs, lower throughput capacity and the need for additional freight transshipment operations. Therefore, Ukraine's transport system should be developed strategically to create an efficient multimodal transport model, rather than replacing one mode of transport with another.

A comparison of the findings with international statistical data was also made. This data was published by the National Council for the Recovery of Ukraine from the Consequences of the War (2022) and BBC News Ukraine (2023). This comparison confirms the general trend towards a substantial increase in the importance of overland transport routes. This increase began following the beginning of the full-scale war. At the same time, the findings of the present study provide a more detailed account of the specific characteristics of Ukraine's transport system and demonstrate that the greatest positive effect was achieved through the simultaneous use of several alternative transport routes rather than through the development of any single mode of transport.

The findings confirm the main conclusions of recent academic studies about the transformation of Ukraine's export logistics under wartime conditions. They also extend these conclusions substantially through a quantitative analysis of changes in the structure of transport flows, logistics costs and the effectiveness of alternative routes. The export-logistics diversification model developed in the study is one of the fundamental means of ensuring Ukraine's economic resilience in the face of prolonged wartime and post-war challenges.

Conclusions

Ukraine's export logistics underwent a structural transformation, which was confirmed by the study to be due to the

blockade of the seaports. The consequences of this are systemic and long-term. While the redirection of exports to alternative routes prevented the complete cessation of foreign trade, it did not fully compensate for the loss of maritime capacity. None of the alternative modes of transport matches pre-war maritime logistics in terms of the combined indicators of cost, throughput capacity, and delivery speed when considered separately. A key outcome of the study was the quantitative assessment of the scale of this transformation. The share of maritime transport decreased by 34 percentage points. Rail transport and the Danube ports formed the new foundation of export logistics. However, this redirection was accompanied by increased logistics costs of between 15% and 40%, depending on the transport method used. This reduced the price competitiveness of Ukrainian exporters, particularly in the agricultural sector, on a systematic basis. The most vulnerable product categories were those that were highly dependent on large-scale maritime transport: grain and oilseed crops, sunflower oil, ferrous metals, and iron ore.

A comparison of the effectiveness of alternative transport routes showed that rail compensated for the largest proportion of export flows. However, its potential is limited by the capacity of border crossing points and differences in railway gauges. Danube ports have emerged as a new strategic export route, recording the lowest level of cost growth among the alternative options. This establishes them as a priority for the further development of export infrastructure. Despite being costly, road transport provided the operational flexibility required for higher-value products. Further research should focus on econometric modelling of the optimal structure of multimodal transport. It should also assess the economic efficiency of investment in Danube infrastructure. Forecasting the throughput capacity of transport corridors after the end of martial law is another area to explore. And an integrated model for managing Ukraine's export logistics in accordance with modern European transport standards should be developed.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

- [1] Antonovych, M. (2024). Impact of the armed conflict in Ukraine on rail freight between Asia and Europe. *Journal of Civil Engineering and Transport*, 6(1), 25-38. doi: 10.24136/tren.2024.002.
- [2] Bandura, R., Timtchenko, I., & Robb, B. (2024). Ships, trains, and trucks: Unlocking Ukraine's vital trade potential. *Center for Strategic and International Studies*. Retrieved from <https://www.csis.org/analysis/ships-trains-and-trucks-unlocking-ukraines-vital-trade-potential>.
- [3] BBC News Ukraine. (2023). *Russia withdrew from the "grain deal". What does this mean for Ukraine and the world?* Retrieved from <https://www.bbc.com/ukrainian/articles/c72ve44j72qo>.

