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DYNAMIC CAPABILITIES FOR GEOPOLITICAL RESILIENCE: A SYSTEMATIC EVIDENCE SYNTHESIS

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Abstract
Disruptions in the geopolitical arena, such as wars, sanctions, pandemics, or energy shocks, expose the limits of the resilience models currently in use. We conducted a systematic review of 50 studies (from 2017 to 2025), which we analysed using the Theory–Context–Characteristics–Methodology (TCCM) framework. Thematic synthesis identifies four structural gaps in the extant literature: macro–micro integration deficits, methodological temporal blind spots, sectoral and contextual parochialism, and underspecified mediating mechanisms. We propose the Dynamic Capability Geopolitical Resilience (DCGR) framework to address these gaps. This multi-level, stage-based model integrates macro-institutional boundary conditions, sensing–seizing–transforming capability bundles, dual mediating pathways (business model innovation and absorptive capacity), and HRM microfoundational enablers into a cumulative learning architecture. Five theoretically grounded propositions structure the future empirical research agenda. Our contribution is a theoretically grounded, empirically falsifiable model of geopolitical resilience applicable to conflict-proximate economies. The DCGR framework explicitly accounts for institutional boundary conditions, stage-differentiated capability demands, and interacting mediating mechanisms. It is proposed as a conceptual basis for future empirical testing rather than as a validated model.

Keywords: *dynamic capabilities; geopolitical resilience; organizational resilience; institutional theory; macro–micro integration; business model innovation; absorptive capacity; DCGR framework; systematic review; sustainable development governance.*

Introduction

Over the past decade, several geopolitical shocks have drastically altered the environment in which organisations operate. From the Russia- Ukraine war, the US-China trade war, the organisational aftershocks of the COVID-19 pandemic, to energy supply volatility in Europe, the challenges that organisations faced were beyond their abilities to adapt to the strategic planning models that had guided them for years (Malik and Terzidis, 2025; Obrenovic et al., 2023). The cumulative effect of these challenges is an environment in which the traditional models of strategic planning are clearly not equipped to succeed.

Dynamic capabilities theory – developed by Teece, Pisano, and Shuen (Teece et al. 1997) and later developed by authors such as Eisenhardt and Martin (Eisenhardt & Martin, 2000), Zollo and Winter (Zollo and Winter, 2002), and Teece (Teece, 2007) proposes that an organisation's ability to gain a sustainable competitive advantage comes from the higher-order capabilities to continually reconfigure its resources to adapt to its environment. This theory is closely linked with the resource-based view of the firm (Barney, 1991) and has been supported by studies investigating the use of AI to enhance supply chain resilience (Modgil et al., 2021) as well as the role of government effectiveness in the use of digital dynamic capabilities in the face of geopolitical challenges (Dubey et al., 2023). However, current studies investigating dynamic capabilities are fragmented; most focus on the supply chain (Stadtfeld and Gruchmann, 2023), are bibliometric analyses without integrating any theoretical frameworks (Joussen et al., 2024), or assume a static view of geopolitical challenges in general (Wang et al., 2024).

Recent advances narrow this gap. Malik and Terzidis (2025) conduct a 59-paper hybrid TCCM–bibliometric review proposing the Resilience Strategy Engine, which identifies dynamic capabilities and institutional adaptation as co-constitutive resilience drivers. Pitelis et al. (2024) provide a systematic review-based framework

linking dynamic capabilities to MNE global strategy in international and geopolitical contexts. Both are substantial contributions. However, neither supplies a stage-based temporal architecture differentiating pre-shock, active-shock, and post-shock capability demands; neither formalises dual mediating pathways; and neither integrates HRM microfoundations explicitly. The DCGR framework contributes precisely these three additions.

Three theoretical traditions underpin the DCGR framework: dynamic capabilities theory (Eisenhardt and Martin, 2000; Teece, 2007; Teece et al., 1997; Zollo and Winter, 2002) for capability reconfiguration logic; institutional theory — North's (1990) rules-as-determinants account and DiMaggio and Powell's (1983) coercive isomorphism for macro-level governance boundary conditions; and Zahra and George's (2002) P/RACAP distinction for knowledge-processing logic linking sensing to seizing and transforming. This chapter is situated in Chapter 6 ("Security dimension of sustainable development") of the monograph. Geopolitical resilience directly advances SDG 16 (Peace, Justice and Strong Institutions) by stabilising governance architectures under external shocks, and SDG 8 (Decent Work and Economic Growth) by preserving productive capacity and employment in conflict-proximate economies.

Materials and Methods

1 Search Strategy

A systematic search was conducted across three databases: Scopus, Web of Science (WoS), and EBSCO Business Source Complete. The following exact search strings were applied:

Cluster A – Dynamic capabilities:

("dynamic capabilities" OR "capability transformation" OR "higher-order capabilities" OR "sensing capabilities" OR "seizing capabilities")

Cluster B – Resilience:

("organisational resilience" OR "organizational resilience" OR "business resilience" OR "supply chain resilience" OR "firm resilience")

Cluster C – Geopolitical disruption:

("geopolitical shock" OR "geopolitical risk" OR "armed conflict" OR "economic sanctions" OR "trade disruption" OR "pandemic disruption" OR "geopolitical turbulence")

Boolean combination applied: (Cluster A) AND (Cluster B) AND (Cluster C). The search was limited to publications from January 2017 to December 2025, applied consistently across all three databases to ensure temporal reproducibility of the corpus construction.

2 Inclusion and Exclusion Criteria

Table 4.8

Inclusion and Exclusion Criteria

Criterion	Inclusion	Exclusion
Publication Type	Peer-reviewed journal articles; one doctoral thesis grounded in dynamic capabilities and geopolitical risk (Zadmehr, 2025)	Books, book chapters, conference papers, grey literature, practitioner reports
Language	English only	Non-English publications
Publication period	2017–2025 for empirical and review studies	Empirical studies published before 2017
Theoretical grounding	Explicit grounding in dynamic capabilities theory, resource-based view, or institutional theory	Purely descriptive studies with no theoretical anchor
Contextual focus	Crisis, turbulence, or geopolitical disruption treated as a substantive contextual variable	Studies where geopolitical context is only a passive background setting
Quality threshold	Published in journals indexed in Scopus or Web of Science	Non-indexed or predatory journals

3 PRISMA-Informed Selection Flow

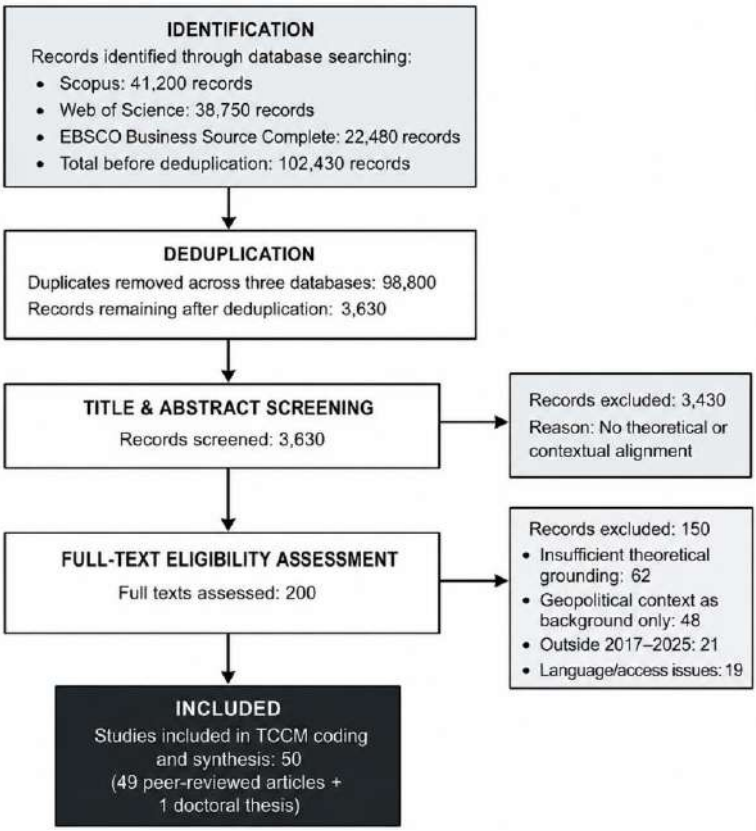


Figure 4.6 Prisma- Informed Selection Flow

Note: Database-level record counts reflect gross retrieval totals prior to deduplication. Cross-database duplicates were identified and removed manually through systematic title–author–year matching applied iteratively at each screening stage; records appearing in two or more databases were counted once and assigned to the database of first retrieval. Abstract screening applied all inclusion and exclusion criteria from Table 4.8 sequentially to titles and abstracts; full-text screening resolved borderline cases against the theoretical grounding and contextual focus criteria specifically. Record counts at each stage are reported as precise figures in the flow figure above.

4 Analytical Framework and Quality Appraisal

Structured thematic synthesis employed the TCCM framework (Paul & Rosado-Serrano, 2019), coding each of the 50 studies along four dimensions: (1) Theory – dominant conceptual lenses; (2) Context – sector, firm type, geography, and shock type; (3) Characteristics – focal constructs, mediators, moderators, and level of analysis; (4) Methodology – research design, data sources, analytical technique, and temporal structure. Coded data were aggregated to identify patterns of concentration and systematic absence, enabling diagnosis of structural rather than incidental gaps. Quality appraisal applied three criteria: (a) journal indexation in Scopus or WoS; (b) clarity of construct operationalisation; (c) alignment between theoretical claims and research design.

Studies meeting all three criteria were retained without reservation; studies meeting two criteria were retained with limitations explicitly noted in the coding record. Studies meeting only one criterion were excluded from the final corpus. The decision to retain studies satisfying two of three quality criteria reflects the structural reality that empirical work conducted in geopolitically exposed or conflict-proximate contexts exhibits endemic methodological constraints such as cross-sectional design, single-country samples, limited construct operationalisation which of that reflect contextual research conditions rather than low scholarly quality. This retention rule is consistent with the review's diagnostic, gap-mapping purpose rather than a meta-analytic one; no effect-size pooling is performed.

It is acknowledged that single-author coding is structural limitation that precludes inter-rater reliability assessment. To partially address this, a standardised TCCM coding template was developed prior to the coding phase and applied consistently across all 50 studies; each study was independently coded across two separate sessions separated by a minimum of one week, and discrepancies between sessions were resolved through a third coding pass with explicit criterion reference. This iterative self-consistency procedure does not substitute for independent second-coder validation but reduces within-author drift. This limitation is carried forward explicitly into the interpretation of synthesis patterns; no synthesis finding should be read as definitive absent replication by

independent coders. A summary table of all 50 included studies, including bibliographic details, theoretical grounding, context, and TCCM coding assignments, is provided in Appendix A.

Results and Discussion

1 Gap domain 1: Macro–micro integration deficit

Geopolitical disruptions reach firms through institutional structures policy regimes, sanctions frameworks, regulatory architectures, and public investment allocations that variably enable or constrain capability-building. North's (1990) institutions-as-rules framework and DiMaggio and Powell's (1983) coercive isomorphism provide the theoretical resources for modelling these effects, but both remain under incorporated in dynamic capabilities research. Dubey et al. (2023) demonstrate that government effectiveness significantly moderates the translation of digital dynamic capabilities into supply chain resilience; Malik and Terzidis (2025) embed institutional adaptation in the Resilience Strategy Engine but acknowledge that cross-level interaction effects remain empirically unvalidated; and Cooke et al. (2024) identify institutional trust as a capability-enabling condition without advancing an integrative specification. The consequence is that policy recommendations risk misalignment with the institutional conditions most powerfully shaping capability development in geopolitically exposed economies.

We contend this is not a minor oversight. Treating institutional context as a stable exogenous control rather than a dynamic, co-constitutive moderator produces capability models that are theoretically incomplete and operationally misleading. This problem is particularly acute for SMEs in conflict-proximate EU economies, where institutional quality varies non-trivially across governance regimes and across time within the same regime. A firm model calibrated to high-effectiveness institutional conditions will mis-predict capability-building trajectories in governance-weak environments, even when the firm-level resource base is held constant. The existing literature has not yet produced a satisfactory account of this conditional relationship.

2 Gap Domain 2: Methodological Homogeneity and Temporal Blind Spots

Cross-sectional survey designs dominate the corpus, creating a structural temporal blind spot. Biswakarma and Bohora's (2025) finding that resilience fully mediates the dynamic capabilities–performance relationship is theoretically valuable but cannot reveal whether this mediation holds across pre-shock, active-shock, and post-shock phases. Joussen et al. (2024) find no longitudinal study among 71 reviewed articles, confirming a field-wide pattern. This is theoretically consequential: Zollo and Winter's (Zollo & Winter, 2002) deliberate learning account and Eisenhardt and Martin's (Eisenhardt and Martin, 2000) iterative capability refinement are inherently temporal processes invisible to cross-sectional designs. Prayag et al. (2023) demonstrate the explanatory gain from staged temporal methods to sensing capabilities dominate pre-shock, seizing the active phase, transforming the recovery. While Napier et al. (2024) develop a multilevel process model capturing temporal dynamics across organisational levels. Kähkönen et al. (2022) provide further empirical support for this temporal logic: their survey-based study of firms during the COVID-19 pandemic demonstrates that upstream supply chain disruptions activated seizing capabilities, while downstream disruptions leveraged reconfiguring capabilities. A sequencing pattern consistent with the stage-differentiated demand structure the DCGR framework formalises.

The theoretical implication extends beyond measurement design. Capability requirements are not constant across shock phases. A firm's sensing architecture that generates competitive advantage pre-shock may become a cognitive liability during active-shock response if it anchors managerial attention to pre-disruption market signals rather than crisis-phase intelligence. This capability-phase misalignment — firms applying pre-shock routines to active-shock conditions is a plausible but undertheorized explanation for why some firms with apparently strong dynamic capability portfolios underperform during acute geopolitical disruption. Cross-sectional designs, by collapsing all phases into a single measurement moment, render this misalignment theoretically invisible and empirically undetectable.

3 Gap Domain 3: Sectoral Concentration and Contextual Parochialism

Supply chain and tourism contexts account for a disproportionate share of empirical work, leaving financial services, healthcare, public sector organisations, and critical infrastructure underrepresented. SME dynamics are underexplored despite their policy significance: Shore et al. (2024) show generative AI and entrepreneurial orientation enhance SME resilience but that severe market turbulence can overwhelm these benefits; Belhadi et al. (2024) demonstrate systematic upstream–downstream capability differences in agri-food firms during the Russia–Ukraine war. Khurana et al. (2022) further show that SME resilience can itself emerge as a second-order dynamic capability within entrepreneurial ecosystems during digital transformation crises. The Baltic states: Lithuania, Latvia, and Estonia represent a promising setting for future empirical testing of the DCGR framework, given their shared geopolitical exposure profile, comparable EU institutional architecture, and traceable sequence of compounding shocks within a single decade; this contextual case is, however, deferred to the future research agenda rather than developed substantively here. Wang et al. (2025) offer a related illustration of these contextual boundary conditions: their structural equation modelling study of Chinese firms finds that environmental uncertainty positively moderates the resilience–performance relationship, with absorptive, reactive, and recovery capabilities functioning as distinct mediators rather than a single undifferentiated resilience construct. The supply-chain-intensive, single-country sample restricts generalisability, but the disaggregated resilience operationalisation aligns with the DCGR framework's stage-differentiated logic.

This deferral reflects scope constraints rather than a theoretical claim about context-invariance. SME resilience in Baltic institutional environments is likely to exhibit institutional co-determination effects that differ systematically from the large-firm, supply-chain-intensive patterns dominating the current corpus. Importing synthesis findings from these dominant contexts into governance-salient, conflict-proximate settings without adjustment risks producing contextually mis specified capability prescriptions which heads to a theoretical problem that the sectoral concentration gap compounds

rather than resolves.

4 Gap Domain 4: Mediating Mechanisms and Microfoundational Underspecification

Despite progress in identifying which capabilities matter, the field has not adequately theorised how they work. Huang and Ichikohji (2024) show that business model innovation partially mediates the dynamic capabilities–performance relationship in Chinese SMEs, consistent with Teece's (Teece, 2007) positioning of value architecture redesign within seizing capability. Oo and Rakthin (2022) synthesise evidence that absorptive capacity — via Zahra and George's (2002) P/RACAP distinction converts geopolitical intelligence into adaptive responses, though cross-context validation remains sparse. Competing treatments of resilience as outcome, capability, or process (Conz & Magnani, 2020; Duchek, 2020; Linnenluecke, 2017) produce measurement inconsistencies that prevent meaningful cross-study comparison. Cooke et al. (2024) establish that HRM practices and employee well-being shape dynamic capability sustainability under geopolitical stress, but theoretical integration across levels remains underdeveloped.

The deeper problem is not merely measurement inconsistency, though the consequences of that are substantial. Treating resilience simultaneously as outcome, capability, and process within the same empirical study produces circular causal structures that are structurally unfalsifiable by standard cross-sectional regression designs. Any empirical programme building on the DCGR framework must operationalise resilience as a theoretically consistent, single-level construct appropriate to the research question before attempting to test mediating mechanisms. Failure to do so will replicate the field's current measurement inconsistency rather than resolve it.

5 The DCGR Framework

The DCGR framework integrates the four identified gap domains into a unified architecture. Three analytical levels structure the model: macro-institutional, meso-organisational, and micro-individual. Three temporal stages organise capability demands across those levels: pre-shock readiness, active-shock response, and post-shock recovery with second-order learning.

At the **macro level**, institutional conditions policy effectiveness, regulatory continuity, sanctions architecture, public digital investment, and institutional trust function as active moderators of capability-building, not passive contextual controls (DiMaggio & Powell, 1983; Dubey et al., 2023; North, 1990). A firm in a high-effectiveness, high-trust governance environment operates in a fundamentally different capability-building landscape than one in a governance-weak or conflict-proximate context, even holding firm-level resources constant.

At the **meso level**, the sensing–seizing–transforming triad (Eisenhardt & Martin, 2000; Teece et al., 1997) produces resilience through two explicitly specified mediating pathways. *Business model innovation* (Huang & Ichikohji, 2024; Teece, 2007) captures the extent to which seizing capabilities enable value architecture redesign rather than operational defence alone. Knowledge absorptive capacity (Oo & Rakthin, 2022; Zahra & George, 2002) captures the PACAP/RACAP conversion through which sensing-phase intelligence becomes actionable seizing and transforming capacity. Potential absorptive capacity (PACAP) enables initial threat recognition; realised absorptive capacity (RACAP) determines whether that recognition translates into operational response. Firms with strong PACAP may still underperform under geopolitical disruption if RACAP routines are underdeveloped or institutionally constrained.

At the **micro level**, HRM practices, leadership cognition, organisational networks, and employee well-being function as microfoundational enablers whose effectiveness is co-determined by institutional context (Cooke et al., 2024; Teece, 2007). Workforce adaptability programmes yield stronger capability outcomes in high-trust, active labour-market environments than in rigid, low-trust systems.

Temporally: the three stages impose distinct capability demands. *Pre-shock readiness* prioritises sensing capabilities and PACAP investment: the goal is threat identification and contingency knowledge accumulation before disruption onset. *Active-shock response* is dominated by seizing capabilities and RACAP routines, enabling resource redeployment, supply chain reconfiguration, and value architecture redesign under crisis conditions. *Post-shock*

recovery foregrounds transforming capabilities and deliberate learning, codifying crisis experience into upgraded organisational routines (Zollo & Winter, 2002). Each completed shock cycle generates second-order capability learning. Geopolitical resilience is therefore an iteratively upgraded organisational property, not a static endowment.

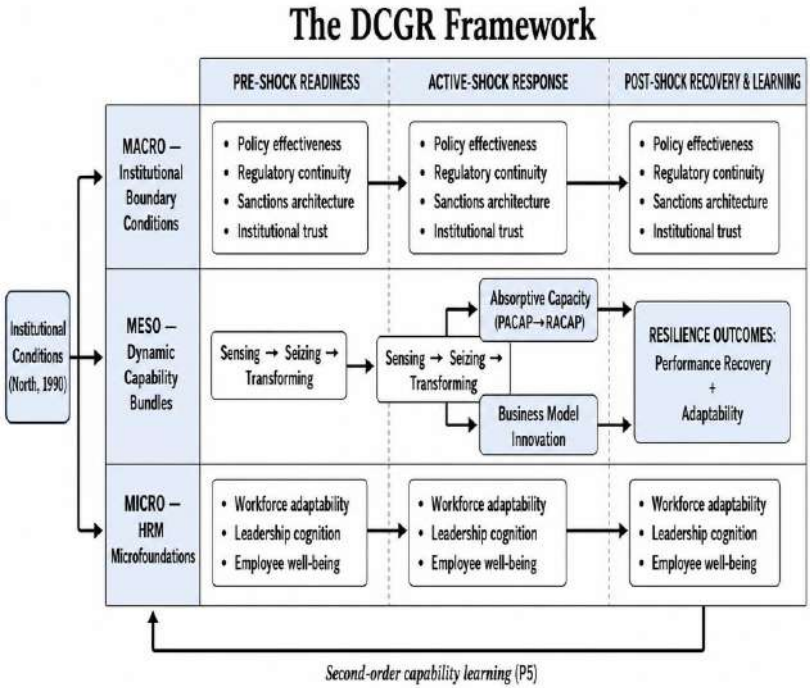


Figure 4.7 The DCGR Framework: Multi-level, Stage-based Architecture for Geopolitical Resilience. Source: Author's own elaboration

In the five propositions below, resilience outcomes are operationalised as firm-level performance recovery and adaptability under geopolitical disruption like empirical proxies for the underlying resilience capability trajectory.

The DCGR framework is introduced here as a conceptual, theoretically grounded model; it is not empirically validated in this chapter and is proposed as a basis for future empirical testing.

6 Five Propositions

P1 (Institutional moderation): Government policy effectiveness positively moderates the capability–resilience relationship, such that firm-level dynamic capabilities translate into stronger performance recovery in high-policy-effectiveness environments (Dubey et al., 2023; North, 1990).

P2 (Business model mediation): Business model innovation mediates the seizing capability–performance recovery relationship, with superior outcomes when seizing capabilities activate value architecture reconfiguration rather than operational adaptation alone (Huang & Ichikohji, 2024; Teece, 2007).

P3 (Absorptive capacity mediation): Realised absorptive capacity mediates the sensing capability–active-shock response quality relationship, with stronger RACAP routines producing more effective conversion of geopolitical intelligence into seizing and transforming actions (Oo & Rakthin, 2022; Zahra & George, 2002).

P4 (HRM–trust interaction): The positive effect of HRM microfoundational investments on capability activation is positively moderated by institutional trust, with workforce adaptability and knowledge-sharing programmes yielding stronger capability outcomes in high-trust institutional environments (Cooke et al., 2024; North, 1990).

P5 (Second-order learning): Organisations that navigate a geopolitical shock cycle and engage in deliberate post-shock knowledge codification exhibit enhanced sensing and transforming capabilities relative to pre-shock baselines, evidencing second-order capability learning rather than mere restoration (Zollo & Winter, 2002).

Summarises the proposed measurement approach for each proposition. Resilience outcomes (P1–P3) are operationalised as firm-level performance recovery indices and adaptability scores from longitudinal panel data; HRM and institutional moderators (P1, P4) require multi-level data combining firm surveys with country-level governance indicators such as the World Bank Governance Index; second-order learning (P5) requires pre/post-shock capability assessments separated by a minimum of 12 months.

Theoretical Advances and Positioning

The DCGR framework makes three theoretical contributions. These contributions are conceptual in nature; the framework is put forward as a theoretically grounded model that requires and invites systematic empirical testing. First, it reconceptualises resilience as an iteratively upgraded capability trajectory indexed to learning processes and institutional conditions, helping to address the measurement inconsistencies that cross-sectional resilience-as-outcome treatments generate. Second, integrating macro-institutional moderators and micro-level HRM enablers into a unified architecture offers a basis for reconciling Teece et al.'s (Teece et al., 1997) idiosyncrasy emphasis with Eisenhardt and Martin's (Eisenhardt & Martin, 2000) best-practice commonalities: variation in institutional and microfoundational conditions explains both within-context heterogeneity and the cross-context consistency of the sensing–seizing–transforming triad. Third, for EU security governance, institutional conditions such as governance architecture, trust infrastructure, and policy continuity may be understood as security inputs of comparable strategic importance to military or cybersecurity assets.

Relative to Malik and Terzidis (2025), whose Resilience Strategy Engine is a rigorous and valuable contribution, DCGR adds a stage-based temporal architecture differentiating capability demands across shock phases, formalises dual mediating pathways that the Resilience Strategy Engine treats only implicitly, and explicitly integrates HRM microfoundations as co-determined by institutional context. Relative to Pitelis et al. (2024), whose framework links dynamic capabilities to long-run MNE global strategy, DCGR is explicitly crisis-centric and security-oriented, models mediating mechanisms and microfoundations, and extends applicability to SME-intensive, conflict-proximate, and non-MNE settings absent from MNE-focused frameworks.

Conclusions

Four structural gaps constrain dynamic capabilities research on geopolitical resilience: macro–micro integration deficits, temporal blind spots, sectoral and contextual narrowness, and underspecified mediating mechanisms. The DCGR framework seeks to address

these by integrating macro-institutional boundary conditions, meso-level dynamic capability bundles, dual mediating pathways through business model innovation and absorptive capacity, and HRM microfoundational enablers into a stage-based, cumulative learning architecture. Five propositions make this tractable empirically, with firm-level performance recovery and adaptability as observable proxies for the underlying resilience capability trajectory.

The principal theoretical contribution reconceptualising geopolitical resilience as an iteratively upgraded capability co-determined by institutional conditions and organisational learning helps address persistent measurement inconsistencies and motivates longitudinal, multilevel research in conflict-proximate and security-salient economies. The DCGR framework's macro-micro integration logic engages with an emerging stream of multilevel capability research (Agostini et al., 2023; Yang, 2024), and its contribution lies not in introducing multilevel analysis as such, but in specifying the institutional boundary conditions and dual mediating mechanisms through which macro and micro levels interact under geopolitical disruption a specification that existing multilevel models do not provide. These contributions are offered as a conceptual basis for future empirical work rather than as evidence of an already tested or validated model.

Limitations include single-author coding, theoretical derivation of propositions pending empirical testing, and the need for validation beyond EU institutional contexts, including sanctioned economies, post-conflict settings, and emerging markets. Regarding the Baltic region specifically, future research should build on existing foundational work on security and societal resilience in this context (e.g., Gečienė et al., 2020) rather than treating it as a theoretical blank slate.

For the *"Sustainable Development Synergy and Security"* agenda, the DCGR framework suggests that institutional resilience infrastructure may serve as a prerequisite for sustainable economic development in conflict-proximate economies. Strengthening governance continuity, public investment access, and institutional trust simultaneously advances SDG 16 (Peace, Justice and Strong Institutions) by stabilising governance under geopolitical pressure, and SDG 8 (Decent Work and Economic Growth) by protecting

livelihoods and productive capacity. Capability-building at firm and institutional levels are complementary instruments of sustainable security governance, not alternative policy priorities.

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Appendix A

Appendix A lists 46 of the 50 corpus studies. Four foundational theoretical works (Barney, 1991; DiMaggio & Powell, 1983; North, 1990; Paul & Rosado-Serrano, 2019) are included in the corpus as theoretical anchors and appear in the reference list but are not assigned empirical TCCM codes given their non-empirical nature.

No.	Author(s) & Year	Theory	Context	Characteristics	Methodology
1	Agostini, Galati & Gastaldi (2023)	DC; Contingency	Multi-sector; Italy; general environmental dynamism	DC–performance; industry dynamism and firm size as moderators; meso-level	Quantitative; survey; SEM
2	Bazile, Manceau & Thiétart (2024)	DC; Strategic intelligence	SMEs; global supply chains; COVID-19 + geopolitical tensions	Strategic intelligence as sensing DC; government support as moderator; meso–micro	Conceptual framework
3	Belhadi et al. (2024)	DC; Strategic contingency	Agri-food SC; Africa; Russia–Ukraine war	Digital seizing and transforming capabilities; upstream vs. downstream	Mixed-method; 14 case studies

				distinction; meso-level	
4	Biswakarma & Bohora (2025)	DC	IT sector; Nepal; COVID-19	DC → organisational resilience (full mediator) → performance; meso-level	Quantitative; survey (N=181); SEM
5	Blessley & Mudambi (2022)	DC; Social capital	Food bank SC; USA; US–China trade war + COVID-19	Anticipating–adapting–recovering stages; macro–meso–micro; government as SC actor	Qualitative; in-depth interviews; 12 propositions
6	Conz & Magnani (2020)	DC; RBV	Multi-sector; conceptual; general disruption	Resilience as dynamic process; temporal stages; meso-level	Systematic literature review
7	Cooke, Dickmann & Parry (2024)	DC; IT	MNEs; multi-country; geopolitical tension + societal challenges	HRM microfoundations; DC sustainability; employee well-being; macro–micro	Editorial review; conceptual
8	DiMaggio & Powell (1983)	IT	Multi-sector; USA; institutional pressure	Coercive isomorphism; macro-level; no mediator	Theoretical; conceptual
9	Dubey et al. (2023)	DC; IT	SC; multi-country; COVID-19 + geopolitical disruption	Government effectiveness as moderator; digital DC; meso-level	Mixed-method; interviews + survey (N=203); SEM
10	Duchek (2020)	DC; RBV	Multi-sector; conceptual; general disruption	Resilience as capability; anticipation–coping–adaptation	Conceptual; capability-based framework
11	Duchek, Raetze & Scheuch (2020)	DC; Diversity management	Multi-sector; conceptual; general disruption	Diversity as resilience antecedent; anticipation–coping–adaptation; meso–micro	Conceptual; theoretical framework
12	Eisenhardt & Martin (2000)	DC	Multi-sector; USA; general environmental	DC best-practice commonalities; meso-level	Theoretical; conceptual

			change		
13	Farrukh, Hussain & Ahmed (2024)	DC; Systemic risk theory	Textile; Pakistan; pandemic + geopolitical tensions	Disruption drivers and resilience enablers; innovation, diversification, digitalization	Qualitative; multiple-case study
14	Gečienė, Žilinskas & Steponėnas (2020)	IT	Public sector; Baltic states; geopolitical security threats	Societal resilience; macro-level; institutional trust	Comparative; secondary data
15	Hillmann & Guenther (2021)	RBV; DC	Multi-sector; conceptual; general disruption	Resilience as outcome vs. process vs. capability; definitional consolidation	Systematic review; conceptual
16	Huang & Ichikohji (2024)	DC	SMEs; China; COVID-19	BMI as mediator; DC–performance; meso-level	Quantitative; survey (N=257); SEM
17	Jiang et al. (2024)	DC; Organizational learning	Manufacturing ; China; US–China trade war	SCDO → resource reconfiguration + OL → firm resilience; full mediation	Mixed-method; survey (N=220); PLS-SEM + thematic
18	Joussen, Kanbach & Kraus (2024)	DC	Multi-sector; multi-country; VUCA environment	Six DC microfoundations; social capital as mediator	Systematic literature review (71 articles)
19	Kähkönen et al. (2022)	DC	SC; Finland + multi-country; COVID-19	Seizing and reconfiguring capabilities; upstream vs. downstream disruption sequencing	Quantitative; survey
20	Khurana, Dutta & Ghura (2022)	DC; Entrepreneurial ecosystems	SMEs; India; COVID-19 digital crisis	Second-order DC; resilience as higher-order capability; ecosystem moderators	Qualitative; case studies
21	Lengnick-Hall, Beck & Lengnick-Hall (2011)	Strategic HRM; DC	Multi-sector; conceptual; general crisis	HRM as microfoundation; cognitive, behavioural,	Conceptual; theoretical framework

				contextual resilience; macro–micro	
22	Linnenluecke (2017)	RBV; DC	Multi-sector; conceptual; general disruption	Resilience as outcome vs. process; measurement inconsistency	Systematic review
23	Malik & Terzidis (2025)	DC; IT	Global business; multi-country; geopolitical uncertainty	Resilience Strategy Engine; institutional adaptation; macro–meso	Hybrid TCCM–bibliometric review (59 articles)
24	Modgil et al. (2021)	DC	SC; e-commerce; multi-country; COVID-19	AI-enabled DC; sensing–seizing–reconfiguring; meso-level	Qualitative; interviews (N=35)
25	Napier, Liu & Liu (2024)	DC	Multi-sector; multi-country; general disruption	Multilevel process model; macro–meso–micro; temporal dynamics	Conceptual; process model
26	North (1990)	IT	Multi-sector; conceptual; institutional change	Institutions as rules; macro-level; path dependence	Theoretical; historical-institutional
27	Obrenovic et al. (2020)	DC; RBV	Multi-sector; multi-country; COVID-19	Enterprise effectiveness under crisis; sensing–responding–recovering	Quantitative; survey; SEM
28	Oo & Rakthin (2022)	AC; DC	Multi-sector; multi-country; general disruption	PACAP/RACAP as resilience mediators; meso-level	Integrative review
29	Ozanne et al. (2022)	DC; Social capital	SMEs; Australia + New Zealand; COVID-19	Internal SC → DC (partial mediator) → resilience; meso-level	Quantitative; survey (N=419); SEM
30	Paul & Rosado-Serrano (2019)	TCCM methodology	Multi-sector; conceptual; general	TCCM framework methodology	Methodological review
31	Pitelis, Teece & Yang (2024)	DC	MNEs; multi-country; geopolitical disruption	DC–MNE global strategy; macro–meso; long-run adaptation	Systematic review–based conceptual framework

32	Prayag et al. (2023)	DC; Disaster–crisis management cycle	Tourism; Bangladesh; COVID-19	Staged temporal methods; 10 DC types across pre–response–recovery; adaptive vs. planned resilience	Qualitative; 30 interviews; processual analysis
33	Shore et al. (2024)	DC; Entrepreneurship	SMEs; France; COVID-19 + geopolitical crisis	Generative AI; entrepreneurial orientation; market turbulence as negative moderator	Quantitative; cross-sectional; SEM (WarpPLS; N=87)
34	Srai, Lorentz & Hennelly (2023)	DC; IT	Multi-sector; multi-country; Russia–Ukraine war	Unhooking pathways; institutional + consumer sentiment as moderators; macro–meso	Qualitative; interviews (N=6 executives)
35	Stadtfeld & Gruchmann (2023)	DC; SCR	SC; multi-country; COVID-19 + Russia–Ukraine	Six DC bundles for SCR; social capital mediator; meta-level	Meta-review (83 literature reviews)
36	Teece (2007)	DC	Multi-sector; USA; general environmental change	DC microfoundations; sensing–seizing–transforming	Theoretical; conceptual
37	Teece, Pisano & Shuen (1997)	DC; RBV	Multi-sector; USA; general change	Sensing–seizing–transforming triad; resource reconfiguration	Theoretical; conceptual
38	Uygur, Yildiz & Ozturk (2025)	DC; IT; Strategic adaptation	Ukraine + Lithuania; energy, agriculture, manufacturing; Russia–Ukraine war	Conflict-proximate economy; sector-specific strategies; regulatory adjustment	Qualitative; secondary data analysis
39	Wang, Liu & Li (2025)	DC; RBV	SC; China; environmental uncertainty + geopolitical conflicts	Absorptive, reactive, recovery resilience as mediators; environmental uncertainty as moderator	Quantitative; SEM
40	Williams et	DC; Crisis	Multi-sector;	Pre–crisis–post	Integrative

	al. (2017)	management	multi-country; general adversity	crisis capability stages; sensing–seizing–transforming alignment	review; 12 propositions
41	Wulandhari et al. (2022)	DC; Enactment theory	Food industry; UK; COVID-19	Sensing–seizing–assessment–transforming; authority vs. consensus structures; sensemaking heuristics	Qualitative; interviews (N=40); framework
42	Yang, Fu & Zhang (2021)	DC; IT; Technology adoption	Manufacturing + service; multi-country; digital transformation	Digital DC adoption; institutional pressure as moderator; meso-level	Systematic review (43 papers)
43	Yang (2024)	DC	MNEs; multi-country; general disruption	Multilevel DC adaptation; macro–meso–micro	Quantitative; longitudinal; MNE panel data
44	Zadmehr (2025)	DC; Geopolitical risk theory	Oil and gas; international; geopolitical risk	DC under geopolitical risk; meso-level; firm-specific capability portfolios	Qualitative; case study
45	Zahra & George (2002)	AC; DC	Multi-sector; conceptual; general disruption	PACAP/RACAP distinction; meso-level; knowledge conversion	Theoretical; reconceptualisation
46	Zollo & Winter (2002)	DC	Multi-sector; conceptual; learning dynamics	Deliberate learning; capability evolution; second-order learning	Theoretical; conceptual

Note: Studies are ordered alphabetically by first author. All 50 studies constitute the systematic review corpus. Reference list entries for all studies appear in the main reference list. DC = dynamic capabilities; IT = institutional theory; AC = absorptive capacity; RBV = resource-based view; SCR = supply chain resilience; BMI = business model innovation; SEM = structural equation modelling; HRM = human resource management; TCCM = Theory–Context–Characteristics–Methodology.

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DRIP IRRIGATION FOR ECOLOGICAL AND ECONOMIC STABILITY IN AGRICULTURE (REVIEW)

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Abstract
As global population growth and escalating urban demand intensify pressure on freshwater resources, irrigated agriculture is increasingly required to enhance food production while minimizing water use. Currently, irrigation accounts for approximately 70% of total global water diversion and represents more than 90% of total water exhaustion. Over the past two decades, irrigated land has expanded at an annual rate of 0.6%; if this trajectory continues, it will result in a 35% increase in irrigated area by 2050. The fundamental objective of drip irrigation system design is to optimize the spatial layout and technical components to ensure uniform water distribution that satisfies crop evapotranspiration (ET) requirements. To enhance irrigation efficiency, models that simulate sub-surface water dynamics under surface drip systems serve as critical tools for predicting the spatial and temporal distribution of soil water content.

Keywords: *environmental security, ecology, agriculture, drip irrigation, modelling.*

Introduction

As the population grows and urban water use increases, irrigated agriculture is being called on to produce more food using less water. Fischer et al. (2007) analysed that mitigation of greenhouse gas

emissions should play an important role in reducing the impacts of climate change on agricultural water resources, regionally and globally. Around 18 % of total cultivated land today presents irrigated crops which produce about 40 % of total agricultural output. According to Fischer et al. (2007) the area of worldwide irrigated land has since 1960 increased at a rate of around 2 % per year, from 140 million hectares (ha) in 1961/1963 to 270 million ha in 1997/1999. In a study by de Fraiture and Wichelns (2010), study it was estimated that irrigated area grew at about 0.6 % per year during the last 20 years. If this trend is extended to 2050 - this will result in a 35 % increase of irrigated area.

Today about 70 % of total water withdrawals worldwide is due to irrigation causes which represent more than 90 % of consumptive water use. In a study by Bruinsma (2003), a 14 % increase in irrigation water withdrawal for countries in development is expected by 2030 without taking into account impacts of climate change. The projections show that under climate change the changes in water availability and demand in the 21st century will affect security of food and agricultural activities. Modified precipitation patterns and water storage cycles will change availability of water for aquatic and terrestrial agro-eco systems. Therefore, the future water availability for food production and for competing human and environmental needs will need to be assured. Climate change will increase irrigation water demand because of a combination of increased evapotranspiration caused by higher temperatures and decreased rainfall in the majority of world regions (Bates et al., 2008).

As discussed by Bruinsma (2003) and Bates et al. (2008) the future improvements in irrigation, as modified irrigation technology or techniques, will play a very important role. These improvements can in the future increase the productivity of water used by irrigation and may provide significant adaptation potential under a changing climate. However, as mentioned by de Fraiture and Wichelns (2010), it is not easy to improve irrigation performance (i.e., increase of water productivity). In order to increase water productivity, capacity buildings, technical assistance and the right incentives and policies are required to motivate farmers. The great potential of drip irrigation lies in improving water management by improving crop yield and quality using less water, and by localising chemical and

fertiliser applications to enhance their efficient use and to reduce the risk of pollution (Fischer et al., 2007; Pavlovic et al., 2008). Drip irrigation systems consist of point or line source emitters. Point source emitters sometimes interact. For instance, for the irrigation of row crops, emitters along the laterals have to be closely spaced to maintain the necessary wetted strip of soil along the row. During water infiltration into the soil the water content changes spatially and temporally. Soil water distribution is strongly dependent on the drip irrigation system design parameters, like emitter discharge rate, spacing between the emitters, system pressure, drip emitter type, soil physical properties, climatic conditions, vegetation properties and root distribution. To design drip irrigation systems effectively, the soil water dynamics needs to be predicted using all above mentioned variables. Information about temporal evolution of the wetted soil volume can be helpful in establishing the optimal emitters spacing and the duration of irrigation for the volume of soil where the main crop roots are located (Provenzano, 2007).

There are some guidelines published (for instance Keller and Karmeli, 1974; Vermairen and Jobling, 1984; Keller and Bliesner, 1990; Benami and Ofen, 1995; FAO, 2002a) to help end users operate surface drip irrigation systems. Unfortunately, there are few, if any, clear guidelines on how to design surface drip irrigation systems by taking into account differences in soil hydraulic properties. Some irrigation manuals and guidelines, such as Vermairen and Jobling (1984), propose excavation of the soil beneath the emitters to visually observe the wetting pattern geometry. In engineering terms, systems are often designed to an economic optimum, which may result in insufficient or excessive irrigation.

On the other hand, models that simulate the dynamics of water in the soil beneath surface drip irrigation can help in predicting soil water content distribution. One such model is the numerical model Hydrus (Šimůnek et al., 2006). The model has been used extensively to simulate water distribution under surface and subsurface drip irrigation systems (e.g. Aussaline, 2002; Cote et al., 2003; Skaggs et al., 2004, 2010; Gardenas et al., 2005; Lazarovitch et al., 2005; Provenzano, 2007; Bufon et al., 2011; Kandelous et al., 2011; Phogat et al., 2011; Dabach et al., 2011). The use of such models can, in

comparison to field experiments, save financial resources and time-demanding laborious work, which would have to be undertaken to examine the dimensions of wetting patterns under different drip irrigation strategies and field/soil conditions. Once all the necessary soil parameters are determined, Hydrus can simulate distribution of water under drip irrigation systems for a wide range of conditions which includes different drip irrigation scheduling options, emitter discharge rates, amount of water applied, pulsing irrigation and different soil water initial conditions.

Drip irrigation

The plastic revolution started after World War II and the equipment for installing subsurface drip irrigation systems had been developed by the 1970s. Surface drip irrigation systems, including fertilizer injection were developed at about the same time in Israel (Dasberg and Or, 1999). When plastic drip emitters and tubing became more reliable, surface drip irrigation systems grew at a greater rate than subsurface ones. This happened because of problems with emitter clogging and root intrusions of the subsurface systems (Camp, 1998). The International Commission on Irrigation and Drainage (ICID) estimated that in 2010 – 2011 the total irrigated area in the world was 299 Mha. According to Bucks (1995) (cited in Dasberg and Or, 1999), the area under drip irrigation in year 2000 was estimated to be around 3 Mha, which represented only 2 % of the total world irrigated area. However, according to Reinders (2007), the irrigated area by microirrigation in the world increased from 0.43 Mha in 1981 to more than 6 Mha in 2006) and was, after ICID estimations, 10.3 Mha in 2013 (ICID, 16.7.2013).

Surface drip irrigation in agriculture - definitions

Micro irrigation is a general defined term meaning slow application of water on or below the soil surface. It can be also called localised irrigation, to emphasize that only part of the soil volume is wetted (Lamm et al., 2007). In ASAE (2007) micro irrigation is defined as the "frequent application of small quantities of water as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line. The micro irrigation method encompasses a number of systems or concepts, such as

bubbler, drip, trickle, line source, mist, or spray". Drip irrigation is, according to ASAE (2007), defined as a ″method of micro irrigation wherein water is applied to the soil surface as drops or small streams through emitters. Emitter (dripper) discharge rates (Q) are generally less than 8 L/h for single-outlet emitters and 12 L/h per meter for line-source emitters″. In the literature, trickle irrigation is used interchangeably with drip irrigation.

Surface drip irrigation (SD)

Surface drip irrigation systems have been at the beginning used for irrigation of widely spaced perennial crops. Today this type of irrigation can be used for irrigating annual or row crops too. Surface drip irrigation system typical components include irrigation controllers, pump, primary and backup filters, system valves, injection systems, underground pipelines and other components (Lamm et al., 2007).

Surface drip irrigation for row crops

Management and design of surface drip irrigation systems for annual row crops and for perennial crops (trees and vines) is different. For some vegetable crops or other density-planted crops, wetting of the entire growing area is needed by overlapping the wetted soil volume formed beneath each emitter. For perennial crops, like trees, a dry zone along the row and between the rows may separate the trees. When drip irrigating the row crops the aim is to wet the plat row uniformly and leave the soil between the rows dry. For irrigation of row crops drip tape emitting hose or point source emitters, usually used to irrigate trees in orchards, can be utilised. To maintain the necessary wetted strip of soil (at the desired depth) along the row, the emitters along the lateral need to have appropriate spacing.

Surface drip system design and crop water needs

Drip irrigation systems design and installation must be site-specific and are governed by soil type, climate, topography, water quantity and quality, proposed crops and cropping systems. These factors will, in the design process, guide the selection of the emitters, emitter spacing and tubing. Water is transported from a source, to a

crop, through a network of emission water devices and pipes. The general goal of drip irrigation system design is to choose appropriate layout and components to achieve adequate water distribution throughout the field to meet the crop evapotranspiration (ET) needs and deliver water efficiently and uniformly to a crop. At the same time, the ability of a system to maintain the desired water content at a root zone depth, is of great importance (Lamm et al., 2007; FAO, 2002a; Evans et al., 2007). It is important to design drip irrigation systems as simple as possible or to meet the user level of expertise. The system also has to be reliable, easy to maintain, sustainable, able to manage salts and allow tillage and harvest operations.

Drip irrigation systems distribute water directly to the crops root zone and therefore selection of the drip emitters must consider the characteristics of crop rooting system, the expected wetted volume of soil, the total amount of water that will need to be applied and the total estimated time of irrigation per day. The emitters selection (discharge rate and spacing) will be based on the estimated time of irrigation, maximum application amounts, water supply and soil hydraulic properties.

Perennial crops (such as trees or vines) may require up to five drip laterals per plant row, to provide enough water to meet the plants ET needs. This mainly depends on soil type, climate characteristics and size of the plants. Closely spaced perennial crops, such as grapes or hops will need only one drip lateral per plant row. Drip irrigation systems can apply water as a point source or a line source. Line sources apply water in a continuous or near-continuous pattern along the length of the lateral and are most suitable for irrigation of row crops or shallow rooted and closely spaced crops. They are designed based on discharge rate per length unit. Soaker hoses or porous pipes (line-source emitters) in which the entire pipe wall is a seepage surface, as well as drip tapes with closely spaced (e.g., 15-30 cm) emission points whose water application patterns overlap belong to this category. Tubings with discrete or point-source emitters usually used for irrigation of wide spaced crops are designed using discharge rate per one outlet (emitter). Point source emitters are grouped based on their flow properties. Thin-walled driplines with periodically spaced emitters infiltrate upon pressurization and have usual emitter spacings ranging from about 50

mm to 1m. Usually water discharge from emission points which are spaced more than 1 m apart are called point source application (emitters) (Dasberg and Or, 1999; Evans et al., 2007; Lamm et al., 2007).

In cropped field water can be lost from the bare soil surface or wet vegetation through the evaporation (E) process which is affected by climatological factors such as air temperature, solar radiation, wind speed and air humidity. The second process of water loss is transpiration (T), where water vaporizes from the plant tissues into the atmosphere through stomata, located on the plant leaves. Both transpiration and evaporation depend on the vapour pressure gradient, wind and energy supply. When assessing transpiration, air temperature, air humidity, wind speed and solar radiation should be considered. Transpiration is also dependent on many other factors, such as crop characteristics and cultivation practices, environmental aspects, soil salinity, waterlogging and the soil water content. The two processes mentioned above are usually combined into a process known as evapotranspiration.

Distinguishing between evaporation and transpiration is not simple because they occur simultaneously. At the beginning of the crop growth, while the crop is small and most of the soil surface is exposed, the prevailing process is evaporation. Later in the crop development process or when the crop completely covers the ground the transpiration process becomes dominant. At the time of the crop sowing, 100 % of the total ET comes from evaporation process. Once the crop develops its full cover, evaporation accounts for roughly 10 % of ET and transpiration accounts for the remaining 90 % (FAO, 2002b). Coelho and Or (1999) compared soil surface evaporation from drip irrigated corn. The results showed that when the crop is fully grown, the evaporation represents only 7 to 10 % of the total water losses. When calculating crop irrigation water requirements the ET_c (crop evapotranspiration) has to be calculated by multiplying ET_o (reference crop evapotranspiration) with crop coefficient (K_c). For calculation of ETo from meteorological data several empirical and semi-empirical methods have been developed over the last fifty years. Some of the methods that have been developed are the Pan Evaporation, Modified Penman, Radiation and

Blaney-Criddle methods. More details of these methods are given in Dorenbos and Pruitt (1977).

Advances in research and science resulted in the development of more accurate methods for assessing crop water use. This revealed that the methods did not behave the same way in different locations around the world which presented their major weakness. This revealed the need for derivation of a standard and more consistent method for ETo calculations. For that reason, in 1990 Food and Agricultural Organisation (FAO) organized a conference with scientists, experts and researchers. An outcome of this meeting was the new FAO Penman-Monteith method which is now recommended as the standard method for calculation of the ETo. This new method has a good probability of correctly predicting ETo for a wide range of climates and even in the case of missing meteorological data (Allen et al., 1998; FAO, 2002b). In the Penman-Monteith method ETo is defined as a hypothetical reference crop which is not short of water, with an assumed crop height of 0.12 m, a fixed surface resistance of 70 sec/m and an albedo of 0.23. It has to be noted that if the crop receives some of its water from other sources (rainfall, water stored in the ground, upward seepage), then the irrigation requirement can be considerably less than the crop water requirement. (Dorenbos and Pruitt, 1977; FAO, 2002b).

Irrigation scheduling can be prepared when the crop water irrigation requirements are determined. In order to compile a good irrigation scheduling, all the elements of the system's hydraulic design and maintenance with various aspects of the soil and the crop characteristics with the atmospheric evaporative demand have to be integrated. Drip irrigation scheduling is controlled by determining soil and plant water status and by estimating or measuring crop water needs (Lamm et al., 2007).

Surface drip system management

In ASAE, 2007 irrigation water management is defined as ″managing plant, soil, and water resources (precipitation, applied irrigation water, humidity) to optimize water use by the crop″. Irrigation scheduling for drip irrigated plant production requires constant attention. Clark (1992) discussed drip irrigation management as dynamic process which requires knowledge of the

soil hydraulic properties, plant growth characteristics, crop water requirements, evapotranspiration demand, irrigation scheduling method and drip system characteristics. Also, as mentioned in Evans et. al. (2007) the micro irrigation management is associated with questions when to irrigate and how much water to apply, how to accurately calculate the plant water status and its needs and how to integrate other cultural practices with irrigation needs.

Micro irrigation management in arid and humid areas differs greatly. In the latter, the crop root system volume is not limited to irrigated zone since water supplies are not a problem and because of frequent precipitation events. Therefore, the root water uptake also occurs outside of the irrigated zone. In this situation it is generally recommended that micro irrigation system should wet at least 50 % of the root zone volume (Evans et al., 2007).

Drip irrigation efficiency

When considering all above-mentioned surface drip design and management practices or more specifically, when appropriate components and layout to achieve suitable water distribution over the field and, at the same time, meet crop need with consideration of economical, operational, water quality and quantity are determined and well designed, the drip irrigation systems should provide equal soil water availability to all plants in the irrigated field at high irrigation efficiency. In ASAE, 2007 irrigation efficiency is defined "as the ratio of the average depth of irrigation water that is beneficially used to the average depth of irrigation water applied, expressed as a percentage".

Advantages and disadvantages of surface drip irrigation systems

Surface drip irrigation has, when compared to other irrigation systems, many advantages and disadvantages. In Keller and Bliesner (1990), Dasberg and Or (1999) and Lamm et al. (2007) they are discussed in more detail, here only the most important ones are presented.

The most important surface drip irrigation advantages are: increased water use efficiency, improved water management (because a smaller soil surface area is wetted the evaporative losses are lower than for surface, sprinkler or micro-sprinkler irrigation),

improved crop yield and quality (because only a proportion of soil is wetted, the irrigation is possible right up to time of harvest), improved crop establishment, improved weed control, improved crop yields and quality (water content in the soil is constant because water is applied slowly and frequently), reduced nonbeneficial use (because of irrigation of smaller soil volume, reduced or eliminated runoff, reduced deep percolation and decreased surface evaporation, the water requirements are smaller when compared to other irrigation methods), reduced deep percolation (drip irrigation offers a great potential to reduce the losses to a minimum), improved fertilizer and other chemical application (to improve crop production the fertilizers, herbicides, insecticides, fungicides, rodenticides, nematocides, growth regulators and carbon dioxide can be applied efficiently), lower costs, reduced insects problems (because of smaller discharge openings the surface drip systems are less likely to be plugged by insects when compared to micro-sprinklers), decreased energy requirements (because of lower operating pressures).

The most important surface drip irrigation disadvantages are: limited wetting of crop root zone, high system costs (extensive lateral networks and supportive equipment can make drip irrigation systems expensive at the initial stage. Costs of operation are comparable to other pressurized irrigation methods), limitations with the cover crop (surface drip irrigation can exclude the use of cover crops in arid climates), persistent maintenance requirements (drip emitters are because of smaller flow passageways than micro-sprinkler irrigation systems, more easily clogged), extensive maintenance requirements (clogging, whether complete or partial represents a serious problem whereas damages to pipelines and other components can occur), potential for excess deep percolation (because water is applied to a small soil volume, deep percolation losses can occur), restricted root development (because water is applied to a specific part of a soil volume, root development may be limited to the wetted soil volume near each emitter or along each lateral line), cleaning difficulties (for example, clogged emitters are almost impossible to clean).

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FINANCIAL SECURITY AND RESILIENCE OF TERRITORIAL COMMUNITIES: THE ROLE OF LOCAL TAXATION IN ENSURING SUSTAINABLE DEVELOPMENT

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Abstract
The article examines the issue of ensuring the financial security of territorial communities in the context of sustainable development, with a particular focus on the role of local taxation. In conditions of decentralization, economic instability, and wartime challenges, the financial capacity of communities becomes a key factor in maintaining social stability, infrastructure development, and the continuity of public services. Local taxes and fees are considered a strategic instrument for strengthening fiscal autonomy and reducing dependence on intergovernmental transfers. The methodological basis of the study includes general scientific methods of analysis, synthesis, comparison, and generalization, as well as systemic, structural-functional, and statistical approaches. Economic-statistical methods (dynamic, comparative, and structural analysis), along with elements of correlation analysis, were applied to assess the influence of local taxation on financial security indicators. The empirical base consists of official budget data, regulatory legal acts, analytical reports of international organizations, and scholarly publications on local finance and decentralization. The study confirms that local taxation is a key determinant of financial security of territorial communities, ensuring stable budget revenues, fiscal autonomy, and investment capacity. It is demonstrated that effective tax policy contributes to economic stimulation, improved budget planning, and reduced dependence on state transfers. The results highlight the importance of digitalization of tax administration, scenario-based budgeting, and reserve fund formation as tools for increasing financial resilience. International experience shows that advanced models of local taxation based on fiscal

autonomy and digital technologies significantly enhance budget efficiency and stability. The study substantiates that the adaptation of these approaches in Ukraine can strengthen the financial capacity of communities and support their sustainable development under crisis conditions.

Keywords: *territorial communities; financial security; sustainable development; local taxes; local budgets; fiscal decentralization; budget autonomy; tax potential; financial resilience; digitalization of tax administration.*

Modern transformational processes in socio-economic development, intensified by global crises, military challenges, and deepening decentralization, bring to the forefront the issue of ensuring the financial security of territorial communities as a key prerequisite for sustainable development. It is precisely at the local level that the conditions for the provision of basic public services, the implementation of social programs, infrastructure recovery, and the stimulation of economic activity are formed, all of which require stable and predictable financial resources.

Within the framework of implementing the concept of sustainable development, the financial security of territorial communities acquires a comprehensive character, integrating economic, social, environmental, and institutional components. Insufficient revenue capacity of local budgets, high dependence on intergovernmental transfers, asymmetries in the tax potential of communities, and the growing scope of expenditure obligations reduce the level of financial resilience and increase the vulnerability of local finances to external and internal shocks.

A particularly important role in ensuring the financial security of territorial communities is played by the system of local taxation, which serves as one of the fundamental instruments for generating own-source revenues of local budgets. Effective utilization of the potential of local taxes and fees contributes to enhancing the financial autonomy of communities, strengthening their budgetary self-sufficiency, and creating financial preconditions for the implementation of long-term sustainable development strategies. At the same time, imperfections in local tax administration mechanisms, the limited tax base, and uneven socio-economic development across

territories necessitate a scientific reassessment of the role of local taxation within the system of financial security.

In view of the above, the study of the potential of local taxation as a tool for ensuring the financial security of territorial communities in the context of sustainable development is timely and scientifically justified. Its results are of significant theoretical and practical importance for the formulation of effective financial policy at the local level, the improvement of budgetary regulation mechanisms, and the strengthening of the capacity of territorial communities to withstand contemporary development challenges.

The methodological framework of the study is based on a combination of general scientific and specialized methods for examining socio-economic processes, ensuring a comprehensive approach to the analysis of the financial security of territorial communities in the context of sustainable development and to determining the role of local taxation in shaping their financial resilience.

In the course of the research, general scientific methods of analysis and synthesis, induction and deduction, abstraction and generalization were employed to systematize scholarly approaches to the interpretation of the concepts of “financial security,” “financial resilience of territorial communities,” and “local taxation,” as well as to develop the theoretical and conceptual foundations of the study.

Methods of systemic and structural-functional analysis were applied to examine the financial security of territorial communities as a component of the sustainable development security system and to identify the interrelationships between the revenue base of local budgets, local taxation instruments, and the socio-economic outcomes of territorial development.

To assess the financial capacity and resilience of territorial communities, economic and statistical methods were used, including dynamic analysis, structural and comparative analysis, index methods, as well as the grouping and ranking of communities according to the level of tax potential and budgetary self-sufficiency. Correlation and regression analysis was applied to identify the impact of local taxes and fees on indicators of financial security.

The empirical basis of the study comprised official statistical data from public authorities and local self-government bodies, local

budget reporting materials, analytical reviews by international organizations, scholarly publications by domestic and foreign authors, as well as regulatory and legal acts governing the functioning of the system of local finance and local taxation.

The integrated application of these materials and methods ensured the scientific validity of the conclusions, the reliability of the results obtained, and the possibility of their practical use in the process of formulating and implementing financial policy for the sustainable development of territorial communities.

Achieving financial resilience in compliance with the provisions of Ukrainian legislation constitutes one of the key objectives of local self-government bodies in the context of territorial community development. Financial resilience enables local authorities to formulate and implement strategies for the socio-economic development of communities, enhance the quality of public service delivery, and improve the overall standard of living of the population. At the same time, it increases the responsibility of local government bodies for the decisions they adopt and the actions they undertake. The issue of financial resilience became a subject of scholarly inquiry following the emergence of the global financial crisis in 2008. With the implementation of decentralization reforms and the establishment of territorial communities, the conceptual foundations of resilience have increasingly been examined in the context of the role of local self-government bodies in adapting to financial threats.

Financial resilience of a territorial community is understood as the preservation of an adequate level of financial capacity. In examining the essence of the concept of financial resilience of a community, it is appropriate to compare it with related notions, such as the financial resilience of the budget and of local government bodies.

Analyzing scholarly approaches to defining the concept of financial resilience of territorial communities demonstrates that it is a multi-component category encompassing resource availability, the ability to manage finances effectively, financial independence, and long-term development capacity. One group of researchers defines financial resilience as the community’s ability to stabilize revenues and cover planned expenditures (Vozniak H.V. et al., 2022;

Zakhidna O.R. et al., 2024; Kopyliuk O.I. et al., 2021). Other scholars emphasize the importance of high-quality financial planning and the implementation of innovative projects (Salignac et al, 2019; Tahir et al, 2025; Kamble et al, 2026).

Thus, financial resilience of a territorial community can be interpreted as a combination of fiscal capacity and budget balance, which includes the ability to cover essential expenditures, ensure financial independence, and maintain institutional and managerial capacity for financial management, strategic planning, and control.

In the context of contemporary decentralization processes, the financial resilience of a territorial community is understood as the capacity of local self-government to achieve stability of budget revenues, fulfill strategic objectives, and ensure resilience to external shocks, including economic, demographic, and security-related disturbances.

The primary source of financial resilience is local taxes and fees, which define the resource base for financing expenditures and supporting the development of territorial communities. Accordingly, it is appropriate to identify and examine the mechanisms through which these mandatory payments influence the formation of financial resilience of territorial communities.

In the context of the proposed conceptual framework, the mechanism of influence is understood as a system of interrelated components that determine the formation and strengthening of financial resilience of territorial communities. It comprises the following elements:

1. Fiscal component. Ensures the formation, distribution, and efficient utilization of financial resources, primarily through local taxation and budgetary revenues.

2. Regulatory-stimulating component. Provides a system of regulatory and incentive tools aimed at shaping favorable conditions for socio-economic development and strengthening local financial capacity.

3. Managerial autonomy component. Reflects the degree of independence of local self-government bodies in financial decision-making, budget planning, and resource allocation.

4. Risk-resilience component. Characterizes the ability of territorial communities to withstand and adapt to external and

internal financial, economic, demographic, and security-related shocks.

5. Investment component. Determines the capacity to attract, allocate, and effectively use investment resources for local development and infrastructure modernization.

6. Multiplier effect component. Describes the indirect and cumulative impact of financial decisions and investments on broader socio-economic development within the territorial community.

Together, these components form an integrated mechanism of influence that shapes the financial resilience and sustainable development capacity of territorial communities.

The main characteristics of the identified mechanisms are considered below. First and foremost, local taxes and fees serve as a key instrument for ensuring stable revenue inflows to the budget. Accordingly, the fiscal mechanism operates in two main dimensions:

– the ability to form a stable share of the community budget, regardless of changes in national-level budgetary policy;

– the forecasting of revenue volumes for planned periods in order to support effective strategic decision-making.

Following the implementation of decentralization reform, the share of local taxes and fees in local budgets has increased and constitutes the core of revenues directly controlled by local self-government bodies, thereby contributing to the financial autonomy of territorial communities. Achieving stable inflows of local taxes and fees creates the basis for long-term financial planning, which is one of the most important characteristics of financial resilience.

Another specific feature of local taxation is its capacity to influence the socio-economic condition of the community. The authority to set tax rates within legally defined limits, as well as to regulate their administration, enables local governments to shape the financial behavior of economic entities within the community, which reflects the regulatory mechanism of influence on financial resilience. The impact of this instrument is manifested through:

– stimulating business activity by reducing tax rates for small businesses, etc.;

– creating a favorable investment environment, including the implementation of flexible approaches to property taxation in industrial zones;

– regulating land relations, which affect territorial development, logistics expansion in the agricultural sector, and industrial development.

One of the key factors enhancing the financial resilience of a territorial community is the reduction of dependence on intergovernmental transfers. This is achieved through an increasing share of own-source revenues in budget structures, primarily due to higher inflows from local taxes and fees (Zahedi et al, 2022). The mechanism of managerial autonomy strengthens this positive effect through faster decision-making without the need to await approval from higher-level authorities, improved quality of public governance through effective administration and strategic planning, and the avoidance of budget underperformance risks via the implementation of tax policies adapted to local conditions.

A significant impact on the level of financial resilience is exerted by the investment mechanism, which reflects the ability not only to cover current expenditures but also to invest in the development of the territorial community. This includes directing financial resources toward infrastructure improvement, modernization of public utilities, proper maintenance and development of the social sphere, and the implementation of effective community development programs. It should be noted that this mechanism ensures long-term financial resilience, as it improves the quality of life within the community (e.g., quality roads, educational infrastructure, energy efficiency upgrades) and enhances the investment attractiveness of the territorial community.

The multifunctionality of local taxes and fees is explained by their multiplier effect, as they function as a financial and economic catalyst that stimulates economic activity within the community and increases tax revenues.

The development of strategic approaches to achieving financial resilience and security of territorial communities is a fundamental prerequisite for stable economic and investment-driven territorial development and for improving the quality of life of citizens. This issue becomes particularly significant under conditions of martial law.

In identifying the key directions for achieving financial resilience, it is appropriate to take into account several critical aspects: outlining

and accumulating budgetary potential with a clear identification of all community needs; ensuring the adequacy of the revenue side of the budget and its efficient utilization; balancing budget revenues and expenditures; and enhancing the investment attractiveness of the territorial community.

Under conditions of uncertainty and increasing dependence on state transfers, the importance of a community's ability to stabilize budgetary flows, cover social and infrastructural needs, and identify and mitigate external and internal risks becomes more pronounced. This capacity constitutes the financial security of a territorial community. The fiscal dimension of security presupposes rational management of budgetary resources, expenditure optimization, and adaptive strategic planning in response to dynamic changes.

Threats to the financial resilience and security of communities caused by martial law significantly undermine the stability of budget revenue formation. Damage to economic infrastructure and reduced business activity lead to a substantial decline in tax and fee revenues to local budgets. At the same time, state transfers become critically important; however, their volume and earmarking often fail to adequately meet actual needs, resulting in only marginal improvements in the situation. Moreover, the likelihood of unforeseen expenditures on infrastructure restoration and support programs for internally displaced persons increases. To finance such expenditures, communities may resort to borrowing, thereby increasing the debt burden, which, in the absence of clear planning, undermines financial resilience in the medium and long term.

Therefore, the development of comprehensive strategies to ensure financial security, taking into account fiscal benchmarks, is essential. One of the initial measures may involve the establishment of reserve funds to cover emergency expenditures. For example, a community may allocate 5% of its own-source revenues and transfers for this purpose, enabling a prompt response to unplanned expenses. Equally important is the development and implementation of clear rules governing the use of reserve resources and effective oversight of these processes. The effectiveness of this approach can be further enhanced through the development of multiple development scenarios (scenario-based budgeting), including baseline, optimistic, and pessimistic scenarios. This would allow communities to adapt to

changes in revenue flows and expenditure needs.

One of the core pillars of financial resilience is tax policy and the effective mobilization of revenues at the local level. Under the challenging conditions of wartime, communities must skillfully balance the need to secure budget revenues with the necessity of supporting business activity. Preferential tax programs for economic entities can motivate businesses to continue operating, while tax optimization and improved administration processes contribute to maintaining fiscal discipline. Practical experience of Ukrainian communities demonstrates that even under complex and uncertain conditions, active cooperation with entrepreneurs positively affects the preservation of community financial resilience and the satisfaction of social needs.

The use of intergovernmental transfers is also an important aspect of fostering inter-community partnerships and strengthening financial resilience and security. Coordinated actions among communities in addressing shared challenges or implementing joint projects-such as infrastructure development or social programs-enhance the efficiency of budgetary resource utilization. Contemporary governance practices also include the attraction of grants and international funding.

Accordingly, a set of mechanisms for achieving financial resilience and security under current conditions is proposed (Table 4.9).

Alongside the proposed mechanisms, it is advisable to apply contemporary innovative approaches to enhance their effectiveness in strengthening the financial security of territorial communities. First and foremost, the introduction of digitalization in financial management and real-time analytics is proposed. This will enable continuous monitoring and control of financial flows, forecasting of budgetary vulnerabilities, and prompt responses to emerging challenges and changes. The digitalization of community finances should not be viewed merely as a transition from paper-based to electronic documentation; rather, it represents a comprehensive transformation of the methods used to collect, process, and utilize financial data.

Table 4.9

Mechanisms for Achieving Financial Sustainability and Security of Communities under Contemporary Conditions

Area	Mechanisms and Instruments	Comment / Example
Budget Planning	Formation of reserve funds, scenario-based budgeting	Enables flexible responses to changes in financial flows and unforeseen expenditures
Tax Policy	Optimization of local taxes, business incentives, transparency of tax administration	Supports economic activity and stability of community revenues
Intergovernmental Transfers	Active lobbying for state support, inter-municipal partnerships	Important for balanced financing of defense, social services, and recovery
Attraction of External Resources	Grants, municipal bonds, credit resources	Can provide financing for reconstruction and investment projects
Debt Management	Monitoring of liabilities, rules for borrowing, debt repayment strategy	Prevents excessive debt burden and financial risks

Source: author's development

The primary advantage of financial digitalization at the community level lies in the quality and timeliness of information, as data become available in real time, enabling local self-government bodies to make informed and contextually appropriate decisions while minimizing the risk of information distortion. In this regard, a government initiative aimed at implementing a strategy for the digitalization of public finances through 2030 (Cabinet of Ministers

of Ukraine, 2025) further underscores the priority of this approach in strengthening community budget management and financial resilience.

In practice, financial digitalization generates both operational and analytical effects. The operational effect is manifested through the automation of payments, electronic submission and signing of documents, and the creation of electronic registers. The analytical effect is based on the development of an integrated data repository used for scenario modeling, comparison of deviations from planned indicators, and the analysis and forecasting of financial metrics.

Table 4.10

Practical and Technical Characteristics of Digitalization of Tax and Fee Administration in Territorial Communities for Achieving Financial Sustainability

Level	Content	Practical Role for the Territorial Community
Data Sources	Treasury systems, banking gateways, registers (tax register, real estate register, business register)	Automatic data inflows without a "human intermediary"
Data Storage	Data warehouse / cloud lake	Single source of truth for analytical processing
Analytics	BI dashboards, scenario-based models, forecasting (time series)	KPI monitoring, early detection of budget deficits
Administrative Tools	Taxpayer CRM systems, automated reminders, e-cash registers	Improved payment discipline and convenience for taxpayers
Data Security and Governance	Access control policies, encryption, logging	Trust, compliance with data protection legislation

Source: (Cabinet of Ministers of Ukraine, 2025; Organisation for Economic Co-operation and Development (OECD), 2025)

The implementation of advanced digital tools will enhance the quality and efficiency of administering local taxes and fees by transforming the entire cycle-from taxpayer identification and tax assessment to enforcement procedures. A key concept in this context may be the creation of a "Taxpayer Profile" for local self-government bodies, containing information on payment history, risk indicators (such as arrears or changes in business structure), and revenue forecasts. This would enable timely detection of payment delays and proactive communication with taxpayers, for example through automated push notifications.

A practical and technical representation of the digitalization of tax and fee administration aimed at achieving the financial security of territorial communities is presented in Table 4.10.

For the effective functioning of digitalized tax administration, it is necessary to apply modern data governance principles, such as a unified system of taxpayer identifiers, standardized data exchange formats, and robust data protection policies. It should be noted that the OECD emphasizes the need for a comprehensive approach to data management within tax administration systems, which facilitates rapid risk assessment and high-quality taxpayer services (OECD, 2025). For territorial communities, this implies significantly lower costs associated with manual verification processes and the ability to make clearer and more accurate decisions regarding administrative priorities.

The implementation of digitalized administration can begin with rapid, low-threshold measures, such as the integration of payment channels and the launch of a financial dashboard for the creation of a Taxpayer Profile. Subsequently, these actions should be scaled up. For example, property registers may be integrated to enable the automatic assessment of land taxes, and various modules for screening potential tax evasion risks may be introduced. Such phased digitalization contributes to more efficient administration and reduces the risks of corrupt practices.

These comprehensive approaches enable territorial communities to withstand the challenging conditions of wartime and to establish a foundation for post-war recovery. The key success factors for the implementation of such innovative ideas include transparency, flexible management of local tax and fee revenues, and strategic

planning.

The fiscal dimension of financial resilience under wartime conditions constitutes a necessary and strategic foundation for resource mobilization, long-term development, and the adaptation of communities to contemporary challenges.

The conducted research demonstrates an inevitable increase in the fiscal significance of local taxes and fees in ensuring the financial resilience of territorial communities. Therefore, identifying and applying instruments to improve the system of local taxation is of critical importance. The experience and practices of developed foreign countries may be particularly valuable in the process of enhancing local taxation systems. In many countries worldwide, local taxes and fees form the core of local budget revenues and encompass a wide variety of tax instruments. It is important to emphasize that in some countries, taxes that are classified as national-level taxes in Ukraine are considered local taxes.

The experience of European countries shows that the financial resilience of municipalities is achieved not only through the optimization of revenues and expenditures, but primarily through the creation and implementation of new governance models based on transparency, digitalization, and analytics.

Compared to other European countries, Ukraine’s local taxation system includes a relatively limited range of taxes and fees. In contrast, some countries administer hundreds of different taxes and fees at the local level. One of the most extensive lists of local taxes exists in Belgium, with approximately 100 types, followed by Italy with around 70 and France with more than 50.

Local taxation systems in foreign countries are largely built on expanded fiscal autonomy of communities, whereby local self-government bodies are entitled not only to set tax rates within defined limits, but also to apply debt policy instruments and influence the tax base.

For example, in German municipalities (Gemeinden), local authorities have the right to set a municipal tax multiplier (Hebesatz) for calculating the trade tax and land tax. This mechanism operates as follows: the basic trade tax rate (3.5%) is multiplied by the local Hebesatz coefficient, which varies by municipality (approximately 200% in smaller towns and over 800% in large cities). This approach

has a significant impact on the tax burden for businesses. At the same time, it contributed to the resilience of local budgets during periods of revenue decline caused by the COVID-19 pandemic.

If this practice were adapted to the domestic local taxation system, it could provide tangible benefits by enabling communities to regulate local tax rates within reasonable limits while taking into account their investment attractiveness. Granting communities the right to apply flexible rate mechanisms would allow for rapid responses to financial challenges under wartime conditions.

Similar local taxation reforms to those implemented in Ukraine have taken place in Poland. A key feature of these reforms and the enhancement of community resilience was the introduction of integrated digital revenue accounting, particularly for property taxation. Under this system, Polish municipalities (Gminy) have access to a unified national property database integrated with GIS systems. This approach significantly reduced the shadow segment of property ownership and substantially increased the accuracy of tax assessments. As a result, local budget tax revenues increased by 12–18% in the early stages of implementing integrated digital systems.

For Ukrainian territorial communities, this mechanism is particularly relevant, as a significant share of land and other real estate assets remains unregistered in cadastres or contains inaccuracies. This results in lost revenues that could otherwise serve as a financial reserve for local budgets under martial law conditions.

Local budgets in Scandinavian countries are recognized for their high level of financial resilience. In particular, the analytical governance approaches employed in Sweden and Denmark enable not only the recording of budget indicators but also their real-time monitoring. This allows financial data to be integrated with demographic, social, and investment indicators, facilitating comprehensive analysis and the development of effective strategies for managing local taxation and public finances.

In the context of wartime conditions in Ukraine, the application of real-time analytical management is especially important, as war-related risks can alter community conditions on a daily basis (e.g., migration, destruction of infrastructure). Such analytics could serve as a fundamental basis for ensuring the financial resilience and security of territorial communities.

A comparative analysis of established approaches to the functioning of local taxation systems aimed at achieving financial resilience in foreign countries is presented in Table 4.11.

Table 4.11

Comparative Aspects of Instruments for Ensuring Financial Sustainability through Local Taxation in Foreign Countries

Country / Model	Key Instrument	Effectiveness	Adaptability to Ukraine
Germany	Flexibility of local tax rates (Hebesatz)	Enables rapid budget adjustment during crisis periods	High – subject to amendments in legal limits for tax rate setting
Poland	Unified digital cadastral registers	Increase in revenues by 12-18% following digitalization	Very high – particularly relevant during wartime for accurate property registration
Denmark and Sweden	Real-time analytics and "smart budgeting" systems	Fast response to financial changes and reduced budget deficits	High – requires investment in digital infrastructure
France	Diversification of local revenue sources and municipal enterprises	Reduces dependence on state transfers	Medium – feasible after reform of municipal enterprises

Source: (Götze et al, 2021; Karran,2024, Ly et al, 2020)

A valuable practice for strengthening the autonomy of local budgets is the ability of local governments to develop sound financial policy, conduct risk forecasting, and create financial reserves. In many countries around the world, stabilization funds operate as an effective instrument; for example, in Norway such funds account for

approximately 5-7% of the annual budget and are formed through allocations from excess revenues. These funds cannot be used for current community needs and are exclusively directed to cover unforeseen deficits caused by crisis phenomena. For Ukraine, the implementation of such an instrument would be an important mechanism for responding to unpredictable circumstances.

At the same time, the introduction of integrated digitalization contributes to increasing the financial sustainability of territorial communities by enhancing control and predictability of budget revenues. In Ukraine, certain elements of such solutions are already being implemented; however, the digital infrastructure remains highly fragmented, which reduces the quality of planning and effective administration. This indicates the need for a more integrated and comprehensive digital approach.

An effective practice is the partnership between municipalities and business entities. In Canada and the United Kingdom, public-private partnership mechanisms are widely used to implement various projects, including educational, energy, and infrastructure initiatives.

The adaptation of foreign practices to the local tax environment should not be mechanical copying but must take into account the specific characteristics of domestic communities and the conditions under which they operate. Given existing risks and threats, the introduction of effective instruments for enhancing the financial sustainability of communities should be based on the principles of flexibility and compliance with security requirements.

Thus, summarizing the study of foreign experience, the most promising international practices in the functioning of local taxation systems and ensuring financial sustainability can be identified as follows:

1. Formation of integrated digital registers of community assets, including data on property, real estate, land, and other resources, in order to prevent losses of tax and fee revenues.

2. Introduction of real-time monitoring of budget indicators to ensure rapid response to changes and risks.

3. Establishment of reserve funds and community risk insurance mechanisms, which have proven effective in many countries and could be implemented in domestic practice through the development

of guarantee programs.

4. Development of public-private partnerships focused on critically important areas of community life, such as logistics, water supply, and infrastructure. This approach forms long-term revenue streams that are not directly dependent on the tax base.

Today, Ukraine is approaching membership in the European Union. These prospects open new opportunities for territorial communities in the context of financial sustainability, innovative approaches, and development, as local self-government in the EU is a multilevel system with clearly defined standards of planning, strategy development, transparency, and digitalization.

An important factor in strengthening the financial sustainability of Ukrainian territorial communities in the process of EU accession will be access to specialized funds. For example, the Cohesion Fund finances infrastructure projects, modernization of heating networks, and transport systems, while the European Regional Development Fund (ERDF) supports business development and innovation. A relatively new instrument is the Just Transition Fund, which aims to ensure a smooth transition to a climate-neutral economy.

To integrate into such EU initiatives, domestic communities will need to establish effective project management systems with qualified specialists in financial planning, risk assessment, and grant writing.

Another mandatory component will be the digitalization of the budget process and the use of electronic audit systems, as transparency is a key requirement of EU-funded projects. This necessitates a full transition to electronic document management, online tracking of expenditures, and risk analysis in accordance with European standards.

Therefore, the implementation of foreign experience and the European integration vector of development for territorial communities of Ukraine not only opens new opportunities but also generates new requirements. This requires the transformation of financial processes, personnel decisions, and the formation of a culture of strategic planning.

The study confirms that the financial security of territorial communities in conditions of sustainable development and crisis instability is primarily determined by the effectiveness of local

taxation as the main instrument of own-source revenue generation.

It has been established that local taxes and fees in the post-decentralization period have become a core financial resource of communities, ensuring budget autonomy and reducing dependence on intergovernmental transfers. Their fiscal role is complemented by regulatory and investment functions, which directly influence local economic activity, business environment, and infrastructure development.

The results show that the financial security of communities is ensured through a combination of stable revenue formation, budget balance, and managerial autonomy. Local taxation strengthens these components by enabling predictable revenue flows and flexible fiscal decision-making at the local level.

A key finding is that local taxes also perform a multiplier function: even minor changes in tax policy (rates, benefits, administration quality) significantly affect business activity and, consequently, the overall tax base of the community.

In wartime conditions, the study identifies a critical weakening of tax revenues due to economic contraction and population displacement. At the same time, local taxation remains the most stable internal financial source, especially when combined with targeted state transfers and reserve funds.

The analysis confirms that the most effective mechanisms for strengthening financial security include:

– scenario-based budget planning and reserve fund formation;

– optimization of local tax administration and digitalization of tax processes;

– expansion of local revenue autonomy;

– development of inter-municipal cooperation and project-based financing.

International comparison shows that the highest level of financial resilience is achieved in systems where communities have broad fiscal autonomy and advanced digital tools for tax administration (e.g., cadastral digitalization, real-time budgeting, integrated analytics). These practices demonstrate measurable effects, including revenue growth (up to 12–18% after digital cadastral reform in some EU countries) and reduced budget volatility.

The obtained results can be applied in three key directions:

1. For local governments**:** implementation of digital tax dashboards, taxpayer profiling systems, and scenario-based budgeting tools to improve revenue forecasting and financial planning.

2. For policy-making**:** refinement of local tax legislation to expand fiscal autonomy, introduce flexible rate mechanisms, and strengthen incentives for local economic development.

3. For post-war recovery and EU integration**:** use of the proposed mechanisms for attracting EU funds, developing project management systems in communities, and aligning local financial governance with EU standards of transparency and accountability.

In the long term, the findings provide a basis for transitioning Ukrainian territorial communities toward a model of financially autonomous, digitally managed, and investment-oriented local governance, capable of ensuring stability under crisis conditions and supporting sustainable development trajectories.

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Chapter 5

INSTITUTIONAL AND GOVERNANCE MECHANISMS FOR ENSURING SUSTAINABLE DEVELOPMENT SYNERGY AND SECURITY

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THE ROLE OF SOCIAL WORKERS IN STRENGTHENING YOUTH INCLUSION AND SOCIAL SECURITY

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Abstract
This article examines the role of social workers in strengthening youth social inclusion and social security in the context of contemporary

social changes. The focus is on young people with fewer opportunities, whose active participation in social life is limited by economic, educational, family, psychological, health, geographical or other social risk factors. The article is based on the premise that social work with young people is not limited to the provision of individual support, but also encompasses empowerment, prevention, the strengthening of social ties, mediation and the creation of a safer social environment.
The aim of the article is to reveal how the methods applied by social workers in practice help to strengthen youth inclusion and social security. A qualitative research strategy was applied to the study. Empirical data were collected using semi-structured interviews with social workers who have practical experience of working with young people with fewer opportunities. The study aimed to highlight the professionals' professional experiences, the methods of support they employ, the roles they perform, and the main challenges arising when working in the field of youth social inclusion and social security. In this article, social work is understood as an important professional activity that helps to reduce social exclusion among young people and to strengthen their motivation, self-esteem, independence and participation in community and societal life. The article contributes to the academic discussion on sustainable, inclusive and socially secure youth participation, emphasising the importance of professional social work in the processes of ensuring youth inclusion and social security.

Keywords: *social security, social work, young people with fewer opportunities, youth inclusion.*

Introduction

In contemporary society, the social inclusion and social security of young people are becoming among the most important aspects of sustainable social development. Social, economic, educational, health, family or geographical circumstances mean that some young people face limited opportunities to participate fully in society, develop social skills, gain independence and build positive life prospects (Renner et al., 2024; Filia et al., 2025). Young people with fewer opportunities are more likely to face risks of social exclusion, low self-esteem, low motivation, emotional insecurity and limited participation in the community. Consequently, social work with young people becomes not only a form of individual support but also a significant tool for strengthening social inclusion, prevention,

empowerment and social security (Cedeño, 2023). Social work in the field of youth inclusion is important in that it focuses on identifying the young person's needs, building a relationship based on trust, providing emotional and social support, and mediating between the young person, the family, educational institutions, the community and other actors in the support system (Creaney & Case, 2022). The academic literature (Gudžinskienė & Ramanauskas, 2017; Cedeño, 2023) emphasises that the work of social workers with young people with fewer opportunities is significant due to this group's vulnerability, limited opportunities to develop social skills, and the risk of social exclusion. It is also emphasised that it is important for social workers to identify young people's needs, apply appropriate support methods, address emerging challenges, and collaborate with other professionals and institutions (Gudžinskienė & Ramanauskas, 2017). From a social security perspective, social work can be understood as a practical activity that helps to reduce the risk of social exclusion, strengthen young people's resilience to adverse circumstances, encourage their participation in social life, and create a safer social environment (Berg-Weger, 2019). Youth inclusion involves a process whereby a young person is empowered to participate, make decisions, express their needs, form social connections and feel like a full member of the community (Lisauskienė & Aleksienė, 2016). In this process, the social worker acts as a consultant, mediator, enabler, supporter and promoter of social security.

The relevance of this article is based on the fact that issues of youth social inclusion and social security are becoming particularly significant in the context of social transformations, growing inequality, social risks and institutional changes. Although youth inclusion is often examined through the lenses of education, employment or social policy, the role of social work in this process requires a more detailed academic foundation. It is particularly important to reveal how social workers and specialists working in the youth sector themselves understand their role in strengthening youth inclusion and social security, what methods they apply, what challenges they face, and what conditions they consider necessary for effective assistance.

The research problem is formulated as follows: how do social workers, in providing support to young people, contribute to strengthening youth inclusion and social security?

The object of the study is the activities of social workers in strengthening youth inclusion and social security.

The aim of the study is to reveal the role of social workers and the specific features of the provision of support in strengthening youth inclusion and social security.

Research objectives:

1. To describe the concepts of youth social inclusion and social security in the context of social workers' activities.
2. To highlight the specific features of social workers' work with young people with fewer opportunities.
3. To reveal the experiences, challenges and opportunities for strengthening the work of social workers when providing support to young people in the areas of social inclusion and social security.

Research methods**.** The article employs an analysis of the scientific literature and qualitative research. Empirical data were collected using a semi-structured interview method, interviewing social workers with practical experience of working with disadvantaged young people. The research data are analysed using thematic analysis to highlight social workers' experiences, perspectives, methods of support, professional roles, challenges faced, and the significance of their work in strengthening youth inclusion and social security.

Concepts of youth social inclusion and social security in the context of social workers' practice

The social inclusion of young people in modern society is regarded as one of the most important elements of social sustainability and social security. It is linked not only to young people's formal participation in education, the labour market or community activities, but also to real opportunities to develop, form social connections, make decisions, express their needs and feel like full members of society (Cano-Hila, 2022). The concept of social inclusion is particularly relevant when discussing vulnerable or disadvantaged young people who, due to social, economic, educational, cultural, geographical, health or family circumstances do not have the same opportunities as their peers to develop their

skills and actively participate in society (Renner et al., 2024).

The concept of young people with fewer opportunities allows us to move away from a stigmatising view of young people as ‘at risk’ (Atkinson & Rees, 2022). Liutkevičienė (2015) emphasises that it is not the young person’s personality itself that is at risk , but the environment in which they live and socialise. This understanding changes the logic of social workers’ practice: their aim is not to control the young person or judge their behaviour, but to identify the barriers preventing them from participating fully in social life and to help reduce them (Gudžinskienė & Ramanauskas, 2017; Cedeño, 2023). The challenges faced by young people with fewer opportunities stem from the interaction of micro- and macro-environmental factors: poverty, family dysfunction, social isolation, learning difficulties, health problems, unemployment or limited access to services (Filia et al., 2025).

Social exclusion is understood as a process whereby certain individuals or groups are systematically marginalised and deprived of access to the resources, rights and opportunities available to other members of society (Boardman et al., 2022). In the case of young people, social exclusion can manifest itself through unsuccessful educational experiences, limited employment opportunities, weak social ties, distrust of institutions, emotional insecurity, low self-esteem or an inability to independently solve everyday problems (Filia et al., 2025). Social exclusion among young people with fewer opportunities often becomes a cyclical phenomenon: an unfavourable family or community environment reduces a young person’s opportunities to engage in education and social life, whilst limited engagement in turn further deepens social exclusion (Frøyland et al., 2022).

Social inclusion is the opposite process, focused on strengthening young people’s opportunities, expanding their participation and reducing barriers. Van Mieghem et al. (2020) link social inclusion to systemic changes in the environment, methods, approaches and structures, so that people with different needs can participate fully in society. This concept is particularly important in the work of social workers, as it demonstrates that support for young people cannot be limited to individual counselling alone. Social workers must operate within a broader context: strengthening young people’s connections

with their family, school, peers, community, the social services system and other institutions.

Frøyland et al., 2022, explain youth inclusion through the logic of the following stages: exclusion, segregation, integration and inclusion. Exclusion occurs when a young person lacks opportunities to develop their skills and participate in social life (Liutkevičienė, 2015); segregation means that they participate in separate activities, isolated from others (Checkoway, 2024); integration allows them to enter shared social structures (Creaney & Case, 2022). ; however, only inclusion signifies genuine participation, where the environment itself changes so that the young person can act as an equal member of the community (Cano-Hila, 2022). This theoretical framework is important for the work of social workers, as it helps us understand that young people must not only participate in activities, but also feel accepted, heard and able to influence decisions.

The concept of social security in the context of young people encompasses not only material or economic security, but also emotional, social, educational and community security (Vílchez & Trujillo, 2023). A young person can be considered socially secure when they have reliable relationships with adults, can access support in a crisis, are aware of their rights and opportunities, trust institutions, have space for self-expression, and can participate in activities that strengthen their self-esteem and sense of responsibility (Lisauskienė & Rimkevičienė, 2019). In this regard, social workers act as enhancers of social security, as they help young people to identify risks, overcome everyday difficulties, access necessary services and create a safer social environment (Lisauskienė & Rimkevičienė, 2019).

A particularly important aspect of social security is the relationship of trust between the social worker and the young person. Ritchie & Ord (2017) emphasise that young people greatly value the support and advice provided by social workers, as this helps them to better understand their life situation and make decisions. Similarly, Clonan-Roy et al. (2021) argue that informal youth spaces can become safe places where young people can express their emotions, receive support and experience a sense of community. Therefore, social security is not merely the provision of institutional services; it stems from genuine relationships, trust, accessibility and the young

person's experience that they are not left alone (Lisauskienė & Aleksienė, 2016).

In the context of social workers' practice, young people's social inclusion and social security are closely interlinked. Inclusion strengthens security, as young people gain connections, skills and a support network (Cedeño, 2023). Social security, in turn, creates the conditions for inclusion, as young people who feel emotionally and socially stable find it easier to engage in education, work, community activities or voluntary work. Thus, social workers help young people not only to solve specific problems but also to create the long-term conditions for social participation (Lisauskienė & Rimkevičienė, 2019; Cedeño, 2023). When working with vulnerable or disadvantaged young people, the work of social workers is multifaceted. It encompasses individual support, emotional support, counselling, social skills development, mediation, advocacy, prevention, collaboration with institutions, and youth empowerment (Munford & Sanders, 2021).

One of the most important roles of a social worker is that of a counsellor and supporter. Jakaitienė & Kavaliauskienė (2023) emphasise that a social worker working with young people with fewer opportunities most often acts as a counsellor. Counselling in this context is understood broadly: it encompasses not only the provision of information, but also emotional support, assistance with decision-making, problem analysis, strengthening motivation, and fostering the young person's ability to act independently. The role of the counsellor is particularly important when a young person lacks a supportive family or an adult they can trust (Jakaitienė & Kavaliauskienė 2023).

Another significant role is that of a mediator. Social workers often help young people to make contact with institutions in the fields of education, healthcare, social services, employment or law enforcement. Gudžinskienė & Ramanauskas (2017) emphasise that when working with young people spending time on the streets, the social worker often becomes a mediator, counsellor, companion and helper. Mediation is important because vulnerable young people often do not trust institutions, do not know where to turn, or lack the social skills to obtain the necessary help independently. In such cases, the social worker helps the young person 'navigate'

institutional procedures and bridges the gap between the young person and the support system.

The social worker also plays an empowering role. Empowerment means strengthening the young person's ability to act independently, fostering their self-confidence, encouraging responsibility, and developing their participation in decision-making. Parker & Doel (2013) argue that social workers should focus on a person's potential for growth and change, avoid judgement or preconceptions, and help the individual act in accordance with their individual needs. Munford & Sanders (2021) link the aim of social work to strengthening an individual's social functioning, dignity, autonomy and meaningful participation. This means that when working with young people, it is important not only to provide support, but also to help them see their own potential, recognise their strengths and believe that they can influence their own lives. An important function of social workers is the development of social skills. Young people with fewer opportunities often experience difficulties with communication, self-control, problem-solving, conflict management, taking responsibility or decision-making. Lisauskienė et al. (2018) note that working with young people requires a suitable socio-educational environment that combines formal and non-formal activities. Non-formal education is particularly significant as it is based on voluntarism, cooperation and free choice. Such an environment allows young people to learn through activity, relationships and experience, rather than through control or coercion (Grajcevci & Shala 2016).

Support methods when working with vulnerable young people must be flexible and tailored to the individual situation (Munford & Sanders 2021). Methods such as individual work with the young person, group discussions, creative workshops, sports activities, project-based activities, the organisation of events , social skills training, psychological support, the search for education and employment opportunities, and support services are employed. These methods demonstrate that the work of social workers should not be narrowly understood as the administrative referral of services. On the contrary, it encompasses a variety of practical, emotional, educational and community-based interventions (Munford & Sanders 2021).

In the context of open youth work, the principles of voluntariness, accessibility, confidentiality, mutual respect, a focus on the young person's needs, active involvement, cooperation and relationship-building are particularly important (Barnes, 2012). These principles enable the social worker to create an informal, safe and youth-friendly support environment. Dilytė-Kotenko (2023) emphasises that open youth spaces provide young people with the opportunity to socialise freely, learn and acquire the necessary skills. De St Croix & Doherty (2023) also highlight that open youth work enables young people not only to participate in activities but also to contribute themselves to the creation of the space and the shaping of its content. Cooperation with other professionals and institutions is crucial in the work of social workers. The problems faced by vulnerable young people are often complex, so the help of a single professional is not sufficient (Bounds et al., 2020). Work with young people must be based on interdisciplinary and cross-sectoral cooperation, involving social educators, psychologists, teachers, healthcare professionals, family members, community organisations and, where necessary, law enforcement agencies (Bounds et al., 2020). Lisauskienė & Aleksienė (2016) emphasise that effective work requires cooperation, which ensures greater continuity, stability and control of situations. When working with vulnerable young people, social workers also face ethical challenges. They must respect the young person's autonomy, confidentiality, freedom of choice and right to an individual pace of support (Barnes, 2012). This is particularly important when a young person has had negative experiences with institutions or adults. Excessive pressure, formality or control can erode trust and prompt the young person to withdraw from the support process. Therefore, social workers' practice must be grounded in respect, patience, consistency and the ability to maintain professional boundaries (Munford & Sanders, 2021).

In summary, it can be said that the role of social workers in strengthening youth inclusion and social security is essential. They help vulnerable young people to build trust-based relationships, identify their needs and opportunities, access the necessary support, develop social skills and engage in community life. Social workers act as counsellors, mediators, enablers, advocates, motivators, information providers and coordinators of cooperation. Their work is

important not only in addressing individual young people's problems, but also in creating broader conditions for social inclusion and social security.

Methods

A qualitative study was conducted to explore the role of social workers and the specificities of their support in strengthening youth inclusion and social security (Ide & Beddoe, 2024). The qualitative research approach was chosen because it allows for a deeper understanding of social workers' professional experiences, their attitudes towards the problems faced by vulnerable or disadvantaged young people, the methods of support they employ, their professional roles, and the challenges they encounter in practice (Padgett, 2016). This approach is appropriate for analysing social phenomena where not only factual information is important, but also the experiences, interpretations and professional context of the research participants (Ide & Beddoe, 2024).

The subject of the study is the work of social workers in strengthening youth inclusion and social security.

Empirical data were collected using a semi-structured interview method. This method was chosen in order to obtain comparable data from all research participants (Hennink et al., 2020). The interviews allowed for targeted data collection in line with the research aim and objectives. The questions were designed to highlight two main analytical strands: firstly, how social workers understand youth social inclusion and social security; secondly, what roles, functions and support methods they employ when working with vulnerable or disadvantaged young people.

Seven social workers with practical experience of working with young people took part in the study. The participants were selected using purposive sampling (Tajik et al., 2025). The main selection criterion was at least one year of practical experience in youth social work with disadvantaged young people. This selection method was chosen because the study required informants who could draw not on theoretical assumptions but on specific professional experience. The study participants possess experience and expert insights, as they deal directly with issues of youth social inclusion, social security, motivation, emotional difficulties, family problems, social exclusion and the availability of support.

The study was conducted in several stages. The first stage involved an analysis of the academic literature, which provided a theoretical basis for the concepts of youth social inclusion, social security, vulnerable young people and the work of social workers. In the second stage, a structured interview questionnaire was developed. In the third stage, interviews were conducted with seven social workers. In the fourth stage, the collected data were organised, grouped and analysed according to pre-defined thematic categories.

The research data were analysed using the principles of qualitative content analysis (Padgett, 2016). The interview responses were read, organised and grouped according to recurring themes. The following main categories were identified during the analysis: the professional relationship between social workers and young people, the nature of the support provided, the most common problems experienced by young people, the support methods used, the roles of social workers, ways of strengthening youth engagement, the prerequisites for ensuring social security, and professional challenges.

The study adhered to the fundamental ethical principles of social research: voluntary participation, informed consent, confidentiality and anonymity (Padgett, 2016). Research participants were informed about the purpose of the study, the nature of data use, and their right to refuse to participate in the study. To protect the identity of the research participants, their first names, surnames, places of work, and other identifying information are not disclosed in the study. The study participants were assigned codes (SW1, SW2, SW3, SW4, SW5, SW6, SW7). The study results are presented in summary form, without revealing the identities of specific individuals.

The study's limitation relates to the small sample size of participants. As seven social workers took part in the study, the data obtained reveal their professional experiences and perspectives, but cannot be considered representative of all social workers working with young people. On the other hand, for qualitative research, the most important factor is not a large sample size, but the opportunity to gain a deeper understanding of the phenomenon under investigation. Therefore, the study's results are significant as an empirical basis for analysing the role of social workers in strengthening youth inclusion and social security.

Results

An analysis of the results of the semi-structured interviews conducted with seven social workers identified four main themes: forms and methods of support, the roles of social workers, strengthening youth inclusion and social security, and professional challenges and opportunities for improving support . These themes reflect the practical experience of social workers in working with vulnerable or disadvantaged young people.

Forms and methods of support. The research data revealed that social workers provide comprehensive support to young people. The most frequently mentioned areas of support are psychological and emotional support, the development of social skills, assistance with education, employment and job-seeking issues, mediation when contacting institutions, accompaniment and practical help in everyday situations. This indicates that social workers' activities in the field of youth inclusion and social security are focused not only on solving specific problems, but also on strengthening young people's independence, self-confidence and ability to function in a social environment.

An analysis of the respondents' answers revealed that the first stage of assistance is most often associated with building a relationship based on trust. Social workers noted that vulnerable or disadvantaged young people often do not accept help immediately, avoid talking about personal problems, and do not trust adults or institutions. Therefore, before applying specific support methods, it is important to create a safe, informal and youth-friendly environment for communication.

"First of all, you need to establish a connection with the young person. Until there is trust, they won't want to talk about school, their family or their problems." (SW1)

"Often, support doesn't start with a consultation, but with a simple conversation. It's important for the young person to feel that nobody is judging them." (SW3)

"Pressure doesn't work with young people. You need to talk, listen and let the young person themselves understand what kind of help they need." (SW5)

These statements suggest that social workers' support for young people is primarily based on a relationship, rather than formal

intervention. Communication based on trust becomes a prerequisite for the young person's further engagement in the support process, learning, activities or community life.

Psychological and emotional support was identified by the study participants as one of the most important forms of support. Social workers noted that a significant proportion of young people face anxiety, low self-esteem, a lack of motivation, family conflicts, feelings of loneliness or emotional instability. In such cases, the social worker becomes the first professional to notice the young person's emotional state, listen to them, help identify the problem and, if necessary, refer them to a psychologist or other support specialist.

"A great many young people come not for a specific service, but because they need someone to listen to them." (SW2)

"Sometimes we are the first to notice that a young person is struggling emotionally, that they no longer want to go to school or socialise." (SW6)

Another important area of support is the development of social skills. Study participants emphasised that some young people lack skills in communication, conflict resolution, independence, taking responsibility, time management, decision-making and self-presentation. Therefore, social workers organise individual conversations, group sessions, practical activities, discussions, creative workshops and other activities that help young people develop the skills necessary for everyday life.

"In our work, it is very important to develop social skills: how to communicate, how to express one's opinion, how to resolve conflict without aggression." (SW4)

"Sometimes young people need very practical advice – how to write a CV, how to ring an organisation, how to go for an interview." (SW7)

Support with education and job-seeking also emerged as an important area of social workers' work. Study participants noted that social workers help young people regain their motivation to learn, find suitable education or vocational training opportunities, prepare for job interviews, and contact employment agencies or employers. Such support is directly linked to strengthening social inclusion, as learning and work are among the most important forms of youth

participation in society.

"If a young person drops out of school or is unemployed, they very quickly start to feel unwanted. That is why we try to help them return to education or find something to do." (SW1)

"Young people often lack confidence when looking for work. We help them prepare, map out the steps, and sometimes even accompany them." (SW5)

Accompaniment emerged in the study as a particularly significant form of support. Social workers noted that for some young people, simply providing information is not enough – they need practical support, accompaniment to institutions, help with filling in forms, or encouragement when making decisions. This is particularly relevant when working with young people who have had negative past experiences, do not trust institutions, or feel unsafe in formal settings.

"Sometimes it's not enough just to tell them where to go. You have to go with them, because the young person simply won't go on their own." (SW2)

"Accompanying them *is very important because it gives the young person a sense of security. They know they are not left alone."* (SW6)

The study also showed that social workers associate support for young people with identifying their individual needs. Respondents emphasised that vulnerable young people are not a homogeneous group: some young people need emotional support most of all, others need help with education or finding work, and others need support in dealing with institutions or developing social skills.

"Every young person comes with a different story, so you can't apply one method to everyone." (SW2)

"One needs a ', another needs help finding training or a job, and a third simply needs someone to accompany them to the institution." (SW5)

"The most important thing *is to understand what that young person actually needs, rather than what we think they need."* (SW7)

In summary, it can be said that the forms of support provided by social workers are complex and interrelated. Psychological support, the development of social skills, assistance in the areas of education and employment, accompaniment, individualised support and

practical assistance form a coherent support system aimed at strengthening the young person's ability to act independently and participate in social life.

The roles of social workers. The research findings showed that social workers have a broad understanding of their professional role. They see themselves not only as service providers, but also as counsellors, mediators, motivators, enablers, mentors and creators of safe relationships. This diversity of roles indicates that working with vulnerable or disadvantaged young people requires flexibility, the ability to adapt to the individual young person's situation, and the ability to combine different professional functions.

The role of the counsellor was most frequently mentioned by the study participants. Counselling involves conversation, listening to problems, providing information, assisting with decision-making, and referring the young person to the necessary services. However, the respondents emphasised that counselling when working with young people should not be formal or directive. It must be based on respect, understanding and the young person's active participation.

"I usually see myself as a counsellor, but not one who tells them what to do. More like someone who helps the young person make sense of the situation themselves." (SW3)

"When counselling young people, it's important not to talk down to them. They can tell very quickly if you're being formal with them." (SW4)

The role of a mediator was also frequently mentioned. Social workers noted that young people often find it difficult to communicate independently with schools, social services, healthcare professionals, employment services or other institutions. In such cases, the social worker acts as a link between the young person and the support system.

"Very often I have to mediate between the young person and the school, family, and other specialists. The young person doesn't always know how to speak up or dare to speak." (SW1)

"Mediation helps to reduce tension. Sometimes institutions fail to see the young person's situation, and the young person is unable to explain what is happening to them." (SW7)

The role of the support provider was associated by the study participants with specific practical assistance. This may include help

with paperwork, finding activities, planning a daily routine, resolving conflicts, preparing for an interview, or accessing social services. This role is important because vulnerable young people often need not only emotional support, but also very specific, day-to-day help.

"Sometimes our help is very practical – helping to fill in a form, arranging a meeting, reminding them where and when they need to go." (SW2)

"Young people often don't need theory, but someone who can help them step by step." (SW5)

The role of the motivator became clear when discussing work with young people who lack clear goals, are disillusioned with education, lack self-confidence, or see no point in participating in activities. Social workers noted that building motivation is a long process in which it is not pressure but support that matters, recognising small achievements and identifying the young person's strengths.

"Motivating a young person isn't easy. You have to show that even a small step is important." (SW6)

"Sometimes the young person cannot see their own strengths. Our task is to help them see them." (SW3)

The role of the enabler emerged in the study as one of the most important factors in achieving long-term change. Social workers emphasised that their aim is not to do everything for the young person, but to help them acquire the skills and confidence to act independently. Empowerment is linked to the young person taking responsibility, becoming independent and participating more actively in decisions about their own life.

"It is not about doing things for the young person, but helping them realise that they can do it themselves." (SW4)

"To me, empowerment means that the young person gradually begins to make decisions for themselves and take responsibility for them." (SW7)

The role of the support worker is particularly important when working with young people who are socially vulnerable, have had negative experiences or are afraid to seek help. In such cases, the social worker not only provides information but also physically or emotionally accompanies the young person through the support process.

"I often act as a companion – not just to the institution, but throughout the entire process until the young person becomes stronger." (SW1)

"It is important for the young person to know that there is someone walking alongside them, yet at the same time allowing them to learn independence." (SW5)

In summary, it can be said that the roles of social workers are dynamic and depend on the young person's situation. In one instance, the social worker becomes a counsellor; in another, a mediator; in a third, a motivator, an enabler or a companion. However, all these roles are united by a common goal – to help the young person overcome the risks of social exclusion and strengthen their participation in society.

Strengthening youth inclusion and social security. The research findings revealed that social workers understand youth inclusion as a process in which young people not only receive support but also gradually become more active, independent and self-confident. Inclusion is linked to young people's participation in activities, interaction with peers, building relationships with adults, returning to education or the labour market, volunteering, community involvement and decision-making skills.

Social workers noted that inclusion begins with creating a safe environment. Young people experiencing social exclusion often feel unaccepted, lack self-confidence and fear being rejected. Therefore, the social worker's task is to create an environment in which the young person can be listened to, accepted and encouraged to participate.

"A young person gets involved when they feel safe. If they're afraid of being judged, they simply won't come or will stay silent." (SW2)

"First of all, you need to create a space where a young person can be themselves. Only then can we talk about participation or change." (SW6)

Respondents linked young people's social security to emotional stability, a reliable connection with an adult, the possibility of receiving help, awareness of services, a safe environment and a supportive social network. Study participants emphasised that social security is not merely material support. It is important for a young

person to know that there is a person or institution they can turn to when difficulties arise.

"For a young person, social security is knowing that they have somewhere to turn to and that their problem will be heard." (SW3)

"Sometimes security starts with something very simple – a young person knowing that they can come and talk." (SW5)

These statements suggest that, in the context of young people, social security is closely linked to emotional security, trust and the availability of support. The social worker becomes the person who helps the young person feel accepted, heard and not left alone.

The development of independence emerged in the study as one of the most important areas of social workers' work. Informants stated that it is important for young people not only to receive help, but also to learn to solve problems themselves, plan their actions, take responsibility and make decisions. Social workers link this to the long-term strengthening of social security, as a more independent young person adapts more easily to social changes and is less dependent on constant support.

"Our aim is not for the young person to always be dependent on help. The aim is for them to gradually learn to act on their own." (SW4)

"When a young person calls themselves, makes their own arrangements, and comes to the meeting themselves – that's already a big step." (SW7)

Building self-confidence was also one of the most frequently mentioned prerequisites for inclusion. Social workers noted that young people, particularly those with negative experiences in the family, at school or in the community, often lack confidence in their own abilities. It is therefore important to recognise their strengths, celebrate small achievements and create opportunities for them to experience success.

"It is very important for a young person to experience success. Sometimes it is a small thing, but it means a great deal to them." (SW1)

Social workers also contribute to strengthening young people's participation in the community. Respondents mentioned that involving young people in group activities, volunteering, creative activities, sports or community events helps them to build social

connections, learn to cooperate and feel needed.

"When a young person gets involved in an activity, they start to see themselves not just as someone with problems, but as part of the community." (SW3)

"Taking part in activities helps young people learn to be with others, take responsibility and feel that they are needed." (SW7)

In summary, it can be said that social workers strengthen young people's inclusion and social security through relationships, support, practical assistance, fostering independence, building self-confidence and creating opportunities for participation. The research participants understand youth inclusion not as a one-off involvement in an activity, but as a continuous process in which the young person gradually grows stronger, gains confidence and becomes a more active participant in social life.

Professional challenges and opportunities for improving support. The study results showed that social workers, when working with vulnerable or disadvantaged young people, face various professional challenges. The most frequently mentioned challenges are a lack of motivation among young people, emotional and psychological problems, a lack of family support, distrust of institutions, limited support resources, difficulties in inter-agency cooperation, and a high emotional burden on the professionals themselves.