- [4] Dashko, I., & Mykhailichenko, L. (2024). The impact of war on the development of freight transportation in Ukraine. *Economics. Finances. Law*, 3, 87-90. doi: [10.37634/efp.2024.3.18](https://doi.org/10.37634/efp.2024.3.18).
- [5] Davydova, I.V., & Reznichenko, S.V. (2022). Transportation contracts: Realities of wartime. *Electronic Journal of Legal Studies*, 7, 530-533. doi: [10.32782/2524-0374/2022-7/129](https://doi.org/10.32782/2524-0374/2022-7/129).
- [6] Echeverria, E.E., Gauthier, G.F., Turzak, P., Ber, O.L., Bulakh, Y., Shkliar, A., & Beschastna, G. (2025). *Ukraine's transport and logistics system: Current and prospective challenges and opportunities*. Washington: World Bank.
- [7] European Commission. (2025). *Solidarity lanes: Latest figures – December 2024*. Brussels: European Commission.
- [8] European Commission. (2026). *EU-Ukraine solidarity lanes*. Brussels: European Commission.
- [9] Lebedieva, L., & Shkuropadska, D. (2024). Resilience of transport logistics in EU and Ukraine. *Foreign Trade: Economics, Finance, Law*, 4(135), 108-127. doi: [10.31617/3.2024\(135\)07](https://doi.org/10.31617/3.2024(135)07).
- [10] Luchnykova, T., Kharsun, L., & Potomkin, S. (2023). Railway transport of Ukraine under turbulence of foreign trade flows. *Commodity science. Technologies. Engineering*, 1(45), 17-26. doi: [10.31617/2.2023\(45\)02](https://doi.org/10.31617/2.2023(45)02).
- [11] Lysenko, O.M. (2016). *Features of developing integrated management systems based on international standards in Ukraine*. *Journal of Cherkasy State Technological University*, 3, 17-23.
- [12] Mazur, K.V., Yanchuk, D.O., & Haleta, D.O. (2023). Features of the organization of agricultural exports from Ukraine under the conditions of marital state. *The Economy and Society*, 51. doi: [10.32782/2524-0072/2023-51-12](https://doi.org/10.32782/2524-0072/2023-51-12).
- [13] Miroshnyk, R.O., & Bahlai, I.Ye. (2022). Problems of the grain crops market in Ukraine and ways to solve them. *The Economy and Society*, 39. doi: [10.32782/2524-0072/2022-39-24](https://doi.org/10.32782/2524-0072/2022-39-24).
- [14] Mykhailyk, N.I. (2024). The main challenges and prospects for the development of transport logistics under war conditions. *The Actual Problems of Regional Economy Development*, 1(20), 163-172. doi: [10.15330/apred.1.20.163-172](https://doi.org/10.15330/apred.1.20.163-172).
- [15] National Council for the Recovery of Ukraine from the Consequences of the War. (2022). *Recovery and development of infrastructure*. Retrieved from <https://ua.urc-international.com/past-conferences/urc22/plan-vidnovlennya-ukrayini>.
- [16] Onyshchenko, O., & Shyshkin, V. (2025). International transport logistics: Managerial decision-making under armed conflicts and economic sanctions. *Management and Entrepreneurship: Trends of Development*, 4(34), 191-206. doi: [10.26661/2522-1566/2025-4/34-15](https://doi.org/10.26661/2522-1566/2025-4/34-15).
- [17] Podtserkovnyi, O.P. (2023). Problems of legal support for the port industry under war conditions. *Law and Public Administration*, 3, 205-212. doi: [10.32782/pdu.2023.3.32](https://doi.org/10.32782/pdu.2023.3.32).
- [18] Prasad, A. (2025). Cargo throughput at Ukrainian ports rose by nearly 60% over the year, to 97.2 million metric tons. *Forbes Ukraine*. Retrieved from <https://forbes.ua/news/vantazhoobig-ukrainskikh-portiv-za-rik-zris-na-mayzhe-60-do-972-mln-t-06012025-26065>.
- [19] Shevchenko, I., & Klius, I. (2023). Problems of transport logistics development in Ukraine under martial law. *Science-Based Technologies*, 59(3), 325-333. doi: [10.18372/2310-5461.59.17953](https://doi.org/10.18372/2310-5461.59.17953).
- [20] Shevchuk, O., & Hayvanovych, N. (2023). Current state, problems and prospects for the development of maritime freight transportation in Ukraine and the world. *Economic Bulletin of NTUU "Kyiv Polytechnical Institute"*, 25, 59-64. doi: [10.20535/2307-5651.25.2023.278603](https://doi.org/10.20535/2307-5651.25.2023.278603).
- [21] State Customs Service of Ukraine. (2026). *Foreign trade statistics of Ukraine*. Retrieved from <https://customs.gov.ua/statistika-ta-reiestri>.
- [22] State Statistics Service of Ukraine. (2022). *Volumes of transported goods by types of transport*. Retrieved from https://www.ukrstat.gov.ua/operativ/open_data/2022/198.xlsx.
- [23] Trachenko, L. (2025). Problems and opportunities for the development of Ukraine's maritime industry business in the post-war period. *The Economy and Society*, 71. doi: [10.32782/2524-0072/2025-71-31](https://doi.org/10.32782/2524-0072/2025-71-31).
- [24] Ukrainian Sea Ports Authority. (2025). *Cargo turnover of Ukrainian seaports in 2024*. Retrieved from <https://www.uspa.gov.ua/news/vantazhoobig-portiv-ukrayiny-u-2024-rocz-dosyag-rekordnogo-pokaznyka-972-mln-tonn>.
- [25] United Nations Conference on Trade and Development. (2024). *Review of maritime transport 2024*. Geneva: UNCTAD.