One of the challenges most frequently mentioned by respondents is the lack of motivation among young people. Social workers noted that some young people are unwilling to engage in activities, do not trust the support provided, see no point in studying or working, shirk responsibility, or quickly withdraw from the support process. However, respondents emphasised that a lack of motivation is often not a personal problem for the young person, but rather the result of previous failures, rejection, low self-esteem or an unfavourable environment.

"A lack of motivation is often just the surface. Behind it lies a lot of disappointment, failure and a feeling that it won't work out anyway." (SW2)

"You can't say that a young person simply doesn't want to. Often they are afraid to try because they have already experienced failure many times." (SW4)

Emotional and psychological problems among young people also emerged as a significant challenge. Social workers indicated that they work with young people who experience anxiety, depressive moods, aggression, self-esteem issues, the risk of addiction, or the consequences of family conflicts. Such problems complicate the process of engagement, as it can be difficult for a young person to maintain relationships, keep to agreements, participate in activities or accept help.

"Emotional difficulties have a major impact on a young person's participation. They may want to come, but lack the strength, be afraid of people, or lack self-confidence." (SW6)

A lack of family support was identified as another significant challenge. Respondents noted that changes in a young person's life are more difficult when the family is characterised by conflict, addiction, neglect, emotional coldness or a negative attitude towards support. In such cases, the social worker often becomes one of the few adults with whom the young person can build a positive relationship.

"If the family is unsupportive, it is very difficult for the young person to sustain change. They return to the same environment where the problems recur." (SW3)

"*Sometimes the social worker becomes the only adult who consistently supports the young person*." (SW5)

Challenges in inter-agency cooperation were also cited as a significant problem. Social workers noted that the effectiveness of support for young people is limited by a lack of information between agencies, differing professional perspectives, bureaucratic procedures, and the fragmented nature of service . When the support system operates in a disjointed manner, a young person may become lost between different institutions or refuse help altogether.

"Sometimes all the professionals work in isolation, and the young person is left between the systems. Then the support becomes very fragmented." (SW7)

"There should be more joint action between schools, social services, psychologists and youth workers." (SW2)

At the same time, the study revealed that cooperation with other specialists and institutions is one of the most important conditions for the effectiveness of support. Social workers often act as

intermediaries between the young person, the family, the school, psychologists, employment specialists, and healthcare or social services institutions.

"A social worker alone cannot solve everything. We need the involvement of the school, the family, a psychologist and other specialists." (SW3)

"*When institutions work together, the young person receives clearer and faster help*." (SW6)

"The problem is that sometimes the systems operate in isolation, and the young person is left in the middle." (SW7)

These results show that the role of social workers is not only to help the young person directly, but also to coordinate the support process, bring together different support providers and ensure that the young person is not left in a fragmented support system.

When discussing opportunities for improving support, respondents most frequently emphasised greater accessibility of services, stronger inter-agency cooperation, more psychological support for young people, long-term support, less bureaucracy and a greater focus on prevention. Social workers emphasised that young people need not short-term, episodic support, but an ongoing relationship and consistent support.

"Young people need continuity. A one-off consultation rarely changes anything, especially if the problems run deep." (SW1)

"There is a severe lack of accessible psychological services. A social worker can do a lot, but not everything." (SW6)

"Support would be more effective if less time were spent on formalities and more on direct work with the young person." (SW4)

In summary, it can be said that the challenges faced by social workers are related both to the young people's situations and to the organisation of the support system. Young people's lack of motivation, emotional problems, lack of family support and difficulties in inter-institutional cooperation hinder the strengthening of social inclusion and social security. However, the responses of the study participants indicate that the effectiveness of support can be enhanced by strengthening inter-institutional cooperation, ensuring continuity of services, improving access to psychological support, reducing excessive bureaucracy, and creating conditions for professional support for social workers.

The results of a structured interview conducted with seven social workers revealed that social workers play a key role in promoting youth inclusion and social security. Their support includes emotional support, the development of social skills, counselling, mediation, accompaniment, assistance with education and job-seeking, and practical support for young people in everyday situations. The study showed that social workers most often see themselves as counsellors, mediators, helpers, motivators, enablers and companions. These roles are not separate, as in practice they often overlap: the same specialist may simultaneously advise a young person, mediate between them and institutions, motivate them to participate in activities, and accompany them through the support process.

Youth inclusion and social security are strengthened by building a relationship based on trust, creating a safe environment, and encouraging young people's independence, self-confidence and participation in the community. The research findings suggest that social workers strengthen youth inclusion and social security through three main approaches: building a relationship based on trust, providing individualised support, and ensuring inter-institutional cooperation.

However, this process is hampered by a lack of motivation among young people, emotional and psychological problems, a lack of family support, fragmented inter-institutional cooperation, and the high emotional burden on professionals. Therefore, to enhance the effectiveness of support for young people, it is necessary to ensure the continuity of services, strengthen inter-institutional cooperation, increase the availability of psychological support, and create conditions for the professional support of social workers.

Discussion

The results of the study provide a deeper understanding of the role of social workers in strengthening the social inclusion and social security of young people with fewer opportunities. The data obtained confirm the position highlighted in the introduction and theoretical section of the article that social work with young people involves a multifaceted process combining emotional support, counselling, mediation, social skills development, accompaniment, motivation, empowerment and the strengthening of young people's participation in the community.

The research findings are consistent with Cedeño's (2023) insights that social work with young people is an important tool for social inclusion, prevention and empowerment. The respondents' experiences showed that social workers not only respond to young people's existing problems but also seek to create conditions for their long-term social participation. This is particularly important for young people with fewer opportunities, whose involvement in education, work, community activities or social relationships is limited by economic, family, educational, psychological and other risk factors. In this regard, the research data confirm the point emphasised by Renner et al. (2024) and Filia et al. (2025) that social exclusion among young people is shaped by interrelated personal and environmental factors.

One of the most important findings of the study is that social workers primarily associate the helping process with the establishment of a relationship based on trust. Respondents emphasised that without trust, young people often do not accept help, avoid talking about their difficulties, and do not trust institutions or adults. This conclusion aligns with Ritchie & Ord's (2017) assertion that support, advice and a relationship from social workers are particularly important for young people, helping them to better understand their situation. The study's findings are also in line with the view of Clonan-Roy et al. (2021) that informal youth spaces can become a safe environment where young people can express their emotions, experience support and a sense of community. This suggests that social security in the context of young people is not merely about the availability of services or institutional support. It is primarily created through a relationship in which the young person feels heard, accepted and not judged.

The research data also confirm the concept of social inclusion discussed in the theoretical section. Cano-Hila (2022) links social inclusion to real opportunities to participate, form social connections, express needs and feel like a full member of society. The results of this study show that social workers also understand inclusion as a process in which a young person gradually becomes more active, more independent and more self-confident. This means that inclusion is not merely the 'involvement' of a young person in activities. It involves creating a safe environment, building self-esteem,

developing practical skills, maintaining motivation and rebuilding social connections.

It is important to note that the study's findings revealed a distinction between formal participation and genuine inclusion. The logic of exclusion, segregation, integration and inclusion identified by Frøyland et al. (2022) helps to better explain the study's data. A young person may be formally involved in learning, work or community activities, but this does not necessarily mean that they feel accepted or have a real opportunity to act. According to the respondents, young people's participation only becomes meaningful when they feel safe, can express their opinions, experience success and see themselves as part of the community . This conclusion aligns with the view of Van Mieghem et al. (2020) that inclusion requires not only the adaptation of the individual, but also changes in the environment, attitudes and structures.

The study's findings also contribute to the concept of social security. Vílchez & Trujillo (2023) link social security in the context of young people not only to economic or material security, but also to emotional, social, educational and community security. Respondents' answers showed that for young people, social security often means knowing that there is someone they can turn to, that their problem will be heard, and that help will be available. This aligns with the view of Lisauskienė & Rimkevičienė (2019) that a young person's sense of security is strengthened when they have reliable relationships, are aware of their options, and can access support in the event of a crisis. Thus, the social worker emerges in the study as a key contributor to social security, helping young people not only to resolve specific difficulties but also to build a more stable relationship with their environment.

An analysis of social workers' roles showed that, in practice, these roles are dynamic and overlap. Study participants described themselves as counsellors, mediators, motivators, enablers, companions and helpers. These results correspond to the roles of social workers identified by Gudžinskienė & Ramanauskas (2017) when working with vulnerable young people, as well as the assertion by Jakaitienė & Kavaliauskienė (2023) that the role of a counsellor is one of the most common when working with young people with fewer opportunities. However, the results of this study show that

counselling in the field of youth work is not merely about providing information. It involves building relationships, analysing problems, providing emotional support, seeking solutions and strengthening the young person's independence.

The role of the mediator and companion emerged as particularly significant in the study. Social workers help young people to connect with schools, social services agencies, healthcare professionals, employment agencies or other parts of the support system. This finding aligns with Creaney & Case's (2022) view that the social worker acts as a bridge between the young person, their family, institutions and the community. Mediation becomes particularly important when young people do not trust institutions, are unaware of their rights or lack the skills to seek help independently. In such cases, the social worker bridges the gap between the young person and the support system.

The aspect of empowerment also emerged in the study as one of the most important directions for long-term support. Respondents emphasised that their aim is not to act on the young person's behalf, but to help them gradually make decisions themselves, take responsibility and act independently. This aligns with Parker & Doel's (2013) view that social workers should focus on an individual's potential for growth and change, as well as Munford & Sanders' (2021) assertion that social work should strengthen an individual's dignity, autonomy and meaningful participation. The research data suggest that empowerment is a crucial link between social support and social inclusion: only by growing stronger as an independent agent can a young person participate more actively in social life.

The study also showed that the methods used by social workers must be flexible and individualised. This aligns with the need, emphasised by Munford & Sanders (2021), to tailor support to the specific situation of the young person. Respondents emphasised that young people with fewer opportunities are not a homogeneous group: some young people need emotional support, others need help developing social skills, others need assistance with education or job-seeking, and still others need support in dealing with institutions. This conclusion is important for practice, as it shows that standardised, one-size-fits-all support is insufficient. A social

worker's professional competence is demonstrated by their ability to identify individual needs and select methods of support that are acceptable and effective for the young person in question.

The research findings also confirm the importance of informal and open youth work environments. The principles of voluntariness, accessibility, confidentiality, respect and a focus on the young person's needs ( ), as highlighted by Barnes (2012), are reflected in the respondents' experiences. Social workers emphasised that pressure or control do not work with young people; support must be based on respect, patience and the opportunity for the young person to engage at their own pace. This is consistent with the insights of Dilytė-Kotenko (2023) and De St Croix & Doherty (2023) that open youth spaces provide young people with the opportunity to socialise, learn, participate and contribute to the development of activities.

Another significant finding of the study relates to professional challenges. Respondents most frequently cited young people's lack of motivation, emotional and psychological problems, a lack of family support, mistrust of institutions, the fragmented nature of services, and difficulties in inter-institutional cooperation. These results indicate that barriers to young people's social inclusion arise not only from the young person's individual characteristics, but also from environmental and systemic factors. This aligns with the view of Atkinson & Rees (2022) and Liutkevičienė (2015) that it is not the young person's personality itself that is at risk, but the environment in which they live and socialise. Therefore, a lack of motivation should be viewed not as the young person's unwillingness to change, but as a consequence of previous failures, exclusion, mistrust and a lack of support.

The research data also allow for a discussion of the importance of inter-institutional cooperation. Bounds et al. (2020) emphasise that the problems faced by vulnerable young people are complex, and therefore the help of a single specialist is often insufficient. The results of this study confirm this view: social workers indicated that effective support requires cooperation between schools, families, psychologists, social services, healthcare, employment services and other institutions. When institutions operate in a fragmented manner, a young person may fall 'between the cracks', and support becomes inconsistent. Therefore, the role of a social worker encompasses not

only direct work with the young person, but also the coordination of the support process.

In summary, it can be said that social workers strengthen youth inclusion and social security through three main approaches: building a relationship based on trust, providing individualised and empowering support, and mediating between the young person and their social environment. These approaches demonstrate that social work with young people is not merely a support service, but also an infrastructure for social inclusion, helping young people with fewer opportunities to build connections, regain self-confidence, participate in the community and feel safer.

Conclusions

Youth social inclusion and social security in the context of social work emerge as closely interrelated processes. The study showed that social inclusion is not merely a young person's participation in activities, education or the labour market. It encompasses a young person's ability to feel accepted, heard, safe, socially connected and able to actively participate in decisions affecting their life. In this context, social security is understood more broadly than material or institutional support; it is linked to emotional stability, trust, the availability of support and a supportive social environment.

The work of social workers in strengthening the inclusion of young people with fewer opportunities is multifaceted and is not limited to the formal provision of services. The research findings revealed that social workers employ comprehensive forms of support: emotional support, individual counselling, social skills training, practical assistance, accompanying young people to institutions, support in the areas of education and job seeking, and involvement in community activities. These forms of support help young people to strengthen their independence, self-confidence, sense of responsibility and ability to function in a social environment.

One of the most important foundations of a social worker's work is building a relationship based on trust. Vulnerable or disadvantaged young people often lack trust in adults, institutions and the formal support system; therefore, the support process can only begin when the young person feels safe, accepted and listened to. A relationship

based on trust becomes a prerequisite for the young person's continued engagement, strengthening of motivation, development of social skills and long-term change.

Social workers play several interrelated roles in the process of strengthening youth engagement and social security: consultant, mediator, support provider, motivator, enabler and companion. In practice, these roles often overlap, as the same professional helps the young person to understand their situation, make decisions, liaise with institutions, get involved in activities and gradually act more independently. Therefore, the role of the social worker is considered essential not only in resolving the young person's individual problems, but also in strengthening their participation in society.

Strengthening youth inclusion is most effective when support is tailored to the specific needs and life circumstances of the individual young person. The study's findings showed that young people with fewer opportunities are not a homogeneous group: some need emotional support, others practical assistance, social skills training, mediation or long-term support. Therefore, standardised and short-term interventions are not sufficient. Flexible, consistent social work focused on the young person's strengths is required.

The main challenges faced by social workers relate to young people's lack of motivation, emotional and psychological problems, lack of family support, distrust of institutions, limited support resources and fragmented inter-agency cooperation. These challenges indicate that the risks of social exclusion among young people arise not only from the individual difficulties faced by young people, but also from broader shortcomings in the social environment and the support system.

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SUSTAINABLE DEVELOPMENT AND MULTIDIMENSIONAL SECURITY IN THE MIDDLE EAST: ECONOMIC, SOCIAL, ENVIRONMENTAL, AND DIGITAL PERSPECTIVES

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Abstract
Specifically in the areas where economic, social, environmental, and digital security play an indispensable role, struggling with the security aspect in sustainable development remains one of the numerous problems that the region of the Middle East encounters. Via the implementation of a qualitative, exploratory, & integrative literature review method, supplemented by secondary quantitative data from internationally recognized datasets (World Bank, UNDP, FAO AQUASTAT, ITU) covering 2023–2025, this monograph part blends modern peer-reviewed studies published between 2023 and 2025 to discover how such dimensions intermingle within a compound regional perspective characterized by economical setbacks, demographic pressures, environmental stress, in addition to speedy digital transformation. Results show that acquiring and maintaining a sustainable development in the Middle East is not something that can be easily attained as it heavily relies on the aforementioned four main aspects. Nonetheless, the economic insecurity, which is even more and more driven by oil dependency and labor market imbalances, is positively correlated with social instability, whereas the environmental challenges such as water scarcity, that intensify both economic and societal risks, remain to be present. Concomitantly, digital transformation introduces innovative opportunities combined with cybersecurity threats and inequalities as well. This research highlights

the standing of adopting a systems-based approach that assimilates multiple dimensions of security to improve resilience and long-term sustainability. Furthermore, the findings highlight the importance of the proper implementation of operative policy frameworks backed up with economic, social, environmental, and digital resilience to address the region's complex and evolving encounters.

Keywords: *sustainable development, economic security, social security, environmental security, digital security, Middle East, systems approach.*

Introduction

Recently, the concept of sustainable development is a trendy science that cannot be discussed alone without its indispensable aspects: operations and security. Such a framework is lately visible in the Middle East due to the fact that this region faces several challenges which are closely linked with economic instability, environmental stress, demographic burdens, and geopolitical uncertainty. Therefore, sustainability is nothing without taking security measures across multiple dimensions into consideration. Recent scholarship has emphasized that the traditional three-pillar model of sustainability (economic, social, environmental) is insufficient without explicitly integrating security governance mechanisms (Malmio, 2024). Additionally, the existing literature stresses the costs of wasteful sustainability on security, given that a breakdown in one domain can spread to another under the concept of cascading events (Lapinskaitė & Skvarciany 2023; Al-Saidi et al., 2023; Oprea & Bara 2026). Out of several possible scenarios, the most prevalent is the environmental degradation, which in the form of water scarcity that can lead to economic instability, which in turn lead to exaggerated social dissimilarities and political pressures. According to Baumann and Roccu (2023), such cascading effects are methodically undervalued in regional policy frameworks, yielding reactive rather than proactive supremacy.

Particularly in the Middle East, such events can be highly spotted. Mahmood (2024) argue that the entire MENA region displays the uppermost global correlation coefficient ($r = 0.74$) between resource shortage and intrastate conflict, highlighting the perseverance of integrated security-sustainability preparation. This region brawls with structural economic reliance on hydrocarbons, increased

unemployment rate, and rough social protection structures, aggravated by the fast digital transformation. Moreover, governments are investing deeply in digitalization and diversification approaches, generating new opportunities accompanied with serious vulnerabilities (Weigl et al., 2024). According to Al-Hawawreh, et al., (2025), digital transformation in the absenteeism of vigorous cybersecurity frameworks has augmented the region's contact to ransomware outbreaks by 312% between 2020 and 2023. Therefore, there is a need to reshape sustainable development within the framework of security. Numerous authors have suggested contexts for operationalizing this incorporation. A multidimensional security index for the Arab region was proposed by Kraitzman and Genauer (2023), whereas Larkin and Rudolf (2024) implemented systems dynamics modeling to trigger security-sustainability trade-offs in post-conflict modernization. Henceforth, this monograph examines four main dimensions: the economic, social, environmental, and digital security, and analyses their contact with sustainable development in the Middle East. Instead of treating these dimensions as independent, the analysis utilizes a system perspective, which integrates their interdependence and holistic effects on sustainable development. This approach aligns with the recent call by Demir et al., (2025) for a "new political economy of sustainable development" in the Middle East that explicitly centers security interdependencies.

This research aims to examine the interrelationship between economic, social, environmental, and digital security within the framework of sustainable development in the Middle East. Through the implementation of a "systems-based" perspective and the combination of late literature reviews, this study aims to categorize how these interrelated dimensions impact regional sustainability, resilience, and long-term development outcomes. In doing so, it responds to the research gap identified by Kim and Ferré Garcia, (2023), who found that only 12% of existing studies on Middle Eastern sustainability treat security dimensions as interactive rather than independent variables.

Materials and Methods

1 Research Approach

This monograph implements a qualitative, exploratory, & integrative literature review method. Such a method works well for

combining perceptions across interdisciplinary sciences. It is worth mentioning that the quantitative approach is not recommended in such monographs because the conceptual nature of "security within sustainability" would lead to the risk of oversimplifying the relationships between variables. Rather, this study selects depth, interpretation, and critical evaluation of recent academic contributions to existing literature.

2 Search Strategy and Data Sources

An exploratory research study was conducted across major academic databases, including Scopus, Web of Science, ScienceDirect, and SpringerLink. The search mainly focused on peer-reviewed journal articles published between 2023 and 2025, ensuring that the analysis reflects the most recent debates and relevant findings. Search terms included phrases such as "sustainable development and security," "economic security in the Middle East," "water scarcity in MENA region," and "cybersecurity sustainable development", "social protection Middle East," "digital inequality Arab world," "climate security nexus MENA," and "energy transition Gulf states." Such a procedure primarily recognized nearly 78 articles. After eliminating duplicates and screening abstracts for relevance, the final result was 36 articles chosen for a more detailed review. The selection criteria for papers were defined by 3 criteria. Articles were included if they addressed at least one dimension of security within sustainability, presented a theoretical and/or empirical analysis relevant to the Middle East region, and clear methodological procedure. To provide empirical grounding for the qualitative themes identified in the literature, this monograph incorporates secondary quantitative data from the following 6 internationally recognized datasets covering the period 2023–2025, summarized in Table 5.1 below.

These datasets serve to triangulate and validate the qualitative findings derived from the peer-reviewed literature, offering observable regional trends without altering the primarily qualitative, exploratory nature of this monograph.

After the selection process aforementioned, the chosen articles were further studied by applying "thematic synthesis" approach, which permits repeated patterns and associations to develop

progressively from the literature. Furthermore, the analysis was built on the basis of four pillars: the economic, social, environmental, and digital security. Finally, a special attention was attributed to the probable existence of correlations between such pillars and how they interact instead of how they independently operate. Dataset indicators were mapped onto each pillar to cross-validate emergent themes.

Table 5.1

Data set sources (source: compiled by authors, 2026)

Dimension	Dataset	Source	Key Indicators Used
Economic	World Bank Open Data (2023–2025)	World Bank	GDP growth, oil rents (% of GDP), youth unemployment rate
Social	UNDP Human Development Report (2023/2024)	United Nations Development Programme	Human Development Index (HDI), inequality-adjusted HDI, Gender Development Index
Environmental	FAO AQUASTAT (2024)	Food and Agriculture Organization	Renewable internal freshwater resources per capita (m^3/person/year)
Digital	ITU World Telecommunication/ICT Indicators (2024)	International Telecommunication Union	Global Cybersecurity Index, fixed broadband subscriptions per 100 inhabitants

Source: compiled by authors, 2026

Results and Discussion

The four main dimensions that were mentioned in the literature review are discussed, each supported by empirical data from the

supplementary datasets and reinforced by recent peer-reviewed studies, and will be discussed in detail further.

1 Economic Security

Economic security is a critical element of sustainable development; nevertheless, in the Middle East, it is manifested by structural vulnerabilities. Nowadays, this region, relies more and more on oil revenues, which in turn exposes national economies to global market instability. Çiçekçi and Gaygısız (2024) concluded that fluctuations in oil prices directly disrupt the shape of public outflows, leading to rounds of expansion and contraction in social and infrastructure investments. Abdelsalam (2023) extended this examination by demonstrating that oil price instability accounts for 58% of the change in public infrastructure spending across Gulf Cooperation Council nations, with direct knock-on effects on employment and social services. Data from the World Bank Open Data set in 2024 supports this organizational dependency: typical oil fees as a percentage of GDP across the main Middle Eastern oil-exporting economies remain above 25%, with numerous Gulf Cooperation Council countries surpassing 40%. Actually, Çiçekçi and Gaygısız (2024) confirm that this is directly related to procyclical monetary policy and reliance on reserves. Besides, in 2023, Msann and Karthiayani proposed panel data evidence based on 12 MENA countries. Results showed that for every 10% decrease in oil prices, non-oil GDP growth fell by about 2.3%, demonstrating the tenacious resource curse even amid diversification efforts.

To address this problem, countless countries have initiated diversification policies. A very specific case can be illustrated by the Gulf region, whose economies rely heavily on investment across sectors such as tourism, logistics, and renewable energy. Nevertheless, realizing these efforts were useless because no noteworthy progress had been made. Bashir et al., (2025) conducted a comparative analysis of diversification outcomes across the Gulf states and found that only the United Arab Emirates and Saudi Arabia have achieved statistically significant reductions in hydrocarbon revenue concentration between 2015 and 2024, with others remaining largely unchanged**.** According to Liu et al., (2024), the gap between labor force skills and emerging industries were due to weak diversification strategies, as well as fragile institutional and

labor market policies. However, Ayadi et al. (2024) presented a different argument, emphasizing the importance of concurrent investments in vocational education aligned with emerging sector needs (renewable energy, logistics, digital services), so that diversification policies can perform as intended.

Concerning unemployment, as another dimension of economic insecurity, it significantly impacts the firm's economic performance, especially among youth. According to World Bank data (2025), the average youth unemployment rate (ages 15–24) in the Middle East stands at approximately 23.6%, substantially higher than the global average of 14.3%. That pragmatism is becoming increasingly serious, for instance, in countries such as Lebanon, Jordan, and Tunisia, where it exceeds 30%, and is forecast to keep increasing. Such a fact can significantly impact productivity, as well as social dissatisfaction and political instability. In an attempt to further analyze the possible existence of causal correlation between youth unemployment rates and social protest intensity, Desai (2023) implements "time-series" econometrics through six different Middle Eastern countries. The authors found that such a relationship is positively correlated. This also shows a positive correlation between economic and social security. Hence, economic improvements must be achieved yet escorted with comprehensive labor policies.

The Digital transformation offers dual aspects: the first is the creation of new economic opportunities through innovation and entrepreneurship, whereas the other is the introduction of risks such as cybercrime and technological disruption, which can undermine financial systems and business continuity (Tabansky et al. 2024). Bellakhal and Mouelhi (2023) surveyed 450 small and medium enterprises across the MENA region and found that firms with higher digital adoption rates experienced 18% faster revenue growth, but those without cyber insurance or IT security protocols were 3.2 times more likely to suffer operational disruption from cyber incidents. Therefore, the economic security in the region is progressively linked to digital resilience.

2 Social Security

Another indispensable aspect in maintaining sustainability is the concept of social security. The latter refers to the process of including admission to vital services, social protection measures, and

inclusive societal stability. Additionally, the Middle East region still hasn't overcome the problem of "inequalities" in social security systems, indicating unblemished changes in economic growth and governance arrangements. In 2023, Zaman et al., performed an exhaustive institutional examination of social protection systems for eight Middle Eastern countries. They concluded that employees make up to 65% of the regional workforce in non-governmental firms. This explains that resilient coverage gaps are the reason, not resource scarcity. Demographic pressure is one of the most significant obstacles faced by firms operating in the sustainability field in the Middle East. The problem is that the population of such a region is characterized by rapid growth, which is increasingly challenging for education systems and labor markets. According to UNDP, in 2024, the youth unemployment rate was among the highest globally, widening the gap between educational attainment and employment opportunities. According to Assaad and Krafft (2023), the unemployment rate for citizens aged 25 to 34 (including university students) was 28% for women and 17% for men, showing that educational expansion unaccompanied does not resolve labor market mismatches. The authors' data set was obtained from labor force survey data from the main MENA countries such as Egypt, Jordan, and Tunisia. Another data set, however, this time from the UNDP Human Development Report 2023/2024 (UNDP, 2024), further exemplifies this encounter: the Arab States region scored 0.704 on the Human Development Index (HDI), below the world average of 0.739. Critically highlighting that the inequality-adjusted HDI plummeted to 0.547, signifying considerable internal discrepancies. Finally, it is worth nothing that the Gender Development Index for the region is 0.87, compared to the world average of 0.95, proving determined gender-based dissimilarities.

Not forgetting the fact that the social security is further worsened by conflicts and augmented displacement. Countries that are directly affected by long-lasting instability experience turbulence in healthcare, tutoring, and elementary services, weakening long-term expansion forecasts. El-Abed et al., (2023) examined the long-term effects of displacement on social cohesion in Lebanon, Jordan, and Iraq following the Syrian conflict, finding that host communities with higher refugee concentrations experienced a 22% decline in

trust in public institutions and a 17% reduction in willingness to pay taxes for local services – direct indicators of degraded social security. Such circumstances have a negative dual effect manifested by weakened social cohesion and mitigated economic recovery. Bitzer and Gören (2024), through using spatial regression models, demonstrate that regions with higher forced displacement exhibit statistically significant reductions in small business formation and local investment, persisting for up to six years after initial displacement peaks. Another perspective on social security is the presence of gender inequality. Despite the fact that certain enhancements have been seen in the female education sector, the women labor force remains comparatively low in several countries. According to a study done by "The World Bank" in 2023, the legal and official obstacles endure to border women's economic participation, hence creating a broader constraint in terms of growth results. Taheri et al., (2024) conducted a legal-mapping exercise across 14 Middle Eastern countries and identified that, on average, women face 2.7 legally codified restrictions on employment (e.g., prohibitions on night work, limitations on sectors, spousal permission requirements) compared to 0.4 in OECD countries, directly correlating with a 31 percentage point gap in labor force participation.

Recent research suggests that strengthening social security requires more than expanding welfare programs. Organizations should focus on reform processes that should comprise constructing comprehensive institutions, improving governance, and nurturing social trust. Goetz et al., (2023) propose a "social resilience framework" based on case studies from Morocco, Jordan, and Tunisia, arguing that investments in decentralized governance and community-level dispute resolution mechanisms yield higher returns in social security outcomes than equivalent investments in centralized cash transfer programs. In the case of the absence of such elements, the social systems remain insubstantial and susceptible to external shocks.

3 Environmental Security

Equally important as previously mentioned aspects, environmental security is very challenging in the Middle East for maintaining sustainability. Additionally, such a region is

characterized by a sterile climate with rising temperatures and declining water availability, all of which pose serious and unwarranted ecological problems. The ecological problem is not bordered with the climate problems only, which worsens the situation is the scarcity of water jeopardizes several aspects. For instance, several Middle Eastern countries already function on the verge of water strain. Furthermore, climate change is forecasted to deteriorate the circumstances. According to Al-Saidi et al. (2023), the lack of water is a dual challenge: the first is that it is an environmental problem per se, whereas the second is that it causes socio-economic and political troubles, due to the significant relationship between agriculture, industry, and the entire region's stability. Hejazi et al. (2023) used climate projection models (RCP 4.5 and 8.5) to forecast agricultural water demand across the MENA region through 2050, concluding that without transformative adaptation, rain-fed agriculture could decline by 40%–60%, displacing an estimated 10–19 million rural livelihoods. Quantitative validation from the FAO AQUASTAT database (2024) is striking: 14 out of 17 Middle Eastern countries fall below the absolute water scarcity threshold of 500 m^3 of renewable internal freshwater resources per capita per year. Several countries, including Jordan, Yemen, and the Gulf states, report values below 150 m^3/person/year well into the extreme scarcity category. These empirical boundaries confirm Al-Saidi et al.'s (2023) conceptual framework and demonstrate the systemic risk posed by water deprivation. Barnay and Zaitchik (2025) further quantify this by calculating the "water security multiplier" for the region: each 10% reduction in renewable freshwater availability is associated with a 4.7% increase in food import dependence, a 2.3% increase in intra-regional water-related diplomatic tensions (measured by event data), and a 1.8% decline in manufacturing output.

Food security is directly correlated with the environmental conditions. The problem lies in the partially cultivable land and very limited water resources, which force numerous nations to depend heavily on food imports, leaving them exposed to global supply chain disruptions. Such reliance has become increasingly apparent throughout current global crises, where variations in food prices have had instantaneous social and economic consequences. Rahimi et al.,

(2023) constructed a food security vulnerability index for 19 Middle Eastern countries, finding that the region's average import dependence for strategic cereals (wheat, rice, maize) reaches 68%, compared to a global average of 24%. They further simulate that a simultaneous 30% increase in global grain prices would increase regional food insecurity by an estimated 22% and raise undernourishment rates by 8–11 percentage points.

A noteworthy point is the impact of energy consumption on environmental insecurity. Notwithstanding cumulative investments in renewable energy, fossil fuels continue to dominate the energy mix. Doytch et al. (2023) and Al-Saidi (2023) analyzed renewable energy deployment across the Gulf states and identified contradictory policy signals: despite ambitious renewable energy capacity targets (e.g., Saudi Arabia's 58.7 GW by 2030), fossil fuel subsidies amount to 25–30 billion annually, diverting funds from sustainable infrastructure.

Importantly, environmental issues do not exist in isolation; rather, they interact through interdependency and concomitancy. As a result, we can identify the intermingling among economic, social, and environmental systems, which may lead to overcomplicating operating structures, specifically in terms of resources. For instance, water scarcity remains a major concern for a firm's operations. This explains why a diminished agricultural production exists, which in turn leads to significant losses in incomes and increased social dislocation. To solve such a problem, the implementation of environmental security systems that necessitate cohesive, cross-sectoral approaches is unquestionable. Hindiyeh et al. (2023), drawing on case studies of water-energy-food nexus governance in eight Middle Eastern countries, identify that institutional fragmentation (averaging 4.7 separate ministries with overlapping mandates) is the primary barrier to integrated environmental security, exceeding resource and technical constraints.

4 Digital Security

For digital security, it is a relatively new but rapidly expanding dimension of sustainable development. Middle Eastern governments began implementing digital operations to follow the trend of comprehensive modernization. However, this transition proposes new challenges. One such challenge is evident in cybersecurity. The

latter comprises threats that are increasingly complex, targeting precarious infrastructure, financial institutions, and government structures. According to Abramson and Baram (2024), the rate of cybercrime can have far-reaching consequences, affecting economic events and corroding public confidence. Yigit et al., (2024) analyzed cyber incident data from 2018 to 2024 across the MENA region and found that critical infrastructure sectors (energy, water, transportation) experienced a 340% increase in targeted attacks, with state-affiliated threat actors accounting for 67% of incidents with confirmed attribution. Data from the International Telecommunication Union (ITU, 2024) reveals a pronounced digital divide within the Middle East: while Gulf Cooperation Council states score above 0.8 on the Global Cybersecurity Index (scale 0–1), several non-Gulf Middle Eastern nations score below 0.5, indicating substantial gaps in legal, technical, and organizational cybersecurity capacities. Additionally, fixed broadband subscriptions per 100 inhabitants range from over 35 in the Gulf states to fewer than 10 in conflict-affected countries, reinforcing disparities in digital infrastructure. Craig et al., (2023) conducted a comparative policy analysis of national cybersecurity strategies across nine Middle Eastern countries and found that only three (UAE, Saudi Arabia, Qatar) have fully operationalized public-private information sharing frameworks, while five lack legally mandated incident reporting requirements for private sector entities a critical gap for threat intelligence.

Nevertheless, a main obstacle is the shortage of skilled cybersecurity professionals, which limits the region's ability to respond effectively to threats. Douzet et al., (2023) surveyed 230 public and private sector organizations across Egypt, Jordan, Lebanon, and Tunisia, finding that 79% reported "severe" or "critical" shortages of qualified cybersecurity personnel, with average vacancy times for security analyst positions exceeding 8.5 months nearly three times the global average. In addition, regulatory frameworks often lag behind technological advancements, creating gaps in data protection and governance. Digital inequality is another concern. While some countries have advanced digital infrastructures, others face limitations in connectivity and access. This uneven development risks widening existing socio-economic disparities.

Muschert and Ragnedda (2024) used survey data from 12,000 households across eight Middle Eastern countries to construct a Digital Access and Literacy Index, finding that rural-urban digital divides average 41 percentage points in broadband access and 34 percentage points in digital literacy comparable to sub-Saharan African levels in the region's most disadvantaged areas**.** The ITU data quantitatively confirms this: the standard deviation in fixed broadband penetration across Middle Eastern countries is 12.4, compared to 5.8 in the European Union, demonstrating significantly higher regional inequality.

Despite these challenges, digitalization also offers significant opportunities. It can enhance service delivery, improve governance, and support economic diversification. The key lies in balancing innovation with security, ensuring that digital systems are both efficient and resilient (Weigl et al., 2024). Dechamps et al., (2025) present a successful case study of Tunisia's digital identity and e-governance platform, demonstrating that targeted investments in cybersecurity capacity-building (including a national computer emergency response team, sector-specific security operations centers, and university-accredited training programs) reduced successful cyberattacks by 58% over three years while increasing digital service adoption by 112%.

Conclusions

The analysis presented in this monograph, integrating qualitative literature synthesis from 17 peer-reviewed studies (2023–2025) with secondary quantitative data from World Bank, UNDP, FAO, and ITU datasets, highlights that sustainable development in the Middle East is fundamentally a question of managing interconnected security challenges. Economic, social, environmental, and digital dimensions are not independent; rather, they form a tightly coupled system in which instability in one area can quickly propagate to others.

The empirical data reinforced the qualitative findings: oil dependency exceeding 25% of GDP in many economies, youth unemployment averaging 23.6%, 14 out of 17 countries below absolute water scarcity thresholds, and a wide digital divide in cybersecurity readiness scores (0.8 vs. 0.5) all confirm that no single dimension can be addressed in isolation. The additional literature integrated into this review further solidifies these conclusions:

quantitative evidence from Msann, and Karthiayani (2023) on oil-GDP linkages, Desai (2023) on unemployment-protest causality, Hejazi et al. (2023) on climate-agricultural displacement, and Yigit et al., (2024) on cyber threats to critical infrastructure collectively demonstrate that the four security dimensions are not merely correlated but causally interdependent.

Policy approaches that focus on isolated sectors are therefore unlikely to succeed. Instead, integrated strategies that address multiple dimensions simultaneously are required. Economic diversification must be aligned with social inclusion, environmental sustainability, and digital resilience. As specifically demonstrated by Ayadi et al., (2024), Taheri et al. (2024), institutional fragmentation across these domains remains the binding constraint and thus the primary leverage point for policy intervention.

Future research should move beyond conceptual analysis toward empirical models that capture these interdependencies. Specifically, researchers should consider structural equation modeling to estimate direct and indirect effects across dimensions, as well as comparative case study designs that isolate successful integrated policy interventions. Such work would provide a stronger foundation for evidence-based policymaking in the region.

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STRATEGIC KNOWLEDGE MANAGEMENT IN THE SYSTEM OF ENSURING COGNITIVE SECURITY FOR SUSTAINABLE DEVELOPMENT

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Abstract
This chapter examines strategic knowledge management as a key component of the system for ensuring cognitive security in the context of sustainable development under conditions of digital transformation and the growing influence of cognitive attacks. The essence of cognitive warfare and its impact on information security, societal resilience, and decision-making processes are analyzed. The interrelationship between strategic knowledge management, cognitive security, and the development of society's intellectual potential is substantiated. A conceptual mechanism for ensuring cognitive security is developed, integrating four functional levels and a comprehensive set of interconnected instruments for countering cognitive threats. Practical recommendations are proposed for governmental institutions, educational organizations, businesses, and civil society aimed at enhancing media literacy, critical thinking, information verification systems, and interinstitutional cooperation in order to strengthen societal resilience to disinformation and manipulative influence.

Keywords: *strategic knowledge management, cognitive security, sustainable development, cognitive warfare, disinformation, critical thinking, media literacy, information resilience.*

Introduction

The modern world is characterized by the rapid development of information technologies and the emergence of new types of conflicts, among which cognitive warfare plays a distinctive role. This phenomenon represents a novel form of confrontation aimed at manipulating the consciousness, beliefs, and decision-making processes of target audiences through complex informational and psychological influences (Paziuk et al., 2025). Unlike traditional armed conflicts, cognitive warfare targets human cognition and intelligence directly, making it particularly dangerous in an era of global digitalization and informational interdependence.

The relevance of studying hybrid informational threats arises from several interrelated factors. First, the rapid expansion of social networks and digital platforms has created unprecedented opportunities for large-scale influence on public opinion and individual consciousness. Second, advances in artificial intelligence technologies, including deepfakes and algorithmic content manipulation, have significantly enhanced the effectiveness of cognitive attacks. Third, escalating geopolitical tensions and international instability have intensified the use of cognitive influence methods as alternatives to traditional coercive instruments for achieving strategic objectives.

This challenge has become particularly acute in the context of Russia's aggression against Ukraine (Strelbytsky et al., 2023), demonstrating the large-scale use of cognitive technologies to destabilize society, spread disinformation, and erode trust in democratic institutions. Ukraine's experience in confronting cognitive threats highlights both the vulnerabilities of modern democratic systems and the potential for effective countermeasures. Consequently, this research is highly relevant not only for Ukraine but also for the international community as a whole.

Cognitive security has become an increasingly important prerequisite for sustainable development, as manipulative informational influences undermine institutional trust, social cohesion, democratic governance, and the long-term stability of socio-economic systems. In the digital age, sustainable development depends not only on economic and environmental factors but also on the resilience of knowledge ecosystems and the ability of societies to

preserve the integrity of information processes. Consequently, the formation of adaptive institutional and managerial mechanisms for cognitive security constitutes a strategic priority for ensuring sustainable societal development.

The purpose of this study is to develop theoretical and methodological foundations for strategic knowledge management as a mechanism for ensuring cognitive security in the context of sustainable development. To achieve this objective, the study pursues several interrelated tasks: to analyze the nature and characteristics of modern cognitive warfare and information manipulation; to investigate the role of strategic knowledge management in strengthening institutional resilience and cognitive security; to develop a conceptual mechanism integrating institutional, technological, educational, and managerial instruments for ensuring cognitive security; and to formulate practical recommendations for the implementation of this mechanism within governmental, educational, business, and civil society structures.

Theoretical foundations of the study

Conceptual principles of strategic knowledge management. The conceptual foundations of strategic knowledge management began to emerge in the second half of the twentieth century, influenced by theories of the post-industrial and information society. A significant breakthrough in this field occurred with the works of Friedrich Hayek (Hayek, 1945), who articulated the fundamental problem of economic coordination through distributed knowledge. Hayek viewed the economic system as a dynamic informational mechanism in which knowledge functions as a central factor for coordinating activities among economic agents.

The establishment of knowledge management as an independent discipline evolved alongside the conceptualization of post-industrial society. The works of (Bell 1973, Machlup 1962 and Toffler 2000) delineated the contours of a new type of social organization in which knowledge constitutes the principal resource of production. Peter Drucker (Drucker 1993) introduced the notion of the “knowledge society” and predicted profound transformations in the economic structure, emphasizing that the productivity of knowledge would become the decisive determinant of competitiveness.

Nonaka and Takeuchi (Nonaka et al., 1995) introduced the SECI model, which conceptualizes four modes of knowledge conversion arising from the interaction between tacit and explicit knowledge: socialization, externalization, combination, and internalization. This model became a paradigm for subsequent research, demonstrating that effective knowledge management requires not only the collection and organization of information but also the creation of an organizational environment that stimulates the generation of new knowledge.

Concurrently, Western researchers advanced their own frameworks. Carl Wiig (Wiig, 1993) proposed a systematic approach to knowledge management, defining it as the systematic, explicit, and deliberate creation, updating, and application of knowledge to maximize organizational performance. Thomas Davenport and Laurence Prusak (Davenport, 1998) adopted a pragmatic perspective, describing knowledge as a fluid mixture of experience, values, contextual information, and expert insight.

During the 2000s, the field diversified into several major directions, including studies of intellectual capital, communities of practice, and organizational learning. Etienne Wenger (Wenger, 1999) developed the concept of communities of practice as self-organized groups sharing a common domain of expertise, emphasizing the social character of knowledge creation and the importance of informal networks within organizations.

The current stage of knowledge management development is shaped by the pervasive impact of digital technologies, artificial intelligence, and big data. These innovations not only expand the available tools but also transform the very nature of knowledge and its creation processes. Contemporary scholars increasingly conceptualize knowledge as a dynamic, distributed, and context-dependent system that requires novel conceptual approaches and practical solutions within the digital environment (Gvozd et al., 2025).

Cognitive warfare: essence and characteristics. Cognitive warfare represents a fundamentally new form of conflict in which the human mind and its cognitive processes constitute the principal battlefield (Marek Havlik, 2024). Unlike traditional military confrontations that seek the physical destruction of the enemy or

territorial control, cognitive warfare targets perception, reasoning, and decision-making within specific audiences (Zolotukhin, 2021).

The essence of cognitive warfare lies in the systematic manipulation of human cognitive functions to alter perception, beliefs, values, and behavioral patterns (Shemaev et al., 2024). It encompasses operations designed to distort thought processes and compromise decision-making capabilities through methods grounded in cognitive science and psychological research (Claverie et al., 2023). Cognitive warfare is particularly insidious because its operations are largely invisible; what becomes observable are only their delayed and often subtle effects (Radchenko, 2024).

The theoretical foundation of cognitive warfare draws upon advances in cognitive science, psychology, neurobiology, and sociology (Deppe et al., 2024). The concept encapsulates the very essence of modern conflict: the deliberate alteration of attitudes and will through cognitive manipulation. This approach transcends the traditional framework of information warfare, which merely modifies the content of information; cognitive warfare, by contrast, seeks to influence the underlying mental processes that interpret and evaluate that information (MacDonald et al., 2023).

A defining feature of cognitive warfare is its integration of diverse instruments of influence. To achieve strategic objectives, it combines cyber, informational, psychological, and social engineering tools into a unified system of impact. When coordinated with other instruments of national power, these operations can shape attitudes and behaviors by influencing, protecting, or disrupting individual and collective cognition (Deppe et al., 2024).

Cognitive warfare methods are characterized by high complexity and multidimensionality (Ibrahim et al., 2023). Typical tactics include direct and indirect intimidation, psychological pressure on opponents, the manipulation of target groups, and the use of distraction techniques (Pijpers, 2024). Modern operations also involve the establishment of front organizations, employment of freelance content producers, and deployment of advanced digital technologies to enhance credibility and reach.

Cognitive warfare is inherently asymmetric (Malik, 2024). With limited resources, an aggressor can achieve significant strategic outcomes by exploiting vulnerabilities in the information

environment and the psychological weaknesses of individuals. Traditional deterrence mechanisms prove ineffective in such cases, as targets often remain unaware of the attack for extended periods (Claverie, 2025).

Potential targets of cognitive warfare include individuals, social groups, institutions, and even entire states. The aggressor seeks to shape the target's worldview, induce actions that serve their interests, or paralyze decision-making capacity. These goals are achieved through manipulation of information flows, fabrication of false narratives, and exploitation of social divisions and emotional vulnerabilities.

The technological dimension of cognitive warfare evolves rapidly, propelled by advances in artificial intelligence, big data analytics, and psychometrics (Claverie, 2025). Modern technologies enable the design of personalized influence campaigns tailored to individual psychological profiles. Machine learning algorithms can autonomously generate and disseminate content optimized for maximum psychological impact on specific audiences.

Another defining characteristic of cognitive warfare is its enduring nature. Unlike conventional conflicts with clearly defined temporal and spatial boundaries, cognitive warfare may persist for years or even decades, gradually reshaping public consciousness (Shemaev et al., 2024). This long-term influence poses a serious threat to democratic societies, in which critical thinking and informed civic participation form the foundation of governance.

The consequences of cognitive warfare may have devastating societal implications (Zolotukhin, 2021). It undermines trust in institutions, deepens social polarization, erodes cohesion, and diminishes a society's capacity to respond effectively to real threats. Ultimately, prolonged exposure to cognitive manipulation can trigger social unrest, political destabilization, and even systemic state failure (Shemaev et al., 2024).

Countering cognitive warfare requires a comprehensive approach that integrates technological, educational, legal, and organizational measures. Central to this effort are initiatives that enhance media literacy, cultivate critical thinking, and develop efficient information verification systems. Within this framework, strategic knowledge management emerges as a pivotal countermeasure, enabling societies

to sustain reliable information ecosystems and build resilience against manipulative influences.

The relationship between knowledge management and countering cognitive threats. The relationship between knowledge management and countering cognitive threats is a multifaceted phenomenon of growing relevance in the contemporary information society. It is grounded in the understanding that knowledge and cognitive processes are integral to human perception and decision-making (Morelle et al., 2023). Cognitive attacks aim to corrupt information processing and knowledge formation, whereas effective knowledge management establishes a powerful defense mechanism against such manipulative influences.

Theoretically, this relationship rests on the understanding of knowledge as an active process rather than a static resource. Cognitive warfare seeks to manipulate the creation, interpretation, and application of knowledge within target audiences (Putter, 2024). By shaping perceptions, values, beliefs, and cultural norms, aggressors aim to transform or destroy target behaviors. In this context, strategic knowledge management functions as a protective system for cognitive processes, ensuring the integrity of information and fostering critical analytical skills.

A key characteristic of this relationship is that information manipulation exploits the same channels of knowledge dissemination and assimilation that knowledge management uses for constructive purposes. Cognitive warfare employs these mechanisms to distort cognition and behavior through cyber, informational, psychological, and social engineering methods (Deppe et al., 2024). In contrast, strategic knowledge management counteracts such influences by establishing reliable information channels, verifying data sources, and cultivating a culture of critical thinking.

In practical terms, cognitive attacks often exploit weaknesses in existing knowledge management systems. Poorly structured information flows, inadequate verification mechanisms, and low levels of media literacy create favorable conditions for the spread of disinformation. Conversely, effective strategic knowledge management enhances societal resilience to cognitive attacks by ensuring timely access to reliable data and by strengthening critical thinking competencies.

Media literacy occupies a pivotal role in this relationship, serving as a key component of knowledge management in countering cognitive threats. It entails the ability to discern credible information from disinformation, analyze sources, and understand mechanisms of media influence. Consequently, developing media literacy through the principles of knowledge management is essential for strengthening societal protection against cognitive manipulation and disinformation campaigns.

The institutional dimension of this relationship manifests through the establishment of specialized entities that combine functions of knowledge management with disinformation counteraction. Such centers – often referred to as counter-disinformation units – practically apply the principles of strategic knowledge management by systematizing information about threats, analyzing trends, maintaining knowledge bases on manipulation techniques, and designing appropriate countermeasures.

The technological aspect of this relationship is particularly significant in the digital era. Advanced tools such as artificial intelligence, big data analytics, and machine learning can serve both as instruments of cognitive aggression and as means of defense. Automated fake-detection systems, fact-checking algorithms, and semantic text analysis technologies exemplify how digital knowledge management can be leveraged to counter cognitive attacks effectively.

The sociocultural dimension of this relationship involves the cultivation of an information security culture within society. Effective resistance to hybrid informational threats requires not only technological measures but also changes in public mentality – fostering critical thinking, raising educational levels, and promoting responsible information consumption[1]. These objectives align directly with knowledge management practices at the societal level, including educational programs, awareness campaigns, and initiatives that institutionalize responsible media behavior.

From the perspective of sustainable development, cognitive security performs a stabilizing function within social and institutional systems. The spread of disinformation, manipulation, and cognitive

[1] *Center for Countering Disinformation. URL: https://cpd.gov.ua/.*

attacks weakens social trust, intensifies polarization, disrupts democratic governance, and undermines the effectiveness of long-term development policies. Therefore, strategic knowledge management contributes not only to information protection but also to the sustainability of institutional structures, the resilience of democratic processes, and the preservation of social cohesion in the digital era.

Strategically, this relationship rests on the recognition that knowledge management and countering cognitive threats are mutually reinforcing components of national security. States that develop robust knowledge management systems inherently enhance their resilience to cognitive attacks[2]. This synergy provides a strategic advantage in hybrid warfare, where information and perception often determine the outcome of conflicts.

One of the major challenges in this relationship lies in striking a balance between safeguarding against cognitive attacks and maintaining an open information environment. Excessive information control may lead to constraints on freedom of expression and access to knowledge, contradicting democratic principles. Therefore, it is essential to design knowledge management strategies that ensure protection while upholding fundamental human rights.

Future prospects for this relationship involve the integration of knowledge management principles into all dimensions of countering hybrid informational threats. This includes developing educational programs that merge traditional learning with media literacy training, creating technological platforms for information verification, and fostering networks of experts for rapid response to information challenges. Additionally, international cooperation in sharing knowledge and best practices on cognitive threats will play an increasingly vital role.

The practical significance of understanding this relationship lies in the ability to apply existing theoretical and methodological developments in knowledge management to strengthen protection against cognitive attacks. This approach avoids constructing new conceptual frameworks from scratch and instead adapts proven

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[2] *Center for Strategic Communications and Information Security. URL: https://spravdi.gov.ua/czentr-strategichnyh-komunikaczij-ta-informaczijnoyi-bezpeky/* .

methodologies to the challenges of the information age – an approach that is both efficient and sustainable.

The systemic nature of this relationship necessitates a comprehensive implementation strategy that coordinates the efforts of the public, private, academic, and civil sectors. Only through such coordinated interaction can a synergistic effect be achieved, whereby knowledge management and cognitive threat mitigation mutually reinforce each other, creating a resilient foundation for democratic societies in the information era.

Research Methodology

The methodological framework of this study is based on a combination of general scientific and specialized methods that ensured a systematic approach to analyzing the interrelation between strategic knowledge management and countering cognitive threats.

The systems approach constituted the primary methodological foundation, enabling the consideration of strategic knowledge management and cognitive threat mitigation as interconnected components of a unified national security system. Structural-functional analysis was applied to identify four functional levels of the countermeasure mechanism and to define the specific roles of the fourteen tools within the overall protection framework. The dialectical method helped to uncover contradictions between the necessity of protecting against hybrid informational threats and maintaining the openness of the information environment.

Among general scientific methods, analysis and synthesis were employed to examine individual aspects of cognitive warfare and knowledge management, followed by their integration into a comprehensive conceptual model. Theoretical generalization facilitated the systematization of interdisciplinary sources and the formulation of an integrated research perspective. Abstraction and concretization methods ensured a logical transition from theoretical constructs to practical recommendations.

Conceptual modeling served as the central specialized research method, leading to the development of a graphical model of the countermeasure mechanism centered on strategic knowledge management. This model integrates four key processes and fourteen countermeasure tools into a cohesive framework. Comparative analysis was also applied to contrast traditional forms of information

warfare with cognitive warfare, as well as to evaluate different approaches to knowledge management.

The classification method was used to organize countermeasure tools by functional levels and categories. Network analysis was applied to model synergistic relationships among the mechanism's elements, encompassing both radial connections from the core to the tools and tangential interconnections between the tools themselves.

The empirical basis of the study comprised document analysis, drawing upon scientific literature, official reports from international organizations, and Ukraine's practical experience in countering cognitive attacks.

Collectively, these methods ensured the scientific and practical robustness of the study, enabling the transition from theoretical justification to the development of a functional model and specific recommendations for implementation.

The interdisciplinary nature of cognitive security necessitates the integration of managerial, informational, psychological, technological, and institutional approaches within a unified analytical framework. The systems approach was particularly important because cognitive security represents a multidimensional phenomenon shaped by the interaction of technological infrastructures, institutional processes, societal behavior, and knowledge ecosystems. Conceptual modeling enabled the identification of synergistic interrelations among the elements of the proposed mechanism and facilitated the development of an adaptive framework capable of responding to the dynamic evolution of cognitive threats in the context of sustainable development.

Developing a mechanism for ensuring cognitive security

The mechanism for ensuring cognitive security within strategic knowledge management is conceived as a comprehensive system of interconnected institutional, technological, organizational, educational, and social instruments aimed at protecting the intellectual and informational resources of society from manipulative influences. The mechanism is based on the premise that sustainable development in the digital age depends on the resilience of knowledge ecosystems, the integrity of information processes, and the capacity of institutions and citizens to critically interpret

information. In this context, strategic knowledge management performs not only managerial and informational functions but also serves as a strategic instrument for strengthening institutional resilience, adaptive governance, and long-term cognitive security.

A key countermeasure involves establishing early detection systems for disinformation and cognitive attacks. These systems rely on big data analytics and artificial intelligence technologies that enable the automated monitoring of information flows and the identification of anomalous data patterns (Dame Adjin-Tettey, 2022).

The early detection system encompasses automated analysis of content across social networks, news outlets, and other digital platforms to identify irregular dissemination patterns that may signal coordinated disinformation campaigns.

Fact-checking plays a central role in countering cognitive threats by verifying information accuracy and context. Contemporary approaches extend beyond individual fact verification to include assessment of sources, contextual framing, and content presentation methods. Effective implementation requires establishing networks of trained fact-checkers, developing standardized verification protocols, and deploying technological tools for automation (Roozenbeek et al., 2023). Importantly, modern fact-checking practices also adopt a proactive stance – monitoring potential sources of disinformation before they reach wide audiences.

Media literacy serves as a foundational element of resilience against cognitive influence (Westlund et al., 2024). It entails developing citizens' capacity to critically analyze information, comprehend media influence mechanisms, and distinguish between credible and unreliable sources. Robust media literacy programs emphasize practical competencies such as reverse image search, content source analysis, and fact-checking techniques, thereby strengthening individuals' ability to recognize manipulation (Kožuh et al., 2023).

Technological instruments for countering cognitive attacks encompass a broad spectrum of IT solutions. Machine learning algorithms detect anomalous patterns in text, images, and video content indicative of artificial origin (Dame Adjin-Tettey, 2022). Automated content classification systems enable rapid identification of harmful materials for further expert verification. Additionally,

blockchain technologies provide immutable records of data origin and authenticity, thereby mitigating the risk of manipulation.

Organizational countermeasures entail establishing specialized structures and coordination centers responsible for monitoring and mitigating information manipulation. These entities facilitate cooperation among governmental, private, academic, and civil sectors (Tkachuk, 2017). Their effectiveness depends on clearly defined roles, efficient information-sharing channels, and procedures for rapid response to emerging threats.

Legal instruments for countering cognitive threats focus on developing regulatory frameworks that govern information security, disinformation control, and protection from manipulative influence. A critical objective is to balance security with freedom of expression and access to information. Legal mechanisms should define harmful content precisely and establish proportionate sanctions, avoiding vague formulations that could enable censorship.

Social countermeasures seek to foster a culture of information security across society. They include public awareness campaigns that inform citizens about hybrid informational threats, methods of recognition, and self-protection strategies. These measures also promote the development of communities of practice – collaborative networks where experts and activists share experiences and develop collective approaches to combating disinformation (Westlund et al., 2024).

Educational tools focus on integrating media literacy and critical thinking into curricula at all educational levels. Such initiatives foster information analysis skills from an early age, thereby building long-term immunity to manipulative influences. They also involve training educators, developing methodological resources, and employing interactive digital learning platforms to reinforce media awareness.

International cooperation mechanisms are vital due to the transnational nature of cognitive threats. These mechanisms facilitate information exchange on identified attacks, coordination of counter-disinformation measures, and the development of shared standards and methodologies (Richter, 2019). They also enable the creation of joint databases, best-practice sharing, and collaborative research efforts aimed at enhancing global cognitive resilience.

Psychological countermeasures draw upon insights from cognitive psychology and behavioral science. They involve the design of communication strategies that account for cognitive biases and emotional resistance to corrective information. Prebunking techniques prepare audiences for potential manipulation, while counter-narratives and behavioral nudges leverage emotional engagement to increase preventive impact.

Technical countermeasures encompass cybersecurity measures that protect information systems from unauthorized access and hybrid threats (Bateman et al., 2024). These include data encryption, network integrity monitoring, and backup communication channels to maintain system resilience. Technical protection also involves continuous surveillance for unauthorized content alterations and ensuring the authenticity of critical information resources.

Economic countermeasures seek to undermine the financial foundations of disinformation networks. These include blocking advertising revenues, imposing sanctions on individuals or organizations responsible for spreading manipulation, and incentivizing platforms to promote reliable content. Furthermore, they involve funding academic research and supporting civil initiatives that develop innovative solutions to hybrid informational threats.

Monitoring mechanisms provide continuous assessment of the effectiveness of cognitive threat countermeasures and facilitate strategy adjustments based on data-driven insights. They encompass indicator systems for evaluating performance, regular threat analyses, and the measurement of intervention impact on information security. Monitoring also includes tracking cognitive threat trends and forecasting potential future challenges.

Rehabilitation measures focus on restoring trust and correcting misconceptions among audiences affected by disinformation (Richter, 2019). They include educational programs, reliable alternative information sources, and reintegration initiatives for affected groups. These measures demand careful consideration of psychological factors and tailored approaches for diverse social categories.

The effectiveness of countermeasures depends largely on their systemic integration within a unified mechanism and on coordinated

implementation. The isolated application of individual measures tends to yield limited results, whereas their synergistic combination creates a robust and adaptive defense system. A critical prerequisite for success is continuous adaptation to emerging cognitive threats and the contextual specificity of each operational environment.

The structure of the cognitive threat countermeasure mechanism and the synergistic interrelations among its components are illustrated in Figure 5.1.

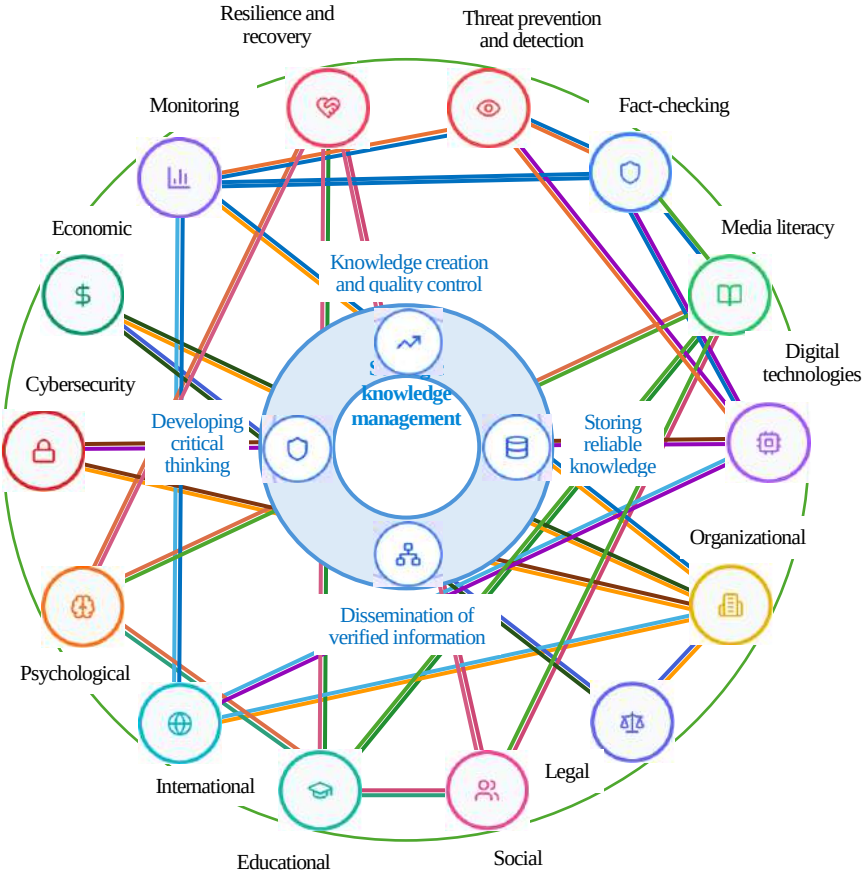


Figure 5.1 Mechanism for ensuring cognitive security based on strategic knowledge management

Source: developed by the authors

The proposed mechanism for countering cognitive attacks is grounded in the core principles of strategic knowledge management, which collectively integrate knowledge creation, quality assurance, reliable retention, dissemination of verified information, and the cultivation of critical thinking skills. This framework emphasizes that the generation of knowledge must be accompanied by rigorous verification and quality control to ensure reliability from the outset. Equally important is the retention of validated knowledge, which safeguards the integrity of the information preserved within the system. The dissemination of verified information facilitates the circulation of authenticated content across the knowledge ecosystem, thereby preventing the spread of misinformation. Finally, the development of critical thinking extends beyond the mere use of knowledge, fostering the ability to analyze, evaluate, and apply information judiciously in decision-making processes.

This core establishes a comprehensive knowledge management cycle that serves as the primary barrier against cognitive attacks. Its effectiveness is achieved through the coordinated operation of fourteen tools, arranged circularly around the core and linked to it by radial connections, as well as to each other through tangential synergistic links. These interrelations define not only the internal interaction among the tools but also form a multi-level protective framework against information and cognitive threats in the form of the following subsystems:

1. Early Detection and Verification Subsystem.

A central component of the mechanism is the early detection and verification subsystem, which integrates technological tools, monitoring systems, and fact-checking procedures. Technological solutions, such as AI-based algorithms and collaborative data analytics, enable the rapid identification of emerging hybrid informational threats. Monitoring networks facilitate the timely flow of information, while fact-checking mechanisms verify detected patterns and assess the scope of disinformation. Collectively, these instruments establish a foundation for real-time situational awareness and preventive action.

2. Educational and Socio-Psychological Subsystem.

The educational and socio-psychological dimension strengthens long-term societal resilience by combining media literacy, formal

and non-formal educational programs, psychological tools, and social engagement initiatives. Media literacy enhances verification skills and critical thinking, while educational programs embed these competencies systematically across curricula. Psychological instruments raise awareness of cognitive biases and promote emotional stability, and social tools support collective resistance through community-based initiatives and rehabilitation practices. Together, this human-centered subsystem fosters the cognitive immunity of society.

3. Organizational, Legal, and Economic Subsystem.

The organizational and legal framework ensures the practical implementation and coordination of countermeasures. Organizational mechanisms manage interagency coordination, monitoring, and reporting processes. Legal instruments provide the regulatory foundation, legitimize economic sanctions, and define responsibilities in the digital and organizational domains. Economic tools operationalize these provisions through financial or administrative enforcement. This institutional subsystem constitutes the backbone that guarantees coherent and effective intervention across all levels.

4. Technological, Cybersecurity, and International Coordination Subsystem.

The technological and cybersecurity dimension underpins the protection of communication infrastructures and the integrity of digital information flows. Cybersecurity measures reinforce both organizational and technological resilience, safeguarding the system against manipulative exploitation. International cooperation facilitates the exchange of best practices, the development of global monitoring analytics, and the dissemination of technological innovations. This transnational layer ensures the adaptability, sustainability, and cross-border applicability of the cognitive threat countering mechanism.

Institutional coordination constitutes a critical component of the proposed mechanism for ensuring cognitive security. Effective implementation requires the establishment of adaptive governance systems capable of integrating the efforts of governmental authorities, educational institutions, research centers, private-sector organizations, media platforms, and civil society actors. Such

coordination strengthens institutional resilience, facilitates knowledge exchange, and enables the rapid adaptation of managerial decisions to emerging cognitive threats. Public-private partnerships and international institutional cooperation play a particularly important role in maintaining sustainable cognitive-security ecosystems in the digital environment.

The instruments of the mechanism designed to counter cognitive attacks can also be categorized into four functional levels:

1. The preventive level enhances the cognitive resilience of society through initiatives in media literacy, education, psychology, and social engagement, forming the foundation for long-term protection.
2. The detection level ensures timely identification of cognitive threats through early warning systems, fact-checking initiatives, technological solutions, and continuous monitoring, operating in real time.
3. The response level is engaged upon the confirmation of threats, mobilizing organizational structures, legal frameworks, cybersecurity measures, and economic sanctions to mitigate or neutralize the sources and impacts of disinformation.
4. The recovery level seeks to restore the trust and resilience of affected audiences while leveraging international cooperation for knowledge exchange and the prevention of future attacks.

Thus, the proposed mechanism constitutes a comprehensive, multi-level system in which strategic knowledge management serves as the central core, while synergistic interactions among its tools ensure the resilience of society to cognitive threats. This framework enables the effective integration of technological, social, legal, and organizational solutions, thereby establishing a robust barrier against disinformation, manipulation, and cognitive attacks. Implementation of this multilevel mechanism contributes to the creation of a sustainable cognitive-security architecture based on strategic knowledge management.

Practical recommendations for using the mechanism to counter cognitive attacks

The practical implementation of the developed mechanism requires the consistent application of its principles across all institutional and societal levels. Translating the theoretical

framework into practice involves integrating analytical, technological, educational, and organizational components into everyday operations of public institutions, private organizations, and civil society structures.

1. Preventive level: building the cognitive resilience of society.

At the preventive level, a key governmental priority is the development and implementation of a comprehensive national media literacy strategy targeting all age groups. This strategy should include:

- establishing an interdepartmental coordination council on information security;
- allocating targeted budgetary funding for programs that foster critical thinking and counter cognitive threats;
- integrating media literacy courses into professional development systems for civil servants, particularly those in communications;
- supporting the production of high-quality, verified content through grants and subsidies for media outlets that adhere to journalistic standards.

Educational institutions constitute the first line of defense against cognitive manipulation. They should systematically embed critical thinking skills across all disciplines rather than confining them to specialized courses. Teachers of mathematics, natural sciences, and humanities alike should train students to analyze sources, verify facts, and identify logical fallacies. Developing a cross-curricular media literacy framework that evolves from primary to higher education – adapting task complexity to age levels – is strongly recommended. Institutions should also create internal knowledge repositories with verified materials and apply strategic knowledge management principles for their continual updating.

Civil society organizations can reach social groups less accessible to state and educational actors. Effective approaches include:

- establishing local communities of practice where citizens exchange experiences in recognizing and countering disinformation, both online and offline;
- conducting targeted educational campaigns adapted to cultural contexts, education levels, and preferred information channels;
- collaborating with trusted opinion leaders and influencers to promote responsible information sharing.

The private sector – especially media companies and technology platforms – bears a particular responsibility for shaping the information environment. These actors should implement internal content verification standards, invest in reliability-assessment tools accessible during content consumption, integrate fact-checking mechanisms into their platforms, and cultivate a corporate culture of accountability for information quality.

2. Detection level: operational identification of cognitive attacks.

At this level, the central objective is to establish a national early-warning system for cognitive attacks capable of operating in real time by analyzing information flows across social media, traditional outlets, and instant messaging platforms. Achieving this requires:

- investing in technological infrastructure for large-scale data processing to identify anomalous dissemination patterns indicative of coordinated disinformation campaigns;
- operating an interdepartmental monitoring center staffed by analysts, psychologists, linguists, and IT specialists;
- supporting the development of independent fact-checking organizations with guaranteed access to official information sources for rapid verification.

Higher education institutions should serve as research and innovation hubs that design algorithms for automated disinformation detection. Universities can integrate fact-checking assignments into journalism, sociology, political science, and information technology curricula, forming student fact-checking initiatives to analyze current information streams. Knowledge exchange between research institutions across countries is crucial for disseminating best practices in detecting cognitive attacks.

Civil society organizations can form decentralized monitoring networks where volunteers record and report suspicious content to dedicated centers. Developing accessible mobile applications and online platforms enabling citizens to verify facts or request guidance on information reliability is recommended. Partnerships with professional fact-checkers should foster hybrid models in which citizens conduct initial screening while experts perform detailed verification.

Technology companies must deploy automatic detection systems on their platforms using machine-learning algorithms to flag

potentially manipulative content. Transparent labeling mechanisms reflecting reliability levels – combining automated and independent fact-checking assessments – should be implemented. Media companies are encouraged to establish in-house fact-checking departments that verify information prior to publication and promptly correct inaccuracies. Cross-platform cooperation is essential to facilitate information sharing on detected threats and to develop unified industry standards and protocols for countering disinformation.

3. Response level: neutralization of detected threats.

Responding to confirmed cognitive attacks requires a coordinated, multisectoral effort that integrates legal, communicative, and organizational measures. The state should:

- promptly refute disinformation through official channels, providing verifiable evidence while avoiding overly technical or bureaucratic language;
- enforce proportionate legal measures against systematic disseminators of false information, while upholding freedom of expression and avoiding repressive actions that could erode trust in democratic institutions;
- impose economic sanctions on platforms that facilitate manipulative content dissemination;
- enhance the cybersecurity of official information resources to prevent their compromise and misuse.

When targeted influence is detected within the student community, educational institutions should organize prompt awareness activities explaining manipulation mechanisms. Crisis communication teams should be established to respond rapidly to disinformation within educational settings by holding discussions, lectures, and seminars on relevant topics. Institutions must leverage their own communication channels to circulate verified information, countering panic and unsubstantiated rumors.

Civil society organizations should design rapid debunking campaigns addressing specific disinformation narratives and tailoring content to diverse audiences. Creative communication formats – infographics, videos, memes, and interactive materials – are more effective in attracting attention than traditional text-based refutations. Mobilizing networks of trusted community members to disseminate

verified information through interpersonal communication can significantly enhance outreach.

Technology platforms should implement graduated moderation mechanisms – from content labeling to temporary or permanent account suspension for repeated violations. Media organizations must publish refutations with visibility comparable to the original false content, ensuring the correction reaches the same audiences.

4. Recovery level: restoration and resilience building.

At the final stage, the principal objective is to restore public trust in the information environment and enhance resilience of democratic systems. Key measures include:

- organizing public campaigns that demonstrate the effectiveness of counter-disinformation efforts and encourage vigilance;
- providing psychological support programs for affected groups;
- developing international cooperation frameworks for sharing practices and methodologies;
- conducting systematic evaluations of implemented measures to refine strategies.

Educational institutions should incorporate real-world cases of cognitive attacks into curricula as case studies, fostering public discussions on identified manipulations and promoting spaces for critical reflection. Universities are encouraged to initiate long-term research projects examining the evolution of hybrid informational threats to update media literacy programs based on emerging disinformation patterns and manipulative techniques.

Civil society organizations should form support groups for individuals affected by disinformation campaigns, providing emotional assistance and helping them rebuild critical thinking capacities. Establishing international partnerships with counterpart organizations abroad will facilitate experience exchange and coordinated action against transnational disinformation.

The private sector should perform internal information-security audits, publish transparency reports on detected incidents, invest in research on new counter-disinformation technologies, and collaborate with academic institutions to foster evidence-based innovations.

Implementation of the proposed recommendations will contribute to the establishment of a sustainable system of cognitive security

grounded in strategic knowledge management. Their consistent application will enhance national resilience, improve institutional coordination, and promote an informed, critically minded society capable of resisting manipulative influence.

Conclusions

The study made it possible to comprehensively substantiate the role of strategic knowledge management in ensuring cognitive security as an essential component of sustainable development under conditions of digital transformation and increasing information confrontation. The conducted analysis confirmed that cognitive warfare has evolved into one of the most significant threats to societal stability, democratic governance, and information security, requiring the development of integrated institutional and managerial countermeasures.

The research demonstrated that strategic knowledge management should be regarded not only as an organizational or managerial practice, but also as a systemic mechanism for strengthening societal resilience to cognitive threats. In the context of sustainable development, knowledge becomes a strategic resource that determines the capacity of institutions and society to preserve information integrity, support informed decision-making, and maintain social cohesion in the face of manipulative influence.

The conceptual mechanism proposed in the study integrates the processes of knowledge creation, quality control, preservation of reliable information, dissemination of verified knowledge, and development of critical thinking into a unified cognitive security framework. The synergistic interaction of technological, educational, organizational, legal, social, psychological, and international instruments forms a multilevel system capable of preventing, detecting, neutralizing, and mitigating the consequences of cognitive attacks.

The scientific novelty of the research lies in the development of an interdisciplinary approach that combines the theoretical foundations of strategic knowledge management with the contemporary challenges of cognitive warfare and cognitive security. Unlike traditional approaches focused primarily on technical or informational dimensions, the proposed framework emphasizes the

strategic role of knowledge ecosystems in building sustainable societal resilience.

The practical significance of the findings is reflected in the possibility of applying the proposed mechanism within public administration systems, educational institutions, media environments, civil society organizations, and private-sector structures. The recommendations developed in the study may contribute to improving national information security strategies, strengthening media literacy and critical thinking, enhancing interinstitutional coordination, and fostering adaptive mechanisms for countering disinformation and manipulative influence.

It was established that effective cognitive security cannot be ensured through isolated measures alone. Sustainable protection against cognitive attacks requires coordinated interaction among governmental institutions, educational and research organizations, technological platforms, businesses, and civil society. Such interaction creates a synergistic effect that enhances the adaptive capacity of society and supports the long-term sustainability of democratic and informational systems.

In conclusion, the study substantiates that strategic knowledge management constitutes a fundamental institutional and managerial mechanism for ensuring cognitive security within the broader paradigm of sustainable development. The integration of adaptive governance, resilient knowledge ecosystems, and coordinated institutional interaction creates the foundation for strengthening societal resilience in the face of cognitive attacks and information manipulation. The proposed conceptual and practical approaches contribute to the development of sustainable cognitive-security systems capable of supporting democratic stability, institutional trust, and long-term socio-economic development in the digital age. At the same time, the results of the study provide a basis for further interdisciplinary research into cognitive security, information resilience, and strategic governance under conditions of rapid technological transformation.

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HOW EFFECTIVE WAS PROJECT-BASED LEARNING AS AN ACTIVE LABOR MARKET POLICY PROGRAM FOR YOUNG ADULTS IN SLOVENIA DURING THE GREAT RECESSION? A QUASI-EXPERIMENTAL APPROACH

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Abstract
This paper aims to evaluate the effectiveness of the project-based learning within Slovenia's active labor market policy programs for young adults during the Great Recession. The propensity score matching method was utilized to evaluate the effectiveness the program by calculating the average treatment effect on participants. Findings indicate that, in the short term, project-based learning for young adults does not have a statistically significant impact on reducing unemployment.

Keywords: *project-based learning, young adults, propensity score matching, active labor market policy.*

Introduction and literature review

This study[3] evaluates a Slovenian active labor market policy (ALMP) program – project-based learning for young adults – to determine if ALMP measures reduce unemployment and to what extent. Unemployment arises from labor market imbalances, caused by differences between the stable labor supply and fluctuating demand driven by economic activity. Effective active labor market policy programs should address both labor supply and demand to

[3] *During the preparation of the manuscript, artificial intelligence tools were used (DeepL for translation from Slovenian to English and Copilot for linguistic editing). These tools did not influence the contents or analytical decisions.*

lower unemployment rates.

Active labor market policies are widely used across Europe to address labor market challenges, with their adoption in EU Member States increasing over the past two decades. Programs vary significantly across countries, complicating evaluation, though improved statistical methods have made assessments easier. Studies by Kluve (2006) and Card, Kluve, and Weber (2010) found that training programs are the most common intervention. Evidence of their effectiveness is mixed, ranging from negative to moderately positive or insignificant outcomes (Bonin & Rinne, 2006; Dmitrijeva & Hazans, 2009; Kupets, 2000; Lubyova & van Ours, 1999; Mikhed, 2007; Puhani, 1998; Walsh et al., 2001).

Several researchers have examined formal education as an active labor market policy. Domadenik and Pastore (2006) investigated youth unemployment in Slovenia and Poland, using a multinomial logit model, and found that higher education reduces the risk of unemployment among young people. Južnik-Rotar (2008) noted that microeconometric studies on the effectiveness of such educational porograms generally report only minimal positive effects on participants' future employment prospects and earnings. This suggests that state interventions need careful planning to improve both employment outcomes and cost-effectiveness. In contrast, Klužer (2008) assessed active labor market policies using a macroeconometric approach – specifically, an augmented matching function. Caliendo and Schmidl (2016) analyze youth unemployment in European countries that invest heavily in active labor market policies. They note that only a small portion of training programs focus on preparing young people to pursue further formal education or vocational training through apprenticeships.

Hämäläinen and Ollikainen (2004) used propensity score matching to study active labor market policy programs for Finnish youth. The outcomes of these programs were mixed: while job placement and training increased both employment likelihood and earnings, youth practical training showed no impact. In another study, Caliendo, Künn, and Schmidl (2011) examined both short- and long-term effects of various ALMP programs in Germany targeting young unemployed individuals. Their findings indicated that many initiatives had positive long-term effects on employment

and supported better labor market integration. However, they noted that German policies often overlook young people with lower levels of education.

Rotar (2021) examines Dutch programs supporting young unemployed people by using difference-in-differences propensity score matching. These programs have a small positive impact on re-employment in the short term, but after two years, the effect becomes negative. In the Netherlands, there is a focus on promoting work and study rather than providing unemployment benefits, as generous social welfare can be counterproductive. Speckesser, Carreras, and Sala (2019) evaluate active labor market policies across EU nations, in a panel of EU countries, finding that wage subsidies and job creation effectively lower youth unemployment rates. The effectiveness of these measures varies by age group: 15–19-year-olds gain more from wage subsidies, while job creation schemes benefit 20–24-year-olds more. Forslund and Skans (2006) analyze Swedish labor market policies for young workers, concluding that youth programs are much less effective compared to those aimed at adults. Youth-targeted initiatives show no evidence of lasting benefits, with any positive effects occurring early during unemployment.

The remainder of this study is organized as follows. Section 2 outlines the data and variables involved, and provides an overview of the propensity score matching methodology. Section 3 presents a detailed explanation of the results regarding project-based learning for young adults. Section 4, the Conclusion, discusses the implications drawn from the empirical analysis. Parts of the Introduction and literature review and Materials and methods sections are adapted from Kavkler (2019), Kavkler and Volčjak (2020), Kavkler (2023) and Kavkler (2024).

Materials and Methods

Data for this study were sourced from the Employment Service of Slovenia (ESS). The UNMPdata database includes all unemployment spells ending between 1 January 2007 and 31 December 2010, plus those ongoing as of 31 December 2010. Available information covers start/end dates of unemployment spells, gender, age, education level, occupation, and statistical region; personal ID numbers identify repeated spells, but no personal data is disclosed. In

total, 411,338 spells with positive duration are recorded.

The second database stores data about ALMP program participants in Slovenia in the period from 2007 to 2010. This database is called ALMPdata. In addition to the variables from the UNMPdata database, ALMPdata also contains information about the type of ALMP program attended by the individual, source of financing and success of the individual at completing the program. From the initial 189,924 spells, the ALMP program ended in 166,166 cases. Since the ALMP program classification changed in 2007, the study only considers the 158,546 spells according to this classification. ALMP programs were successfully completed in 122,492 cases.

In estimating the logit models, this study considered several variables:

- Status is a dummy variable indicating employment status: it equals 0 if an individual is unemployed at a given time, and 1 otherwise.
- Age refers to the individual's age at the start of their unemployment period.
- Male is a dummy variable identifying male individuals who are unemployed.
- For geographical information, four dummy variables were used to represent groups of regions: RegionNE (northeastern regions including Pomurska, Podravska, Koroška, and Savinjska), RegionSE (southeastern regions like Zasavska, Spodnjeposavska, and Jugovzhodna Slovenija), RegionCentral (Osrednjeslovenska and Gorenjska), and RegionSW (Notranjsko-kraška, Goriška, and Obalno-kraška). This division is relevant both geographically and in terms of unemployment rates.
- The study also followed previous research in defining four dummy variables for education levels: PrimarySchool (either incomplete or completed primary education), VocationalOrSecondary (vocational or secondary education), University (professional college or bachelor's degree), and Postgraduate (master's or doctoral degree).
- Slovenia's Standard Classification of Occupations separates jobs into ten groups. For the analysis, four aggregated

occupational categories were used as dummy variables: ManagersAndExperts (including armed forces, legislators, senior officials, managers, and experts); TechniciansAndOfficials (technicians, associate professionals, and officials); ServiceAndCraft (service workers, vendors, skilled agricultural and fishery workers, and craft or related trades workers); and IndustrialAndElementary (plant and machine operators, assemblers, and elementary occupations).

- The study also used a dummy variable FirstJob with a value of 1 for first-time job seekers and those returning to the labor market after at least two years of inactivity, and 0 otherwise.

It is essential to reference additional variables that have demonstrated statistical significance in comparable studies by other researchers, such as health status, income, marital status, and number of children. However, this study was unable to obtain data for these variables within Slovenia.

A statistical matching method is employed to assess the effectiveness of a treatment within a population. The control group comprises individuals who did not receive the treatment, while the experimental (or treatment) group includes those who did. In labor market analyses, the population is comprised of all unemployed individuals during specific periods, and the treatment group consists of participants in a particular ALMP program.

The performance of ALMP programs is typically evaluated using the average treatment effect on the treated (ATT), which is detailed below. ATT reflects the difference between the expected probability of employment for the treatment group and the estimated probability if these individuals had not participated in ALMP. As the latter probability cannot be directly observed, it must be approximated.

Initially, logit or probit models are applied using relevant explanatory variables to estimate the propensity for participation in the ALMP measure. Subsequently, for each participant in the treatment group, one or more individuals from the control group are matched based on similar propensity scores. This subgroup of the control group provides the necessary probability estimates for ATT calculation. Further details, including relevant equations, are

provided below.

The matching approach can be formally outlined as follows (Stuart, 2010; Murn et al., 2008; Caliendo & Kopeinig, 2008). Within the population *P*, researchers observe two binary variables: *T* and *Y*. The variable *T* is set to 1 for an individual *i* if that person receives treatment (*Ti* = 1); otherwise, it is set to 0. Using *Yi*(*Ti*), the study tracks the outcome for both the treatment and control groups. For instance, *Yi*(*1*) equals 5.1 if individual *i* participated in the observed active labor market program (ALMP) and subsequently became employed. For each individual, the outcome can be expressed as a linear combination:

$$Y_i(T_i) = T_iY_i(1) + (1\text{-}T_i)Y_i(0). \quad (5.1)$$

Given covariates X, the average treatment effect on the treated (ATT) is formally defined as follows:

$$ATT = E(Y(1)|T=1, X) - E(Y(0)|T=1, X). \quad (5.2)$$

The propensity score for an individual *i* is defined as the likelihood of receiving treatment (specifically, participation in an ALMP program) based on the observed covariates (Stuart, 2010):

$$e_i(X_i) = P(T_i=1|X_i). \quad (5.3)$$

As outlined by Stuart (2010), the principal characteristic of propensity scores is their function as balancing scores. Specifically, for any given value of the propensity score, the distribution of covariates *X* is equivalent between the treatment and control groups. Logistic regression is the most frequently employed model for estimating propensity scores and was utilized in the empirical analysis presented. Propensity scores also facilitate the calculation of the propensity score distance between individuals *i* and *j* as follows:

$$D_{ij} = |e_i - e_j|, \quad (5.4)$$

where: e_j is the propensity score for individual j.

For each participant in the treatment group, the study identified the most similar individuals from the control group based on their calculated likelihood of receiving treatment, known as the propensity score using nearest-neighbour matching techniques. The *1:1* nearest neighbour approach pairs every treatment group member with the single closest control group counterpart, while the *k:1* method finds the top *k* matches for each individual. To ensure higher-quality matches and avoid poor pairings, the researchers used a calliper as recommended by Stuart (2010), which means that only those matches falling within a defined range were considered valid.

The study accounted for ties, including all matched observations and weighting them as needed (Sekhon, 2011). Matching with replacement allows controls to be selected multiple times, which may reduce bias compared to matching without replacement (Stuart, 2010).

Results and Discussion

This section presents empirical results for project-based learning among young adults. Key findings include ATT values at specified intervals, assessed for statistical significance using matching methods and a nearest neighbor algorithm (with replacement and ties). Individuals from the control group with similar probabilities of program inclusion were considered, applying a 0.01 caliper as commonly recommended. The main text details indicators like ATT, standard error, t-statistic, p-value, and the logit model estimate. The model variables met the balancing assumption based on bootstrapped Kolmogorov-Smirnov test p-values, the results of the variable balance tests can be found in the Appendix. Analyses used Sekhon's (2011) R package Matching.

The study analyzed unemployment inflow for a selected base year, following the approach of several authors (Fitzenberger & Speckesser, 2007; Leetmaa & Vork, 2004; Ramos et al., 2009). Individuals who became unemployed in different years, such as 2007 versus 2009 or 2010, were not directly compared due to significant labor market changes. The base year was chosen based on the number of ALMP program participants and anticipated effects, but can be adjusted if enough new participants are available in another year.

Following Frederiksson and Johansson (2003), Fitzenberger and Speckesser (2007) and Leetmaa and Vork (2004), the study included a squared age variable and interaction between age and gender into the logit model. The study compared the results to models without these variables and found that the inclusion had only a minimal impact on ATT.

Table 5.2 provides a brief overview of project-based learning for young adults.

Table 5.2

Program summary (from ESS Catalogue of Active Labor Market Policy Measures, 2010)

OBJECTIVE AND PURPOSE:
- Encouraging young unemployed individuals to return to education or employment; - increasing general education, professional identity formation and socio-cultural engagement.
IMPLEMENTATION PROCEDURE
Project-based learning for young adults includes activities that help participants improve their general awareness and flexibility of thinking, and acquire the functional skills needed for successful reintegration into the school environment and everyday life. Integration is based on an employment plan.
TARGET GROUP:
Unemployed people under 26 who have left school.
DURATION OF INCLUSION: Maximum one school year.

The ALMP program aims to promote employment or further education. Figure 5.2 displays training duration, with the program lasting 1 school year. Many participants likely continue their studies afterward, meeting one objective. However, for those not listed as unemployed by late 2010, it is unclear whether they found jobs or pursued more education.

The average age of participants is 20.3 years, with 86% having attained only primary education. Given that educational programs are designed to evaluate long-term outcomes, it is advisable to designate the initial year of observation as the baseline. However, enrolment numbers in the project-based learning for young adults program for 2007 and 2008 were insufficient; of 127 individuals enrolled in 2007,

only 84 registered in UNMPdata, which does not provide an adequate sample for analysis using the matching method. Consequently, 2009 has been selected as the baseline year.

Table 5.3

Annual enrolment figures for young adults participating in project-based learning programs

Year of inclusion	2007	2008	2009	2010
No. of participants	127	132	213	157

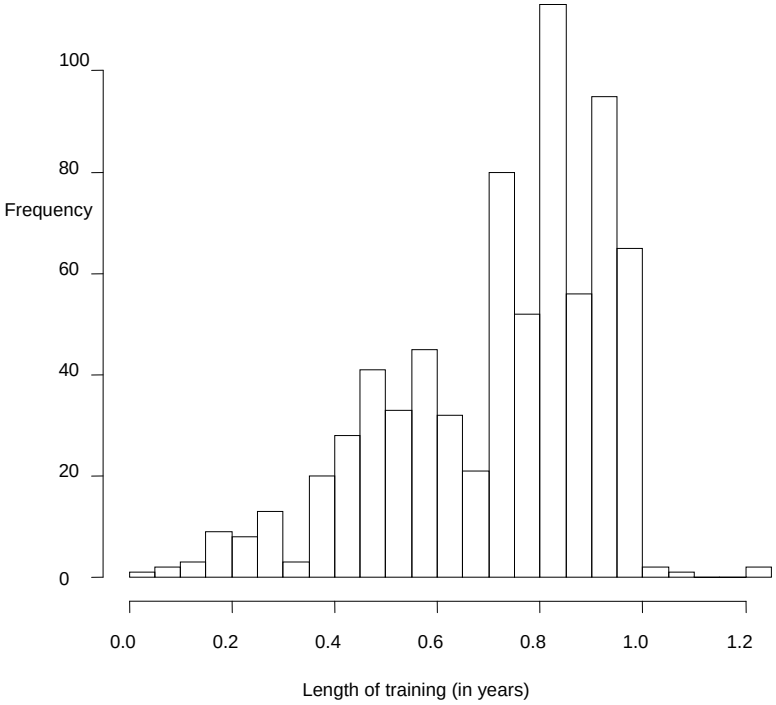


Figure 5.2 Length of training for project-based learning for young adults

Table 5.4

Estimated logit model for project-based learning for young adults

Coefficients	Estimate	Std. Error	z-value	Pr(>|z|)
Intercept	-9.797	1,671	-0.006	0.9953
Age	-0.7211	0.4734	-1.523	0.2143
Age^2	0.0142	0.0114	1.242	0.2143
Age * Male	0.0096	0.0669	0.144	0.8854
Male	-0.3150	1.372	-0.230	0.8184
RegionSE	-0.0860	0.2397	-0.359	0.7198
RegionCentral	-0.4551	0.2009	2.265	0.02348 *
RegionSW	-0.4084	0.2887	-1.415	0.1571
PrimarySchool	16.55	1,671	0.010	0.9921
VocationalOr Secondary	13.81	1,671	0.008	0.9934
University	0.1662	1,712	0.000	0.9999
FirstJob	-0.5650	0.3552	-1.590	0.1117
Technicians AndOfficials	-2.029	0.7839	-2.588	0.00964 **
ServiceAnd Craft	-1.846	0.4479	-4.123	0.0003 ***
IndustrialAnd Elementary	-1.048	0.3766	-2.784	0.0054 **

*Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*
Null deviance: 1694.4 at 11812 degrees of freedom
Residual deviance: 1358.9 at 11798 degrees of freedom
AIC: 1388.9
Number of Fisher Scoring iterations: 18

In 2009, 163 of the 213 young adults who joined project-based learning were included in the UNMPdata database as the experimental group. The control group comprised 11,653 individuals under 26 from the same database, also eligible for the program. Due to Social Security Agency rules, ATT was measured only at the end of 2010. Table 5.5 shows the ALMP measure had a negative but statistically insignificant effect, possibly due to a "locking-in" effect where participants job-seek less during training. Card, Kluve, and Weber (2010) similarly found lower effectiveness of ALMPs for

young unemployed people in EU, in a meta-analysis of the EU countries.

Table 5.5

ATT calculations

	At the end of 2010
ATT	-0,0620
AI SE	0,0406
t-stat	-1,5277
p-value	0,1266

Note: AI SE denotes standard errors proposed by Abadie and Imbens (2006)

Conclusions

Our analysis shows no significant short-term effect of project-based learning for young adults. This aligns with previous studies reporting short-term outcomes from ALMP programs for the young (Južnik Rotar, 2011; Foreslund & Skans, 2006; Rotar, 2021). As shown in the literature overview, other authors obtained mixed results for active labor market policy programs for young unemployed individuals.

Further research on project-based learning for young adults in Slovenia should examine long-term impacts.

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Appendix

Table A1: Variable balance (logit model for project-based learning for young aduls)- output from Matching package in R

********** (Variable 1) Age **********

	Before matching	After matching
avg. treated....	20.281	20.416
avg. control....	22.15	20.399
std. avg. diff..	-74.12	0.67707
variance ratio..	1.3101	1.1122
T-test p-value..	< 2.22e-16	0.87033

********** (Variable 2) Age^2 **********

	Before matching	After matching
avg. treated....	417.64	422.69
avg. control....	495.46	421.42
std. avg. diff..	-74.727	1.2459
variance ratio..	1.1836	1.1551
T-test p-value...	< 2.22e-16	0.78159

********** (Variable 3) Age * Male **********

	Before matching	After matching
avg. treated....	12.531	13.019
avg. control....	12.891	13.502
std. avg. diff..	-3.5717	-4.8601
variance ratio..	0.84613	1.0238
T-test p-value..	0.65462	0.40395

********** (Variable 4) Male **********

	Before matching	After matching
avg. treated....	0.61875	0.64286
avg. control....	0.58749	0.66507
std. avg. diff..	6.4164	-4.6213
variance ratio..	0.97943	1.0307
T-test p-value..	0.42142	0.40011

********** (Variable 5) RegionSE **********

	Before matching	After matching
avg. treated....	0.15625	0.16234
avg. control....	0.12143	0.15621
std. avg. diff..	9.5604	1.6553
variance ratio..	1.2434	1.0317
T-test p-value..	0.23085	0.7741

********** (Variable 6) RegionCentral **********

	Before matching	After matching
avg. treated....	0.24375	0.23377
avg. control....	0.28817	0.22534
std. avg. diff..	-10.313	1.9847
variance ratio..	0.90422	1.0261
T-test p-value..	0.19725	0.6502

********** (Variable 7) RegionSW **********

	Before matching	After matching
avg. treated....	0.09375	0.077922
avg. control....	0.12091	0.07587
std. avg. diff..	-9.2898	0.76313
variance ratio..	0.80427	1.0248
T-test p-value..	0.24563	0.88465

********** (Variable 8) PrimarySchool **********

	Before matching	After matching
avg. treated....	0.89375	0.88961
avg. control....	0.28611	0.90102
std. avg. diff..	196.57	-3.6276
variance ratio..	0.46781	1.1011
T-test p-value..	< 2.22e-16	0.18454

********** (Variable 9) VocationalOrSecondary **********

	Before matching	After matching
avg. treated....	0.10625	0.11039
avg. control....	0.64035	0.098984
std. avg. diff..	-172.78	3.6276
variance ratio..	0.41489	1.1011
T-test p-value..	< 2.22e-16	0.18454

********** (Variable 10) University **********

	Before matching	After matching
avg. treated....	0	0
avg. control....	0.070111	0
T-test p-value..	< 2.22e-16	1

********** (Variable 11) FirstJob **********

	Before matching	After matching
avg. treated....	0.6625	0.66883
avg. control....	0.438	0.65449
std. avg. diff..	47.329	3.0377
variance ratio..	0.91398	0.97949
T-test p-value..	1.6399e-08	0.43116

********** (Variable 12) TechniciansAndOfficials ********

	Before matching	After matching
avg. treated....	0.0125	0.012987
avg. control....	0.09474	0.013015
std. avg. diff..	-73.79	-0.024637
variance ratio..	0.14482	0.99788
T-test p-value..	4.4409e-16	0.99758

********** (Variable 13) ServiceAndCraft **********

	Before matching	After matching
avg. treated....	0.06875	0.071429
avg. control....	0.23144	0.087928
std. avg. diff..	-64.097	-6.3857
variance ratio..	0.36216	0.82705
T-test p-value..	2.2893e-13	0.17954

********** (Variable 14) IndustrialAndElementary **********

	Before matching	After matching
avg. treated....	0.19375	0.2013
avg. control....	0.193	0.20686
std. avg. diff..	0.18979	-1.3837
variance ratio..	1.0092	0.97992
T-test p-value..	0.981	0.72867

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MODERN MECHANISMS OF ENTERPRISE FINANCIAL PERFORMANCE FORMATION AS A TOOL FOR ENSURING ECONOMIC SECURITY AND SUSTAINABLE DEVELOPMENT: COMPARATIVE ANALYSIS OF UKRAINIAN AND GLOBAL PRACTICES

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Abstract

The article examines modern mechanisms of enterprise financial performance formation as an important tool for ensuring economic security and sustainable development. The essence of financial performance is revealed as an integral indicator of the efficiency of business entities, reflecting the relationship between revenues and expenses and determining the final result in the form of profit or loss. Particular attention is paid to the regulatory framework governing the formation of financial results in Ukraine, in particular the provisions of national accounting standards and the Tax Code of Ukraine.

A comparative analysis of Ukrainian and international practices of financial performance formation is carried out, identifying key differences in approaches to revenue and expense recognition, accounting methods, and taxation systems. It is substantiated that international systems are oriented toward assessing capital efficiency, investment attractiveness, and risk management, whereas domestic practice is characterized by a more regulated fiscal nature.

It is established that the digitalization of the economy and the harmonization of financial reporting with international standards create prerequisites for improving the mechanisms of financial performance formation in Ukraine. Directions for enhancing the efficiency of financial management of enterprises are proposed, taking into account best international practices.

Keywords: *financial result, profit, loss, economic security, sustainable development, accounting, taxation, corporate income tax, International Financial Reporting Standards (IFRS), tax planning, financial management, comparative analysis, enterprise, revenues and expenses.*

Introduction

The key indicator of the effectiveness of any business entity, its economic stability, and its ability to ensure long-term development under modern transformational challenges is financial performance. It is profit or loss that reflects the overall outcome of the entity's financial and economic activities, characterizing the effectiveness of managerial decisions, the level of competitiveness, the efficiency of resource utilization, and the degree of adaptability to changes in the external environment.

A comprehensive understanding of the mechanisms for forming financial results makes it possible to assess the internal efficiency of an enterprise, its role in ensuring economic security, socio-economic stability, and sustainable development at the macroeconomic level. Financial results serve as an important component in the formation of national income and act as a source of investment resources, industrial development, improvement of social standards, and the enhancement of employees' material well-being.

Financial results are of particular importance in the management information support system, as they are reflected in the financial statements of enterprises and serve as a basis for decision-making by a wide range of stakeholders, including investors, creditors, government authorities, owners, and international partners. In the current context of globalization, harmonization of financial reporting standards, and increasing requirements for business transparency, the issue of reliable formation of financial results has become especially relevant. This is due to the influence of numerous factors, among which revenues, expenses, accounting policy specifics, methods of asset and liability valuation, tax regulation, International Financial Reporting Standards, industry characteristics, and managerial approaches play a significant role. The use of different methods of cost accounting, approaches to revenue recognition, provisioning, taxation, and financial planning can significantly affect the final financial results of an enterprise, which necessitates a comparative analysis of Ukrainian and global practices.

The study of modern mechanisms for forming the financial results of enterprises under conditions of ensuring economic security and sustainable development is of particular importance. It enables the adaptation of national management systems to international requirements, improves business efficiency, and forms the strategic foundations for stable economic growth.

The aim of the study is a comprehensive examination of modern mechanisms for forming the financial results of enterprises, determining their role in ensuring economic security, operational efficiency, and sustainable development of business entities, as well as conducting a comparative analysis of Ukrainian and global practices in order to identify promising directions for improving financial management under conditions of global economic transformations.

Materials and Methods

The methodological basis of the study is a set of general scientific and specialized methods of cognition that ensure a systematic examination of modern mechanisms for forming the financial results of enterprises in the context of ensuring economic security and sustainable development. The following methods were used in the research: the method of theoretical generalization and systematization – to study the economic essence of financial results, their role in the functioning of enterprises, and to summarize scientific approaches to their formation; comparative analysis – to compare Ukrainian and global practices of forming financial results of business entities, identify common trends, differences, and opportunities for adapting international experience; institutional analysis – to assess the impact of regulatory and legal frameworks, accounting standards, tax regulation, and financial policy on the formation of financial results; structural-functional method – to determine the interrelations between management mechanisms, financial instruments, and the level of economic security of enterprises; graphical and tabular methods – to visualize research results and present analytical data.

Thus, the application of a comprehensive methodological approach made it possible to thoroughly assess modern mechanisms of forming financial results of enterprises, determine their impact on economic security, competitiveness, and sustainable development,

and formulate practical recommendations for improving the effectiveness of financial management in Ukraine, taking into account best international practices.

Results and Discussion

The activities of business entities are primarily aimed at achieving economic efficiency, ensuring competitiveness, and generating a stable financial result. Historically, economic activity was oriented toward creating utility both for individual entities and for society as a whole. With the development of economic systems, institutional mechanisms, and entrepreneurship, the concept of utility has acquired a clearly defined financial and economic meaning, transforming into the pursuit of a positive financial result as the foundation of enterprise functioning.

In the modern business environment, the financial result serves as a key indicator reflecting the final economic outcome of an enterprise's economic activity over a specific reporting period. It characterizes the level of resource utilization efficiency, the quality of management decisions, the ability of the enterprise to generate profit, maintain financial stability, and ensure further development under conditions of global economic instability.

The financial result is not only a criterion for assessing the success of an enterprise's performance but also an important management tool that enables the formulation of strategic development directions, evaluation of the effectiveness of individual business activities, forecasting growth prospects, and minimizing risks. For enterprise management, it serves as a basis for making relevant managerial decisions, optimizing costs, increasing profitability, and ensuring economic security.

At the macroeconomic level, the financial results of enterprises are of significant importance for the development of the national economy, as they influence the formation of budget revenues, the investment attractiveness of the state, the development of the production sector, business activity, and overall economic stability. The effective formation of financial results of business entities contributes to strengthening the country's economic security and implementing sustainable development strategies.

The study of modern mechanisms for forming the financial results of enterprises has become particularly relevant in the context of the

integration of the national economy into the global economic space, the harmonization of accounting standards, the strengthening of tax regulation, and the digital transformation of business processes. The diversity of approaches to revenue and expense recognition, accounting methods, financial performance measurement, provisioning, and taxation leads to significant differences in the determination of financial results both in Ukraine and in international practice.

The evolution of scientific approaches to the interpretation of the concept of financial result demonstrates its multifaceted nature: from understanding it as a form of gross income to the modern definition as a comprehensive indicator of enterprise performance efficiency, an "instrument for comparing revenues and expenses" (Mardus et al, 2021), a mechanism for determining profit or loss (Skrypnyk, 2020), an indicator that reflects the state of an enterprise (Nahorna et al, 2021), and an important element of strategic management and the foundation of the economic development of business entities (Yaremenko et al, 2020).

Analyzing scholarly research on the understanding of the concept of "financial result," it can be summarized that all approaches reveal the essence of this concept from different perspectives in relation to enterprise activity and the objectives of providing information through mechanisms of accounting, taxation, analysis, and evaluation. All of this necessitates a systematic analysis of modern mechanisms for forming financial results of enterprises, their role in ensuring economic security, and the adaptation of best international practices to Ukrainian realities.

In the modern enterprise management system, the financial result is viewed as a key indicator of the ratio between revenues and expenses, which allows determining profit or loss depending on the specifics of the entity's activity. In the context of forming financial results as an instrument for ensuring economic security and sustainable development, these indicators not only reflect the level of profitability or loss but also perform strategically important functions of information support, control, planning, and evaluation of business performance.

For accounting purposes, the financial result is a fundamental category that ensures the reliable representation of an enterprise's

performance, forms an informational basis for both external and internal users, and contributes to enhancing the transparency of financial reporting. It is through the mechanism of comparing revenues and expenses that the objectivity of determining the final financial result is ensured, which is a necessary condition for effective management and financial stability.

Within the taxation system, the financial result is based on the categories of profit and loss as the foundation for forming the tax base, determining tax liabilities, and ensuring effective tax administration. The correctness of financial result formation in this context directly affects the financial security of the enterprise, its tax discipline, and compliance with state regulatory requirements.

For financial analysis purposes, the financial result serves as a source for developing a system of indicators that characterize the financial position, operational efficiency, level of economic stability, and development prospects of the enterprise. Based on analytical, mathematical, graphical, and tabular calculations, management personnel are able to objectively assess performance results, identify problem areas, forecast future development, and formulate strategic managerial decisions.

Thus, summarizing modern approaches, the financial result should be considered as a comprehensive tool for assessing the efficiency of an enterprise's functioning, formed through the comparison of revenues and expenses and serving as the foundation for ensuring economic security, competitiveness, and sustainable development. Its magnitude and economic significance depend on a wide range of factors, among which market conditions, business environment, counterparties' solvency, institutional framework, state regulation, tax policy, and international financial management standards play an important role. Therefore, the study of modern mechanisms for forming financial results of enterprises requires a comprehensive comparative analysis of Ukrainian and global practices.

When examining the essence of the financial result for accounting, taxation, and analytical purposes, it is appropriate to consider it through the prism of key characteristics that define profit as the main form of a positive financial result (Figure 5.3).

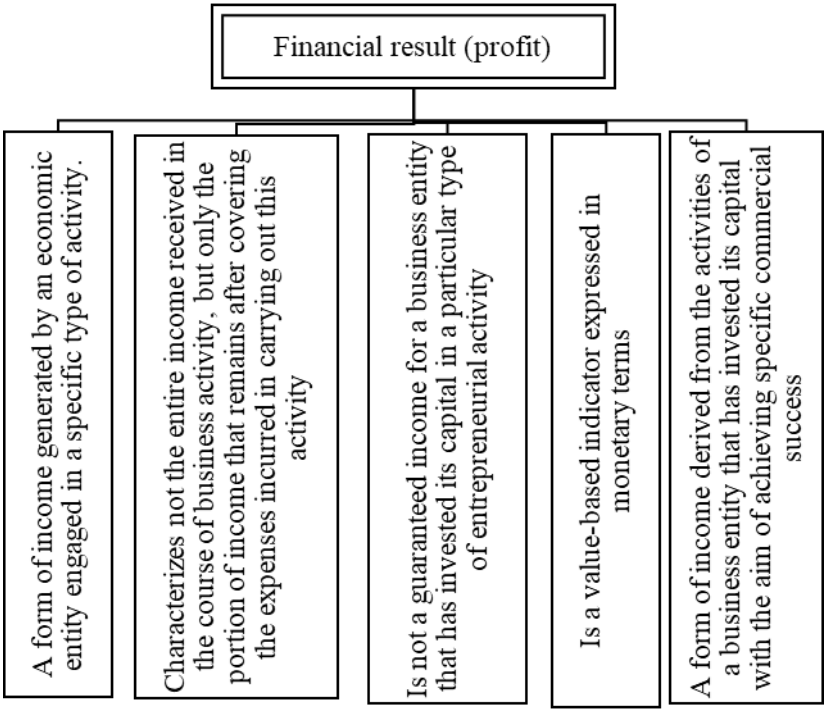


Figure 5.3 System of Characteristic Features Defining the Essence of Financial Result

Thus, in the process of studying financial results as an instrument for ensuring the economic security and sustainable development of enterprises, profit serves as a central economic category characterized by a number of important features. In particular, it is measured exclusively in monetary terms, which ensures its comparability and generalization within the financial management system. In addition, profit is formed and analyzed separately according to the various types of enterprise activities, which is especially significant in modern diversified business models, where different areas of operation may demonstrate varying levels of efficiency. An important characteristic of profit is its close relationship with the category of capital, which makes it possible to assess the efficiency of profit utilization and determine the average

return on the enterprise's operating capital. From an economic perspective, profit is formed as the residual result between total revenues and total expenses of business activity, reflecting the final effectiveness of economic operations and the success of the enterprise's business model.

In the context of modern approaches to financial result management, profit should also be considered as a kind of "payment for risk" that arises in the course of entrepreneurial activity under conditions of uncertainty, competition, and a changing institutional environment. It is precisely the enterprise's ability to effectively manage risks, optimize costs, and adapt to external challenges that determines the level of its financial result and, accordingly, its stability and long-term development prospects.

When studying modern mechanisms for forming the financial results of enterprises as an instrument for ensuring economic security and sustainable development, it is also necessary to mention the category of "loss," which serves as an integral component of the system for evaluating business performance, although its theoretical treatment in economic literature is significantly less common compared to the category of "profit."

The reason for this is that, in its economic essence, loss is the opposite phenomenon to profit; however, both categories are the result of a single process of forming the enterprise's financial result. Within the framework of modern financial management, loss should be considered an important analytical indicator that reflects inefficient resource utilization, failure to achieve planned financial objectives, or the impact of negative external and internal factors on the activities of a business entity.

From a methodological perspective, loss is determined according to the same logic as profit, namely as the difference between the enterprise's revenues and expenses. However, unlike a positive financial result, the final indicator in the case of loss-making activity has a negative value, indicating that expenses exceed revenues.