Проблеми експорту через блокаду портів, перебудову на сухопутні та альтернативні маршрути

Ростислав Осадчук

Аспірант

Національний університет біоресурсів і природокористування України

03041, вул. Героїв Оборони, 15, м. Київ, Україна

<https://orcid.org/0009-0005-6422-899X>

Анотація. Метою статті було дослідження проблем експорту України, спричинених блокадою морських портів у період воєнного стану, а також обґрунтування напрямів перебудови логістичних потоків на сухопутні, річкові та мультимодальні маршрути. Методологічною основою дослідження стали системний підхід, методи порівняльного аналізу, статистичного узагальнення, структурно-логічного аналізу та економічної інтерпретації. Інформаційну базу сформували статистичні дані Державної служби статистики України, матеріали державних органів, аналітичні звіти міжнародних організацій, а також наукові праці, присвячені розвитку транспортної логістики, зовнішньої торгівлі та експортної інфраструктури України в умовах воєнних ризиків. Було систематизовано наслідки блокади портів для експортної логістики України та визначено ролі альтернативних транспортних маршрутів у забезпеченні стійкості зовнішньої торгівлі. У результаті дослідження проведено комплексну оцінку трансформації експортної логістики України внаслідок блокади морських портів у 2021-2025 роках. Встановлено, що частка морських перевезень у структурі експортної логістики скоротилася з 72 % у 2021 році до 38 % у 2023 році, тобто на 34 відсоткових пункти. Одночасно частка залізничного транспорту зросла з 15 % до 31 %, дунайських портів – з 5 % до 18 %, автомобільного транспорту – з 8 % до 13 %. Визначено, що переорієнтація експортних потоків забезпечила часткове збереження зовнішньої торгівлі, однак супроводжувалася суттєвим підвищенням логістичних витрат: перевезення залізничним транспортом подорожчали на 25-30 %, автомобільним транспортом – на 30-40 %, річковими маршрутами через Дунай – на 15-20 %. Доведено, що альтернативні логістичні маршрути дозволили підтримати експорт аграрної продукції, продукції гірничо-металургійного комплексу та сировинних товарів, проте їх пропускна спроможність поки не забезпечує повноцінної компенсації довоєнних морських перевезень. Практичне значення результатів полягає у розробленні рекомендацій щодо розвитку мультимодальних перевезень, модернізації прикордонної інфраструктури, розширення потужностей дунайських портів, інтеграції української транспортної системи до мережі TEN-T та підвищення стійкості національної експортної логістики в умовах воєнних і післявоєнних ризиків

Ключові слова: транспортна логістика; мультимодальні перевезення; дунайські порти; залізничний транспорт; зовнішня торгівля

**НАУКОВИЙ ВІСНИК
МУКАЧІВСЬКОГО ДЕРЖАВНОГО УНІВЕРСИТЕТУ
СЕРІЯ «ЕКОНОМІКА»**

Науковий журнал

Том 13, № 2. 2026

Заснований у 2014 р. Виходить чотири рази на рік

Оригінал-макет видання виготовлено
у редакційно-видавничому відділі Мукачівського державного університету

Відповідальний редактор:
К. Мовчан

Підписано до друку 25.05.2026 р.
Формат 60*84/8
Умовн. друк. арк.14,3
Наклад 300 примірників

Адреса видавництва:
Мукачівський державний університет
89600, вул. Ужгородська, 26, м. Мукачево, Україна
Тел.: +38 (03131) 21109
E-mail: info@economics-msu.com.ua
<https://economics-msu.com.ua/uk>

SCIENTIFIC BULLETIN
OF MUKACHEVO STATE UNIVERSITY
SERIES "ECONOMICS"

Scientific Journal

Vol. 13, No. 2. 2026

Founded in 2014. Published four times per year

The original layout of the publication is made
in the publishing department of Mukachevo State University

Managing Editor:
K. Movchan

Signed for print 25.05.2026.
Format 60*84/8
Conventional printed pages 14.3
Circulation 300 copies

Publishing Address:
Mukachevo State University
89600, 26 Uzhhorodska Str., Mukachevo, Ukraine
Tel.: +38 (03131) 21109
E-mail: info@economics-msu.com.ua
<https://economics-msu.com.ua/en>