In the system of modern financial result management, loss performs not only an accounting function but also has important managerial significance, as it signals the need to revise the business model, optimize costs, improve the efficiency of resource utilization, and enhance the institutional and managerial mechanisms of

enterprise operations. Within this approach, loss analysis is an important element of ensuring the financial security and sustainable development of business entities, as it allows for the timely identification of crisis phenomena and the development of measures to overcome them.

The mechanism for the formation and calculation of financial results in modern Ukrainian accounting, taxation, and financial analysis practices is implemented in accordance with the current regulatory and legal framework, particularly National Accounting Standard 1 "General Requirements for Financial Reporting" (NAS, 2013). In order to ensure the transparency and comparability of financial information, the performance results of business entities are reflected in financial statements, particularly in Form No. 2 "Statement of Comprehensive Income (Financial Results)," which serves as a key source of information for evaluating enterprise performance in the context of ensuring its economic security and sustainable development.

According to the requirements of the specified regulatory document, the financial statements of an enterprise disclose information on revenues, expenses, profits and losses, as well as other comprehensive income for the reporting period (NAS 1, 2013). It is on the basis of these indicators that the financial result of the enterprise's activity is formed, which in practical terms is determined by comparing revenues and expenses, thereby allowing the identification of both a positive (profit) and a negative (loss) business outcome.

An important element of the modern mechanism for the formation of financial results is the regulation of the revenue recognition process, which is carried out in accordance with National Accounting Standard 15 "Revenue." This regulatory document establishes the methodological principles for determining an enterprise's revenues and defines the criteria for their recognition within the accounting system. It is particularly emphasized that the personal income of owners, managers, or employees is not included in the enterprise's revenues as an economic entity.

According to National Accounting Standard 15 "Revenue," revenue is recognized in cases of an increase in assets or a decrease in liabilities that leads to an increase in equity (except for contributions from owners), provided that its value can be reliably measured (NAS

15, 1999). Such an approach ensures the objectivity of financial result formation, its comparability in both national and international practice, and also enhances the level of informational transparency of enterprises' financial reporting, which is an important factor in strengthening economic security and improving the efficiency of management.

In academic literature, income generated through the use of economic resources (factors of production) is defined as factor income, reflecting the result of the involvement of labor, capital, land, and entrepreneurial abilities in economic activity.

Given the multifaceted nature of business entities' activities and the diversity of sources of income formation, an enterprise's revenues are classified according to a broad range of categories. In the process of determining the financial result, in order to ensure its analytical clarity and managerial relevance, they are aggregated into appropriate groups. In particular, operating revenues are distinguished, which constitute the primary source of financial result formation and reflect the outcomes of the enterprise's core activities; financial revenues, arising from the management of financial assets and instruments; investment revenues, associated with capital investments in other enterprises or projects; as well as other revenues that do not belong to core or regular types of activity but still affect the overall financial result of the business entity.

Such grouping of revenues ensures a more accurate and systematic formation of the financial result, enables a deeper analysis of the effectiveness of different areas of the enterprise's activity, and also serves as an important component of managerial decision-making aimed at increasing profitability, financial stability, and ensuring sustainable development in a volatile economic environment.

For modern mechanisms of financial result formation in business entities and the assurance of their economic security, the regulatory framework governing expenses incurred in the course of operations is of significant importance. The recognition and presentation of expenses are defined by National Accounting Standard 16 "Expenses." According to its provisions, expenses are defined as a decrease in economic benefits in the form of asset outflows or an increase in liabilities, which results in a reduction of equity (except

for decreases arising from withdrawals or distributions to owners) (NAS 16, 1999). Such an approach ensures a unified interpretation of expenses within the accounting system and provides a methodological basis for the accurate determination of an enterprise's financial result.

For the purpose of financial result formation, expenses are grouped according to their functional purpose. This allows for greater analytical transparency and comparability. For example, cost of goods sold (works, services), administrative expenses, selling expenses, other operating expenses, as well as financial and investment expenses are distinguished. Such grouping serves as an important tool of management accounting, as it enables the assessment of the effectiveness of different areas of the enterprise's activity and the identification of reserves for improving its profitability.

Thus, the financial result of an enterprise is formed as the difference between total revenues and total expenses. In cases where revenues exceed expenses, a positive financial result is generated – profit, which reflects the creation of added value in the course of economic activity. Added value arises as the excess of the value of manufactured products over the costs of their production and serves as an aggregate indicator of the efficiency of the enterprise's resource utilization. It is directly associated with the enterprise's financial stability, competitiveness, and capacity for sustainable development.

Based on regulatory documents, an algorithm for forming the financial result of an enterprise's activity can be developed, which must be reflected in financial reporting in accordance with Ukrainian practice (Figure 5.4).

At the first stage of the algorithm, the gross profit/loss is calculated by deducting the cost of goods (services) sold from the total revenue generated by the enterprise from the sale of products or services. The recognition of such expenses must correspond exclusively to the products or services that were sold by the business entity during the reporting period.

The second step is to determine the financial result from the entity's operating activities. This calculation involves adding other operating income to the gross profit/loss and then subtracting total

operating expenses, including selling expenses, administrative expenses, and other operating costs.

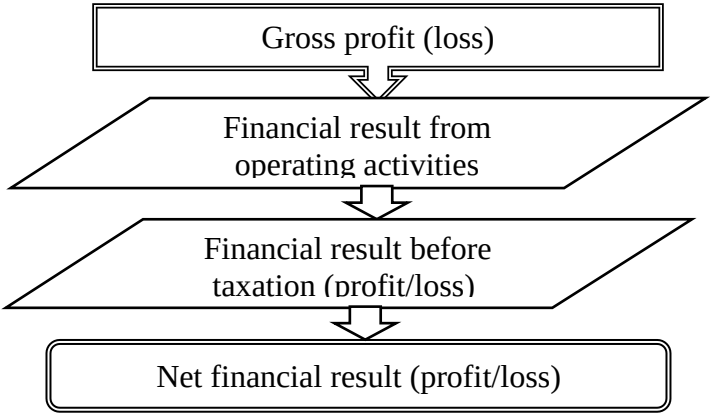


Figure 5.4 Algorithm for calculating the financial result of an enterprise's activity in accordance with current regulatory documents of Ukraine

The calculation of the financial result before taxation constitutes the third stage. At this stage, all components of the enterprise's financial activity are consolidated, ensuring a comprehensive assessment of its performance. The calculation methodology is as follows: financial income is added to the operating result, while financial expenses are deducted; subsequently, investment income is considered net of investment expenses, as well as other income and expenses that are not related to the enterprise's core activity. Such an approach enables the formation of an objective financial result before taxation, reflecting the overall efficiency of resource utilization across all areas of the business entity's operations.

At the final stage, the amount of income tax is deducted from the resulting profit or loss, and through this calculation the net financial result (total income) is determined. This indicator serves as an integral measure of performance efficiency and is used to assess the financial stability, investment attractiveness, and the enterprise's capacity for further development.

In Ukrainian practice, ensuring the formation of a reliable

information base for evaluating operational efficiency, financial stability, and the economic security of an enterprise places a central role on the system of financial management of a business entity. A key component of this system is the current practice of accounting. Its specific feature lies in the clear regulatory framework governing the mechanisms for the formation of financial results in accordance with National Accounting Standards, which are harmonized with International Financial Reporting Standards (IFRS).

The formation of the financial result in the Ukrainian accounting system is carried out through a sequential comparison of revenues and expenses by types of the enterprise's activities. The accounting organizational model is based on the fact that the formation of financial results is considered one of the objects of accounting – namely, accounting for business processes – and takes place during and/or after the product realization process. The summarization of this information is carried out on account 79 "Financial Results," which is structured into separate sub-accounts to reflect the results of operating, financial, and other activities. Such a methodology makes it possible to detail the sources of profitability or loss, ensures the transparency of financial information, and creates a basis for effective managerial analysis. However, today, due to its complexity, it is rarely used by small enterprises. At the same time, for those business entities operating under the general taxation system, it is mandatory.

An important characteristic of the Ukrainian model is the systematic classification of expenses according to their functional purpose, the method of inclusion in production cost, as well as their division into direct and indirect costs. This allows for a more accurate determination of production cost, control over the cost side of operations, and evaluation of the effectiveness of individual business areas. Revenues of the enterprise, in turn, are grouped according to the relevant accounts of Class 7 of the accounting system, which ensures a comprehensive reflection of all sources of financial result formation.

The financial result for Ukrainian individuals and legal entities is a key object of taxation and, as a rule, is subject only to administration under the corporate income tax. When forming the financial result for taxable income purposes, all expenses incurred by

the enterprise and all income received from all sources without exception are included.

Tax authorities implement special norms, provisions, and rules to determine which elements of the financial result are treated as expenses and which are subject to taxation. The specifics and rules of taxation are regulated by the Tax Code of Ukraine, according to which the financial result serves as the object of corporate income taxation if its amount is less than forty million hryvnias received by the taxpayer during the previous year. Exceeding this income threshold by a company implies the application of a system for adjusting the financial result through tax differences. These differences may affect the value of the financial result for corporate income tax administration purposes in different ways – either reducing it or, conversely, increasing it.

The tax base for corporate income tax is the financial result before taxation, formed on the basis of all enterprise revenues, including both internal and external sources. The standard corporate income tax rate in Ukraine is 18%, although certain categories of taxpayers may be subject to special regimes or differentiated rates depending on the specifics of their activities.

An important feature of the national tax system is the determination of the timing of profit taxation administration, meaning that the accrual principle is applied. According to legislative provisions, this occurs at the moment when income is recognized as a result of a sale, i.e., upon the full transfer of all risks associated with the goods, rather than when cash is actually received. For example, for taxation purposes, revenue from sales is recognized at the moment of delivery, even if payment is expected to be received later. This ensures a more objective determination of tax liabilities and aligns the tax mechanism with the accounting principles of financial result formation.

According to the Tax Code of Ukraine (TCU), taxpayers of corporate income tax include both residents and non-residents of Ukraine that conduct entrepreneurial activities. As for legal entities, the only exception applies to those that have voluntarily applied to the tax authorities and, based on a submitted application, have chosen a simplified taxation system.

Corporate income tax is expressed exclusively in monetary form

and is paid by taxpayers as advance quarterly payments. A specific feature of its payment is that the business entity – whether a legal entity or an individual – calculates the tax amount independently, based on its average profit received in the previous quarter. Such payment rules apply for the first, second, and third quarters, with payments due by the 20th of the respective month. In the fourth quarter, the payment is calculated using an adjustment method, meaning that the total annual income is determined, the total tax amount is calculated, and then reduced by the tax already paid during the first nine months. The final recalculation of the resulting amount is carried out at the beginning of the following year.

For reporting to tax authorities, a taxpayer submits a tax return, with the deadline for filing the annual declaration being within 40 calendar days following the reporting period.

Thus, the tax regulation of financial results in Ukraine is an integral component of the overall system for managing enterprises' financial performance, ensuring the interconnection between accounting, tax administration, and economic security mechanisms. This strengthens the role of the financial result not only as an indicator of operational efficiency but also as a strategic tool for the sustainable development of the enterprise.

In contrast to the domestic approach, where emphasis is placed on the step-by-step formation of the financial result through the aggregation of revenues and expenses, in international practice profit is viewed as an indicator of the return on invested capital and the efficiency of its reproduction. Foreign accounting systems interpret the determination of financial results through the lens of assessing the effective use of capital invested by owners. In this interpretation, profit is considered not from the perspective of its role in the process of expanded reproduction, but in terms of the payback period of invested funds (irrecoverable and recoverable). Such global practice allows for a deeper assessment of an enterprise's investment efficiency and the level of investment risk, which is an important element of modern institutional and managerial mechanisms for ensuring sustainable development.

International accounting and financial reporting systems use different methodological approaches to determining the financial result of business entities' activities, reflecting their institutional and

managerial specificity. In general, a number of approaches to the formation of the financial result can be summarized as follows:

– the balance sheet approach, in which the basis of calculation is the equality between assets on the one hand and equity and liabilities on the other. This allows the financial result to be determined through changes in the structure of the balance sheet;

– the “input–output” method, which is based on the relationship between incurred costs and obtained results (output of goods, works, or services) and is used to assess the efficiency of operating activities;

– the net assets change method, according to which the financial result is determined as the difference between the value of net assets at the end and at the beginning of the reporting period.

For the practical application of the above-mentioned approaches in accounting systems, different models of chart of accounts are used, which are closely linked to the structure of financial reporting and the specific features of national and international accounting standards. This ensures the possibility of adapting these methodologies to the specific conditions of enterprise operation and the requirements of the regulatory environment.

At the same time, it should be noted that financial results calculated using different methodologies may differ from one another. Such deviations are caused by different approaches to revenue and expense recognition, asset and liability valuation, as well as the specifics of institutional rules in different countries. This highlights the importance of comparative analysis of national and international practices in the study of financial result formation mechanisms and their impact on economic security and the sustainable development of enterprises.

The features of how different countries apply the described methodologies, as well as the set of indicators used in this process, are presented in a summarized form (Table 5.6).

Table 5.6

Determination of financial results in foreign countries

Method type	Classes of accounting accounts	Methodology for determining the financial result	Reporting
Financial accounting			
Balance method	"Non-current assets", "Inventories", "Equity", "Long-term liabilities", "Current liabilities", "Provisions"	1. Result = Assets – Equity – Liabilities. 2. Change in the value of net assets between the beginning and the end of the reporting period.	Financial statements (balance sheet)
Input–output method	"Expenses by elements", "Expenses by types of activity" (France), "Expenses by function of the enterprise" (USA, Canada, United Kingdom)	Result = Revenues – Expenses	Financial statements (statement of financial results)
Management accounting			
Changes in net assets method	"Financial result by responsibility centers", "Analytical financial result"	The financial result reflected in financial accounting is detailed and reclassified in accordance with the objectives of analysis	Internal reporting based on management accounting data

Analyzing international experience in the formation of financial results, it is appropriate to pay attention to the specifics of French practice, which is based on accounting data and enterprises' financial reporting and is characterized by an alternative approach to its determination. Thus, French enterprises may apply one of two main algorithms for calculating the financial result.

The first approach involves the use of an accounting account in which expenses (consumption of the enterprise's resources) are recorded on the debit side, while revenues from the sale of products, goods, or services provided are recorded on the credit side. This

ensures a direct comparison of expenses and results within the accounting system.

The second approach is based on the so-called linear calculation, according to which the output of products or goods, including the amount of "past" costs, is compared with the total value of newly created value. This method makes it possible to form a comprehensive assessment of the process of value-added creation within the enterprise and the efficiency of resource utilization over time.

In the process of determining the overall financial result in French practice, enterprise expenses are also taken into account and are grouped into three main categories: financial, operating, and extraordinary. Operating expenses are directly related to the statutory activities of the business entity, whereas financial expenses reflect transactions associated with capital management and financial instruments. A distinctive feature of the French approach, which differentiates it from domestic practice, is the identification of extraordinary activities, which, according to international regulation, include long-term operations lasting from 2 to 5 years. Thus, this approach makes it possible to take into account the impact of atypical and long-term operations on the formation of the enterprise's financial result and ensures an analytical assessment of its performance within the framework of international standards.

The algorithm for forming financial results using the "input-output" method, which is widely applied in global practice, is characterized by a complex multilevel system of calculations. At the initial stage, based on accounting data, the newly created value of finished products is determined. The next step involves constructing an input–output matrix, which allows for the systematization of interrelationships between resource costs and the results of production activity. In the final stage, using the constructed matrix, the financial result of the enterprise is determined without taking into account the actual cost of goods intended for sale. This methodology enables the assessment of value-added creation efficiency and serves as an important tool for analyzing the economic sustainability of a business entity.

A particularly notable and distinctive practice is the accounting system in the United States, the essence of which lies in focusing accounting on the operational determination of financial results. The

specificity of the calculation is related to the fact that expenses are grouped by elements as a basis, thereby forming value added. For ease of calculation, in the US chart of accounts, a separate class of accounts is designated for expenses by elements.

A key principle for determining financial results under the USA methodology is the revenue realization principle, which ensures the reliability of profit measurement and the accuracy of financial reporting. The main premise of this principle is that, in order to ensure accurate and proper profit calculation, revenue is recognized in the same period in which it is earned and is supported by the corresponding asset created to generate it. This promotes an objective matching of revenues and expenses, which is the basis for the correct determination of the financial result and for improving the effectiveness of an enterprise's financial management. The final stage of implementing this principle is the preparation of an adjusting accounting entry, through which accounts receivable are recognized in the accounting system for the amount of cash not yet received, while simultaneously recording the corresponding revenue of the enterprise.

In the United States, the objective of financial accounting is to determine net income in accordance with generally accepted accounting principles (GAAP), whereas under the Internal Revenue Code, the purpose is to determine taxable income and tax liabilities in accordance with USA federal and state tax legislation.

This methodology of forming financial results ensures the timely recognition of financial outcomes, enhances the transparency of accounting information, promotes a high level of operational efficiency in financial analysis, and improves the accuracy of cost control. Ultimately, it provides a high-quality informational basis for assessing economic security, investment attractiveness, and the strategic development of an enterprise, and overall makes the American model an important example of a modern institutional and managerial mechanism for ensuring sustainable development.

An analysis of international practice in the formation of enterprise financial results shows that most foreign accounting systems are oriented toward the requirements of International Financial Reporting Standards (IFRS), which serve as the foundation for ensuring transparency, comparability, and efficiency in financial

management. According to IFRS provisions, revenue is defined as an increase in economic benefits during the reporting period in the form of inflows of assets, enhancement of their usefulness, or decreases in liabilities, resulting in an increase in the entity's equity.

Despite the existence of national differences in regulatory frameworks, most countries adhere to common basic principles of revenue recognition. In particular, the key conditions include the reliable measurability of revenue and a high probability of receiving future economic benefits as a result of business activities. Such an approach ensures the unity of methodological foundations for the formation of financial results in the global economic environment.

As for expenses, the mechanisms of their formation and recognition significantly depend on the accounting system applied, in particular the use of standard-costing, direct-costing, or other approaches to differentiating the inclusion of costs in the production cost of goods. This determines the specific features of financial result calculation and the characteristics of analytical support for enterprise management.

Foreign experience in taxing financial results is characterized by the application of different tax rates. These rates vary depending on the relevant tax jurisdiction, the legal structure of the company, and, most importantly, the nature of the income received. Some taxation systems apply progressive tax rates, meaning that higher rates are imposed on higher levels of taxable income.

Governments of various countries continuously introduce tax incentives to encourage and promote certain types of business behavior. For example, incentives may support investment in research and development or the implementation of environmentally friendly practices. Tax benefits and tax credits may also be available to reduce tax liabilities associated with specific activities.

In the modern formation of enterprises' financial results, effective tax planning becomes increasingly important, serving as one of the tools for optimizing financial performance, ensuring economic security, and supporting the sustainable development of business entities. In order to improve the efficiency of corporate income tax administration, enterprises actively use mechanisms for structuring business operations, applying legally permitted tax deductions, and managing resources efficiently with consideration of tax

implications.

For legal entities and individual entrepreneurs, a clear understanding of the essence of financial results as an object of taxation is of fundamental importance. First, it ensures compliance with current tax legislation and minimizes the risk of financial penalties. Second, the correct interpretation of the mechanisms for forming financial results supports the adoption of well-founded managerial decisions aimed at increasing profitability and financial stability. Third, it is a necessary condition for the proper fulfillment of tax obligations and the maintenance of stable relations with state regulatory authorities.

Thus, the system of taxation of financial results goes beyond a purely fiscal mechanism and acquires strategic importance for shaping an enterprise's financial policy, its competitiveness, and long-term economic development.

These processes are becoming particularly relevant in the context of economic digitalization and the transformation of accounting, analytical, and tax administration systems. Digitalization is shaping new standards of transparency, automation, and control over financial flows, which requires the modernization of approaches to the formation and administration of financial results.

The improvement of the corporate income tax administration system in Ukraine should be aimed at enhancing the efficiency, transparency, fairness, and adaptability of tax mechanisms to current economic challenges. This will contribute to strengthening the economic security of enterprises, improving their competitive position, and creating prerequisites for the sustainable development of the national economy.

Thus, global practice demonstrates that an enterprise's financial result is formed as a consequence of comparing revenues and expenses, resulting in either profit or loss. Profit reflects a positive excess of revenues over expenses and indicates operational efficiency, whereas loss characterizes a negative business outcome due to the excess of expenses over revenues. The determination of financial results in international accounting systems is one of the priority tasks of financial management; however, each country implements this process taking into account its own institutional, regulatory, and managerial specificities. This highlights the

importance of a comparative analysis of Ukrainian and global practices for improving national mechanisms for ensuring economic security and sustainable enterprise development.

Conclusions

As a result of the conducted study, it has been established that an enterprise's financial result is a key integral indicator of business performance, reflecting the level of economic stability, competitiveness, financial security, and the entity's capacity for sustainable development. Its formation is carried out through the systematic comparison of revenues and expenses, which makes it possible to determine profit or loss as a generalized outcome of the enterprise's functioning.

It has been demonstrated that modern mechanisms for forming financial results in Ukraine are based on a clearly regulated system of accounting, tax administration, and financial analysis, which ensures the normative clarity and controllability of the process. At the same time, national practice is largely oriented toward fiscal aspects, whereas international approaches place greater emphasis on assessing capital efficiency, investment attractiveness, risk-oriented management, and strategic development.

A comparative analysis of Ukrainian and international practice has shown that foreign systems are characterized by greater flexibility, adaptability to global economic challenges, broader use of International Financial Reporting Standards, digital technologies, management accounting tools, and tax planning instruments. This creates additional opportunities for optimizing financial results, enhancing the transparency of enterprise operations, and strengthening their economic security.

It has been substantiated that the improvement of the national system for forming financial results should be carried out through the harmonization of national legislation with international standards, the digitalization of accounting and analytical processes, increased transparency in tax administration, the development of effective tax planning, and the implementation of modern financial and managerial tools.

Thus, the financial result should be viewed not only as an accounting or tax category but also as a strategic instrument for

ensuring the economic security of enterprises, enhancing their competitiveness, and creating prerequisites for long-term sustainable development at both micro- and macroeconomic levels. The adaptation of best international practices to Ukrainian conditions will contribute to strengthening the national economy, improving the efficiency of business entities, and ensuring their stability in the context of contemporary global transformations.

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STATE FINANCIAL SUPPORT FOR SUSTAINABLE DEVELOPMENT OF AGROINDUSTRIAL COMPLEX IN NEW GLOBAL RISK ARCHITECTURE

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Abstract
Scientific and practical approaches to planning state financial support for agro-industrial production in the system of state strategic planning and forecasting were identified. The features of the use of tax and budgetary instruments for planning state financial support for agro-industrial production in Ukraine were generalised. The main trends in the dynamics of the volume and structure of the budgetary support for Ukrainian agro-industrial production in the 2021-2025 period were analysed. Directions for modernising the planning of agrarian budget expenditures during the transition to a medium-term budget planning system were outlined. Strategic vectors for reforming the budgetary regulation of agro-industrial production in the context of implementing the country's strategic priorities social and economic development have been proposed.

Keywords: *state financial support, agro-industrial complex, budgetary support, budget program, medium-term program-targeted planning, strategy, effectiveness, socio-economic efficiency.*

Introduction

The latest challenges in the form of geopolitical conflicts and wars, global financial and economic crises, climate change and natural disasters, pandemics and other dangers significantly affect the effectiveness of the functioning of national economies, which requires improving mechanisms to support their stability in conditions of uncertainty and instability, recovery from crises and destruction. The agro-industrial complex, as a key sector of the economy of most countries, also operates in conditions of dynamic

change and global challenges, which require it to be able not only to resist external influences but also to adapt quickly to new economic conditions. The above-mentioned challenges make it urgent to deepen research on achieving a high level of resilience of the country's economy, which characterise its ability to adapt to changes in the external and internal environment, not only to maintain stability or recover from crises, but also to modernise and transform in time to maintain a sustainable growth trajectory in the modern dynamic environment. The state plays a decisive role in the mechanism for ensuring the resilience of economic development by forming and implementing effective economic policy, using tax and budgetary instruments to support key sectors of the economy during crises, stimulating investments in infrastructure and human capital, and promoting the development of institutions and mechanisms for anti-crisis management, innovation, and entrepreneurship.

Materials and Methods

The theoretical and methodological basis of the study was the scientific works of domestic and foreign scientists on the formation and implementation of fiscal policy and the features of the use of its tax and budgetary instruments, as well as regulatory and legal acts on fiscal regulation of the agro-industrial complex in Ukraine and the EU. During the study, a set of scientific methods and approaches was used, including systemic and structural approaches, methods of scientific abstraction and generalisation, analysis and synthesis, and factor and comparative analysis.

Results and Discussion

The issue of strengthening the level of resilience is becoming increasingly important for the economy of Ukraine and its agro-industrial complex, which have suffered significant destructive impact since the beginning of the full-scale war and continue to function under conditions of increased military risks and threats, in particular, a large number of industrial and infrastructure facilities have been destroyed and damaged, significant losses have been caused to farmers and rural communities, production and supply chains of agricultural products and raw materials have been disrupted, and the workforce and labour potential in general have been partially lost due to migration and mobilization processes.

It is important to note that the agricultural sector is critically important for maintaining socio-economic stability in the country, as it guarantees food and, to a certain extent, economic and environmental components of national security, in particular, it forms a significant share of GDP and export revenues, ensures the development of other technologically related sectors of the economy, determines the socio-economic living conditions of the rural population and the development of rural areas, etc. Even in the face of unprecedented wartime challenges, the industry does not lose its strategic potential to maintain and further increase production and export volumes, which will contribute to strengthening Ukraine's socio-economic stability, accelerating its post-war recovery and reconstruction (Lupenko et al., 2023).

An important prerequisite for achieving a high level of resilience of the agro-industrial complex of Ukraine is effective state support for the industry, primarily in matters of maintaining uninterrupted production and supply of agricultural products in modern economic conditions with increased military risks in order to guarantee food security, maintain the stability of the national economy and socio-economic stability in the country. Of particular importance is balanced direct state financial support for priority and effective agricultural producers to successfully overcome the latest military and European integration challenges in carrying out production and export activities, in particular in the areas of strengthening their financial stability during the war period, stimulating productivity growth and competitiveness for successful integration into the European and international markets of agro-food products. The strategic priority of state regulation of the development of the industry is also defined as active state stimulation of the processes of reforming national agro-industrial production in accordance with EU's standards regarding the application of sustainable, ecological, inclusive, innovative approaches in the implementation of production activities, the introduction of new requirements for the quality and safety of agro-food products, the digitalisation of state support for the industry, etc. (Tulush et al., 2025).

Given the limited capabilities of Ukraine in terms of state support and stimulation of economic activity in the conditions of the functioning of the wartime budget with the need for priority

financing of the needs of the security and defence sector and social payments, the issues of optimising the volumes, as well as modernising the mechanism, instruments and areas of state support for the domestic agricultural sector are becoming particularly relevant. In these conditions, a balanced and mutually agreed combination of tax and budgetary instruments to support the industry is necessary, taking into account the expected socio-economic effects of their application to achieve specific, socially significant results from spending budget funds on the industry's development.

It should also be noted that in the context of accelerating and deepening European integration processes, it is strategically important to gradually transform the mechanism and instruments of state financial support for the industry in accordance with the standards of the EU's Common Agricultural Policy, in particular in terms of introducing long-term strategic indicative approaches to planning its volumes and structure, distribution taking into account the principles of economic justice, environmental friendliness and innovativeness of agricultural production, priority support for rural communities, small agricultural producers, young farmers, as well as digitalization of its administration processes (Samoshkina, 2025).

State financial support for the development of Ukraine's agro-industrial complex is carried out using the following budget instruments:

budget financing of institutional and infrastructural providing for the functioning of the agrarian sector, priority industry areas and reform measures;

direct state financial support for agricultural producers in the form of subsidies, grants, compensations, reimbursements, additional payments and other special payments, differentiated by industry and territorial criteria, organisational forms and sizes of recipients;

budget lending to agricultural producers of priority industry areas;

budget financing of fundamental and applied research in the field of agrarian economy, measures to stimulate the implementation of their results in production activities.

The dynamics of the volumes of budgetary support for the Ukraine's agro-industrial complex for the period 2021-2025 indicates stable trends towards a decrease its share in the structure of consolidated budget expenditures from 1.01 % in pre-war 2021 to

0.23 % in 2025, which is primarily due to the transition to the functioning of a wartime budget with limited budgetary support for economic activity due to the need for priority financing of the security and defence sector and social support for the population (Figure 5.5).

The structure of budgetary support for the development of Ukraine's agro-industrial complex of on average for the period 2021-2025 was characterised by the following indicators: budgetary financing for institutional providing – 60 %; direct state financial support for agricultural producers – 27 %; budgetary financing for fundamental and applied research in the field of agrarian economics – 12.8 %; budget lending to farms – 0.2 % (Figure 5.5).

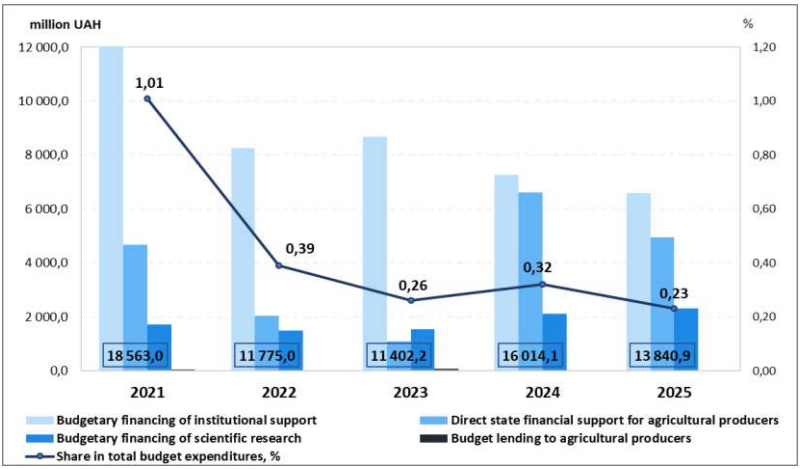


Figure 5.5 Dynamics of the volume and structure of budgetary support for Ukraine's agro-industrial complex in 2021-2025

Source: based on the data (Ministry of Finance of Ukraine; Ministry of Economy, Environment and Agriculture of Ukraine; State Agrarian Register of Ukraine)

The largest share in the structure of state support for the agro-industrial complex of Ukraine is budget financing of institutional provision for the functioning of the industry, which is aimed at creating a favourable institutional and competitive environment that will stimulate agricultural producers to effectively realise their internal potential for production activities, increase their productivity

and competitiveness. Analysis of the relevant budget programs indicates the need to reformat them, taking into account the new approved strategic priorities for the development and reform of the domestic agricultural sector in the context of overcoming military challenges, fulfilling European integration requirements, and meeting the needs of post-war recovery and reconstruction of the industry. It is also important to actively stimulate the development of digitalization and automation of state management processes, in particular through the platform of the State Agrarian Register, the Diya portal, and the IT system for budget planning and monitoring, which will create the prerequisites for reducing the share of management costs in budget financing of the agricultural sector, contributing to savings and increasing the efficiency of spending budget funds on the development of the industry.

An important tool for state regulation of the dynamics of the development of the agro-industrial complex and optimisation of its sectoral and territorial structure is direct state financial support for agricultural producers, which is provided mainly on an irrevocable basis in the form of budget subsidies, grants, compensations, reimbursements, benefits, additional payments, etc. Direct budgetary payments to agricultural producers can maintain the appropriate level of financial security for the production needs of farmers, increase the indicators of profitability, productivity, competitiveness of their activities, which is extremely important for maintaining and further increasing their production and export activity to support the stability of the national economy in war conditions, successful integration into the European and international markets of agro-food products and reforming production processes in accordance with EU standards. Budget lending is also an instrument of direct state support for agricultural producers, which operates on a revolving basis and provides for the provision of preferential loans for the implementation and diversification of production activities, the renewal of the material and technical base in order to increase the production volumes of competitive agricultural products and support priority sectoral investment projects.

It should be noted that since 2017, the main instrument of state financial support for domestic agricultural producers has been direct budgetary support in the form of partial compensation for the cost of

production resources, the total amount of which was to be at least 1 % of agricultural output, but this norm was not met. Trends in the pre-war and war periods indicate a decrease in the amount of direct budget support for domestic agricultural producers in relation to gross agricultural output from a maximum of 0.9 % in 2017 to 0.6 % in the pre-war 2021 and 0.2 % in the war period, respectively (Tulush, & Samoshkina, & Hryshchenko, 2024).

It is important to note that until 2017, tax instruments to support domestic agricultural producers prevailed in the form of a preferential VAT taxation regime and the possibility of choosing a simplified taxation system with the application of a single tax, while the use of budget support instruments was quite limited and was carried out mainly in the areas of stimulating the development of livestock and agricultural product processing industries, reducing the cost of lending and budget lending to farms. After the abolition of the special VAT regime for agricultural producers in 2016-2017, the use of tax instruments to support the industry has been significantly reduced. Currently, it provides only the possibility of choosing a simplified taxation system through the payment of a single tax of group IV for agricultural producers with an agricultural production share of at least 75%, the application of a reduced VAT rate of 14% for certain types of agricultural products, as well as certain tax and customs stimulus within industrial parks for processing industry enterprises and in the areas of scientific research.

The state policy of supporting and stimulating agro-industrial production in Ukraine is implemented through the planning and implementation of budget programs of the agrarian direction within the state and local budgets, on the basis of medium-term (three-year) program-targeted management. The essence of this approach is to allocate budget resources to develop the industry, in line with the approved strategic priorities of the country’s agrarian and rural development and to achieve the planned results of the state agro-food policy.

The program-targeted method of budget formation is a model of budget process organisation that links the processes of budget allocation and use with the expected and achieved results of the activities of state administration bodies in implementing the country’s priority goals and objectives of socio-economic

development. As a result, the emphasis shifts from budget resource management to budget results management in implementing approved priorities for the country's development across various spheres of public relations, enabling a qualitatively new level of governance. The effectiveness indicators of budget programs enable assessing the efficiency of budget funds in achieving planned goals and results, comparing program results over time and across budget fund managers, and identifying the most effective budget programs in allocating limited budget resources. Monitoring the effectiveness of budget programs can be carried out at different stages of the budget process and should aim to streamline and optimise the list of budget programs, review and improve their internal structure, and stop ineffective or insufficiently effective budget programs with the redistribution of funds in favour of other more effective budget programs (Chuhunov et al., 2015).

At the present stage, further improvement of the program-targeted method of budget resource management is underway, aimed at strengthening its prospective orientation and interconnection with the country's state strategic planning and forecasting of socio-economic development. In most developed countries, there has already been a transition to long-term budget forecasting (a period of 10-20 years) and, within it, medium-term program-targeted budget planning (for a period of up to 5 years) in order to ensure resource potential for the implementation of strategic plans for the country's socio-economic development in the medium and long term.

The budget process of Ukraine is also undergoing a transition from annual budget planning to a system of medium-term budget planning, which involves the implementation of processes for the formation of budget expenditures in the context of budget programs of budget fund managers for three years within the framework of the implementation of approved strategic priorities for the country's socio-economic development. Medium-term budget planning involves the implementation of strategic planning in the practice of public administration bodies responsible for the formation and implementation of the country's agro-food policy, by drawing up strategic plans for their activities, which should specify their main goal, objectives and tasks for the medium term, a list of budget programs for their implementation and expected results. Passports of

agrarian budget programs implemented by sectoral managers should also include the general goal, objectives and tasks defined for the medium term, areas of activity for their implementation, and effectiveness indicators, with which it is possible to assess the degree of achievement of the planned goals and results.

An important prerequisite for the introduction of medium-term budget planning is the functioning of a holistic system of state strategic planning for the country's socio-economic development, since the formation of budget indicators for the medium-term period should be carried out within the framework of the implementation of the approved long-term and medium-term strategic plans for the country's socio-economic development. It will require deepening the application of strategic approaches in the formation of state agro-food policy by introducing strategic planning for the development of agro-industrial production in Ukraine and its certain sectors.

In view of this, it is necessary to strengthen the prospective orientation and scientific validity of state strategic planning for the development of national agro-industrial production, which operates in conditions of dynamic changes, increased global and military challenges and threats. Long-term forecasting and further strategic planning of the development of the industry should specify the vision of the holistic architecture of the agro-industrial complex of Ukraine for a period of up to 10-20 years, provide an understanding of what the industry structure of production and exports should be, the technological level of production, adaptation to climate change, the dynamics of the development of rural areas, the ratio of economic entities by size and organizational forms, so that this gives the maximum socio-economic effect for the country, guarantees the appropriate level of food security, and ensures a high level of resilience of the industry development in the face of permanent military and European integration challenges.

To date, the Strategy for the Development of Agriculture and Rural Areas in Ukraine for the period until 2030, the Strategy for the Food Security of Ukraine for the period until 2027, the Strategy for the Development of the Fisheries Industry of Ukraine for the period until 2030 have already been approved, the State Target Economic Program for the Development of Livestock for the period until 2033 and other strategic documents on the development of the agricultural

sector have been approved. In addition, the strategic priorities for the development and reform of the agro-industrial sector of Ukraine and indicative indicators of their achievement are defined in the Plan for the Recovery, Reconstruction and Modernisation of Ukraine (Ukraine Plan), the effective implementation of which is a necessary condition for receiving financial assistance from the EU's budget in 2024-2027 through the Ukraine Facility instrument.

In order to implement the approved sectoral strategic documents, public administration bodies responsible for the implementation of agro-food policy form state policy goals in the relevant field of activity and indicators of their achievement (expected results) for a three-year period, which have already been included in the Budget Declarations for 2025-2027 and 2026-2028, and are also considered when preparing the Budget Declaration for 2027-2029. Simultaneously, the main administrators of budget funds form strategic plans for their activities and budget programs for their implementation, which are then included in the State Budget of Ukraine for the corresponding year.

It is important to note that, in the future, the application of strategic indicative approaches in the process of state regulation of the development of Ukraine's agro-industrial sector will be further deepened in the context of its European integration and the need to align with the principles of the EU's Common Agricultural Policy. Ukraine will need to transition to the implementation of a comprehensive and long-term policy for the development of the agricultural sector and rural areas, in particular, the introduction of long-term strategic planning for the country's agrarian and rural development, the features of its state financial support, in particular, at the expense of budget funds. The National Strategic Plan, which is developed by the EU member states within the framework of the Common Agricultural Policy and determines the long-term strategic priorities for the development of the country's agro-industrial sector, mechanisms and instruments of state support for their implementation, parameters of budget payments to farmers, priorities and target indicators for the development of rural areas should play a decisive role in this process.

The efficiency of the governance process in the EU is largely determined by the quality of the state's strategic planning system,

which should ensure a consistent transition from long-term goals to medium-term and annual programs, with the obligatory specification of the financing features, in particular at the expense of budget funds. Strategic goals and priorities must necessarily be checked for resource capacity and consistency with fiscal policy, and for a financial and economic justification for the features of their implementation, with an assessment of the impact on budget indicators, and specification of needs for investment resources or financing at the expense of state and/or local budgets. These approaches contribute to the development of a more holistic system of state strategic planning and forecasting, in which strategic goals are determined in a coordinated and harmonised manner, reflected in budget plans and forecasts, and supported by the necessary resources not only in the annual but also in the medium- and long-term.

An important component of the process of drafting strategic documents for industry development should be an assessment of the financial resources required to achieve the planned goals and results. It will require strengthening the alignment between the processes and documents for strategic and budget planning to ensure that strategic documents cannot be adopted with unrealistic or uncertain financing amounts. No less important is the scientific support for these processes, substantiating scientific and practical approaches to fiscal regulation of the agricultural sector, which will require a deeper understanding of the regulatory potential of tax and budget instruments to support and stimulate the development of agro-industrial production in modern conditions.

It is also necessary to improve the management of budget expenditures for the development of the industry in the direction of strengthening its relationship with the long-term strategic planning of the development of national agro-industrial production by introducing long-term forecasting of budget expenditures and implementing within its framework medium-term and annual program-target planning of agrarian budget programs with clearly defined, approved at the state level, sectoral strategic goals and expected results. Thanks to this approach, the medium-term and annual detailed plan of agrarian budget expenditures will be formed within the framework of long-term budget constraints and to fulfil the established strategic priority goals of the development of the

industry, which will guarantee financial support for the processes of implementing approved sectoral strategies and the achievement of planned results of the state agro-food policy in the medium and long term.

Conclusions

The transition to medium-term program-targeted management of budget resources in Ukraine involves implementing planning processes for agrarian budget expenditures for the medium-term, aligned with strategic goals, budget programs, and effectiveness indicators for budget managers. Expanding the planning horizon of agrarian budget programs to 3 years will ensure the budget policy supports the sector, with continuity and consistency in implementing the country's approved strategic priorities for agricultural and rural development, achieving the planned goals and results of the state agro-food policy.

The persistent trends of the pre-war and war periods towards a decrease in the volume of direct budget support for domestic agricultural producers with limited use of tax support instruments for the development of the industry significantly limit the possibilities of using the regulatory potential of fiscal policy in achieving the strategic priorities of the country's agrarian and rural development, especially in the context of significant military risks to maintain the positive dynamics of the development of domestic agro-industrial production, its restoration in the affected and deoccupied territories, and reform in accordance with EU's standards. It is advisable to increase the volume of direct budget support for agricultural producers to the level of 1% of agricultural output with an emphasis on the affected territories and territories with increased military risks, and in the medium and long term, gradually bring its level to the standards of providing financial support within the framework of the EU's Common Agricultural Policy to reform industry production processes in accordance with the requirements of the European Union, increase the competitiveness of domestic agricultural producers and ensure their successful European integration.

The implementation of strategic priorities for the development of Ukraine's agro-industrial complex should be ensured within the framework of the development of a mutually agreed hierarchical system of state strategic planning documents – from long-term

strategies for the socio-economic, agrarian and rural development of the country to strategic plans for the activities of sectoral state administration bodies and the medium-term Budget Declaration. Ensuring the consistency of various strategic documents with each other is a necessary condition for their implementation, since the combination and synchronisation of strategic planning for the development of the industry with medium-term budget planning will ensure the effective achievement of the planned goals of the state agro-food policy, and will allow avoiding possible imbalances in the financial provision of their implementation in the medium and long terms.

Modernization of the domestic system of state strategic planning and forecasting requires the introduction of long-term budget forecasting and, within its framework, the improvement of the system of medium-term and annual program-target planning of agrarian budget programs, taking into account the criteria of their priority and effectiveness, which will allow linking the implementation of the Strategy for the Development of the Agricultural Sector of Ukraine with the long-term budget trajectory and the financial capabilities of the budget for its implementation, making the process of planning agrarian budget expenditures more targeted, effective, productive and transparent. It is also important to introduce the practice of assessing the effectiveness of the implementation of sectoral strategic documents and the responsibility of state administration bodies for their improper implementation in order to prevent an uncontrolled increase in their number and, accordingly, the dispersion of limited budget resources instead of their concentration on budget programs that provide the greatest socio-economic effect for the country and the necessary sectoral results. It will allow moving to a qualitatively new level of public administration and budget planning – management of budget results in the implementation of the established strategic goals of the country's agrarian and rural development.

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TECHNOLOGICAL DEVELOPMENT OF ENTERPRISES IN THE ENVIRONMENT OF INNOVATION ECOSYSTEMS

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Abstract
This subsection of the monograph is devoted to the study of technological competitiveness as a comprehensive capability of an enterprise to create, implement, and commercialise innovative technologies, ensuring sustainable advantages under accelerated technological cycles and intensified global competition within the framework of Industry 3.0-6.0. The evolution of views on competitiveness is revealed, tracing the shift from a static interpretation focused on comparative advantages to a dynamic, systemic, and multidimensional approach that integrates technological,

organisational, and human components.
It is substantiated that modern technological competitiveness is determined not only by the availability of technical solutions, but also by the enterprise's ability to systematically renew technological competencies, develop human capital, R&D, and efficient supply chains, as well as by institutional support and technology transfer mechanisms, which are particularly critical for countries with transformational economies. It is shown that under conditions of digital transformation, ecosystem-based logic becomes decisive, whereby competitive advantages are formed through the integration of enterprises into broader networks of knowledge, technologies, and partnerships. The role of interaction between the state, business, science, and society within the Quadruple Helix framework is characterised as a key factor in accelerating the identification, absorption, and scaling of innovations and increasing the level of technological readiness (TRL). Approaches to managing enterprise technological advantages are systematised (the resource-based view and VRIN/VRIO criteria, dynamic capabilities, innovation and technological tools such as TRL and the ISO 56002:2019 standard, and the ecosystem approach), and the expediency of their integration is substantiated to ensure strategic uniqueness, rapid adaptation, measurability of innovation processes, and synergy of network-based interaction.
It is concluded that there is a need to align management approaches with ecosystem logic and performance indicators, including TRL parameters, R&D intensity, and partnership interaction, and to emphasise the transformation of requirements for technological competitiveness as a result of the transition from Industry 3.0 to Industry 6.0, with an increasing role of artificial intelligence, human-centred solutions, and a focus on sustainable development.

Keywords: *technological competitiveness, innovation ecosystem, open innovation, Quadruple Helix, digital transformation, Industry 3.0-6.0, resource-based view, dynamic capabilities, technology transfer, human capital, enterprise.*

Introduction

The intensification of global technological competition and the acceleration of industrial transformations within Industry 3.0-6.0 highlight the need to rethink the sources and mechanisms of forming competitive advantages of enterprises, as it is technologies, digital

systems and innovative processes that increasingly determine the dynamics of national economies and the positioning of production structures in the global environment. It is obvious that in the context of shorter technological cycles and the growing role of cyber-physical systems, artificial intelligence, robotics, sensor technologies and information and communication solutions, technological competitiveness appears not only as a factor in increasing productivity, quality and speed of innovation processes, but also as a strategic prerequisite for the long-term development of an enterprise, its ability to continuously update and adapt to changes in the technological and market configuration.

At the same time, the evolution of ideas about competitiveness - from a static interpretation focused on comparative advantages to a dynamic, systemic and multidimensional vision that encompasses technological, organisational and human components, forms the basis for a more in-depth analysis of technological competitiveness as the ability of an enterprise to compete on the basis of technical and scientific competencies that ensure the creation, implementation and commercialisation of innovative technologies. The emphasis on highly competent personnel, a developed R&D and innovation system, efficient supply chains and the use of advanced digital solutions is combined with an understanding that for developing economies, professional training, educational level, institutional stability, as well as the processes of digitalisation and greening of production are of decisive importance.

Under the influence of digital transformation, enterprises are increasingly faced with the need to develop not only their own technological potential, but also interaction with other participants in the innovation environment, since modern technological competitiveness is determined not by the company's isolated resources, but by the level of its integration into a broader ecosystem of knowledge, technologies and partnerships. In this context, cooperation between the state, business, science and society, in particular in the Quadruple Helix model format, creates an innovation-active environment in which an enterprise can quickly identify, assimilate and scale technological innovations, increasing the level of technological readiness and accelerating the transition to the commercial implementation of technologies. That is why the rest

of Chapter 1 focuses on the theoretical and methodological foundations of open innovation in innovation ecosystems, revealing the essence of an enterprise's technological competitiveness and the logic of its formation within network and cooperative structures, where knowledge, resources and partnerships are transformed into strategic assets for technological development**.**

Materials and Methods

A significant body of work has been produced in the scientific literature on the role of technology in shaping the competitive advantages of enterprises and national economies. The basic principles of the relationship between technological development and competitiveness are highlighted in the works of Fagerberg (1996), and the evolution of ideas about competitiveness in a globalised business environment and its multidimensionality are highlighted in the studies by Dunning (2013) and Porter and Ketels (2001). The specifics of technological competitiveness in the context of accelerating technological change and industrial transformation, in particular Industry 4.0-5.0, are systematised in the work of Alvarez-Aros and Bernal-Torres (2021), and the issues of transition between generations of industrial development are addressed in contemporary review studies (Islam, 2025; Ghobakhloo, 2023) and works outlining the prospects of Industry 6.0 and cognitive systems (Cobo et al., 2022).

A separate block of studies is devoted to tools for measuring and forecasting technological development. In particular, approaches to forecasting technological trends through patent analytics are reflected in the work of Bernal, Jun and Lee (2018), while issues of science, technology and innovation policy in developing countries and the role of government incentives are addressed in the study by Alnafrah and Mouselli (2017). For transformational and emerging economies, the focus remains on the knowledge base of technological competitiveness and the role of human capital (Domínguez et al., 2009), as well as the impact of digital transformation on the competitive position of enterprises (Bednar & Welch, 2019). Taken together, these works emphasise that technological competitiveness cannot be reduced to the availability of technical solutions and requires institutional support and

appropriate technology transfer mechanisms (Alnafrah & Mouselli, 2017).

An important area of research is related to theoretical and methodological approaches to managing the technological advantages of an enterprise. The resource-based view of competitive advantage and the VRIN/VRIO criteria are thoroughly explored in the works of Barney (1991a, 1991b), while the dynamic capabilities approach as a mechanism for renewing resources and competencies in conditions of technological turbulence is discussed in the works of Teece, Pisano and Shuen (1997) and Teece (2007). The practical dimension of the resource approach in a digital context is also reflected in the study by Saura, Palos-Sanchez and Correia (2024). The operationalisation of technological readiness and innovation process management is ensured by the TRL methodology in the materials of the European Commission (2016) and the ISO 56002:2019 standard (International Organization for Standardization, 2019), which forms the basis for planning investments in R&D and making decisions on technology scaling.

In contemporary discourse, the ecosystem logic of technological competitiveness is becoming increasingly important. The conceptual foundations of innovation ecosystems and their relationship to innovation strategy are explored in the works of Adner (2006) and Autio and Thomas (2021), while the origins of the ecological metaphor of competition are explored in the classic work of Moore (1993). The issues of the Quadruple Helix and network modes of knowledge production are discussed in the works of Carayannis and Campbell (2012, 2009), while the definitional field of innovation ecosystems and approaches to their description are discussed in the work of Jackson (2011) and the conceptual review by Granstrand and Holgersson (2020). Applied aspects of orchestrating network-centric innovations are highlighted in the work of Nambisan and Sawhney (2011), and practices for accelerating the growth of technology hubs and building ecosystems are covered in the analytical materials of McKinsey & Company (Davis et al., 2023) and in works that introduce the life-cycle perspective on ecosystem design (Jütting, 2024). In the same context, the concept of open innovation (Chesbrough, 2003a) and modern generalisations of its research possibilities (West & Bogers, 2017) outline the mechanisms of

inbound, outbound and coupled interaction that support the co-creation of value in networks.

Separately, the literature notes the strengthening of the link between technological competitiveness, ecosystem openness and political competitiveness guidelines, in particular in the analytical documents of the European Commission (2024) and in the report on the future of European competitiveness (Draghi, 2023). Related aspects is the role of innovation ecosystems in open innovation. These are presented in a recent study (Hernandar et al., 2024), and corporate foresight tools as a component of sensing capabilities in the work of Rohrbeck and Kum (2018). In terms of assessment tools, there are also methodological materials on TRL developed by NASA (Mankins, 1995).

At the same time, despite a significant number of theoretical and applied developments, there is still a need in the literature to harmonise approaches to managing technological competitiveness with the ecosystem logic of network interaction and with performance measurement tools, including TRL, innovation management standards, R&D intensity indicators and partnership parameters (European Commission, 2016; Autio & Thomas, 2021; Granstrand & Holgersson, 2020). It also remains relevant to deepen the analysis of technological competitiveness in the context of developing and transitional economies, taking into account the role of human capital, institutional support and technology transfer mechanisms (Alnafrah & Mouselli, 2017; Domínguez et al., 2009).

Results and Discussion

The concepts of technology and competitiveness are among the most commonly used categories in contemporary scientific and economic discourse, as they largely determine the dynamics of national economies and the opportunities for positioning of enterprises in the global environment (Fagerberg, 1996). In the context of accelerating technological change, technological competitiveness is becoming a key factor in adapting to industrial transformations, ensuring sustainable development and improving operational efficiency.

In scientific approaches, technological competitiveness is interpreted as the set of opportunities for an enterprise to create,

implement and commercialise innovative technologies that provide advantages in terms of productivity, quality, speed of innovation processes and flexibility in the use of resources. The intensive development of technologies, digital systems and automation forms the basis for industrial revolutions from Industry 4.0 to Industry 5.0, within which the interaction of humans, artificial intelligence and cyber-physical systems is changing the logic of competition (Alvarez-Aros & Bernal-Torres, 2021). Accordingly, technological competitiveness reflects not only the availability of technical solutions, but also the ability of an enterprise to ensure the systematic updating of technological competencies.

In developed economies, technological competitiveness is usually based on highly skilled personnel, a well-developed R&D and innovation system, efficient supply chains and active use of advanced technologies. Throughout history, the concept of competitiveness has evolved from a static, comparative advantage-oriented approach to a dynamic, systemic and multidimensional one that includes technological, organisational and human components (Dunning, 2013). The modern understanding of competitiveness encompasses the ability of organisations to continuously innovate, utilise knowledge and combine human and technological potential within a single development trajectory (Porter & Ketels, 2001).

Technological competitiveness as the ability to compete on the basis of technical and scientific competencies is less deeply explored, especially in the context of developing economies (Alvarez-Aros & Bernal-Torres, 2021). Statistical methods and R&D+i patent indicators are used to assess technological development, as well as approaches to forecasting technological trends through the analysis of publications or the creation of technological development indices (Bernal, Jun, & Lee, 2018). The growing role of technology highlights the need for public policy in the field of science, technology and innovation and for stimulating technology transfer between the public, academic and industrial sectors (Alnafrah & Mouselli, 2017), which emphasises the dependence of technological competitiveness on external institutional and cooperative conditions.

For enterprises in countries with transitional economies, technological competitiveness is linked to the development of “soft” technologies, the role of human capital, the competencies and

knowledge of employees, and their ability to integrate new solutions into production processes (Domínguez, Garcia, & Pontes, 2009). At the same time, it should cover the assimilation and implementation of the latest technologies – cyber-physical systems, artificial intelligence, robotics, sensor technologies, automation, information and communication technologies, and new materials (Bednar & Welch, 2019). The development of technological competitiveness is inextricably linked to the evolution of industrial revolutions, as each stage has shaped new requirements for technological competencies, management models, and human–technology interaction (Islam, 2025).

Industry 4.0 initiated a digital revolution based on IoT, Big Data, analytics, AI, and cyber-physical systems (Ghobakhloo, 2023), while Industry 5.0 emphasises the interaction between humans and intelligent systems, taking into account the ethical, social, and environmental dimensions of competitiveness (Fagerberg, 1996). At the same time, a vision of Industry 6.0 is emerging, which envisages deeper integration of biotechnology, AI, quantum computing, nanomaterials and neural network systems, and the formation of "self-learning" innovative ecosystems (Cobo, Bednar, & Welch, 2022) (Table 5.7).

Under the influence of global digital transformation, enterprises are increasingly faced with the need to develop not only their own technological potential, but also interaction with other participants in the innovation environment. In today's environment, technological competitiveness is determined not by the isolated resources of an enterprise, but by the level of its integration into a broader ecosystem of knowledge, technologies and partnerships (Carayannis & Campbell, 2012). Scientists emphasise that the processes of creating innovations and technological advantages are increasingly unfolding within network structures in which manufacturers, research centres, universities, suppliers, technology users and government institutions interact (Carayannis & Campbell, 2012; Barney, 1991). This format of cooperation, in turn, ensures faster dissemination of knowledge, lower research costs, more effective exchange of R&D results, and accelerated diffusion of innovations.

Of particular importance is the quadruple helix model, which expands the classic triple helix of university–business–government

interaction and adds a civil society component. Within this model, interaction is formed between: (1) the state, which creates institutional conditions, a legislative framework and financial incentives for the development of technologies; (2) science and education, which produce knowledge, competencies and innovative ideas; (3) business, which transforms scientific developments into commercially viable products; (4) society, which determines the demand for technological solutions and ensures the social legitimacy of innovations (Carayannis & Campbell, 2012). Thus, the result of the interaction of these elements is the formation of an innovation-active environment within which an enterprise has the opportunity to quickly identify, assimilate and scale technological innovations.

Table 5.7

Comparative characteristics of Industries 3.0-6.0

Industry generation	Technological basis	Human factor	Type of competitive advantage	Management model	Role of innovation	Focus on sustainability
3.0 - Automation	Computers, PLCs, automated lines	Human – operator	Productivity, quality	Hierarchical	Incremental	Low
4.0 - Digitalisation	IoT, Big Data, AI, CPS	Human – analyst	Flexibility, efficiency	Network	Open innovation	Average
5.0 - Human-centred	Human-robot collaboration, cognitive systems	Human as co-creator	Personalisation, creativity	Collaborative	Inclusive	High
6.0 - Intelligent ecosystems	Bio-, nano-, quantum technologies, AI 2.0	Humans – an element of the ecosystem	Self-learning, eco-efficiency	Ecosystem	Cognitive	Very high

Source: compiled by the authors based on Ghobakhloo (2023), Fagerberg (1996), and Cobo, Bednar, and Welch (2022).

Participation in joint research projects, technology clusters and open innovation platforms provides access to external knowledge, which increases the level of technological readiness (TRL) and accelerates the transition to commercial implementation of technologies. At the same time, in modern conditions, technological competitiveness is increasingly becoming ecosystemic in nature, with sources of innovation distributed among many entities, and their combination forming a co-creation value network. This allows the company not to limit itself to using its own resources, but to attract external technological assets, expanding the boundaries of innovative activity (Teece, Pisano, & Shuen, 1997).

An important prerequisite for effective cooperation is the digital integration of ecosystem participants. The use of cloud platforms, analytical systems, and data exchange tools ensures process transparency, supply chain synchronisation, coordination of R&D activities, and joint knowledge management. Following this logic, digital infrastructure becomes an "innovation framework" that supports real-time collaboration between partners (Saura, Palos-Sanchez, & Correia, 2024). In addition to economic effects, ecosystem interaction forms a socio-technical result – a culture of trust, openness, and shared learning, stimulating the development of human capital and competencies, without which technological competitiveness is impossible. Thus, cooperation between the state, business, science and society is not an external backdrop, but a fundamental component of managing the technological competitiveness of an enterprise.

The management of an enterprise's technological competitiveness is based on a number of modern scientific approaches that explain the mechanisms of formation, maintenance and development of technological advantages in a changing environment. The key approaches include: the resource approach, the dynamic capabilities approach, the innovation and technology approach, and the ecosystem approach. Their combination forms a comprehensive theoretical and methodological basis for managing competitiveness in the digital economy and accelerated technological evolution.

Resource theory (Barney, 1991) views an enterprise as a set of tangible, intangible and organisational resources that can be a source of long-term competitive advantage if they meet the VRIN criteria:

(1) Value; (2) Rarity; (3) Imitability; (4) Non-substitutability (Barney, 1991). In the context of technological competitiveness, this means that the advantages of an enterprise are determined by a unique combination of technological resources (equipment, software, know-how), intellectual capital (knowledge, competencies, innovative culture) and organisational capabilities that ensure the effective use of technologies. The further development of RBV in the 2000s was complemented by the logic of VRIO analysis, within which the fourth feature (O – Organisation) emphasises the enterprise's ability to create internal mechanisms for the effective use of technological resources. Accordingly, managing technological competitiveness within RBV involves: (1) identifying strategically important resources; (2) accumulating, developing and protecting them; (3) transforming resources into dynamic capabilities that ensure adaptation to technological change (Barney, 1991b).

Since resources alone do not guarantee a stable advantage, Teece, Pisano and Shuen (1997) developed the concept of dynamic capabilities, which expands RBV and explains how enterprises renew resources in the face of technological change (Teece, Pisano, & Shuen, 1997). Dynamic capabilities are defined as the ability of a company to integrate, develop and reorganise internal and external competencies to respond to rapid market and technological transformations. This approach is based on three processes: (1) sensing – identifying new technological opportunities and threats; (2) seizing – mobilising resources to exploit opportunities; (3) reconfiguring – reorganising assets, processes and structures to support innovative development (Teece, 2007). Within this approach, technological competitiveness is a function of organisational flexibility, speed of decision-making and effective innovation management. This is particularly relevant in the context of Industry 4.0 and 5.0, where technological cycles are significantly shortened and competitive advantage increasingly depends on the pace of technological adaptation and the ability to integrate digital solutions into production processes.

The innovation and technology approach focuses on the Technology Readiness Level (TRL), innovation process management, and standardisation of innovation activities. The TRL methodology, developed by NASA and later adapted by the

European Commission, is used to quantitatively assess technological readiness from idea to industrial implementation and includes nine levels – from TRL 1 (scientific observation) to TRL 9 (commercial exploitation) (European Commission, 2016). The application of this approach makes it possible to evaluate technological developments, predict risks, plan investments in R&D, and make informed decisions about scaling technologies. In addition, the international standard ISO 56002:2019 Innovation Management System proposed a systematic model for innovation management based on the principles of strategic thinking, leadership, process integration, and value creation for stakeholders (International Organization for Standardization, 2019). The combination of the TRL methodology and ISO 56002 forms a practical toolkit for managing technological development: the enterprise is able to determine the current level of technology maturity, identify "technology gaps" and plan steps to increase the level of readiness, which, in turn, allows managing the evolution of technological competitiveness at a strategic level.

The ecosystem approach to managing technological competitiveness is based on the assumption that the modern economy functions in the format of innovative ecosystems, where enterprises, universities, government institutions, investors and consumers form networks of joint value creation. In this context, Adner (2006) and Autio and Thomas (2021) emphasise that the ecosystem approach changes the logic of management, as companies not only compete but also co-evolve within interconnected systems where the success of one participant depends on the success of others (Adner, 2006; Autio & Thomas, 2021). The ecosystem model of technological competitiveness involves: (1) open knowledge sharing between partners (open innovation); (2) interaction of complementary technologies (e.g., AI + robotics + digital twins); (3) joint investment in R&D; (4) digital platforms for process coordination and innovation lifecycle management. In practical terms, this manifests itself in the formation of clusters, alliances, technology parks, open laboratories and partnership programmes with universities, which ensure the systematic exchange of knowledge and innovation. At the same time, the ecosystem approach corresponds to the concept of shared value, i.e. a focus not only on profit, but also on social, environmental and technological

benefits, which strengthens the sustainability of the enterprise in the global environment.

Thus, the combination of these approaches forms a multi-level system for managing the technological competitiveness of an enterprise: the resource approach ensures strategic uniqueness; the dynamic capabilities approach ensures the ability to adapt quickly; the innovation and technology approach provides tools for measuring and standardising innovation; the ecosystem approach provides network interaction and synergy. The integration of these approaches makes it possible to transform technological resources into a source of long-term competitive advantages, increase the level of innovation capacity, and ensure sustainable development even in conditions of global market turbulence.

Over the past two decades, the concept of an "innovation ecosystem" has gained particular popularity in academic, political and business circles, while remaining controversial in terms of its conceptual boundaries and the lack of an established single definition. On the one hand, this situation reflects the real processes of increasing complexity in innovation activities and their transition from isolated R&D practices to networked value co-creation. On the other hand, it demonstrates that the scientific tools for describing new forms of interaction between actors are still in the process of being developed. That is why the literature simultaneously contains interpretations that focus on the geographical concentration of innovative activity, on the platform coordination of actors, on co-evolutionary knowledge flows, or on institutional conditions that set the rules and incentives for innovative behaviour (Adner, 2006; Jackson, 2011; Nambisan & Sawhney, 2011; Davis et al., 2023).

The widespread use of the term is largely due to numerous examples of successful innovation hubs — Silicon Valley, Boston, London, Munich, Rio de Janeiro, Singapore, Tel Aviv — which are described in public discourse as clusters, innovation hubs, technology parks, but increasingly as "innovation ecosystems," by analogy with natural ecosystems (Budden & Murray, 2016). In this context, emphasis is placed not only on the effectiveness of innovations, but also on the way they are produced — through interdependence, complementary roles and sustainable channels for the circulation of knowledge, resources and competencies between

diverse participants.

According to Budden and Murray (2016), innovative ecosystems, like their biological counterparts, are based on the interdependence and interaction of diverse but complementary actors, each of which plays a key role in ensuring the sustainability and development of the entire environment. The authors highlight the following characteristics: (1) ecosystems are usually formed around urban centres with a population of over a million; (2) they are not limited by administrative boundaries; (3) they include research-oriented universities capable of translating knowledge into practice; (4) they are characterised by a high concentration of innovative activity, particularly in the early, even pre-commercial stages (Budden & Murray, 2016). Thus, even at the level of basic characteristics, it becomes clear that an innovation ecosystem cannot be reduced to a single organisation or sector; it is an environment for interaction between many actors who simultaneously cooperate and compete, ensuring the innovation cycle "from knowledge to market".

In a strategic context, the ecosystem metaphor was proposed by James F. Moore in his article *Predators & Prey: A New Ecology of Competition* (1993), in which the author emphasised the need to rethink the role of firms as self-sufficient units in the direction of considering them as parts of more complex inter-organisational communities (Moore, 1993). Moore proposed to imagine business as a biological ecosystem that evolves from a simple collection of "organisms" to a harmoniously structured environment – "from meadow to forest" — and identified stable and consistent interaction between entities that coexist, evolve and exchange resources, competencies and knowledge as the key mechanism for such a transition (Moore, 1993). It is important that in this logic, the ecosystem does not deny competition, but rather frames it as an interconnected process in a broader community of value creation.

At the same time, the concept of an innovation ecosystem is not without criticism. Granstrand and Holgersson (2020) emphasise that although the term has become widely used, it still lacks a clear definition, is not a coherent theory, and often abuses the biological analogy. Oh, Phillips, Park, and Lee (2016) also note that the use of ecological metaphors, although in line with current trends in bio-inspired thinking, carries the risk of misapplying the laws of the

natural environment to socio-economic systems. In such remarks, it is important not to deny the usefulness of the metaphor as such, but to emphasise the need for conceptual accuracy, limitations of application, and correct differentiation of related concepts.

It is noteworthy that even critically minded researchers recognise the applied potential of the concept, provided that it is empirically substantiated. Thus, Ritala and Almpanopoulou (2017) emphasise that the concept of an innovation ecosystem can serve as a useful addition to innovation theories and management tools, but requires a clear distinction from the concepts of "innovation system," "network," and "ecosystem," and should include both the commercialisation of ideas and the evolution of institutional mechanisms. In fact, this distinction is fundamental, since in most works, an innovation ecosystem is not considered synonymous with national or sectoral innovation systems (Freeman, 1987; Lundvall, 1992; Breschi & Malerba, 1997), but as a framework focused on the dynamics of interactions, complementarity and joint value creation that goes beyond a purely institutional description (Granstrand & Holgersson, 2020).

Within the framework of Clarysse, Wright, Bruneel, and Mahajan (2014), innovative ecosystems are viewed through the prism of value creation business models, emphasising that they are formed as value networks - business ecosystems, in which value propositions are generated through the complementarity of participants. Under such conditions, partners gain competitive advantages not only from their own resources, but also from the synergy of interaction; at the same time, the geographical localisation of innovation in "hot spots" enhances the ecosystem due to the role of leading universities and public research organisations that facilitate technology transfer (Clarysse et al., 2014). Thus, the ecosystem emerges as a combination of interrelated roles, within which innovative value is not "produced" linearly, but "constructed" through the coordination of contributions from many participants.

In view of the above, the concept of an innovation ecosystem is multifaceted, promising and conceptually complex. It allows various entities to be combined in a joint process of creating, disseminating and implementing innovations, but requires a correct definition of the limits of application and consideration of the real context of

economic interactions (Granstrand & Holgersson, 2020; Oh et al., 2016; Ritala & Almpanopoulou, 2017). That is why, in practical analytics, it is advisable to note that the definitions of an innovation ecosystem vary depending on the research focus: scientific sources emphasise the networked, co-evolutionary and platform nature of interactions, while strategic documents of the European Commission or the OECD emphasise regulatory conditions, institutional support and political levers for development, and Ukraine's National Economic Strategy – 2030 integrates the ideas of sustainable interaction between science, business, the state and society (Adner, 2006; Jackson, 2011; Nambisan & Sawhney, 2011; Davis et al., 2023).

After defining the field, the question of the structural organisation of the innovation ecosystem becomes key, as it is the structure that enables the performance of functions, coordination of actors, circulation of resources and, ultimately, the creation of innovative value. At the same time, describing the structure of an ecosystem is a difficult task, as innovative ecosystems are complex, dynamic, multi-level systems that change in space and time and do not have a fixed configuration (Su et al., 2019). Their architecture is formed as a result of the interaction of business, science, the state and society at different stages of development, and therefore any structuring is inevitably a simplified model that selects key variables.

One of the basic approaches to structuring is the life cycle model proposed by Moore (1993), according to which an innovative ecosystem goes through four stages: birth, expansion, leadership, and self-renewal, and at each of them faces cooperative and competitive challenges – from forming a value proposition and protecting an idea to scaling, establishing itself in the market, and institutional renewal (Chesbrough, 2003). Within this logic, an ecosystem is a process rather than a state: it is born around an innovative idea, expands by attracting complementary participants, achieves leadership by stabilising roles and rules of interaction, and maintains viability through self-renewal mechanisms (Figure 5.6).

At the same time, applied sources emphasise that the formation and development of technology hubs as innovation ecosystems is not an automatic consequence of "talent availability" or "business concentration," but rather the result of purposeful work to create

conditions for the transfer of knowledge into products and economic growth. Thus, McKinsey & Company notes that it is possible to accelerate the growth of technology hubs by creating innovative ecosystems that allow scientific discoveries to be transformed more quickly into products and economic growth, identifying five elements of a successful innovative ecosystem: scientific potential, effective technology transfer mechanisms, a favourable environment for start-ups, market access and strategic leadership; all elements must work as a system that changes according to the phase of development – from the launch of innovations to their scaling and adaptation to new conditions (Davis, Safran, Schaff, & Yayboke, 2023). Thus, in this formulation, the structure is revealed through the functional pillars of the ecosystem, as well as through the ability to integrate these pillars into a coordinated system (Figure 5.7).

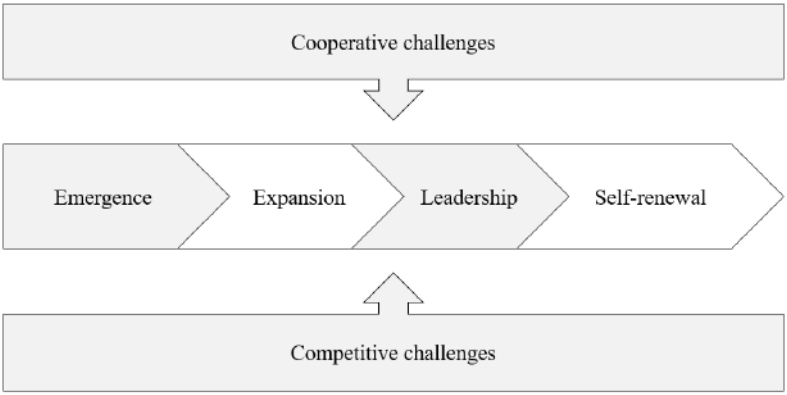


Figure 5.6 The life cycle of an innovation ecosystem according to James Moore

Source: compiled by the authors based on Chesbrough (2003)

Along with the structure that defines the "framework" of interactions, the functional content of the innovation ecosystem is decisive, since it is the set of functions that allows us to assess how the ecosystem creates innovative value, supports the development of enterprises and ensures sustainability in a dynamic environment. The functional approach, accordingly, allows us to move from describing "who is in the system" to analysing "what the system does", i.e. to identifying the key processes and outcomes that support innovation.

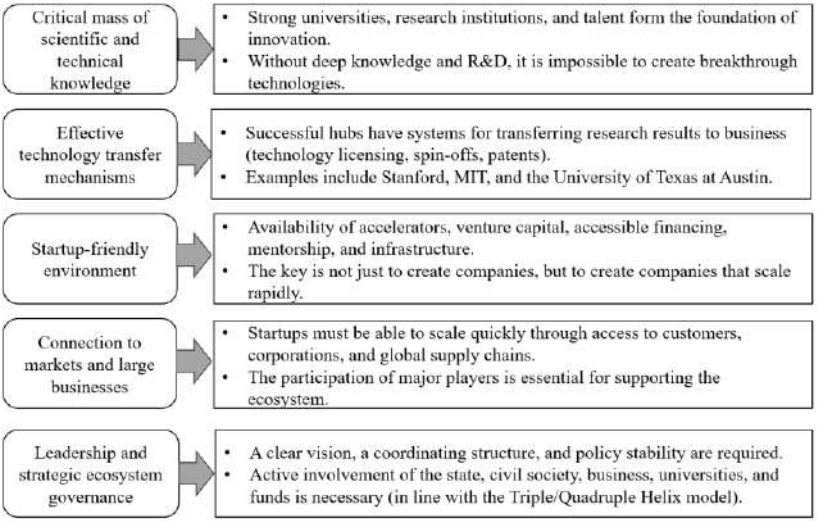


Figure 5.7 Five key elements of successful innovation ecosystems

Source: Compiled by the authors based on Davis et al. (2023)

First, the basic function of an innovation ecosystem is the generation of knowledge and research, which is ensured through the interaction of universities, research institutions and corporate laboratories, and within the Triple Helix model, the university acts as a key generator of knowledge, which, through the transfer of technology and applied research, ensures the transition from fundamental science to applied innovation (Jackson, 2011; Etzkowitz & Leydesdorff, 2000).

Secondly, the ecosystem performs the function of technology transfer and commercialisation, ensuring the transfer process "from invention to market product" through licensing, the creation of start-ups and spin-offs, project incubation, and the creation of conditions for market entry. In this sense, technology transfer systems are an indicator of the ecosystem's ability to transform ideas into economic value (Davis et al., 2023; Granstrand & Holgersson, 2020). Thirdly, the coordination of actors and resource flows is critically important and can be achieved through a platform, leading firms or government structures; the degree of integration and coordination determines whether the ecosystem will be synergistic or fragmented (Teece, 2007; Nambisan & Sawhney, 2011). Fourth, the ecosystem provides

support for entrepreneurship and innovative activity, including access to financing, mentoring, acceleration programmes, business networks and infrastructure; the key is the ability to support entrepreneurship at different stages of the innovation cycle – from idea to scaling (Roundy, 2017). Fifth, a separate functional phase is the scaling of innovations and entry into markets, which requires resources, connections, institutional support, and the ability to involve partners in the project expansion process (Jütting, 2024). Sixth, the ecosystem creates a favourable environment and culture of innovation, i.e. it supports openness to change, trust and mutual support, which in many approaches is considered a critical condition for the viability of innovative structures (Roundy, 2017). Seventh, ecosystems must be capable of adaptation and self-renewal by attracting new participants, mastering new technologies, and responding to external challenges, which is particularly relevant in conditions of global turbulence and accelerated technological change (Moore, 1993; Su et al., 2019).

Thus, an innovative ecosystem emerges as a multi-level system of interactions, within which structure (as the architecture of actors and connections) and functions (as a set of processes for creating innovative value) are mutually dependent. On the one hand, without the presence of key participants – science, business, the state, financial and intermediary institutions, as well as society – the functional capacity of the ecosystem is limited; on the other hand, even the formal presence of participants does not guarantee effectiveness without proper coordination of resource flows, knowledge and commercialisation mechanisms (Teece, 2007; Davis et al., 2023; Su et al., 2019). It is in this logic that an innovative ecosystem can be viewed as an environment that provides opportunities for the formation and development of an enterprise's technological competitiveness, as it creates access to external knowledge, partnerships and institutional conditions necessary for the innovation cycle.

In the modern economy, the technological competitiveness of an enterprise is determined not only by its internal potential, but also by its ability to interact effectively with elements of the external environment, within which resources, competencies and partnerships are formed that ensure the sustainability of technological advantages.

In this context, the innovation ecosystem acts as a key environment within which knowledge, infrastructure, human capital and institutional conditions are integrated to create, disseminate and commercialise innovations, and technological competitiveness can be seen as the result of the functioning of such a system of interactions (Adner, 2006; Hernandar, Nugroho, & Sutanto, 2024). Thus, at the level of cause-and-effect logic, the innovation ecosystem creates conditions and channels for access to innovative resources, while the enterprise transforms these resources into technological solutions and market results.

At the same time, there is a reverse relationship between these categories: enterprises with a high level of technological competitiveness become the core or "locomotive" of the ecosystem, determining its strategic directions of development, increasing the level of technological maturity among other participants, and forming management practices and standards of interaction. Thus, the innovation ecosystem and technological competitiveness are in a state of mutual reinforcement: the former provides the enterprise with opportunities for development through external knowledge, partnerships and support, while the latter "feeds" the ecosystem with new competencies, technologies and management approaches, creating a feedback effect that supports the innovative dynamics of the system as a whole (Adner, 2006; Hernandar et al., 2024; European Commission, 2024).

In this context, it is fundamentally important that the effectiveness of technological competitiveness management depends on the enterprise's ability to integrate into the ecosystem, maintain partnerships, attract external knowledge and promote the development of collective innovation potential. One of the fundamental principles of the functioning of innovative ecosystems is openness, which determines the intensity and direction of flows of knowledge, technologies and resources between participants. Within the ecosystem approach, openness is not limited to the concept of open innovation (Chesbrough, 2003), but is seen as a way for a company to be part of a shared space for creating value, like an institutional and organisational feature that gives access to complementary resources and skills (Hernandar et al., 2024).

According to the material presented, the openness of ecosystem

interaction takes three forms: (1) inbound openness, which means attracting external knowledge and technologies through partnerships with universities, research centres, suppliers and customers; (2) outbound openness, which involves the transfer of proprietary technologies through licensing, joint development or participation in joint projects; (3) coupled openness, which means a two-way exchange of knowledge that enables the joint creation of innovative products and technologies (West & Bogers, 2017). It is this kind of open interaction that creates the effect of ecosystem enrichment, where resources circulating between actors increase the overall innovative capacity of the system, and companies operating in mature ecosystems with a high level of trust and interdependence demonstrate greater speed in developing and implementing new technologies than those operating in isolated environments (European Commission, 2024).

The level of openness of an ecosystem depends on its structure, type and maturity. Local or cluster ecosystems are characterised by a high intensity of horizontal interaction, which facilitates rapid knowledge exchange; global or network ecosystems, on the other hand, provide scale and access to global technology markets, but require greater coordination and unification of interaction standards.

In developed innovation ecosystems, openness thus emerges as a strategic management factor that provides access to critical resources, promotes flexibility and shapes the dynamic capabilities of an enterprise, as partnership networks, joint research platforms and technology transfer programmes enable the transformation of knowledge flows into technological advantages (European Commission, 2024). Thus, openness is not only a characteristic of the ecosystem, but also an institutional mechanism for shaping technological competitiveness, since it is through openness that external innovations are integrated into the internal processes of the enterprise.

An important benchmark for understanding the link between openness, innovation and technological competitiveness is the *EU Competitiveness Compass,* adopted by the European Commission in 2024, which emphasises that strategic competitiveness is based on three key areas: (1) closing the innovation gap; (2) decarbonising the economy; (3) reducing critical dependencies (European Commission,

2024; Draghi, 2023). The areas presented in this material are directly related to the technological competitiveness of industrial sector enterprises: closing the innovation gap involves stimulating innovation through partnerships, integration into research networks, digitalisation and investment in human capital; decarbonisation emphasises the role of technological innovations aimed at energy efficiency and emission reduction; reducing dependencies requires the development of internal technological competencies, the expansion of local chains and the diversification of supplies, which is achieved through ecosystem interaction between business, science and government (Draghi, 2023).

In this context, the innovation ecosystem emerges as a tool for achieving a balance between openness, sustainability and strategic autonomy, and ecosystem openness management as a way of aligning innovation development with competitiveness priorities (European Commission, 2024; Draghi, 2023).

The further logic of revealing the relationship between the innovation ecosystem and the technological competitiveness of an enterprise in this material is based on a sequence of processes covering the perception of opportunities (sensing), their use (seizing), organisational renewal/transformation (transforming) and the formation of synergies with ecosystem partners (Hernandar, Nugroho, & Sutanto, 2024). This process is cyclical, with each stage reinforcing the next, and the enterprise acting simultaneously as a consumer and generator of innovation.

The first stage is *sensing capabilities*, i.e. the ability of an enterprise to identify and analyse technological opportunities in the external environment. Within the innovation ecosystem, such capabilities are formed through interaction with partners – universities, research centres, suppliers, consumers and government agencies – which creates conditions for technological monitoring, joint analysis of trends and knowledge sharing, allowing for faster identification of innovative development vectors. At the same time, it is noted that developed ecosystems support sensing capabilities with digital tools – joint research platforms, patent databases, and joint R&D hubs (Rohrbeck & Kum, 2018). Thus, technological foresight in this logic is derived not only from internal analytical capabilities, but also from the quality of ecosystem connections that provide

access to signals of change.

The second stage is seizing capabilities, i.e. the transition from identifying opportunities to realising them through investment, organisational and partnership decisions. The innovation ecosystem provides institutional support for this process through venture capital funds, joint grant programmes, scientific and industrial consortia or public–private partnership projects; seizing capabilities are manifested in the ability of an enterprise to form an innovation strategy that aligns internal resources with external opportunities. The material presented indicates that this strategy includes determining the degree of openness to cooperation, priorities for innovative development, and mechanisms for commercialising technologies (licensing, cooperation, joint ventures), and the decisive role is played by the management's ability to integrate external knowledge into the internal structure of the enterprise, ensuring synergy between internal R&D teams and external partners (Teece, 2007).

The third stage is *transforming capabilities*, which means rethinking the business model and organisational processes in order to align new technologies with the logic of creating, delivering and capturing value. Within the innovation ecosystem, transformation is linked to the development of digital platforms, closed value creation cycles (circular economy) and service models (product-as-a-service), while the business model is seen as a tool for integrating internal and external resources and as a reflection of the maturity of ecosystem interaction. The material also emphasises that high adaptability and readiness for organisational change form the basis for increasing the effectiveness of the innovation cycle (International Organization for Standardization, 2019). Thus, transforming capabilities are the mechanism that translates innovative activity from the realm of "having ideas" to the realm of "sustainable results," i.e., growth in technological competitiveness.

The result of this cycle is an increase in technological competitiveness, which in this paper manifests itself in the ability of an enterprise to implement complex technological solutions, shorten the innovation cycle (time-to-market), increase the share of revenue from innovative products, and establish technological leadership in its industry (Figure 5.8). Managing this process involves the use of a

system of indicators (TRL, R&D intensity, share of external knowledge in developments, number of partnerships), which allows assessing the effectiveness of ecosystem interaction (Mankins, 1995). Accordingly, the innovation ecosystem is not only a context but also a practical environment that provides the enterprise with resources and mechanisms for going through the stages of sensing-seizing-transforming, and the enterprise, in turn, through technological results, strengthens the potential of the ecosystem, forming a dynamic of mutual reinforcement (Hernandar et al., 2024).

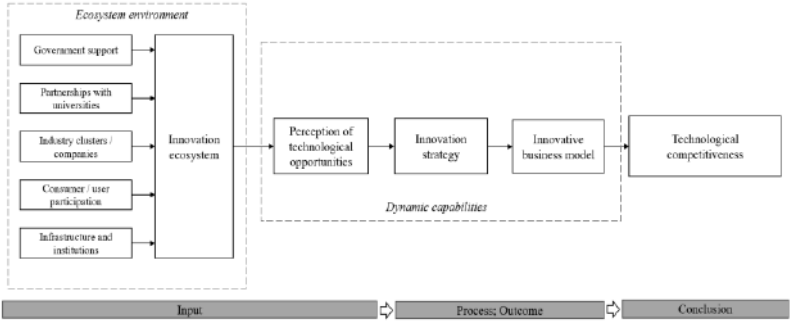


Figure 5.8 Model of technological competitiveness formation within the enterprise's innovation ecosystem

Source: compiled by the authors based on (Hernandar, Nugroho, & Sutanto, 2024)

A separate section of the analysis in this material is devoted to assessing the level of technological competitiveness of an enterprise within an innovation ecosystem, which requires the use of a system of interrelated quantitative and qualitative indicators that reflect not only internal technological potential, but also the effectiveness of ecosystem interaction (Mankins, 1995). Quantitative indicators include: the share of revenue from innovative products; the share of investment in R&D; the average time to market for a new product; the number of technologies introduced into production over the last 3–5 years; the technology readiness level (TRL) index for key projects; the volume of external knowledge integrated through ecosystem cooperation (partnerships, joint developments, licences). Assessment practice also uses an aggregate indicator – the average

technology readiness level (TRL), which is calculated as the weighted average of technology readiness levels for projects, taking into account weighting coefficients of strategic importance or budget (Mankins, 1995).

Qualitative indicators cover the level of innovation culture and staff engagement, the degree of institutional maturity of the ecosystem (availability of platforms, clusters, support programmes), the quality of ecosystem links (stability of partnerships, trust), and the technological image of the enterprise (recognition in the industry, participation in initiatives). Thus, the combination of quantitative and qualitative parameters provides an assessment not only of the results of innovation activity, but also of the enterprise's ability to maintain sustainable innovation processes, which corresponds to the essence of technological competitiveness.

Thus, the relationship between technological competitiveness and the innovation ecosystem is complex and mutually reinforcing: the innovation ecosystem creates an environment and mechanisms for accessing knowledge, resources, and partnerships that enable the enterprise to develop technological advantages; a technologically competitive enterprise, in turn, strengthens the ecosystem with new technologies, competencies and management practices, supporting its innovative dynamics (Adner, 2006; Hernandar, Nugroho, & Sutanto, 2024).

The mechanism of forming technological competitiveness within an innovative ecosystem is logically described through a sequence of sensing – seizing – transforming processes, within which the ecosystem acts as a catalyst for the development of the enterprise, and the effectiveness is reflected in indicators of technological readiness, speed of the innovation cycle and strengthening of market positions (Hernandar et al., 2024; Mankins, 1995). It is this logic that forms the basis for further analysis of the real mechanisms and practical aspects of managing the technological competitiveness of an enterprise in the context of its innovation ecosystem.

Conclusions

The results of the study show that the theoretical and methodological foundations of managing technological competitiveness in the context of the formation and development of an enterprise's innovation ecosystem are based on an understanding

of technological competitiveness as a complex characteristic of an enterprise's ability to create, implement and commercialise innovations, ensuring sustainable advantages in the context of digital transformation and global competition. In this context, the decisive determinants of its formation are the development of scientific and technical potential, dynamic capabilities, human resource competencies and strategic knowledge management.

A summary of the results obtained gives grounds to assert that the evolution of industrial revolutions – from Industry 3.0 to 6.0 – has significantly transformed the approach to ensuring the technological competitiveness of enterprises. While automation and efficiency improvement were the priority factors in previous stages, the current stage focuses on the use of artificial intelligence, ensuring flexibility, integrating human-centred approaches and focusing on sustainable development. These shifts are driving changes in the requirements for production organisation, enterprise structure and the nature of its interaction with the external environment, which, taken together, highlights the need to integrate enterprises into innovative ecosystems.

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DIGITAL ENTERPRISE STRATEGY AS A TOOL FOR ENSURING SYNERGY OF INNOVATION AND SUSTAINABLE DEVELOPMENT

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Abstract
This chapter substantiates the concept of a digital enterprise strategy as an integrated managerial framework for achieving synergy between innovation and sustainable development. Digital transformation is interpreted not as a set of isolated technological initiatives but as a structural reconfiguration of value creation mechanisms, decision-making processes, and long-term development trajectories. The chapter addresses the scientific problem of coordinating digitalization, innovation activity, and sustainability objectives within a single strategic logic, given that in managerial practice these directions are often implemented in parallel and remain weakly interconnected.
The theoretical contribution of the chapter lies in clarifying the position of digital strategy within the hierarchy of corporate strategies and in differentiating it from IT strategy and process digitalization strategies. Digital strategy is conceptualized as a corporate-level instrument that reshapes business models, integrates data architecture, and aligns innovation initiatives with economic, environmental, and social performance indicators. Particular attention is paid to the methodological challenge of measuring the integrated effect of digital initiatives, innovation outcomes, and ESG performance, which remains insufficiently addressed in existing research.
The chapter presents a structural and logical model for achieving synergy between innovation and sustainable development through a digital strategy. The model integrates digital infrastructure, innovation activity, and sustainability indicators into a unified management framework, emphasizing data integration, strategic alignment, and adaptive governance. The analytical approach combines financial metrics, digital performance indicators, and ESG criteria, enabling

more balanced strategic decisions and reducing the risk of prioritizing short-term economic outcomes over long-term resilience.
The practical value of the chapter lies in its applicability to the development of digital transformation roadmaps, the formation of portfolios of digital and innovative initiatives, and the design of integrated KPI systems. The findings provide a methodological basis for moving from fragmented digitalization to a strategically managed transformation in which digital solutions enhance innovation capacity and support sustainable enterprise competitiveness.

Keywords: *digital enterprise strategy, digital transformation, innovation management, sustainable development, synergy effect, ESG integration, data-driven management, digital maturity, integrated performance indicators, strategic adaptability.*

The aim of this work

The aim of this chapter is to substantiate the digital enterprise strategy as a corporate-level mechanism for integrating digital transformation, innovation activity, and sustainable development, and to develop an integrated framework for assessing and managing their synergy based on financial, digital performance, and ESG indicators, supported by coordinated governance and continuous monitoring.

Presentation of the main material

The issue of digital enterprise strategy in ensuring innovation and sustainable development has been widely examined in academic and analytical studies.

At the same time, the analysis of existing publications shows that most studies consider digital transformation, innovation activity, and sustainable development as interrelated but largely autonomous research areas. Digital enterprise strategies are predominantly interpreted in terms of technological modernization or efficiency gains, while innovation is usually examined as a function of research and development, and sustainability is reduced to the system of ESG indicators and reporting practices. As a result, insufficient attention is paid to the integrative role of digital strategy in coordinating these directions within a unified strategic framework. This methodological fragmentation limits the understanding of how digital enterprise

strategy can ensure a synergistic interaction between innovation processes and long-term sustainable development.

Digital transformation of enterprises is increasingly viewed not as a set of isolated technological solutions, but as a structural shift in value creation mechanisms, the management of innovation processes, and the achievement of long-term resilience. Under these conditions, a scientific challenge emerges in aligning three components of enterprise development, – digitalization, innovation activity, and sustainability performance, within a single strategic logic. In practice, these areas are often pursued in parallel: digital projects are implemented to optimize operations, innovations are introduced to strengthen competitive positions, and ESG priorities are adopted in response to regulatory or reputational pressures. The absence of an integrated approach reduces their combined impact and complicates strategic management.

The scientific relevance of the study lies in substantiating digital strategy as a coordination mechanism capable of linking innovation processes with the economic, environmental, and social dimensions of development. In this context, digital strategy is treated as an instrument of structural integration: it defines data architecture, principles for managing digital initiatives, approaches to assessing their performance, and the interconnection between investment decisions and the enterprise's long-term objectives. Such an approach makes it possible to move from fragmented digitalization to the systemic management of transformation.

The problematic side of this topic is linked not only to practical issues, but also to methodological ones. Although there is a wide range of studies devoted to digital transformation, innovation-oriented growth and sustainability, the question of how to measure their joint effect is still open and rather controversial. In many cases, attempts to evaluate synergy remain fragmented. In particular, approaches that would combine financial results such as ROI, indicators of digital efficiency, as well as ESG parameters within one management framework are still poorly elaborated. Because of this, strategic decisions are often made under conditions of incomplete assessment, which may unintentionally shift the focus toward short-term economic results rather than balanced long-term development.

In this regard, the section is aimed at conceptualizing the

enterprise's digital strategy as a tool for ensuring synergy between innovation and sustainable development. It systematizes the differences between an IT strategy, a process digitalization strategy, and a corporate-level digital strategy; substantiates the relationship between innovation activity and sustainability indicators; proposes a structural and logical model for integrating digital infrastructure, innovation initiatives, and ESG priorities; and defines approaches to assessing the integrated effect and managing risks.

Thus, the section establishes a theoretical and methodological foundation for the transition from technology-oriented digitalization to strategically managed enterprise transformation, within which digital solutions serve as instruments for enhancing innovation capacity and ensuring long-term competitiveness.

It should be noted that in the contemporary system of strategic management, a company's digital strategy does not function as a separate technological direction but as an integral component of a long-term development model. It defines the logic of using digital technologies to create, transform, and scale value. This involves not only the implementation of information solutions, but also the restructuring of management mechanisms, the formation of new channels of interaction, and a reassessment of approaches to decision-making.

In order to clearly distinguish digital strategy from related managerial categories, it is advisable to systematize their differences according to key criteria (Table 5.8).

The comparison presented makes it possible to clearly delineate the boundaries of each managerial category and to specify the role of digital strategy within the system of enterprise strategic management.

An IT strategy focuses on the development of information infrastructure, including the maintenance of servers, software, data protection, and system integration. It has a functional nature and ensures the technical capability of the enterprise to achieve its business objectives.

A process digitalization strategy is aimed at transferring operations into a digital format, automating procedures, reducing execution time, and minimizing the human factor. Its primary outcome is operational optimization.

A digital strategy operates on a different scale. It addresses

questions such as how digital technologies transform the business model; how revenue sources evolve; how channels of interaction with customers are integrated; what the data governance architecture should be; and how digital tools affect innovation potential and the long-term resilience of the enterprise. Thus, digital strategy goes beyond functional management and acquires the status of an element of corporate strategy.

Table 5.8

Conceptual distinction between IT strategy, process digitalization strategy and enterprise digital strategy

Criterion	IT strategy	Process digitalization strategy	Enterprise digital strategy
Management level	Functional (IT service)	Operating	Corporate, strategic
Object of influence	Technological infrastructure	Individual business processes	Business model, value chain
Main goal	Ensuring the stability of IT systems	Optimization and automation of operations	Transformation of sources of competitive advantage
Time horizon	Medium-term	Short/medium term	Long-term
Role in creating innovation	Supportive	Partial (local improvements)	Systemic
Impact on sustainable development	Indirect	Through increased resource efficiency	Integrated (economic + environmental + social effect)
Performance measurement	Reliability, availability of systems	Reduction of costs and operation time	Integrated KPIs (ROI + digital + ESG)
Degree of transformation	Evolutionary	Operating	Structural, strategic

The use of digital strategies helps to increase the efficiency of the enterprise, create new products and ensure its development. The use of modern information technologies allows to minimize costs, automate processes and increase labor productivity. In addition,

digital technologies allow enterprises to form new business models based on personalized products and services, flexible logistics solutions and integrated digital ecosystems (Ivanets & Mokhonko, 2025).

As a component of strategic change management, digital strategy performs an integrative function. It links technological solutions with the enterprise's financial, innovation, and organizational objectives. Its implementation involves the consistent transformation of processes, the development of employee competencies, the adaptation of management structures, and the introduction of new systems for performance assessment.

Structurally, digital strategy can be considered across several levels.

The first level is the business model level. It is at this level that the transition to platform-based solutions, service ecosystems, digital products, subscription models, and the use of data as a distinct asset takes place. Digital sales and interaction channels form a new revenue structure and reduce dependence on traditional instruments.

The second level is the process level. It encompasses the automation of production, logistics, financial, and managerial procedures. The use of ERP systems, CRM solutions, supply chain management systems, and analytical platforms ensures cost reduction, improves planning accuracy, and lowers operational risks.

The third level is the customer experience level. The analysis of behavioral data, the personalization of offerings, and omnichannel communications create additional customer value and enhance trust.

The fourth level is data and analytics. Data-driven management implies the integration of financial, production, and non-financial indicators into a unified system. This reduces uncertainty and supports more informed strategic decision-making.

The fifth level is the technological architecture, which determines system compatibility, cyber resilience, and scalability.

Thus, digital strategy represents a multi-level managerial construct that forms the foundation of enterprise transformation. At the same time, its effectiveness depends on the extent to which it is integrated with the key strategic development priorities. These priorities include innovation and sustainability, which require separate theoretical consideration.

The innovation activity of an enterprise ensures the renewal of the product portfolio, improves process efficiency, and supports adaptation to changes in the market environment. Product innovations modify the consumer characteristics of goods and services. Process innovations optimize technological operations and logistics. Organizational innovations relate to new forms of coordination and management. Marketing innovations transform promotion channels and demand-generation mechanisms.

Enterprise innovation activity is influenced by many factors, including competitive pressure, technological change, regulatory frameworks, consumer expectations, as well as access to investment resources. At the same time, when innovation is aimed only at achieving economic results, it can unintentionally lead to additional environmental or social risks. Because of this, innovation processes increasingly need to be coordinated with the principles of sustainable development rather than treated as an isolated economic tool.

The sustainable development of an enterprise is usually associated with a certain balance between economic efficiency, environmental performance and social responsibility. From an economic perspective, this means maintaining financial stability and the ability to accumulate resources for further investment. The environmental aspect focuses on issues such as emission reduction, waste handling and more rational use of resources. The social dimension, in turn, concerns working conditions, development of human capital and a sufficient level of transparency in management practices.

The link between innovation and sustainability can be seen in how technological and organizational changes affect both productivity and environmental outcomes. In many cases, innovations do not only improve operational efficiency but also help reduce negative impacts on the environment. Examples include energy-saving technologies, digital systems for monitoring resource use, or automated quality control, although their effect may vary depending on implementation conditions.

Synergy between innovation and sustainability emerges when innovative solutions ensure long-term economic benefits while at the same time contributing to better environmental and social performance. Such synergy is often expressed through lower

resource costs, higher confidence from investors and a stronger institutional stability of the enterprise. Still, these effects are not always immediate and may develop unevenly over time.

At the same time, achieving this kind of synergy requires a coordinating mechanism that connects innovation projects with sustainability goals and allows their results to be assessed in a measurable way. Under current conditions, a digital strategy can play this coordinating role. However, its application also raises certain limitations and practical challenges, which makes further analysis of digital strategies in the context of sustainable enterprise development especially relevant.

The integration of digital strategy with innovation and sustainability objectives creates a set of managerial advantages. Process automation and the use of analytics increase productivity and reduce costs. Digital monitoring of resources makes it possible to lower energy consumption and waste generation. Integrated information systems ensure operational transparency and accountability to stakeholders.

Digital tools also shorten the innovation cycle. The use of analytical platforms and digital modeling enables solutions to be tested at early stages, reducing the risks of unsuccessful investments. In combination with ESG priorities, this contributes to the development of innovations that meet the requirements of long-term sustainability.

At the same time, the development of a digital strategy is associated with a number of challenges. A lack of digital competencies complicates the implementation of complex technological solutions. Data fragmentation and the absence of a unified information architecture reduce the effectiveness of analytics. Resistance to change may slow down transformation processes. Growing cyber risks require additional investment in data protection. Financial constraints and regulatory uncertainty may restrain large-scale digital initiatives.

Therefore, the mere existence of a digital strategy does not guarantee the achievement of an integrated effect. A clear conceptual model is needed to combine digital infrastructure, innovation activity, and sustainability indicators into a unified management system. This determines the necessity of developing an appropriate

theoretical framework.

Synergy within a digital strategy is understood as a systemic effect of integrating digital tools, innovation processes, and ESG priorities. It arises when the integrated outcome exceeds the cumulative effect of their autonomous functioning.

Synergy arises from aligned goals, integrated data, transparent management, and adaptive strategies that ensure consistency with sustainability priorities and enable performance-based adjustments.

The generalization of these provisions allows us to present a structural and logical model for ensuring the synergy of innovations and sustainable development (Table 5.9).

Table 5.9

Structural and logical model for ensuring synergy of innovation and sustainable development based on digital strategy

Model element	Content	Management mechanism	Evaluation indicators	Expected integrated effect
Digital infrastructure	ERP, CRM, IoT, analytical platforms, cloud solutions	Data integration, process standardization, cyber security	Level of automation, integration, data availability	Information transparency
Innovative activity	New products, processes, business models	Using digital tools to reduce time-to-market	Share of revenue from new products, speed of implementation	Increasing competitiveness
Sustainability indicators	Economic, environmental, social indicators	Integrating ESG indicators into digital dashboards	Energy efficiency, emission levels, social responsibility indices	Increasing resilience
Integrated results	Growth in enterprise value, stakeholder trust	System coordination of goals and KPIs	Comprehensive performance index (ROI + ESG + digital indicators)	Synergistic effect

Structurally, the proposed model consists of four interrelated blocks, each of which performs a distinct function but becomes effective only through interaction with the other elements of the system. The first block is digital infrastructure, which provides the technical foundation for data collection, processing, and protection.

The second block is innovation activity, realized through new products, processes, and business models supported by digital technologies.

The third block represents a system of sustainability indicators used to evaluate how innovations affect economic, environmental and social results. The fourth block is related to integrated outcomes, which are reflected in enterprise value growth, higher resilience and, to some extent, improved competitiveness in the market.

The synergistic effect appears only under certain conditions, such as strategic coherence, an adequate level of digital maturity, active involvement of top management and the existence of an integrated monitoring system. When these conditions are missing, digital initiatives often operate on their own, innovations tend to be fragmented, and sustainability indicators are reduced mainly to a formal reporting function without real managerial influence.

Therefore, digital strategy can act as a tool for achieving synergy only if it is consistently connected with innovation policy and sustainable development objectives. It is this type of integration that enables the shift from isolated digitalization efforts toward a more stable and long-term transformation of the enterprise.

The implementation of an enterprise's digital strategy requires defining priorities and building a technological foundation to integrate innovation and sustainability indicators. Digital technologies do not constitute an end in themselves; rather, they function as management tools that create an information environment for decision-making and process coordination. The systematization of key digital technologies and their impact on innovation activity and sustainability indicators is presented in Table 5.10. As shown in this table, key digital technologies perform different managerial functions; however, they are united by their ability to generate an integrated effect through a simultaneous impact on innovation activity and sustainability indicators. An examination of the mechanisms underlying this impact makes it possible to gain a deeper understanding of the logic behind synergy formation.

At the basic level, digital infrastructure is largely built around Big Data and analytical tools. Data-driven management gradually changes the way planning, control and even strategic forecasting are carried out.

Table 5.10

Key digital technologies and their role in creating synergies between innovation and sustainable development

Digital technology	Management mechanism	Impact on innovation activity	Impact on sustainability	Integrated effect
Big Data and analytics	Forecasting, optimization of solutions	Reducing time-to-market	Improving resource efficiency	Reducing uncertainty
AI and ML	Algorithmic control	Test and development automation	Reducing losses and downtime	Productivity improvement
IoT and monitoring	Real-time control	Innovations in process management	Energy efficiency	Reducing operational risks
Cloud solutions	Scaling and integration	Rapid implementation of new services	Optimization of capital expenditures	Infrastructure flexibility
Blockchain	Traceability and control	Maintaining trust in ecosystems	ESG compliance	Increasing transparency

Working with large volumes of information allows enterprises to notice certain patterns in consumer behaviour, anticipate demand, adjust logistics routes and evaluate how efficiently resources are being used. The main effect here is connected with a reduction of information asymmetry and a generally higher accuracy of managerial decisions, although this does not happen automatically. When financial, production and non-financial data are brought together, it becomes possible to form a more comprehensive view of economic, environmental and social performance.

The next layer of digital support is associated with artificial intelligence and machine learning technologies. AI and ML significantly extend analytical capabilities and make it possible to process information much faster than traditional approaches. Algorithm-based models can automate parts of decision-making and support quicker reactions to changes in market conditions. At the same time, their effectiveness depends on data quality and the way these tools are embedded into existing management processes, which is not always straightforward.

In the production sphere, this is reflected in optimized equipment utilization, predictive maintenance, and the minimization of downtime. In marketing, it manifests through offer personalization and more accurate customer segmentation. The synergistic effect is achieved through the simultaneous increase in economic performance and the reduction of resource losses.

Internet of Things technologies together with digital monitoring tools provide continuous control over physical processes in real time. Sensor systems register energy use, emission indicators and key equipment parameters, which allows enterprises to move away from purely reactive responses toward more preventive forms of management. As a result, operational risks tend to decrease, energy efficiency improves, and compliance with environmental standards becomes easier to maintain, linking production efficiency more closely with sustainability objectives.

The Industrial Internet of Things (IioT) is a system of interconnected computer networks and connected industrial (production) facilities with built-in sensors and software for data collection and exchange, with the possibility of remote monitoring and control in an automated mode, without human intervention [19].

Cloud-based solutions and digital platforms add a certain level of infrastructural flexibility to the enterprise. The possibility to scale resources, combine different functional modules and quickly introduce new digital services reduces barriers to innovation activities. In addition, the gradual shift from capital-intensive IT investments to an operating expenditure model helps optimize the investment load and makes the enterprise more adaptable to changes in the external environment, even if the transition itself may require organizational adjustments.

Blockchain technologies and traceability systems, in turn, complement this technological framework by increasing transparency. The use of distributed ledgers for recording transactions limits opportunities for data manipulation, strengthens trust among partners and simplifies control over compliance with ESG-related requirements. For enterprises involved in international supply chains, such solutions often provide additional institutional advantages and contribute to stronger competitive positions, although their adoption is still uneven across sectors.

Thus, each of the technologies considered performs a specific function within the digital strategy, yet their combined impact produces a systemic effect. It is through the integration of analytics, algorithmic management, monitoring, infrastructural flexibility, and transparency that an information environment is created in which innovative solutions are aligned with sustainability requirements.

Digital strategy affects innovation activity primarily by changing how ideas are generated, selected and further developed. In traditional models, innovation cycles are usually quite long and accompanied by a high degree of uncertainty. The introduction of digital tools allows enterprises to shorten the stages of testing and analysis, which in practice reduces the time gap between the emergence of an idea and its commercial application.

The acceleration of innovation processes is largely supported by digital modeling, the analysis of large data sets and the use of collaborative platforms. These tools make it possible to conduct virtual experiments, test prototypes without significant capital expenditures and adjust product characteristics at relatively early stages, when changes are still less costly.

Digital strategy also contributes to the formation of an innovation ecosystem. Platform solutions facilitate interaction with partners, startups and research institutions, while open innovation becomes feasible through shared digital environments and data exchange. As a result, enterprises become less dependent on their own internal resources and more flexible in responding to external changes.

At the same time, the portfolio of digital initiatives can be used as a way to manage uncertainty. Distributing projects according to their level of risk, expected effect and consistency with strategic priorities helps balance short-term and long-term innovations. This approach supports control over the overall investment load and encourages a more structured organization of innovation activity.

In this sense, digital strategy does not merely support innovation processes but gives them a clearer structure by embedding innovation into the broader system of strategic management.

The integration of digital tools into enterprise management also has a direct impact on economic, environmental and social performance. Automated monitoring systems, inventory management and production planning enable more rational use of resources.

Algorithmic solutions help reduce losses, avoid excessive inventories, lower operating costs and, at the same time, limit negative environmental effects.

Increased transparency is achieved through digital reporting, the integration of supplier information and the traceability of product origin. Compliance with ESG requirements becomes more measurable and is supported by specific indicators, which simplifies interaction with both investors and regulatory bodies.

The social aspect of digital strategy is reflected in safer working conditions due to the automation of hazardous operations, the development of employees' digital skills and the establishment of open communication with stakeholders. Internal digital collaboration platforms can strengthen employee involvement and support the formation of a more responsible organizational culture.

Thus, digital strategy creates practical conditions for implementing the principles of sustainable development through concrete managerial instruments rather than abstract declarations.

At the same time, the realization of digital strategy is accompanied by a number of barriers that should not be underestimated.

Organizational risks are often linked to weak coordination between departments, the absence of a clear governance framework and a low level of process maturity. Without centralized oversight, digital initiatives may overlap or even contradict each other.

Financial constraints arise from underestimating the total cost of technology ownership, uncertainties regarding payback periods and insufficient attention to cybersecurity investments. Incomplete cost calculations can result in the suspension of projects at intermediate stages of implementation.

Human resource risks include shortages of relevant skills, resistance to organizational change and the lack of leadership capable of managing transformation. Without targeted investment in human capital, digital solutions tend to remain largely formal.

Technological risks are expressed through system fragmentation, low data quality, dependence on specific vendors and exposure to cyber threats. The absence of a unified digital architecture restricts data integration and weakens the analytical potential of digital tools.

The systemic character of these barriers highlights the need to

develop instruments for assessing and monitoring synergy. Such assessment requires the integration of economic, digital and ESG indicators within a single framework. Integrated KPIs should capture how digital initiatives influence profitability, productivity, energy efficiency and social performance, providing a more balanced basis for managerial decision-making.

To ensure a comprehensive approach to measuring the integrated effect, it is proposed to systematize key indicators by functional blocks, as presented in Table 5.11.

Table 5.11

System of indicators for evaluating the synergy "digitalization – innovation – sustainability"

Evaluation block	Key indicators	Data source	Management appointment
Digital maturity	Share of automated processes; level of IS integration; use of analytics in management; data quality and cyber resilience	ERP/CRM systems, BI platforms, IT audit	Assessment of technological readiness and reliability of digital infrastructure
Innovative activity	Share of revenue from new products; ROI of innovations; time-to-market; share of digital products in the portfolio	Financial statements, project portfolio, R&D reports	Determining the effectiveness of innovation policy
Sustainability indicators (ESG)	Energy efficiency; emissions; resource consumption; staff turnover; investment in training	ESG reporting, production monitoring, HR analytics	Monitoring environmental and social performance
Integrated effect	Combined ROI + ESG + digital performance; enterprise value dynamics	Consolidated management reporting	Comprehensive assessment of strategic sustainability

An important element of the system is the identification of data sources on which the assessment is based.

The use of ERP and CRM systems, financial and non-financial reporting, as well as the results of IT audits ensures the reliability

and comparability of indicators. The managerial purpose of the system lies not only in recording outcomes but also in providing a basis for adjusting the portfolio of digital initiatives and investment priorities.

Digital maturity indicators make it possible to assess the level of business process automation, the degree of integration of information systems, and the intensity of analytical tool usage in managerial decision-making.

Digital maturity typically consists of internal and external processes of the business ecosystem. External processes are visible to customers, while internal processes are only accessible to employees of the organization. In practice, large companies (agencies and service providers) annually study (monitor) the level of digital maturity, which is called digital IQ (Slobodianyk et al., 2022).

On this basis, indicators of innovation returns reflect the share of revenues from new products, time-to-market, and the profitability of innovation projects, thereby establishing a link between digital infrastructure and innovation performance.

ESG indices and non-financial reporting form the basis for measuring environmental and social impact. The combination of these indicators with financial results makes it possible to assess the integrated effect of enterprise activity.

The "ROI + ESG + digital efficiency" model provides for the evaluation of projects according to three groups of criteria: financial returns, sustainability impact, and the level of digital integration. This approach enables the alignment of short-term economic outcomes with long-term development parameters.

The balance of effects is a core assessment principle, as profitability must not undermine environmental or social outcomes. Integrated monitoring aligns strategic decisions with long-term goals, while digital strategies increasingly transform value creation and stakeholder interaction through embedded digital ecosystems.

These transformation directions can be summarized in the form of a systemic architecture for the development of an enterprise digital strategy, reflecting the interconnection between technological, institutional, financial, and forecasting components (Table 5.12).

Let us consider in more detail the substance of each element within the system architecture, beginning with the technological

component, which acts as a basic prerequisite for the implementation of a digital strategy. In practice, this component largely determines the scope and depth of further transformations rather than serving as a purely technical foundation.

Table 5.12

System architecture for developing an enterprise's digital strategy in the context of innovation and sustainable development

Block/Key directions	Mechanism of influence	Key tools and implementation indicators	Expected strategic effect
Technology block/ Platformization; data-driven management; automation and intellectualization of processes	Reducing transaction costs; data integration; analytical decision support; resource optimization	ERP/CRM/SCM; BI analytics; RPA; AI models; digital maturity indicators; level of automation; data processing speed	Increased productivity; scalability; operational efficiency
Institutional block/ Regulatory requirements; ESG reporting; strategic partnerships; international programs	Establishing transparency standards; increasing accountability; integrating into ecosystems	ESG metrics; non-financial reporting; compliance systems; digital traceability; compliance audit	Market access; institutional stability; investor confidence
Financial block/ Portfolio financing; stage-gate; «green» financial instruments	Balance of risk and return; phased financing; integration of ROI and ESG criteria	"ROI + ESG + digital efficiency" model; TCO assessment; innovation impact indicators; digital initiative budget	Investment viability; balanced growth

Predictive block/ AI in strategic management; cyber resilience; integrated KPIs	Transition to proactive management; risk management; integration of financial and ESG indicators	Scenario analysis; digital dashboards; integrated KPIs; cyber risk indicators	Long-term competitiveness; strategic adaptability

One of the most significant directions in this area is business platformization.

The platform model is based on the formation of a digital environment that brings together producers, suppliers, consumers and service partners within a common interaction space. Its functioning is associated with lower transaction costs, faster information exchange, the emergence of network effects and the accumulation of data, which gradually increases the scalability of business activities. For an enterprise, this translates into the possibility of combining its own products with partner services, entering new sales markets and generating additional sources of income without a proportional expansion of the resource base.

From the perspective of sustainable development, the ecosystem approach also plays an important role. It supports higher transparency of supply chains, promotes the coordination of environmental standards among participants and encourages a shared sense of responsibility for overall performance results. At the same time, the effectiveness of such an approach depends on the degree of coordination within the network and the willingness of participants to adhere to common rules, which is not always guaranteed in practice.

The second direction is the development of data-driven management. Data are gradually transforming from a supporting resource into a strategic asset that influences the nature of managerial decisions. This requires the establishment of data governance policies, the implementation of procedures for data verification, integration, and protection, as well as the assignment of responsibility for information quality. An analytics culture implies that decisions are made on the basis of systematic indicator analysis and scenario modeling rather than intuitive judgments. The

mechanism of impact consists in reducing uncertainty, improving the soundness of investment decisions, and enabling the integration of financial and non-financial indicators within a unified performance control system.

The third direction is the automation and intellectualization of processes. The use of robotic process automation (RPA), intelligent assistants, and predictive analytics changes the cost structure and the nature of operations management. Automating routine procedures reduces operational risks, minimizes the human factor, and increases productivity.

Predictive models allow enterprises to forecast demand, manage inventories more accurately, anticipate technical failures and use resources in a more rational way. From a strategic point of view, this gradually creates conditions for moving away from reactive management practices toward a more proactive approach, where decisions are taken with consideration of expected development scenarios rather than only past data.

In general, the further evolution of digital strategies appears to be linked to a shift from fragmented digitalization initiatives toward the systemic integration of digital solutions into the business model, organizational arrangements and the overall strategic management system of the enterprise. Such integration changes not only individual processes but also the logic of managerial decision-making.

At the same time, the implementation of these development directions depends not solely on the internal capabilities of the enterprise. External conditions also play a significant role, as they shape both incentives and limitations for digital transformation. Institutional and market factors largely determine the speed, scale and priorities of change, which makes their separate consideration justified.

Institutional and market environments form the broader external context for digital strategy implementation, influencing its intensity, directions of adaptation and the balance between available transformation opportunities and existing constraints. These factors often act unevenly and may change over time, increasing uncertainty for enterprises.

Increasing requirements from customers and business partners

regarding transparency and traceability stimulate the introduction of digital accounting and monitoring systems. Enterprises that are unable to provide open and verifiable data on product origin, environmental impact or social responsibility risk losing access to certain market segments. Under such conditions, digital tools become not only an operational solution but also a practical way of demonstrating compliance with established standards.

The role of standards, non-financial reporting, and compliance is gradually strengthening. The introduction of mandatory reporting procedures for environmental and social indicators creates the need to integrate digital systems for data collection and processing. The mechanism of impact lies in the fact that regulatory requirements stimulate the creation of internal information frameworks capable of ensuring the accuracy and timeliness of reporting.

International programs and partnerships create additional opportunities for the implementation of digital and "green" innovations. Participation in transnational projects, access to grant funding, and cooperation with technology centers enable enterprises to accelerate innovation deployment. Thus, the institutional environment can act as a catalyst for digital transformation, provided that the enterprise adopts a proactive stance.

The influence of institutional and market incentives increases requirements for the speed and scale of digital change, which necessitates appropriate resource support. Under such conditions, issues of financing and the economic feasibility of a digital strategy acquire a systemic character.

The effectiveness of a digital strategy depends on the availability of sufficient financial and organizational resources. Investment approaches to digital transformation should take into account not only direct economic effects but also impacts on sustainability indicators.

Portfolio financing makes it possible to allocate investments among projects with different risk levels and expected returns. The stage-gate mechanism ensures "step-by-step" assessment of the feasibility of continued funding based on achieved results. Evaluating effects using a model that combines financial returns (ROI) with environmental and social indicators helps to avoid a bias toward short-term profit.

Grant and donor programs, as well as green financing instruments, create opportunities to attract resources for implementing energy-efficient and digital solutions. Project-based partnerships allow financial risks to be shared among multiple participants and enhance the scalability of innovations.

Cost optimization is achieved through the use of cloud models, subscription services, and shared platforms. This approach reduces the need for substantial upfront capital investments and increases infrastructural flexibility.

Therefore, financing a digital strategy should be carried out with an integrated approach to the assessment of outcomes and risks.

Assessing the financial mechanisms for implementing a digital strategy makes it possible to determine its long-term viability. This, in turn, requires consideration of medium-term trends in the transformation of managerial and technological models.

Taking into account the identified institutional, technological, and financial factors, it is appropriate to define the key trends in the development of enterprise digital strategies over a 5-10 year horizon. Analysis of medium-term changes makes it possible to outline directions for the transformation of management models and requirements for organizational structures.

In the medium term, artificial intelligence systems are likely to play a more noticeable role in both strategic and operational decision-making. Algorithmic models are increasingly applied to scenario analysis, forecasting market changes, risk evaluation and the optimization of investment portfolios. The core mechanism here is the gradual move away from purely retrospective analysis toward decision-making oriented at future developments. This shift inevitably affects managerial competencies, increases the value of analytical functions and requires closer involvement of digital specialists in strategic planning processes.

At the same time, issues of cyber resilience and data ethics are becoming more acute. The expansion of digital infrastructure and the growing integration of platforms increase exposure to cyber threats, which makes systematic information security management unavoidable. Data protection, security audits, access regulation and compliance with regulatory requirements are no longer viewed as purely technical tasks. Instead, they are increasingly incorporated

into the broader system of strategic risk management. Alongside this, more attention is being paid to ethical aspects of data use, including the transparency of algorithms and responsibility for automated decisions, areas that are still evolving in practice.

Another important trend is the integration of digital indicators with sustainability metrics within unified management dashboards. Combining financial, operational and ESG indicators allows enterprises to assess performance in a more comprehensive manner. Such an approach helps reveal the links between investments in digital technologies, innovation activity and environmental or social outcomes. In practical terms, this leads to the development of integrated KPIs and the use of digital platforms for continuous monitoring of strategic goals, although the level of maturity of such systems may differ across enterprises.

Taken together, these tendencies point to a gradual transition toward integrated management models in which technological solutions, innovation processes and sustainability principles are not treated separately but operate as interconnected elements of a single strategic system. It is this type of model that supports long-term adaptability and helps maintain competitiveness in an increasingly digital environment.

The development of a digital strategy aimed at achieving synergy between innovation and sustainable development therefore requires a systemic approach that combines technological, organizational and strategic components. In practice, the implementation of such a strategy should begin with an objective assessment of the enterprise’s initial conditions rather than with isolated digital initiatives.

The first step in this process is the diagnosis of digital maturity, innovation potential and the extent to which sustainability principles are embedded in management practices. Assessment of digital maturity should include the level of process automation, the degree of integration between information systems, the regular use of analytical tools and the formalization of data management procedures, which together determine the real readiness of the enterprise for further digital transformation.

In parallel, it is necessary to identify the enterprise’s innovation competencies, the structure of its innovation portfolio, and the

existence of procedures for evaluating innovation effectiveness. From a sustainability perspective, the analysis should focus on energy efficiency, resource intensity, compliance with environmental standards, and social responsibility. The outcome of this diagnosis should be the identification of «growth points», that is, areas where the integration of digital solutions can generate the greatest synergistic effect.

The next stage involves the formation of a system of goals and KPIs that align business objectives with innovation and ESG indicators. It is important to avoid the parallel existence of separate sets of goals for different areas of activity. A digital strategy should integrate profitability metrics, innovation returns, and sustainability indicators into a single measurement system. This ensures consistency in managerial decision-making and minimizes conflicts between short-term economic interests and long-term development objectives.

The development of a strategy implementation roadmap requires the identification of priorities, the sequencing of initiatives, and mechanisms for scaling. It is advisable to combine projects with rapid effects that build confidence in digital change with long-term transformational initiatives. This approach helps maintain a balance between operational stability and strategic modernization.

Particular attention should be paid to the data management system. The implementation of data governance principles involves defining responsibility for data quality, regulating procedures for data updating and access, and integrating information flows. Data quality and accessibility are prerequisites for sound managerial decisions and effective monitoring of synergy.

The human resource dimension is no less important for the success of a digital strategy. The development of digital skills, the creation of cross-functional teams and a consistent approach to change management determine whether the enterprise is able to implement transformational initiatives without disrupting its operational stability. Clear internal communication plays a key role here, as it helps explain strategic goals and expected results of change, thereby lowering resistance and encouraging greater employee involvement.

The effectiveness of a digital strategy depends not only on what it

contains, but also on how well it is embedded in existing management systems and interactions with external partners. This often requires adjustments to the organizational model rather than relying on existing structures without modification.

In this context, the establishment of a coordinating unit, such as a digital office or a Project Management Office (PMO), appears justified. Such a structure supports systematic management of the digital initiative portfolio and helps align individual projects with broader strategic priorities. The appointment of product owners and the use of cross-functional teams make it easier to combine technical, operational and strategic expertise. As a result, the risk of project fragmentation is reduced and consistency with overall strategic objectives is better maintained.

Another important aspect of integration is the formation of a partnership ecosystem. Cooperation with IT firms, universities, startups and suppliers accelerates innovation processes and opens access to new technological solutions. Within this type of ecosystem, opportunities emerge for data exchange, joint product development and the coordination of sustainability standards, although such cooperation also requires clear rules and mutual trust.

As digitalization increases the enterprise's reliance on information systems, cyber resilience becomes a matter of strategic importance. Information security policies, regular audits, access control and incident response mechanisms should be incorporated into the general risk management framework. Building and maintaining trust in digital processes is therefore not a technical task alone, but a necessary condition for long-term and sustainable enterprise development.

Regular monitoring of the effects of digital strategy implementation makes it possible to assess the degree to which synergy between innovation and sustainability has been achieved. The use of integrated indicators and digital management dashboards ensures transparency of results and enables timely adjustment of the initiative portfolio.

The methodological approach to managing synergy should be based on a staged model that combines strategic analysis, planning, implementation, and control.

Stage 1 involves strategic diagnostics of digital maturity,

innovation potential, and ESG positioning. Its outcome is the identification of initial conditions and integration potential.

Stage 2 focuses on integrating business, innovation, and sustainability indicators into a unified system of objectives. This ensures alignment of strategic priorities and forms the foundation for subsequent planning.

Stage 3 entails the formation of a portfolio of digital initiatives with consideration of the expected synergistic effect. Project evaluation is conducted according to criteria of financial returns, impact on innovation activity, and effects on sustainability indicators.

Stage 4 consists in building a system for monitoring synergy through integrated KPIs and digital management dashboards. This provides the ability to track relationships between digital investments, innovation dynamics, and environmental and social performance.

Stage 5 involves strategy adjustment based on evaluation results. Adaptability is a key condition for sustaining synergy in a changing environment.

The role of top management in this process lies in shaping strategic vision, ensuring resource availability, and supporting a culture of accountability for results. The governance system should define the distribution of responsibilities, decision-making mechanisms, and control procedures.

Risk management tools and cyber resilience measures are integrated across all stages of strategy implementation. They help minimize technological, financial, and reputational risks arising in the course of digital transformation.

Overall, the proposed recommendations form a coherent system for the practical implementation of a digital strategy oriented toward achieving synergy between innovation and sustainable development. This approach ensures not only technological modernization but also a structural transformation of enterprise management based on principles of integrated effectiveness.

Conclusion

The conducted study substantiates an enterprise’s digital strategy as a system-forming mechanism for integrating innovation activity and sustainable development goals within strategic management.

Unlike functionally oriented approaches, it entails a structural transformation of the business model, information architecture, and performance evaluation system.

The position of digital strategy within the hierarchy of strategic decisions has been clarified. It is demonstrated that, in contrast to an IT strategy and a process digitalization strategy, digital strategy operates at the corporate level, is oriented toward transforming value creation sources, and is capable of coordinating innovation initiatives with economic, environmental, and social indicators.

The developed structural and logical model for ensuring synergy has both scientific and practical significance. In this model, digital infrastructure, innovation activity, and the system of sustainability indicators are integrated into a unified management framework. The mechanism for generating the integrated effect is based on data integration, goal alignment, and the establishment of a monitoring system that combines financial, ESG, and digital metrics. This reduces the risk of short-term financial priorities dominating and ensures balance with long-term sustainability.

The methodological contribution lies in the systematization of tools for assessing synergy based on the "ROI + ESG + digital efficiency" model, which integrates financial returns, sustainability impact, and the level of digital integration. This approach formalizes the criteria for selecting digital initiatives and enhances the soundness of project portfolio formation.

It is shown that the effectiveness of a digital strategy is determined not only by technology, but also by organizational capacity, including the level of digital maturity, the quality of governance, the development of competencies, and the integration of digital processes into the risk management system. A lack of coordination reduces the potential for synergy and leads to initiative fragmentation.

The practical relevance of the results lies in the possibility of developing digital transformation roadmaps, integrated KPI systems, and mechanisms for portfolio financing of digital and "green" projects. The proposed approach supports the transition to strategically managed enterprise transformation.

Further research should focus on empirical validation of the integrated model and the development of quantitative methods for

measuring the relationship between digital investments, innovation dynamics, and sustainability indicators.

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TRANSFORMATION OF SOCIAL MANAGEMENT FUNCTIONS AS A FACTOR OF BUSINESS ADAPTABILITY AND RESILIENCE IN WARTIME CONDITIONS

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Abstract
This paper examines the transformation of the social functions of industrial enterprise management in the context of full-scale war. Based on an analysis of data from the World Bank Group (2025), a national labor market study (2025), and reports by the UNDP (2025), OECD (2025), and VoxUkraine (2025), the thesis regarding a qualitative shift in the role of the enterprise – from a market agent to a multifunctional social institution – is substantiated. Four key social functions during wartime (stabilization, protection, integration, and mobilization) are identified, and a three-stage conceptual model of transformation is proposed (reactive adaptation – institutional transformation – strategic socialization). The key directions of management system transformation are identified: decentralization, digitalization, development of resilience, and integration of social functions into the enterprise's strategy.

Keywords: *management, social functions of the enterprise, martial law, corporate social responsibility, organizational resilience, adaptability, post-war recovery.*

Introduction

Armed conflicts, which in recent decades have spread to an increasing number of regions around the world, have extremely devastating consequences not only for the population – which suffers from shelling, forced displacement, and the destruction of homes and critical infrastructure – but also place significant pressure on

businesses, “which must survive in a multi-risk environment, overcome disruptions, and adapt” (Sobolieva et al., 2026). Indeed, the Russian Federation’s full-scale military invasion of Ukraine in February 2022 created an unprecedented institutional burden on domestic industrial enterprises, exerting profound pressure on various spheres of business activity, and above all on organizational culture and business management.

The multi-level impact of military challenges has led to a profound transformation of Ukrainian companies’ management strategies and a shift in their operational priorities – from profit maximization to ensuring operational and social viability. Under these conditions, enterprises are taking on fundamentally new social functions that go far beyond the bounds of classical market logic, and the transformation of management systems is becoming comprehensive in nature, encompassing both functional and structural changes.

The scientific relevance of this issue stems from the fact that the transformation of business’s social role in the context of armed conflict has not been sufficiently conceptualized in contemporary economic science, despite the obvious practical significance of this phenomenon for the development of post-war recovery strategies and the achievement of the Sustainable Development Goals (SDGs). Current events, as emphasized by researchers Havrylyshyn et al. (2024), demonstrate the key role of management science in understanding and navigating the complexities generated by war.

Materials and Methods

The study was conducted using a mixed-methods approach: (1) collection and analysis of secondary statistical data, specifically: data from the World Bank Group (2025), a national labor market survey (2025), reports by the UNDP (2025), the OECD (2025), VoxUkraine (2025), and PwC Ukraine to analyze macro trends in business development and management models; (2) the conceptual framework of the study was an institutional-comparative analysis, which allows viewing the enterprise not only as an economic agent but also as a social institution operating within the framework of accepted social norms, obligations, and social functions; (3) to analyze the social functions of enterprises, we applied the conceptual framework of

corporate social responsibility (CSR) and sustainable development theories, utilizing the analytical tools of the international standard ISO 26000 and the indicators of the UN Sustainable Development Goals; (4) The systematization of existing management models of adaptation has made it possible to describe specific stages in the development of adaptive management strategies and to formulate a three-stage conceptual model of the transformation of an enterprise's social role in wartime conditions.

Results and Discussion

The transformation of enterprise management systems in wartime is characterized by the multi-level nature of crisis processes – security, humanitarian, and economic. As researchers emphasize, "Local businesses operating in Ukraine are under stronger pressure due to the double risks of economic and physical damages" (Sobolieva et al., 2026).

UNDP experts identify ongoing economic and security uncertainty as the key factors hindering business development. "Over 60% of enterprises cite the unpredictability of military and economic factors as the key obstacle to recovery and growth" (UNDP, 2025). The main challenges faced by enterprises during the war include the following:

– Disruptions to operations caused by the physical destruction of production facilities and infrastructure, coupled with interruptions in the supply of energy and raw materials, have led to the shutdown or significant reduction in operations at many companies. Enterprises located near the front lines have become the most vulnerable. According to estimates by the Kyiv School of Economics, by early 2025, the total cost of war damage had reached $170 billion; according to the World Bank, reconstruction needs amount to $524 billion (World Bank Group, 2025);

– Disruption and/or distortion of production and logistics chains due to territorial losses, forcing company management to diversify supply sources and sales markets and adapt logistics routes to wartime challenges, which leads to increased transaction costs and reduces overall business efficiency. This has had the most critical impact on export-oriented enterprises, whose operations depend on damaged transport infrastructure and the suspension of port

operations;

– Restrictions on the use of energy resources and disruptions in the supply of raw materials due to blocked transport routes, which significantly complicate production planning and the implementation of management decisions. As a result, companies are forced to switch to an adaptive management mode focused on short-term stabilization of operations;

– Labor shortages linked to the mobilization of workers, forced migration, and a decline in the labor force. According to surveys of small and medium-sized businesses (2023–2025), staff shortages due to mobilization and workforce outflow remain one of the three key barriers to operational activities;

– Instability in demand and a decline in the purchasing power of the population and counterparties. Under these conditions, financial management focuses primarily on ensuring liquidity and minimizing the risk of insolvency. Starting in 2024, a larger share of enterprises reported a "decrease in business activity due to falling demand and changing market conditions." The non-manufacturing sector experienced the sharpest decline in activity (UNDP, 2025);

– A deterioration in the economic security of businesses, linked to an increase in cyber threats, risks of asset loss, data breaches, and other forms of disruptive impact;

– Institutional and regulatory transformations (changes in tax, customs, and administrative rules) that increase demands on the institutional capacity of enterprise management and their ability to quickly adapt to new conditions.

According to OECD estimates (2025), the full-scale invasion has profoundly distorted the structure of the economy, triggering a large-scale relocation of business structures and a reorientation of business activities toward new markets for sales and resource supply.

A key challenge in conditions of uncertainty and high risk is the conflict arising from the need to simultaneously address short-term business sustainability issues and long-term planning horizons. Management under martial law requires constant adaptation to changing business conditions and conflicting demands from the institutional environment.

In the early stages of the war, these challenges led to a situational shift away from strategic management toward adaptive and/or

stabilization management strategies. During this period, companies' primary efforts were directed toward purely humanitarian functions atypical for business: ensuring the evacuation of the population and company personnel, providing aid in the form of food or essential goods, and so on. Ensuring physical, economic, and food security became a priority for companies.

At the same time, companies faced the challenge of maintaining the economic resilience of their businesses, which also meant fulfilling an important social function – supporting economic stability in communities and society as a whole. Despite the challenges and risks of wartime, the destruction of infrastructure, and the collapse of markets, businesses continue to operate, pay taxes, preserve jobs, and maintain supply chains for critically important goods.

One of the key challenges Ukrainian companies have faced in ensuring business sustainability has been a significant labor shortage caused by mobilization and emigration. According to a survey of top managers at member companies of the European Business Association (EBA, 2025), 75% of enterprises operating in Ukraine are experiencing a labor shortage. The labor market has been particularly affected by a shortage of male workers: 59.5% of respondents noted that the supply of male workers in regional labor markets has decreased by more than 25% since the start of the full-scale invasion (UNDP, 2025).

A shortage of skilled workers has further constrained the labor market, reducing the economic potential and competitiveness of Ukrainian businesses in the international market.

However, despite the labor shortage, constant shelling, and blackouts, data from a national labor market survey (NISD, 2025) (61,000 enterprises, 4.4 million employees) show that 67% of enterprises continued to hire staff throughout 2025. According to a UNDP report (2025), based on a survey of 628 business leaders (December 2024–January 2025) and covering all regions of Ukraine (excluding temporarily occupied territories), most enterprises demonstrate a conscious effort to retain their workforces, even despite reduced production volumes. A VoxUkraine study (2025) confirms that in 2024–2025, approximately 85% of enterprises resumed operations at least partially, although production volumes

and profitability often remain below pre-war levels.

The labor shortage is forcing companies to shift from standard personnel administration to HR strategies based on social responsibility and flexibility, focusing on the following tasks:

– *Caring for employees and ensuring their safety* includes providing economic and psychological support to staff, organizing evacuations to safe regions, setting up shelters, and implementing mental health programs and psychological counseling (PwC Ukraine, 2023).

– *Balancing efficiency and empathy*. Leaders are faced with a paradoxical challenge: ensuring the operational efficiency of the business while demonstrating deep concern for the well-being and welfare of their employees.

– *Operational adaptation.* To overcome staff shortages and ensure business continuity, companies are implementing flexible and hybrid work schedules. The LIGA Projects report (2024) documents adaptive employment practices at many companies the introduction of hybrid work formats, extended schedules, and the redistribution of workload among organizational units.

Various corporate social responsibility practices, which had already become institutionalized in large industrial companies even before the full-scale invasion, took on new forms and functions during the war. For instance, corporate volunteering has evolved into "anti-crisis social responsibility" – focused on creating a safe environment for the development of both the company and the local community.

Military threats have had a significant impact on the expansion of the external scope of socially responsible initiatives by Ukrainian and foreign companies operating in Ukraine, broadening the "circle of stakeholders and the scope of support" (Uvarova & Saprykina, 2023). Support not only for employees but also for external stakeholders – the local community, internally displaced persons, veterans, and families of military personnel –has become standard practice in response to public expectations. Many companies have joined the volunteer movement, providing services or goods free of charge or at cost to the military, IDPs, and healthcare facilities.

As we can see, businesses are expanding the scope and configuration of their social functions, which do not fit into any of

the established theoretical models of private enterprise. The social functions that Ukrainian enterprises have begun to actively develop can be grouped into the following categories:

– Stabilization – employment and household incomes amid a shrinking labor market;

– Protection – ensuring the safety and social protection of staff, including psychological support;

– Integration – promoting the integration of IDPs through job creation and social inclusion;

– Mobilization – participation in societal mobilization through corporate volunteering and support for national defense capabilities.

The expansion of social functions necessitates a transformation of companies' development strategies aimed at ensuring business sustainability. Obłój & Voronovska (2024) note "a shift in the focus of management decisions from reactive, primarily operational responses at the start of the war to strategic decisions aimed at adapting and strengthening business resilience after the conflict entered a protracted phase."

Opatska et al. (2024) distinguish three phases of corporate response: (1) a reactive strategy at the onset of conflict; (2) the resumption of business activity after overcoming the initial shock; (3) adaptation to new conditions and the transformation of business models.

A telling example of adapting management strategies to the challenges of business relocation is the case of Nova Poshta, documented in the PwC Ukraine report (2023). Given the large-scale forced migration of the Ukrainian population, the company decided to adhere to the strategy of "following Ukrainians and growing despite everything" and began opening branches abroad.

The transformation of a company's social role across these three stages can be represented as a three-stage conceptual model:

Stage I – Reactive Adaptation (the first months of the full-scale invasion): situational decisions aimed at retaining staff and minimizing social risks. According to UNDP (2024), in 2022, 31.7% of enterprises completely or almost completely suspended operations; however, by 2023, 84% had resumed them at least partially.

Stage II – institutional transformation (the transition of the

military conflict into a protracted phase): the systematic incorporation of social functions into management strategy; the formation of new organizational structures aimed at addressing social issues; the integration of IDPs into the workforce.

Stage III – Strategic Socialization (Focus on Sustainable Development and Post-War Recovery): rethinking the enterprise's mission through the lens of CSR; systematic implementation of internal and external CSR practices; building the company's social capital as a resource for competitiveness.

This model reflects a systemic conceptual transformation of the social role of the enterprise, which, in times of crisis, takes on the characteristics of a social institution that shares responsibility for social stability. Sobolieva et al. (2026) identify this as a structural change in the enterprise's function within society. Thus, the war has accelerated the transition from a business model focused exclusively on profit maximization to a pfvytbusiness with a mission" model, where social responsibility is an integral part of a company's strategy aimed at creating public good and sustainable development.

As we can see, during the war, the Ukrainian business went far beyond purely commercial activities, taking on a number of social functions that were previously a priority for the state or did not require such intensive attention from society. In conditions of critical threats, business became a key partner of the state in ensuring the stability of society. The expansion of the social functions of enterprises became an important safeguard for stabilizing the social situation in Ukraine and implementing the UN Sustainable Development Goals, in particular: SDG 8 (decent work), SDG 10 (reduced inequality) and SDG 16 (peace and strong institutions). Thus, the transformation of the social role of companies has a cumulative positive effect for sustainable development both at the national and global economic levels.

At the same time, it should be noted that alongside the significant positive impact on society and the operational sustainability of companies themselves, the expansion of their social functions occurs predominantly at the expense of their own resources, which generates a systemic risk – a reduction in organizational resilience. An additional resource burden on Ukrainian companies has been the "rising costs of security and personnel evacuation, which weaken

financial stability" and limit their development potential. As a result, in the context of a protracted armed conflict accompanied by persistent wartime risks and recurring disruptions to energy supply, business activity is declining, as evidenced by the Ukraine Business Index (UBI) falling below 40 points. Despite the fact that the actual number of business entities in 2023 nearly recovered to pre-war levels, reaching 1.91 million, by 2024 more than 50% of enterprises were forced to reduce their production volumes (UNDP, 2025).

This situation underscores the urgent need for systematic state support for business development and corporate social initiatives, which should be manifested through tax incentives, subsidies, partnership programmes, and various forms of public-private partnership. One of the priority directions of such state support should be the creation of an institutional foundation for business social initiatives and the green modernisation of the economy (Nebrat, 2024). The Organisation for Economic Co-operation and Development (OECD), in support of the implementation of the UN Sustainable Development Goals, calls for the consolidation of initiatives from private and public organisations, as well as domestic and international resources, in order to advance the development of CSR mechanisms. The OECD (2025) recommends that Ukraine continue to develop systemic corporate social responsibility in business with a view to reducing social tension and identifying effective mechanisms for addressing social challenges.

Conclusions

The state of martial law is driving a qualitative transformation of enterprise management systems and social functions: from the role of a market agent to a socio-institutional role as a labour market stabiliser, a provider of social protection, and an agent of community support. The transformation of enterprise management systems is characterised by the multi-level nature of crisis processes and encompasses the operational, financial, human resources, and institutional dimensions; its key directions include decentralisation, digitalisation, the integration of risk management, and the strengthening of the security component. The key vectors of the transformation of enterprise social functions are: labour market stabilisation, personnel protection, the integration of internally

displaced persons (IDPs), and participation in societal mobilisation – as confirmed by data from the national labour market study (2025) and UNDP reports (2025). This transformation is systemic rather than situational and is described in the form of a three-stage model: from reactive adaptation through institutional transformation to strategic socialisation, oriented towards the achievement of the SDGs and sustainable post-war recovery. The further full-scale expansion of the social functions of corporate management requires the development of systemic public-private partnerships, regulatory incentives, and the support of international financial institutions.

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MEDIA LITERACY IN EDUCATION AS A STRATEGIC DIMENSION OF SUSTAINABLE DEVELOPMENT SECURITY

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Abstract
This paper explores the strategic role of media literacy in education as a fundamental pillar of sustainable development security in the era of generative AI and hybrid threats. It analyzes the multi-layered impact of media education across four key dimensions: digital security (developing AI literacy to counter deepfakes and algorithmic manipulation), social security (acting as an antidote to disinformation and societal polarization), economic security (protecting learners from phishing and financial fraud), and environmental security (enabling the identification of greenwashing and eco-disinformation). Evaluating modern educational frameworks, the study advocates for a hybrid integration model combining specialized modules with cross-curricular approaches and gamified learning as a crucial strategy to bridge the generational digital divide and build long-term societal resilience.

Keywords: *media literacy, sustainable development, digital hygiene, AI literacy, disinformation, social resilience, greenwashing, digital divide, cybersecurity.*

Introduction

The current stage of human civilization is characterized by total digitalization, the expansion of information communications, and the transition to a global information society. Information has transformed into a key strategic resource that determines the pace of economic growth, social stability, and the level of national security of states. Concurrently, the rapid advancement of technology, the emergence of generative artificial intelligence, social networks, and content personalization algorithms have created unprecedented

challenges for human perception.

Under the conditions of hybrid threats, information warfare, mass dissemination of disinformation, fake news, and psychological manipulation tools (Information-Psychological Operations – IPSOs), traditional approaches to security are undergoing a radical transformation. The security of sustainable development can no longer be viewed exclusively through the prism of military-political or purely economic protection. Today, its fundamental component is the cognitive and digital resilience of each individual citizen, alongside the society's capacity to resist destructive informational influences. Therefore, media literacy within the educational system attains the status of more than just an additional soft skill; it becomes a critically important element of national security and a strategic tool for ensuring sustainable development.

The concept of sustainable development, enshrined in the United Nations Sustainable Development Goals (SDGs), envisions a balanced combination of economic growth, social inclusion, and environmental safety. Information and media literacy directly correlate with several key goals:

1. Goal 4 (Quality Education): Modern quality education is impossible without the formation of critical thinking and the ability to verify information. Media education transforms a passive consumer of content into an active, conscious participant in the digital society.
2. Goal 16 (Peace, Justice, and Strong Institutions): The spread of fakes and hate speech in the media space destroys social cohesion, provokes conflicts, and weakens trust in state institutions. Media literacy acts as a preventive tool against societal destabilization.

The purpose of this study is a comprehensive analysis of the role and mechanisms of integrating media literacy into the educational system as a basic tool for ensuring digital, social, economic, and environmental security within the context of the sustainable development of society.

In today's digital world, the educational space has long expanded beyond physical auditoriums and classrooms. Distance learning, the use of cloud technologies, educational platforms, and social communications have become an integral part of the educational process. However, parallel to these technological advantages, the

vulnerability of educational process participants–both learners and educators–to digital threats has also increased.

Digital security in the context of media literacy begins with the basic elements of digital hygiene. Digital hygiene is a set of rules and practices aimed at protecting personal data, maintaining confidentiality, securing devices from malicious software, and minimizing the risks of negative psychological impacts from the digital environment.

Within the educational environment, the formation of digital hygiene skills must include the following mandatory components:

- An understanding by adolescents and youth of the value of their private information and an awareness of the concept of the "digital footprint" – information that remains online indefinitely after any activity and can be exploited by malicious actors or future employers.
- Educational institutions are becoming arenas for new forms of social pressure, such as trolling, hating, cyberbullying, and stalking. Media literacy teaches how to recognize toxic behavior, respond to it correctly, and forms a culture of non-toxic network communication.
- Modern cybercriminals frequently employ social engineering methods to deceive users. Training in the recognition of phishing dispatches is a critically important part of media education.

Thus, digital hygiene represents the first, protective level of media literacy, without which the transition to higher levels–content analysis and critical thinking – is impossible.

The development of generative artificial intelligence technologies and neural networks has fundamentally altered the landscape of the information space. While previously the creation of high-quality fake news or manipulative content required specific professional skills, significant time, and financial resources, today any user can generate convincing text, realistic imagery, or audio recordings with just a few clicks. Under such conditions, traditional methods of information verification demand urgent modernization, and media literacy in education must decisively transform into so-called "AI literacy."

One of the greatest challenges for the modern educational system and public safety as a whole is deepfake technology – synthetic media in which a person's face or voice is replaced with another using artificial intelligence. In the context of media education, higher and secondary education students must clearly realize the threats

associated with deepfakes.

Another hidden yet exceptionally powerful factor of influence is the recommendation algorithms of social networks (TikTok, Instagram, YouTube, etc.). These algorithms are engineered for maximum retention of user attention; hence, they artificially curate content that matches user preferences or triggers strong emotions (fear, anger, delight). As a result, an "echo chamber" forms around the young person – a closed ecosystem where the user sees only the information that confirms their own biases, fully isolating them from alternative views. This leads to the radicalization of views, intellectual laziness, and an inability to conduct constructive dialogue.

Educational programs in media literacy must teach students to deconstruct the operation of these algorithms. Learners must understand that the news feed in their smartphones is not an objective picture of the world, but a personalized commercial product. Critical thinking in the era of AI consists not only in analyzing the message itself, but also in understanding the architecture of the digital platforms that delivered that message.

Ensuring digital and information security cannot be achieved solely through the individual efforts of an isolated student or teacher. It requires the formation of institutional resilience across the entire educational system. Educational institutions must transform into spaces where a security culture is integrated into daily practices at all levels of management and learning.

The formation of such resilience through educational programs involves three key components:

1. Moving away from the practice of isolating media literacy into a separate, standalone subject, which is often perceived formally. Instead, information analysis skills should be developed within the study of humanitarian, natural, and technical disciplines (a cross-curricular approach).

2. Implementing technical protection tools (two-factor authentication, licensed software, content filtering in the institution's local networks) combined with staff training.

3. The presence of clear protocols within the institution for responding to cyberattacks, personal data leaks, cases of online blackmail, or the mass spread of panic-inducing fakes among the student body or staff.

Only through a systemic approach, where media literacy acts as the core of educational policy, can it be guaranteed that future specialists will possess a high level of resilience to digital threats, providing a reliable foundation for the digital security of the entire state.

The social security of sustainable development presupposes the preservation of social harmony, the protection of cultural values, and the maintenance of a high level of trust between citizens and state institutions. However, in the modern geopolitical environment, the social sphere has become the primary theater of warfare within the framework of so-called hybrid wars. Information-Psychological Operations (IPSOs) have turned into weapons of mass destruction that strike not physical objects, but human consciousness.

IPSOs are planned actions aimed at disseminating specific information and disinformation to a target audience to influence its emotions, motives, critical judgment, and, ultimately, the behavior of individuals, groups, or entire nations. Unlike ordinary news errors or rumors, IPSOs possess a systemic character, a clear strategic goal, and are coordinated by professional structures (intelligence services, bot factories, and analytical centers of aggressor countries).

The primary targets and, concurrently, retransmitters of such operations are frequently young people, due to their high activity in social networks, emotional mobility, and lack of life and political experience. The main destructive consequences of the spread of fakes and IPSOs include:

- The artificial incitement of enmity between different social, ethnic, religious, or age groups within society, thereby fracturing social trust.
- The systemic undermining of the authority of the military, government, healthcare, and educational systems, which paralyzes the state’s capacity to respond effectively to crises.
- The formation of a sense of helplessness, despair regarding one’s own future and the future of one’s country.

The implementation of media literacy in education within this context functions as a mechanism of social inoculation. An individual who understands the mechanics of fake news creation (the use of emotionally charged words, the absence of links to primary sources, manipulative clickbait headlines) acquires cognitive

immunity. They cease to be a blind instrument in the hands of manipulators, which directly safeguards the social stability of the country.

One of the most dangerous consequences of the modern informational chaos is societal polarization – a process whereby public opinion splits into two opposing, uncompromising, and hostile camps, causing the space for compromise and rational dialogue to vanish. In the digital era, polarization is stimulated artificially: both by social media algorithms and targeted destructive campaigns. Youth, due to their inherent maximalism and emotional sensitivity, are the most vulnerable to radical narratives.

In this context, the educational system must perform the function of a primary stabilizer and depolarization tool. Here, media literacy acts not merely as a set of technical skills for fact-checking, but as a deep cognitive practice based on the development of emotional intelligence and psychological resilience.

The educational process, when integrated with the principles of media literacy, counters radicalization through several key mechanisms:

- Disinformation and propaganda always offer simple, unambiguous answers to complex societal questions, artificially dividing the world into “us” and “them.” Media education teaches youth to see the multi-layered complexity of social phenomena, fostering an awareness that reality is rarely unipolar.
- Messages aimed at radicalizing an audience invariably appeal to primal emotions: anger, fear, resentment, or pride. By teaching students to notice their own emotional reactions while reading the news (cognitive self-regulation), education enables them to pause before sharing manipulative content or engaging in aggressive online discussions.
- Critical thinking presupposes the ability to listen to and analyze the arguments of the opposing side, even if they contradict one’s own convictions. Conducting debates, round tables, and practical exercises on media text analysis within educational institutions builds civil discourse skills among youth, lowering the overall level of aggression in society.

Thus, media literacy in education shifts the focus of youth perception from emotional reacting to rational analysis, transforming

a potentially radicalized group into a rational and stable element of the social structure.

A citizen who does not possess the tools to analyze the media space becomes an object of manipulation during electoral processes, reforms, or nationwide discussions. Media literacy in the educational system lays the groundwork for the realization of a conscious civic position through the following aspects:

1. Media literacy training allows future voters to distinguish real campaign platforms and strategies from populist promises, political black PR, and "dzhynsa" (hidden political or commercial advertising). This directly influences the quality of the formation of state authorities and local self-government.

2. Media-literate citizens are capable of effectively utilizing tools for accessing public information, analyzing open data, registries, and reports of state bodies, thereby exercising civil oversight over the activities of institutions and countering corrupt practices.

3. Modern civil society operates actively within the digital space (electronic petitions, participatory budgeting, online public consultations). Media education ensures an understanding of the rules governing these tools and protects citizens from digital manipulations (for example, the use of artificially created bot networks to simulate the "voice of the people").

Consequently, the integration of media literacy into the educational system directly advances the tasks of the UN Sustainable Development Goals, ensuring the formation of a mature society capable of sustaining and defending the democratic institutions of its country from any internal or external informational encroachments.

The economic dimension of sustainable development security is traditionally linked with macroeconomic indicators, currency stability, inflation rates, or the investment climate. However, in the conditions of a digital economy, the micro-level – the economic behavior and security of an individual household or citizen – becomes decisive for the overall resilience of the system. Financial and media literacy have become tightly intertwined today, as the majority of economic crimes against citizens are committed precisely through digital communication channels utilizing information manipulation.

Educational programs in media literacy are designed to protect

the economic interests of future specialists by building resistance to several primary economic threats in the media space:

- The majority of monetary thefts from citizens' accounts begin not with a hacker breach of the banking system, but with the manipulation of human psychology (fear, greed, curiosity). Media literacy teaches how to recognize the signs of phishing messages, fake giveaways, fraudulent e-commerce websites, or announcements regarding "instant social aid" from state bodies or international funds, which are actually traps set by scammers.
- The internet space is oversaturated with aggressive advertising of "easy earnings," new types of financial pyramids, dubious cryptocurrency projects, or pseudo-investment platforms. Youth striving for rapid financial independence frequently fall victim to such schemes due to an inability to critically evaluate information, verify company licenses, and distinguish real business from fraud.
- The algorithms of social networks and media platforms utilize clickbait (manipulative, shocking) headlines and personalized targeted advertising to create artificial demand. Media literacy helps develop mindfulness during information consumption, which directly converts into more rational economic behavior, a reduction in impulsive purchases, and a general increase in personal financial resilience.

The environmental dimension of sustainable development security is traditionally associated with environmental protection, biodiversity conservation, and countering climate change. However, the success of any environmental initiatives and reforms directly depends on public support and civic awareness. In the modern world, the media space has become a field of fierce manipulation of environmental themes, where large corporations and interested political forces exploit informational chaos to achieve their own ends. Therefore, environmental security today is inextricably linked with the ecological and media literacy of the future generation.

The educational process aimed at forming media literacy within an environmental context must focus on two key challenges:

1. Greenwashing Deconstruction: Greenwashing is a form of environmental marketing where a company employs manipulative methods in media and advertising to create a false impression about the environmental friendliness of its products, services, or overall

operations. Corporations frequently use the color green in branding, imagery of nature, and vague ecological slogans (“100% natural,” “eco-friendly”) without any valid certification, or they focus attention on one minor eco-friendly initiative while concealing the colossal environmental damage caused by their core production. Media literacy teaches students to critically evaluate brand claims, demand verified facts, and distinguish independent environmental certification (such as the “Euro-leaf” logo) from empty marketing.

2. Combating Climate Skepticism and fakes regarding the harms of renewable energy (for instance, myths that wind power plants massively destroy bird populations or cause earthquakes), as well as conspiracy theories surrounding environmental crises, which actively proliferate in the digital space. Media literacy enables learners to distinguish populist statements or paid information campaigns by fossil fuel lobbyists from the consensus of the global scientific community.

The formation of environmental media literacy within the framework of the educational process allows for the preparation of not just passive witnesses to climate change, but conscious consumers and activists capable of making rational decisions, supporting effective environmental policies, and resisting manipulations that threaten the ecological security of the planet.

The implementation of media literacy into educational practice on a global level has sparked a discussion regarding the optimal methodological model for its execution. Global and domestic experience demonstrates two primary approaches, each possessing its own advantages and limitations, requiring their balanced analysis within the context of sustainable development security strategies.

Modern educational philosophy leans toward a hybrid model, which combines short, intensive specialized courses with subsequent long-term cross-curricular (infused) integration of media education elements into core disciplines. This allows for ensuring both the systematic nature of knowledge and the practicality of its daily application.

The primary driver of any changes in the educational environment is the educator, teacher, or mentor. However, it is precisely at the level of pedagogical cadres that the implementation of media literacy encounters its most difficult barrier, known as the digital divide or

generation gap.

Modern learners (representatives of Gen Z and Gen Alpha) are "digital natives" – they were born in the era of the internet and smartphones, possess intuitive navigation tools in the digital space, and spend a significant portion of their lives there. Conversely, many representatives of the pedagogical corps are "digital immigrants" who mastered technologies in their adulthood.

This creates a specific paradox:

- Students are significantly more proficient in the technical side of the digital world (search speed, utilizing new applications, video editing, interacting with AI). At the same time, their level of critical thinking, life experience, and understanding of security threats remains very low. They easily fall victim to IPSOs or cyber-scammers.
- Pedagogies possess deep fundamental knowledge and critical thinking, but frequently do not understand the context and architecture of youth's modern media space. They attempt to teach media literacy using examples from printed newspapers or television, whereas youth consume content via Telegram channels, TikTok, and closed Discord servers.

Therefore, a strategic task for educational security is the systemic retraining and professional development of the educators themselves. The teacher must cease to be the sole source of information and become a facilitator–a guide who helps the student structure and critically evaluate information flows, speaking to them in the same technological language.

The effectiveness of implementing media literacy in the educational system is confirmed by numerous successful practices both globally and within Ukraine. The study of this experience allows for the formation of an effective matrix of security solutions for the national educational system.

Finland traditionally ranks first in the European Media Literacy Index. The country initiated a large-scale educational reform in the sphere of countering disinformation back in 2014. The main secret of Finnish success is a purely cross-curricular approach. Children are taught to recognize fakes starting from kindergarten (through fairy tales and drawings). In schools, manipulative advertising slogans are analyzed in language classes; in mathematics, students learn how

statistics can be used to lie on graphs; and in visual arts, they create their own digital collages to understand how easily visual content can be manipulated. As a result, Finnish society possesses the highest level of cognitive immunity in the world against external information attacks and IPSOs.

Ukraine is compelled to develop media literacy under the conditions of real, full-scale hybrid and cybernetic aggression, making the Ukrainian experience unique for the entire world. In recent years, powerful institutions have been established in the state, such as the National Media Literacy Project "Filter" under the Ministry of Culture and Strategic Communications, alongside the Center for Countering Disinformation. Together with international partners, cross-curricular materials have been developed and integrated into hundreds of schools and universities in Ukraine. A distinct role is played by the implementation of edutainment (education through play) – the creation of online simulators and interactive tests that allow youth to test their level of resilience to manipulations and cyberthreats in a gamified format.

The analysis of domestic and global experience proves: media literacy is effective only when it constitutes a state strategic policy, backed by real tools at the level of each individual educational institution.

Conclusion

A comprehensive study of the role of media literacy in the educational system through the prism of sustainable development security allows for the formulation of the following key conclusions:

1. In the era of total digitalization and the development of generative artificial intelligence, the security of sustainable development has expanded far beyond the boundaries of traditional military or purely physical protection. The informational and cognitive space has become the main arena for geopolitical confrontation and social crises. Under these conditions, media literacy in education attains the status of a strategic element of national security, serving as a foundational tool for building social resilience.

2. Media literacy in education lays down fundamental digital hygiene and security skills. It transforms into AI literacy, teaching learners to recognize deepfakes, comprehend the manipulative nature

of social media recommendation algorithms, and counteract cognitive traps ("echo chambers"), which protects private data and user devices from cybercrime.

3. The implementation of media education acts as a tool for social inoculation against disinformation, fakes, and Information-Psychological Operations (IPSOs). By developing critical thinking and emotional self-regulation, education lowers the level of radicalization and polarization in society, particularly among youth. This directly supports the fulfillment of UN Sustainable Development Goal 16, fostering a conscious civil society capable of protecting democratic institutions.

4. The study revealed deep, hidden interconnections of media literacy with other dimensions of sustainable progress. In the economic sphere, it protects citizens from digital financial fraud, investment scams, and impulsive consumption, thereby enhancing the financial stability of households. In the environmental sphere, media literacy enables the recognition of greenwashing phenomena and counters eco-disinformation, forming a responsible consumer and supporting real steps toward environmental preservation.

5. The strategic success of developing media literacy in education depends on bridging the "digital divide" between generations of instructors and students. The optimal model is a hybrid approach–the combination of short intensive courses with deep cross-curricular integration of media literacy elements into all academic disciplines, featuring the wide utilization of gamified formats and simulators.

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Chapter 6

PRACTICAL IMPERATIVES AND STRATEGIC GUIDELINES FOR THE IMPLEMENTATION OF SUSTAINABLE DEVELOPMENT SYNERGY UNDER SECURITY CHALLENGES

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LOGISTICS TOOLS FOR OPTIMIZING MARKETING DISTRIBUTION AND SALES POLICY

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Abstract

The effectiveness of marketing distribution and sales policy is increasingly dependent on the integration of logistics tools and technologies. In modern competitive environments, enterprises must optimize supply chains, distribution channels, and customer service systems in order to improve operational efficiency and market responsiveness. The purpose of this study is to examine the role of logistics tools in optimizing marketing distribution and sales policy and to identify the most effective approaches for enhancing distribution efficiency. The research employs a conceptual analysis combined with systematization of modern logistics instruments, including inventory management systems, transportation optimization models, warehouse management technologies, digital platforms, and data-driven analytics. The findings demonstrate that logistics tools significantly improve coordination between marketing and supply chain functions, reduce operational costs, and enhance customer satisfaction through faster and more reliable product delivery. The study also proposes a conceptual framework linking logistics capabilities with marketing distribution performance. The results confirm that the integration of logistics and marketing strategies contributes to sustainable competitive advantage and improved organizational performance.

Keywords: *logistics tools, marketing distribution, sales policy, supply chain management, logistics optimization, digital logistics.*

Introduction

The increasing complexity of modern markets requires enterprises to adopt integrated approaches to managing distribution and sales processes. Globalization, digitalization, and increasing customer expectations have transformed traditional marketing distribution systems into complex networks involving multiple intermediaries, logistics providers, and digital platforms.

Marketing distribution policy determines how products move from producers to final consumers. However, the effectiveness of this policy largely depends on the efficiency of logistics operations that ensure product availability, transportation, and delivery. Consequently, logistics has evolved from a purely operational function into a strategic tool that supports marketing objectives.

Modern enterprises face numerous challenges in managing distribution channels, including rising transportation costs, fluctuating demand, increasing competition, and the need for rapid response to market changes. Logistics tools provide mechanisms for addressing these challenges through optimization of inventory levels, transportation routes, warehouse operations, and information flows.

The integration of logistics tools with marketing strategies allows companies to achieve higher levels of efficiency and customer satisfaction. In particular, logistics technologies support accurate demand forecasting, faster order fulfillment, and improved coordination between supply chain participants.

The purpose of this research is to analyze logistics tools used for optimizing marketing distribution and sales policy and to evaluate their impact on organizational performance.

The objectives of the study include:

- analyzing the theoretical foundations of logistics in marketing distribution and sales policy;
- identifying key logistics tools used in modern distribution systems;
- developing a conceptual framework for integrating logistics tools into marketing distribution and sales policy;
- evaluating the impact of logistics tools on distribution efficiency and sales performance.

Literature Review

Marketing distribution refers to the set of activities that ensure the movement of goods from producers to consumers. According to modern supply chain theory, distribution systems include transportation, warehousing, inventory management, and order processing functions (Hong-Xia, 2014). In healthcare, supply chain management aims to ensure timely, accurate delivery of products while minimizing costs, with innovations driven by physical configuration and information flow enhancements (Villa, 2021). Emergency management logistics also applies supply chain principles, utilizing models like SCOR for planning and execution, influenced by factors such as event frequency and resource availability (Matthew et al., 2016). The pharmaceutical sector exemplifies the application of intelligent ecosystems, integrating IoT,

big data, and real-time monitoring to improve safety, quality, and resilience, especially in complex and risk-prone environments (Raza et al., 2025). Additionally, regional studies highlight the importance of value chain management and transportation logistics, emphasizing flexible, well-organized processes that adapt to dynamic market conditions (Kuranovič, 2023). Overall, modern supply chain theory is characterized by its focus on technological integration, strategic collaboration, and adaptability to diverse operational contexts, aiming to improve responsiveness, transparency, and resilience in global supply networks.

Researchers emphasize that logistics plays a central role in supporting marketing distribution strategies. Logistics activities ensure product availability in the right quantity, at the right place, and at the right time. Effective logistics systems therefore enhance customer satisfaction and support competitive advantage (Lancaster & Reynolds, 1998).

The integration of logistics and marketing functions has become an important trend in supply chain management. Marketing departments focus on market demand and customer needs, while logistics departments ensure efficient product flow. Collaboration between these functions enables companies to create value for customers while minimizing operational costs (Velychko et al., 2019).

Materials and Methods

This study applies a qualitative research methodology based on conceptual analysis and synthesis of scientific literature on logistics and marketing distribution and sales policy.

The methodological framework includes the following methods:

- system analysis for examining the relationship between logistics tools and marketing distribution and sales policy;
- comparative analysis for evaluating different logistics instruments used in marketing distribution and sales policy;
- conceptual modeling for developing a framework linking logistics capabilities with marketing distribution performance.

The research also incorporates elements of empirical modeling to illustrate how logistics tools influence distribution efficiency.

Research and Discussion

Logistics tools refer to methods, technologies, and management approaches used to improve the efficiency of logistics processes. These tools can be classified into several categories:

1. Inventory management tools.
2. Transportation optimization tools.
3. Warehouse management systems.
4. Digital logistics technologies.
5. Data analytics and forecasting tools.

Inventory management tools help companies maintain optimal stock levels and reduce storage costs. Transportation optimization models enable companies to select the most efficient routes and transportation modes. Warehouse management systems improve the accuracy and speed of warehouse operations.

Digital technologies such as enterprise resource planning systems and supply chain management platforms have further enhanced the efficiency of logistics operations by enabling real-time information sharing among supply chain participants.

Sales policy defines the principles and mechanisms used by companies to sell products and interact with customers. It includes pricing strategies, distribution channel selection, customer service standards, and promotional activities.

Logistics tools play a critical role in supporting sales policy by ensuring reliable product availability and timely delivery. Efficient logistics systems enable companies to offer flexible delivery options, reduce order fulfillment time, and improve service quality.

Empirical studies consistently demonstrate that the integration of logistics and marketing systems enhances customer satisfaction and market competitiveness. For instance, the research by highlights a strong positive correlation ($r = 0.74$, $p = 0.01$) between digital supply chain management (SCM) and marketing integration and improved customer satisfaction, operational efficiency, and competitive advantage (Haque & Begum, 2022). Similarly, a study on retail businesses emphasizes that integrated marketing strategies lead to better demand forecasting, inventory management, and customer satisfaction, facilitated by technology such as AI and data analytics (Mitchell, 2024). The importance of cross-functional collaboration and leadership in fostering such integration is also underscored.

Additionally, the conceptual framework proposed by paper supports the notion that coordinated efforts improve responsiveness, inventory management, and profitability (Mishra et al., 2024). While some literature emphasizes the strategic alignment of logistics with marketing principles, especially in international contexts, the overarching consensus is that integrated systems lead to enhanced operational outcomes and customer satisfaction, thereby strengthening market competitiveness. The studies collectively affirm that companies leveraging integrated logistics and marketing systems are better positioned to respond swiftly to market demands, optimize resources, and sustain competitive advantage in dynamic environments.

Inventory management systems help organizations maintain optimal stock levels and prevent shortages or overstocking. Key tools marketing distribution and sales policy include: economic order quantity (EOQ), Just-in-Time (JIT), ABC analysis, safety stock models and automated replenishment systems (Table 6.1).

Inventory management tools play a critical role in marketing distribution and sales policy by ensuring that products are available at the right time, in the right quantity, and at the lowest possible cost. Effective inventory control supports customer satisfaction, reduces operational inefficiencies, and strengthens competitiveness. Combining these tools enables businesses to improve supply chain performance, reduce costs, respond more effectively to market demand, and support sustainable sales growth. Modern companies often integrate several inventory management methods rather than relying on a single approach, creating a more flexible and efficient inventory strategy.

Transportation optimization tools is one of the most significant cost components in marketing distribution and sales policy. Logistics tools for transportation optimization include: route optimization algorithms, transportation management systems (TMS), vehicle routing problem models, multimodal transportation planning, GPS and telematics tracking (Table 6.2).

Transportation optimization tools are essential components of marketing distribution and sales policy because they improve the efficiency, speed, and reliability of product delivery. Effective transportation management helps organizations reduce operational

costs while enhancing customer satisfaction and service quality. The integration of transportation optimization tools allows businesses to strengthen supply chain performance, improve resource utilization, lower logistics expenses, and ensure more reliable customer service. In modern distribution systems, using a combination of these technologies creates a more adaptive and competitive transportation strategy.

Table 6.1

Inventory management tools in marketing distribution and sales policy

Tool	Function	Key benefits	Example applications
Economic order quantity (EOQ)	Determines optimal order quantity	Minimizes total inventory costs	Retail chains, manufacturing firms
Just-in-Time (JIT)	Aligns inventory with production schedules	Reduces storage costs, prevents overstock	Automotive industry, electronics
ABC analysis	Classifies inventory based on value/importance	Prioritizes management focus on critical items	Warehouses, distributors
Safety stock models	Maintains buffer stock	Prevents stockouts due to demand variability	FMCG, e-commerce
Automated replenishment systems	Automatic ordering when stock reaches threshold	Reduces manual errors, ensures continuous supply	Supermarkets, pharma distribution

Source: authors' generalizations

Warehouse management systems are essential for ensuring efficient marketing distribution and sales policy. Modern warehouse management systems provide: barcode and RFID technology, automated inventory tracking, dynamic storage allocation, warehouse layout optimization and inventory cycle counting (Table 6.3).

Table 6.2

Transportation optimization tools in marketing distribution and sales policy

Tool	Function	Key benefits	Example applications
Route optimization algorithms	Calculates most efficient delivery routes	Reduces fuel and travel time	Courier companies, last-mile delivery
Transportation management systems (TMS)	Plan, execute, and monitor shipments	Improves coordination and reduces delays	Logistics providers, global shipping
Vehicle routing problem models	Optimizes delivery schedules for multiple vehicles	Increases fleet utilization	E-commerce, grocery delivery
Multimodal transportation planning	Combines different transport modes	Reduces cost and improves flexibility	International shipping, intermodal logistics
GPS and telematics tracking	Monitors vehicle location in real-time	Enhances delivery reliability and transparency	Courier services, fleet management

Source: authors' generalizations

Warehouse management systems are a fundamental element of marketing distribution and sales policy because they improve inventory control, warehouse efficiency, and order fulfillment performance. Effective warehouse operations contribute to lower costs, faster delivery processes, and higher customer satisfaction. The integration of warehouse management tools strengthens supply chain effectiveness by improving accuracy, reducing operational costs, and accelerating product movement. Modern organizations achieve the best results by combining multiple warehouse technologies and optimization methods into a unified warehouse management strategy.

Digital transformation has significantly expanded the capabilities of logistics management. Digital logistics tools in marketing distribution and sales policy include: enterprise resource planning

(ERP), supply chain management (SCM) platforms, cloud-based logistics solutions, e-commerce logistics integration and IoT-enabled logistics platforms (Table 6.4).

Table 6.3

Warehouse management systems in marketing distribution and sales policy

Tool	Function	Key benefits	Example applications
Barcode and RFID tracking	Digital identification and tracking of goods	Reduces errors, increases picking speed	Retail, e-commerce, pharma
Automated inventory tracking	Robotics-assisted item handling	Faster order fulfillment, reduced labor costs	Amazon fulfillment centers, warehouses
Dynamic Storage Allocation	Smart assignment of inventory to storage locations	Optimizes space usage, reduces retrieval time	Cold storage, large warehouses
Warehouse Layout Optimization	Plan efficient shelf/aisle arrangement	Minimizes travel distance, increases throughput	Distribution centers, FMCG warehouses
Inventory Cycle Counting	Frequent checks of inventory	Reduces discrepancies, maintains accuracy	Retail chains, manufacturing warehouses

Source: authors' generalizations

Digital logistics technologies have become a critical component of marketing distribution and sales policy by improving connectivity, transparency, and operational efficiency throughout the supply chain. These technologies enable businesses to make faster decisions, enhance coordination, and respond more effectively to changing market conditions. The use of digital logistics technologies enables organizations to optimize operations, reduce costs, improve customer service, and gain a competitive advantage. Businesses increasingly rely on integrated digital ecosystems that combine multiple technologies to create agile, data-driven, and efficient logistics strategies.

Table 6.4

Digital logistics technologies in marketing distribution and sales policy

Platform	Function	Key benefits	Example applications
Enterprise resource planning (ERP)	Integrates logistics, inventory, finance, and sales	Provides real-time data for decision-making	Large corporations, multi-branch operations
Supply chain management (SCM) platforms	Monitors supply chain operations	Enhances visibility, collaboration, and efficiency	Global supply chains, manufacturing networks
Cloud-based logistics solutions	Offers scalable digital logistics infrastructure	Reduces IT cost, allows remote monitoring	Startups, e-commerce logistics
E-commerce logistics integration	Links online sales with fulfillment	Improves order accuracy and delivery speed	Shopify, Amazon sellers
IoT-enabled logistics platforms	Real-time monitoring of goods & vehicles	Improves traceability and responsiveness	Cold chain, pharmaceutical distribution

Source: authors' generalizations

Data analytics and forecasting tools enable companies to analyze customer demand patterns and optimize distribution planning. Key technologies in marketing distribution and sales policy include: predictive analytics, machine learning models, Big Data analytics, dashboard & KPI monitoring and customer behavior analysis (Table 6.5).

Data analytics and forecasting tools play a crucial role in marketing distribution and sales policy by helping organizations anticipate market demand, optimize inventory levels, and improve operational decision-making. The use of data-driven approaches allows businesses to become more proactive and responsive to changing customer needs and market conditions. Integrating data analytics and forecasting tools enhances supply chain efficiency, reduces operational risks, and improves customer satisfaction. Organizations that effectively combine analytical technologies gain stronger market responsiveness and a competitive advantage through more accurate planning and informed decision-making.

Table 6.5

Data analytics and forecasting tools in marketing distribution and sales policy

Tool	Function	Key benefits	Example applications
Predictive analytics	Forecasts demand patterns using historical data	Reduces stockouts and overstock, improves planning	Retail, FMCG, seasonal products
Machine learning models	Uses algorithms to predict customer demand	Improves accuracy over traditional forecasting	E-commerce, consumer electronics
Big Data analytics	Analyzes large volumes of structured / unstructured data	Detects trends, improves decision-making	Global retail chains, online platforms
Dashboard & KPI monitoring	Visualizes logistics performance in real-time	Enhances management oversight, quick action	Logistics managers, supply chain controllers
Customer behavior analysis	Analyzes purchase patterns and preferences	Enables personalized distribution and inventory planning	E-commerce, supermarkets, online marketplaces

Source: authors' generalizations

The proposed conceptual framework integrates logistics tools with marketing distribution and sales policy performance. The framework consists of three main components: logistics capabilities, distribution efficiency and sales performance. Logistics tools enhance logistics capabilities such as inventory control, transportation efficiency, and information integration. These capabilities improve distribution efficiency by reducing costs and delivery times. Improved distribution efficiency leads to higher sales performance through increased customer satisfaction and market responsiveness.

Discussion

The findings highlight the strategic importance of logistics tools in optimizing marketing distribution and sales policy. Traditional approaches to marketing distribution focused primarily on channel management and promotional activities. However, modern markets

require integrated supply chain strategies that combine logistics and marketing functions.

The adoption of digital logistics technologies significantly enhances distribution efficiency by improving information transparency and coordination among supply chain partners. Moreover, advanced analytics tools enable companies to anticipate market trends and respond quickly to changes in customer demand.

Enterprises that effectively integrate logistics tools into their marketing strategies gain several advantages:

- reduced operational costs;
- improved delivery reliability;
- enhanced customer satisfaction;
- greater market competitiveness.

Conclusions

The conducted research demonstrates that modern marketing distribution and sales policy increasingly depend on the implementation of advanced logistics, technological, and analytical tools. The analysis of inventory management systems, transportation optimization methods, warehouse management technologies, digital logistics platforms, and data analytics solutions shows that integrated approaches significantly improve organizational performance and market responsiveness.

The findings indicate that inventory management tools such as EOQ, Just-in-Time systems, ABC analysis, safety stock models, and automated replenishment systems help organizations balance product availability with cost efficiency. Effective inventory practices reduce storage expenses, minimize stock shortages, and ensure continuity of supply processes. Businesses that adopt multiple inventory management techniques are better equipped to maintain stable operations and adapt to market fluctuations.

The research also highlights the strategic importance of transportation optimization tools in distribution systems. Route optimization algorithms, transportation management systems, vehicle routing models, multimodal transportation planning, and GPS-based monitoring technologies contribute to lower transportation costs, improved fleet utilization, and more reliable delivery performance. Efficient transportation management strengthens customer satisfaction by reducing delays and enhancing service quality.

Warehouse management systems emerged as another critical component of effective marketing distribution. Technologies such as barcode and RFID tracking, automated inventory systems, dynamic storage allocation, warehouse layout optimization, and cycle counting increase operational accuracy and productivity. Modern warehouse solutions reduce human errors, accelerate order fulfillment, and improve resource utilization, thereby supporting overall supply chain effectiveness.

Furthermore, the study confirms the growing influence of digital logistics technologies on business operations. ERP systems, SCM platforms, cloud-based logistics solutions, e-commerce integration systems, and IoT-enabled platforms provide real-time information and strengthen communication across the supply chain. Digitalization supports better coordination among stakeholders, improves transparency, and enables organizations to respond quickly to operational challenges.

The results additionally demonstrate that data analytics and forecasting tools are becoming essential for strategic planning and decision-making. Predictive analytics, machine learning models, Big Data technologies, KPI dashboards, and customer behavior analysis provide valuable insights into demand trends and consumer preferences. These technologies improve forecasting accuracy and allow organizations to implement more personalized and customer-oriented distribution strategies.

Overall, the research confirms that no single tool is sufficient to achieve maximum efficiency in marketing distribution and sales policy. The greatest benefits are obtained through the integration of multiple technologies and management approaches into a unified system. Organizations that adopt comprehensive and data-driven logistics strategies gain significant advantages, including reduced operational costs, improved customer service, increased flexibility, and stronger competitiveness in dynamic market environments.

Future development trends suggest that businesses will increasingly rely on artificial intelligence, automation, real-time analytics, and interconnected digital ecosystems. Therefore, continuous investment in technological innovation and logistics modernization will remain a key factor for sustainable growth and long-term business success.

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ENVIRONMENTAL TRANSFORMATION WITHIN PROJECT PORTFOLIO MANAGEMENT: ECOLOGICAL RESPONSIBILITY AND ENVIRONMENTAL SECURITY IN PROJECT SELECTION AND PRIORITIZATION PROCESSES

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Abstract
As sustainability includes three pillars of environmental, social, and economic dimensions, the environmental pillar is most often prioritized in investment portfolios in Europe and the United States, while the social pillar is the least prioritized, with the reasons being a possible research gap. European, Asian, and North American institutional investors prioritize different sustainability aspects, stating another research possibility. Moreover, greenhouse gas accounting is a leading sustainability indicator among state-owned investors globally. Since all projects are considered investments, portfolio management is used to select and prioritize projects. To address the research gap, the main aim of the study is to examine whether environmental responsibility and security can be embedded in portfolio project selection and prioritization decision-making. Based on a bibliometric analysis of the most recent literature, environmental responsibility and security can be embedded in portfolio project selection and prioritization decision-making. The main findings include that the project selection and

prioritization could include air, waste, water, crops, resources, and environmental justice focus. The main decision-making methods are analytic hierarchy process (AHP), multi-criteria decision making (MCDM), and analytic network process (ANP). However, the literature review reveals no observable regional differences in the integration of environmental responsibility and security within project selection and prioritization, which could be empirically analyzed in future studies.

Keywords: *environmental sustainability, ecological responsibility, environmental security, project portfolio management, project selection and prioritization.*

Introduction

The three sustainability pillars are environmental, social, and economic (Anjamrooz et al., 2024). The environmental pillar of sustainability is most often prioritized in investment portfolios in Europe and the United States, while the social pillar is the least prioritized (Top ESG Aspect in PE Investments Europe and the U.S. 2024 | Statista, n.d.). European institutional investors prioritize climate action and the circular economy, Asian investors prioritize the circular economy and financial inclusion, while North American investors prioritize healthcare and financial inclusion (*Top ESG Aspect in PE Investments Europe and the U.S. 2024 | Statista*, n.d.; *Asia–Pacific: Sustainable Product Themes 2024| Statista, n.d.; North America: Sustainable Product Themes 2024| Statista, n.d.)*. While greenhouse gas accounting is a leading sustainability indicator among state-owned investors globally (*Global: SOIs Sustainability Reporting Indicators | Statista*, n.d.).

As all projects are considered investments, the value they bring, whether financial or nonfinancial, must meet or exceed targets to justify the investment (Project Management Institute, 2025). Furtermore, portfolio management is used for projects and programs selection, prioritization, management, and optimization, and is usually based on organizational strategic goals and objectives (Project Management Institute, 2025). Therefore, this study focuses on environmental transformation within the project portfolio and on how environmental responsibility and security align with portfolio project selection and prioritization. The main aim of the study is to analyze whether environmental responsibility and security can be

embedded within portfolio project selection and prioritization decision-making. The main research questions are the following:

1. RQ1: How can environmental responsibility and security be embedded in portfolio project selection and prioritization decision-making, as per the bibliometric analysis of the most recent literature?
2. RQ2: What decision-making frameworks most effectively integrate environmental responsibility metrics into project selection and prioritization?
3. RQ3: How does the integration of environmental responsibility and security within project selection and prioritization differ across regions with varying sustainability investment priorities (e.g., Europe, Asia, North America), and what factors influence these differences?

Methods

The Web of Science Core Collection database is used for research on topics by using the following keywords: Environmental". OR "Environmental transformation" OR "Environmental transition" OR "Ecological responsibility" OR "Environmental security" OR "Environmental sustainability" AND "Project portfolio" OR "Project selection" OR "Project prioritization". The results provided 200 publications, which are being analyzed by utilizing Biblioshiny (Bibliometrix package) software to answer RQ1-RQ2. The regional analysis (RQ3) is conducted by manually searching the titles, keywords, and abstracts of 200 publications for regional identifiers.

Results and Discussion

The Web of Science Core Collection search results provide 200 thematically close publications. The period of publication spans from 1991 to 2026, with a peak in 2023 with 19 publications. Since then, there has been a slight decline, as in 2025, there are 15 publications. As of 2026, there are 4 publications (as per Figure 6.1).

As per RQ1, recent publications include minimization of environmental impacts, environmental resilience (pollution level parameter, static and active waste production, and sealable waste), critical performance indicators (water conveyance efficiency, application efficiency, and cropping intensity), environmental

impacts – climate change, air quality and emissions, natural, community, and cultural resources, and environmental justice, reducing carbon dioxide emissions.

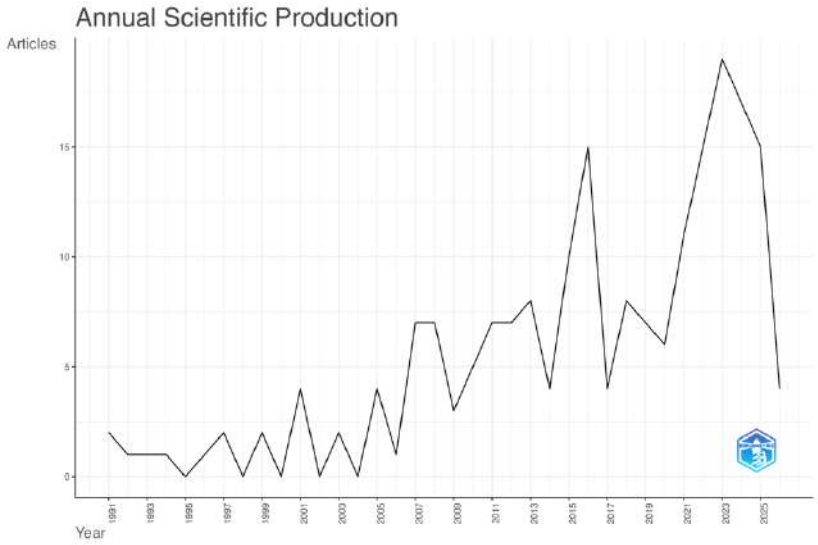


Figure 6.1 Annual Scientific Production

For instance, suggest prioritizing efforts to minimize environmental impacts (Lostumbo et al., 2025). Environmental resilience and portfolio project selection fuzzy logic model, including pollution level parameter, which has the highest impact, followed by static and active waste production, and sealable waste (Gholami et al., 2025). Utilizing multi-criteria decision-making (MCDM) for irrigation projects and critical performance indicators, for instance water conveyance efficiency, application efficiency, and cropping intensity (Lamichhane et al., 2025).

Also, project selection criteria evaluation for transportation improvement, the prioritization criteria include environmental impacts – climate change, air quality and emmisions, natural, community, and cultural resources protection (projects mitigating harm receive positive scores, and negativelly impacting are penalized) and environmental justice – project do not negatively

impact communities (prioritize projects that are in compliance with regulations or make transportation more accesible) (Baghersad et al., 2025). Moroever, a study finds that the selection of renewable energy power projects increases economic revenue by more than 26% and reduces carbon dioxide emissions by more than 60% (Lv et al., 2025). Learning across projects and the "transition planning office" are proposed to institutionalize these capabilities (Vermeulen et al., 2025).

As per RQ2 and the word cloud in Figure 6.2, the analytic hierarchy process (AHP) (Anjamrooz et al., 2024; Souza et al., 2020; Yavuz & Altay, 2014; Beiler & Treat, 2014; Özkir & Demirel, 2012; Hsueh & Yan, 2011; Dağdeviren, 2008), fuzzy AHP, multi-criteria decision making (MCDM) – FVIKOR method in particular (Zhou et al., 2016), and fuzzy analytic network process (ANP) (Chen et al., 2023; Aragonés-Beltrán et al., 2010) are mostly mentioned in the decision-making framework.



Figure 6.2 World cloud

As for RQ3, there are no particular differences among the analyzed publications by region. For instance, North America – Southeastern USA metropolitan planning organizations are mentioned, and their criteria include climate change, air quality, and emissions, natural, community, and cultural resources protection, and

not negatively impact communities (Baghersad et al., 2025).

As for Europe, the Portuguese territorial impact assessment (TIA) for the economy, low emissions, environmental protection, risk prevention and management, climate change adaptation, and resource efficiency is suggested (Medeiros et al., 2022). Belgium's construction logistics analysis proposes to use off-site zero-emission construction vehicles, and it also includes an assessment of the environmental impact (Brusselaers et al., 2022). The Western Balkans energy portfolio and the EBRD project portfolio are analyzed (Buzar, 2008). Finland's portfolio decision analysis proposed instead of confusing on specific environmental measures to have a clear process of selecting a shortlist of actions (Mustajoki et al., 2024)

As for Asia, Nepal's irrigation project prioritization is based on critical performance indicators: water conveyance efficiency, application efficiency, and cropping intensity (Lamichhane et al., 2025). East China's optimization of renewable energy portfolios considers human development, different aspects of human life, and socioeconomic well-being (Hashemizadeh & Ju, 2021).

Conclusions

The bibliometric analysis confirms that environmental responsibility and security can be systematically embedded in portfolio project selection and prioritization decision-making processes. Key findings include:

As for RQ1, and based on a bibliometric analysis of the most recent literature, the study finds that environmental responsibility and security can be embedded in portfolio project selection and prioritization decision-making. It includes that the project selection and prioritization could include air, waste, water, crops, resources and environmental justice focus: pollution level parameter, air quality and emissions, reducing carbon dioxide emissions; climate change; static and active waste production, and sealable waste; water conveyance efficiency, application efficiency, and cropping intensity; natural, community, and cultural resources; and environmental justice.

As for RQ2, the primary decision-making methods that most effectively integrate environmental responsibility metrics into project

selection and prioritization are the following: analytic hierarchy process (AHP), multi-criteria decision-making (MCDM), and the analytic network process (ANP).

As for RQ3, even though the publications include North America (USA), Europe (Portugal, Belgium, Western Balkans, Finland), and Asia (Nepal and East China), the literature review reveals no extraordinary regional differences in the integration of environmental responsibility and security within project selection and prioritization, which could be empirically analyzed in future studies.

Future research could focus on empirically testing the relationship between investor types (state-owned vs. private) in line with environmental sustainability decision-making in portfolio project selection and prioritization.

The managerial implications include developing environmental project portfolio selection criteria. Also, adopting a multi-criteria decision-making approach. Moreover, focusing on adaptive, agile portfolio management processes to adapt to ever-changing internal and external environments (e.g., the changing climate, geopolitics, and regulations).

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EDUCATION REFORM IN UKRAINE AS A COMPONENT OF INNOVATIVE, HIGH-TECH DEVELOPMENT

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Abstract
The effectiveness of the European integration reforms of education "New Ukrainian School", the project of the profile reform of education from the point of view of forming its components as elements of the ecosystem of innovations and high-tech development of Ukraine, which will enable the post-war reconstruction of the country on the basis of high-tech and innovations, was studied. A lack of resources was established to achieve the goals of the profile reform of education regarding the creation of the projected number of academic lyceums with the necessary infrastructure due to ignoring the system of resettlement in territorial communities, the difficult situation of stakeholders of the process as a result of the war; institutional support for the reform; communications of the Ministry of Education and Science with communities of parents and teachers. It was emphasized that if the goals of the profile reform are achieved, there will be a threat of the disappearance of a number of institutions of tertiary education (ITE), including flagships of education, R&D and innovations. To ensure the post-war reconstruction of Ukraine on a high-tech basis, a larger number of specialists with higher education is needed.

Keywords: *high technologies (high-tech), innovations, innovation ecosystem, "New Ukrainian School" (NUS) reform, specialized educational reform, academic and professional lyceums, territorial communities, financing of educational reforms.*

Introduction

The education system of Ukraine (secondary, vocational, higher) is an important component of the formation of the technological base of society, and the challenges it has faced for more than 6 years in a

row (the COVID-19 pandemic, war, the departure of a significant part of the population, including children, abroad or to safer regions of the country, a decrease in the financial resources of the state and local governments, etc.) have highlighted serious development gaps, which, if the old logic and architecture of the system are maintained, will significantly weaken the country's position in providing personnel for its innovative and high-tech development. It is important because Ukraine, as a result of the large-scale armed aggression of the Russian Federation, lost a significant part of its potential – territories, human, physical, financial and resource; infrastructure, and during the period of post-war reconstruction, these losses can only be compensated by increasing the efficiency of social production due to the transition of all sectors of the national economy to knowledge-intensive, high-tech. innovative rails. This will ensure an increase in their productivity, competitiveness, faster adaptation of business to new technologies, facilitate the inclusion of the economy in global value chains and its transformation into a Fluid Economy (an economy without borders for the transfer of labor, capital, technologies), European integration. This is possible only with a fundamental improvement in the quality of all components of the education system and its transformation into a full-fledged component of the ecosystem of innovations and the introduction of high technologies. However, serious gaps and even threats to the achievement of the goals of rebuilding the country on a high-tech basis are already seen in the plans for education reforms, so it is necessary to develop proposals for their elimination**.**

Materials and Methods

The research is based on statistical materials, scientific and periodical articles, general and profile legislative framework of Ukraine. The methods used are empirical (comparison, observation, statistical), intermediate (modeling, analogy, analysis-synthesis, induction, deduction).

Results and Discussion

The development of human capital as a component of the innovation ecosystem of Ukraine is indicated as one of the main directions of the Strategy for the Digital Development of Innovations

until 2030 (WinWin) with an emphasis on high technologies: defense, space, medical, bio-, agricultural, public administration, educational, green, immersive, semiconductor, AI, cybersecurity, Fluid Economy (borderless based on a flexible digitalized ecosystem that promotes business development, integration into the global market, economic competitiveness through the most favorable regulatory environment for the free movement of goods, services, capital and digital innovations), which will enable the implementation of the Recovery Plan of Ukraine by increasing the intellectual potential of the country, developing the high-tech base of society and sectors of the national economy and on this basis developing high-tech sectors of the economy with high added value. After all, digital literacy directly affects well-being: Ukrainians with a high level of digital skills earn an income on average 5 times more than those who do not have them.

According to the WinWin Strategy, strengthening the education system as an important component of the innovation ecosystem involves the implementation of strategic goals: 1) transforming **the institution of secondary education (ISE)** system into a component of the innovation ecosystem by forming digital, entrepreneurial, scientific, creative, etc. key competencies in students, developing the ability to solve problems in a non-standard way, produce original ideas, effectively implement creative potential (creativity); motivation for independent research; encouraging cooperation with enterprises by involving practicing specialists in teaching and consulting on the necessary skills (both directly vocational and technical, and on the specifics of entrepreneurship in the digital economy); creating informational and entertainment content in the media to interest students in studying mathematical and applied disciplines, 2) transforming **institutions of vocational education (IVE)** into an integrated link in the innovation ecosystem by integrating IVE into industry innovation environments by establishing ties with enterprises, promoting the improvement of the material and technical base of IVE with the help of international technical assistance and coordination of donors and business, involving IVE in studying the labor market to adapt educational programs to market needs, supporting the exchange of information between institutions on R&D, 3) transforming **institutions of**

professional pre-university education (IPPUE) and institutions of higher education (IHE) into centers of innovative development integrated into market processes and business, by creating platforms for cooperation with business on the basis of IHE, which will work on business-relevant research and development (R&D); developing a system of organizational, social and financial incentives for scientists and students who initiate the creation of startups, spin-off companies based on R&D; using incentives to encourage IHE and research institutions to create innovations, removing bureaucratic barriers to cooperation between IHE and research institutions and the private sector, creating an institutions to assist IHE in technology transfer.

The "New Ukrainian School" (NUS) education reform, the methodological provisions of which have been implemented since 2017, which took on the character of an action plan in 2024, serves the goals of the WinWin Strategy: it takes into account changes in the environment surrounding the student, saturated with information and technology, which together with significant tragic events, have caused psychological changes in adolescents, such as desocialization, clip thinking due to almost constant stay in virtual space, etc. **Traditional school approaches with an emphasis on memorizing information**, in the rapidly changing conditions of the technological development paradigm, have not sufficiently provided most students with analytical and creative thinking, skills for processing large amounts of information, flexibility, adaptability, resilience, initiative, critical thinking, leadership, curiosity, self-confidence; ability for cooperation and social communication, introspection. **The focus of NUS is the acquisition of competencies**, the key ones of which are: fluency in the state language, the ability to communicate in native and foreign languages, mathematical, natural sciences, engineering and technology, information and communication, environmental, civic and social, cultural, entrepreneurship and financial literacy, lifelong learning, etc., which makes it possible to include a person in the innovation process. Therefore, an NUS graduate can become a creator to a greater extent; an innovator, able to change the world, solve non-standard problems, generate hypotheses, test them, present and defend their own ideas, develop their own projects, startups, plan a budget, compete in the labor market, learn throughout life, etc.

The need for changes in the education system was also indicated by the OECD International Monitoring Studies on the Quality of Education PISA 2018 and 2022, which show that a significant proportion of students do not reach the basic literacy level in mathematics (42%), reading (41%) and natural science subjects (34%). According to the results of the National Multi-Subject Test (NMST) 2025, 11.9% of test participants did not overcome the threshold of 100 points in mathematics, 10.5% in physics, and 2.4% in English. Average scores out of 200 possible: chemistry – 136.7; physics – 134.3; mathematics – 132.3. Graduates of lyceums, gymnasiums and colleges had better NMST results in all subjects than graduates of other ISEs; graduates of urban ISEs than rural and township ones (Kalaitan, 2025). That is, over the 8 years of NUS reforms, there has been no significant improvement in the main indicators of education quality.

It should be noted that the NUS reform is taking place in extremely difficult war conditions (preceded by 2 years of the COVID-19 pandemic), when the quality of the educational process was significantly worsened by the distance and blended learning, due to security considerations, relocation, and destruction of the educational infrastructure (as of the beginning of October 2025, 17.1% of 25.5k educational institutions 4k were damaged, 400 were destroyed, among them the largest number of schools (2k)). At the beginning of the 2024/2025 academic year (a.y.) in Ukraine, out of 12.2k ISE, offline worked 64.0%, remotely – 16.4%, blended – 19.7%. Against the backdrop of enemy shelling, alarms, blackouts; severe frosts in early 2026, bursts of heating and sewage systems, not all schools are equipped with uninterruptible power supply systems and generators. According to the Ministry of Education and Science (MES) and the Government, only 70-80% of schools have their own shelters or access to them nearby. In addition, students are distracted during alarms, because usually school shelters are designed only to accommodate children, and not to organize full-fledged education. Sometimes it is difficult for children of internally displaced persons to adapt: according to the Department of Education and Science of the Lviv Regional State Administration, in 2025/2026 a.y. 8k such students study offline, 50k – remotely, while often have low-paid part-time jobs, live in a virtual environment. According to the

Ministry of Education, in 2025/2026 a.y. 3.5 million students study in Ukraine, that is, due to a full-scale war and migration, the number of schoolchildren has fallen to the lowest level in the last 30 years, decreasing by 755k people during this time. There are over 2 million Ukrainian school-age children abroad, of which 330-358k students (grades 1-11) continue their education in Ukrainian schools, mainly remotely. Over 1.4 million children are integrated into the educational systems of EU countries, but 50% of them do not attend local schools.

One of the difficult tasks of the NUS reform is to reduce the gap in knowledge levels between urban and rural students due to the lack of teaching staff in small-sized rural schools and the overload of rural teachers with various subjects. According to the MES, in 2024/2025 a.y. 40k (12%) teachers left the education system, in ISE there is a shortage of English teachers – 267 vacancies, computer science – 149, mathematics – 130, Ukrainian language and literature – 111, physical education – 99, history – 72, physics – 68.

In Ukraine in 2020-2025 the number of schools decreased by 20% units (from 14.8 to 12.3k), and in the spring of 2025, at least 403 schools were under threat of closure or reorganization due to a small number of students, because according to the Government's decision, from September 1, 2025, funding from the educational subvention of schools with a number of students less than 45 (except for primary schools) was terminated, and from September 1, 2026 – less than 60. TC received the right to independently decide: to close / reorganize, to finance such ISE from the local budget. Even in Lviv region, an urbanized region, there is an intention to close 54 schools in 2026, despite the fact that the region is safer than the central ones, and families with schoolchildren and businesses are moving here from all over the country. The reason for the decrease in the number of students in the region is the departure of high school students abroad (Trade Union of Education and Science Workers of Ukraine, 2026). Due to the above, it is urgent to optimize the ISE network by closing and merging under-enrolled schools, which is another burden on state and local budgets in addition to the implementation of the core education reform.

According to the Concept of the Profile Reform of Education (Ministry of Regional Development…, 2025), at the first stage (from

September 1, 2025), the content of the training is being piloted in 30 lyceums in 19 regions. The 2026 NMST will give the first assessment of the first stage of the reform. At the second stage (from September 1, 2026), students in grades 10-12 will study in 150 academic lyceums, which will test a new model of education, where they will be able to choose their profile within the STEM and STEAM clusters, language and literature, socio-humanitarian and in-depth study of mandatory and elective subjects according to future professional plans. Career counselors will work in the lyceums, providing better conditions for entering IHE. An adaptation period is provided during which students can change their chosen direction. The second stage of the reform also includes the creation of vocational lyceums, where students after 8-9 or 10 grades will acquire a working profession / specialty and at the same time receive a complete general secondary education. Vocational lyceums will be created mainly on the basis of IVE and IPPUE, colleges, so their network does not require significant changes, although the Law of Ukraine "On Vocational Education" does not directly mention vocational lyceums in the list of IVEs. The third stage (from 1.09.2027) provides for the full implementation of the provisions of the reform.

According to the approved MES project network, in 2027 1.8-2.0k academic lyceums will be created in Ukraine, in 16 regions, the corresponding decisions have been adopted by regional councils and military administrations. According to MES calculations, in 2029/2030 a.y. only 15k graduates of academic lyceums should enter IHE. However, this project number of academic lyceums is underestimated, since many territorial communities, due to the specifics of the location and settlement system, have to maintain many different types of ISE, which combine different types of educational institutions (Table 6.6). At the beginning of 2024/2025 a.y. only lyceums of all organizational forms and forms of ownership numbered 7456 units, 2966.6k pupils studied in them, incl. in urban areas – 3626, rural – 3797 units, with the number of pupils, respectively, 2158.5 and 808.2k people in accordance.

According to the Concept of the Reform of Specialized Education, the transformation of an ISE into an academic lyceum is approved by its founders – local government bodies of the territorial

Table 6.6

Number of ISEs and their students in Ukraine in 2024/2025 a.y.

Indicator, unit of measure-men	Total	Primary Schools, of them:		Gymnasiums, of them:		
		With pre-school depart ment	Total Prima-ry Scho-ols	With pre-school departmen t and Primary school	With elemen-tary school	Total Gymna-siums
Total						
ISE, units	12291	238	417	1176	2537	188
pupils, k	3743,9	15,9	40,1	117,4	526,8	39,9
in an urban area						
ISE, units	5225	90	171	139	918	69
pupils, k	2696,1	13,0	35,3	36,8	391,3	29,9
in the countryside						
ISE, units	7066	148	246	1 037	1 619	119
pupils, k	1047,8	2,9	4,8	80,6	135,5	10,0

Indicator, unit of measu-rement	Lyceums, of them:						Special ISE *
	With pre-school depart-ment, Primary School, Gymna-siums	With elemen-tary school, Gymna-siums	With pre-school depart-ment, Gym-nasi-ums	With Gymna-siums	Ly-ce-ums	**Total Lyce-ums**	
Total							
ISE, units	1276	5329	10	335	506	**7456**	278
pupils, k	313,0	2340,7	3,0	144,6	165,3	**2966,6**	37,2
of them in an urban area							
ISE, units	251	2751	3	314	307	**3626**	211
pupils, k	118,3	1773,4	2,2	140,7	123,9	**2158,5**	31,3
of them in the countryside							
ISE, units	1025	2578	7	21	199	**3830**	67
pupils, k	194,8	567,3	0,8	4,0	41,3	**808,2**	5,9

Note: * - special schools for children who need correction of physical and/or

mental development

Source: General secondary education in Ukraine in 2024. Statistical information. State Statistics Service of Ukraine. 2025. https://www.ukrstat.gov.ua/operativ/menu/menu_u/osv_.htm

unit and the state according to the following criteria: number of students; location (up to 30 km from the lyceum); possibility of transportation using the territorial unit budget (the state allocates special funds to the territorial unit for the purchase of school buses: since 2023, 1,5k buses have been purchased, in 2026 an additional UAH 2 billion subvention is provided for the purchase of another 500 buses); staffing; material and technical base of specialized education. If the lyceum is located far away and daily travel is impossible, the legislation provides for the possibility of students living in a boarding house at the institution using the territorial unit budget, which should provide a safe and inclusive environment, Internet, daily life and control over accommodation. In regions with difficult terrain and low population density, gymnasium grades 5-9 may function within the lyceum structure. Taking all this into account, there may be significantly more candidates for academic lyceums than there are lyceums themselves.

And although ISE is financed from various sources (the general fund and the development budget of the city budget, charitable contributions; payment for services provided by schools; educational subvention from the state and regional budgets), the financial capacity of the territorial communities in modern conditions, in addition to solving the organizational and financial problems of primary schools, to ensure the full creation of vocational and academic lyceums with their infrastructure (under conditions of significant increases in the cost of transportation, dormitories, food, supervision) in small settlements, in front-line territories, which, due to the long outflow of the population, have lost taxpayers and a production base, despite the significant amounts of educational subventions from the state budget to local budgets: in 2025, their volume for wages and additional payments to teachers amounted to UAH 103.2 billion; an additional UAH 3 billion was allocated for the renovation of educational spaces and UAH 150 million for the development of NUS teachers. Taking into account the realities of a full-scale war, martial law, and deductions of military tax on the

income of military individuals from local budgets to finance defense needs, the budgets of the territorial communities may have difficulties in financing all these reforms, despite the fact that, according to the Ministry of Finance, in 2025 the general fund of local budgets received UAH 514 billion (+ UAH 63 billion / +14.0% by 2024). However, the expenditures of the territorial communities increased more (+18.3%) to UAH 422.6 billion in the main areas: financing of budgetary institutions – 59% (education – 45.1%, healthcare – 3.6%, social protection and social security – 6.5%, spiritual and physical development – 3.8%, municipal services – 12.2%, housing and communal services – 10.7%, economic activity – 7.4%, intergovernmental transfers – 8.4%) (Kyiv International Institute of Sociology…, 2024).

This is confirmed by the results of a 2024 KIIS (Ministry of Regional Development…, 2025) survey of 80k respondents (heads of local governments, deputies of local councils, heads of education management bodies, heads of ISEs and teachers) from 300 out of 1,469 territorial communities (of which 409 are urban, 435 are settlement and 625 are rural, including 31 territorial communities in the occupied territories of Donetsk and Luhansk regions) in all regions of Ukraine. Thus, only 42% of territorial communities heads and 37% of deputies were completely sure that their territorial communities were ready to create academic lyceums in territorial communities; 56% of territorial communities heads and 59% of deputies were ready to join forces with other territorial communities, but on condition that the lyceum would be in their territorial communities. Only 32% of the heads of the territorial communities and 28% of the heads of the heads of education management bodie agreed / rather agreed with the ability of the territorial communities to provide accommodation, meals for students in the lyceum, another territorial communities, respectively, 48% and 40% – rather disagreed / disagreed. The heads of the territorial communities saw the main challenges of the reform in financing the creation of a modern material and technical base in ISE and lyceums, additional financing for the repair / reconstruction of ISE, road construction, improving the qualifications of teachers to work according to new standards, transport accessibility of lyceums, especially in rural areas due to an underdeveloped transport and infrastructure network,

parental resistance due to the remoteness of lyceums, living conditions in the boarding house of their children, ISE – in an uneven load due to the choice of subjects. 33% of territorial communities heads and 43% of heads of of education management bodies, territorial communities in cooperation – 24 and 21%, respectively, agree that transportation of students to the academic lyceum should be carried out by the territorial communities and the state budget. 71% of ISE heads and 65% of teachers agreed with the possibility of students choosing subjects and believe that this can be done, but 1/3 of those surveyed did not see the possibility of organizing this. 40% of teachers agreed to work in other territorial communities if there is no academic lyceum in their territorial communities, 48% were against it. 38% agreed only on the condition of their transfer to the lyceum / provision of housing.

According to a survey by the Association of Cities of Ukraine (AMU) in April 2025, the key obstacles to the effective start of the reform territorial communities were seen in the lack of an approved regulation on a specialized lyceum (86% of respondents), misunderstanding of funding sources (81%), failure to take into account the challenges of the war (82%), lack of information about the content and results of the reform (68%), and weak communication from the MES (62%). The data from the KIIS 2024 and AMU 2025 surveys have lost their relevance, but they indicate the problems of creating academic lyceums for the main stakeholders at the initial stage.

In 2024/2025 a.y. IHEs of Ukraine graduated 11.4k foreign students in all majors. If such volumes are maintained in 2029/2030 a.y. and provided that the goals of the profile education system regarding the number of graduates of academic lyceums in 2029 (15k) are achieved, in IHEs in 2029/2030 a.y. 15k bachelors, citizens of Ukraine, graduates of academic lyceums, 11k foreign students in all majors, master's students, of whom 132.4k were admitted in 2024/2025 a.y. (the ratio of bachelors to masters is 3:2). If this ratio is maintained, then after one iteration of bachelor's training (3 years), approximately 10.5k master's students will be accepted for training. That is, as a result of the reform, approximately 36.5k people will study at IHEs, of which about a third will be foreigners. This proportion looks unbalanced.

Unresolved issues: 1) 15k people will study under a state order, or is this the total number; 2) how will the license volumes be distributed among IHEs of different forms of ownership; 3) how will the state order / license volumes be distributed by areas of study, fields of knowledge and specialties, the current distribution of applicants for educational and qualification level (EQL) bachelor's and master's degrees in all fields of knowledge, which according to the State Statistics Service of Ukraine in 2024/2025 a.y. 185.2k people studied for EQL bachelor's degrees, of which 33.8% were on a budget form of study, 66.2% were on a commercial form; master's degrees - 132.4k people, of which 28.3% were on a budget form of study, 70.7% were on a commercial form, and 0.9% were on an educational voucher. The MES does not specify these issues with orders, but communicates with society and educators through the media, which raises even more questions.

In any case, 15k bachelors and 10k masters are catastrophically few specialists with higher education for the post-war restoration of the national economy and society on an innovative and high-tech basis. Even taking into account the fact that the demand for education has really fallen due to emigration. According to the Center for Economic Strategy, as of January 2026, there were 5.6 million refugees in the EU. Depending on the scenario, it is expected that 1.3-2.2 million people may return, which can significantly increase the number of pupils and students.

For example, in 2025, the IT sector of Ukraine provided 12% ($6.7 billion) of the country's total exports, 42% of service exports, is one of the main taxpayers, providing $1.4 billion in revenue (+35% by 2024), and creates 3.2% of the country's GDP. And how many of the 15k places for applicants to IHE MES will be allocated to IT studies? The number of applicants to IT specialties is already decreasing due to the war, problems with the Ukrainian economy and the global crisis, the departure of potential applicants abroad, accumulated demographic problems, etc.: in 2025/2026 a.y. Ukrainian applicants to IHE and IPPUE submitted 114.2k applications for IT specialties (-8% compared to the previous one), in 2024/2025 a.y. – -24%, in 2023/2024 a.y. – -15%. In addition to IT, there are a number of other professions that ensure the innovative and high-tech development of the country, defense, infrastructure,

social needs, etc.

According to the calculations of the MES, the reform should increase competition for applicants among IHEs. However, such a significant decrease in the number of applicants will lead to the closure of a significant number of IHEs, dismissals of teaching staff, and the loss of many scientific schools, because even the most well-known and respected IHEs will not have enough students to fully function. The remaining applicants will be forced to leave the country to obtain higher education, and it is not a fact that they will return to Ukraine. According to Article 53 of the Constitution of Ukraine, "... the state guarantees the availability of ... higher education in state / municipal institutions." These are direct rules regardless of clarifying laws that contradict them, therefore the inability to obtain higher education due to restrictions on the reform of specialized education will cause an appeal to the courts of Ukraine and international courts. In addition, for refusals to enter IHEs graduates of other educational institutions other than academic lyceums, graduates of schools with primary vocational training will not be able to obtain a full higher education: according to the State Statistics Service, in 2023/2024 a.y. 6.5k people (7.7% of IVE graduates) entered IHEs.

In a situation where applicants have an excessively large choice of IHEs, taking into account their location, a situation of oligopsony in the market may arise, where there are few buyers and many sellers, which will contribute to the emergence of corruption schemes in the relations of IHEs with applicants, and subsequently with students. Restricting admission to IHEs on a commercial basis will lead to deformation of the higher education market. The choice of a profession is, after all, a personal matter for a person, especially if he pays for it himself. And the issue of an excessive number of people with IHE diplomas in certain specialties is solved by changing the volume of state orders, license volumes for training students, which the MES issues based on checking the institution's compliance with the licensing conditions. The number of applicants can also be limited by increasing the NMST passing score for enrollment in a certain IHE, restructuring through mergers; competition among IHEs due to high places in international rankings, connections with potential employers; high-quality infrastructure for student life

(convenient campuses, dormitories, logistics, etc.).

In addition, IHEs not only fulfills the state's tasks of training specialists under state orders and educational vouchers for retraining the adult population. It is also a business, because in 2024/2025 a.y. 68.2% of students were accepted on a contract, which allows IHEs to pay decent salaries to its teaching staff, solve economic issues, finance R&D, and innovation activities.

An example of reforming the IHEs system to integrate them into the ecosystem of innovation and high-tech development is the activities of a number of leading universities in the country, flagships of innovation, high technologies, startup movement, commercialization of R&D and inclusion of students in this process. Thus, the National Technical University of Ukraine "Kyiv Polytechnic Institute named after I. Sikorsky" (KPI), where 25k students studied in 2025, through the open innovation ecosystem "Sikorsky Challenge Ukraine" (SCU), introduces innovative teaching methods, creates business incubators and accelerators, cooperates with enterprises; unites institutions interested in the development of the Ukrainian innovative economy: universities, scientific institutions, state and local governments, business companies, investment funds and companies, business angels, business environment, public organizations, regional clusters. SCU's area of interest includes innovative projects in the following areas: defense and security (defense-industrial complex; IT, cybersecurity); industrial high-tech; aviation and space; civil and military infrastructure; environmental and energy security; biomedical engineering and human health; agricultural engineering and food security; transport and logistics. The goal of SCU is to create, develop and support a school of startups based on the advanced science and technology, innovations of Ukrainian universities, and their acceleration. NTU "KPI" cooperates with leading global technology companies (Ericsson, Siemens, Samsung, Microsoft, Boeing, Safe Pro Group), international organizations (UN, NATO, UNDP, UNESCO, UNIDO), creating joint R&D centers, laboratories and internship programs for students aimed at the development of engineering education and scientific innovations. In the QS World University Rankings 2025, NTU "KPI" is in the TOP-1000 (positions 801-850), in the QS Europe 2026 ranking – in the TOP-

350 (2nd place in Ukraine).

The leading innovative universities of Ukraine are also the Taras Shevchenko National University of Kyiv, which leads in the national and world rankings of QS, Academic Ranking of World Universities (ARWU), Center for World University Rankings (CWUR). In 2026, the university took 288th place in QS Europe and 721-730th place in QS World; Lviv Polytechnic National University, which, together with the Lviv IT Cluster, interacts through deep integration of business into the educational process: creates joint bachelor's programs (Internet of Things (IoT), AI, Robotics), updates curricula, provides mentoring from practitioners (Senior/Lead) and offers students internships, focusing on market needs; Ukrainian Catholic University, which is consistently among the top three private IHEs in Ukraine, is highly rated for the quality of educational programs, international cooperation and graduate employment, etc., which occupy high places in international IHEs rankings, lead in Ukrainian ratings of technical and IT specialties, develop startup culture, modern educational programs, R&D. Such IHEs are interested in preparing high-quality ISEs applicants.

Conclusions

The trials that fell to Ukraine have highlighted the gaps in the development of the education system, which, if the old logic of its construction is maintained, will significantly weaken the country's position regarding the possibility of providing its post-war innovative and high-tech development with highly qualified personnel. To prevent this, the NUS reform has been launched: a transition is being implemented to the development of competencies in students that are more inherent in the change in the paradigm of technological development, for this purpose, methodologies and programs, sets of teaching disciplines, etc. are being revised; to overcome the gap in the quality of education between urban and rural ISEs, their network is being optimized; schools are being digitized, saturated with computer technology, smart devices. The profile education reform should strengthen the career guidance of high school students and develop criteria for their division into those who will continue their studies at IHEs (equipment, laboratories are being prepared for this), and those who will receive professional and technical skills and start

working. The logical conclusion of the reforms of primary and secondary schools will be the transformation of the IHEs network, which should become centers of quality education, the development of innovations and high technologies, and implement the best practices of IHEs flagships in this area.

However, before the start of the second stage of the specialized education reform, threats to its implementation became obvious: 1) there are doubts about the ability of the stakeholders of the process (local governments, the state) to organize and finance the projected number of academic lyceums in accordance with the requirements of the legislation with proper infrastructure in the conditions of budget deficit and rising prices; 2) the MES does not model how limiting admission to IHEs only to graduates of academic lyceums in the projected number will affect the filling of specialties, the distribution of state orders and funding, 3) whether contract training will be preserved, etc. Perhaps the MES is considering these issues, but due to communications with society and educators only in the media, the number of questions is only increasing. This should be corrected.

The implementation of the intentions of the MES regarding the number of graduates of academic lyceums will most likely lead to the closure of a number of IHEs, the loss of scientific schools and teaching staff, even the headliners of higher education, R&D, innovation and high technologies of Ukraine; it may deform the market for these services due to the formation of oligopsonic market structures that may stimulate corruption. To ensure the recovery of the economy and society of Ukraine, a significantly larger number of highly qualified specialists in various industries is needed than that expected by the MES in 2029/2030 a.y.

Therefore, before the start of the second stage of the profile education reform in September 2026, the Government should more critically and thoughtfully consider the details, possible consequences, obstacles to its implementation, possible threats to the national economy and society, which are already experiencing very difficult times. To do this, it is advisable to make adjustments to the projected number of academic and professional lyceums, their students, taking into account the location and settlement system in the territorial communities in coordination with local government bodies; to legally prescribe the criteria for distributing students to

study in academic or professional lyceums, IVE within comfortable territorial reach and action if their profile does not satisfy students and parents; estimates should be developed indicating the contribution of stakeholders to financing the creation of academic and professional colleges and their infrastructure (transportation, dormitories, food, supervision).

The Concept of Specialized Education should include points from the Innovation Development Strategy to improve the conditions for the development of innovation and high technologies in all components of the education system. Up-to-date and relevant statistics are needed to monitor educational reforms.

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ENSURING THE SUSTAINABLE FUNCTIONING OF TRADE AND SERVICE ENTERPRISES IN THE CONTEXT OF THE DEVELOPMENT OF INTERNET MARKETING AND E-COMMERCE

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Abstract
The rapid development of internet marketing and e-commerce is transforming the operating environment of trade and service enterprises, creating new opportunities for growth while simultaneously increasing competition and market uncertainty. Under such conditions, ensuring the sustainable functioning of enterprises requires the

implementation of adaptive management approaches, digital technologies, and customer-oriented business models. The purpose of this study is to examine the key factors influencing the sustainability of trade and service enterprises in the context of digital transformation and to identify effective mechanisms for improving their competitiveness through internet marketing and e-commerce tools.

The research highlights that digital channels have become a critical component of enterprise development, enabling companies to expand market coverage, optimize communication with consumers, reduce transaction costs, and increase operational efficiency. Particular attention is paid to the role of social media marketing, search engine optimization, personalized advertising, data analytics, and electronic payment systems in strengthening enterprise resilience and customer loyalty. The study also emphasizes the importance of integrating e-commerce platforms into overall business strategies to ensure flexibility and rapid adaptation to changing consumer behavior.

It is determined that sustainable enterprise functioning depends not only on technological modernization but also on the ability to maintain financial stability, cybersecurity, service quality, and effective interaction with stakeholders. The implementation of innovative digital solutions contributes to increasing business transparency, improving decision-making processes, and enhancing long-term competitiveness. At the same time, enterprises face challenges related to digital risks, market volatility, and the need for continuous staff development.

The results of the study confirm that the combination of internet marketing instruments and e-commerce technologies forms a strategic basis for the sustainable development of trade and service enterprises in the modern digital economy.

Keywords: *sustainable development, trade enterprises, service enterprises, internet marketing, e-commerce, digital transformation, competitiveness, customer loyalty, online platforms, digital technologies, business sustainability, marketing strategies.*

Introduction

In the contemporary global economy, the rapid development of digital technologies has significantly transformed the mechanisms of conducting business activities, especially in the spheres of trade and services. The widespread adoption of internet marketing and e-commerce has changed traditional approaches to communication

with consumers, product promotion, sales management, and enterprise development. Under conditions of increasing competition, economic instability, and constantly changing consumer preferences, ensuring the sustainable functioning of trade and service enterprises has become one of the key priorities of modern business management (Dwivedi et al., 2021; Verhoef et al., 2021).

Digital transformation has accelerated the integration of online technologies into business processes, enabling enterprises to expand their market presence, improve operational efficiency, and strengthen customer relationships. Internet marketing tools, including social media marketing, search engine optimization, content marketing, targeted advertising, and web analytics, provide enterprises with new opportunities for attracting and retaining consumers (Dwivedi et al., 2021; Li et al., 2021). At the same time, e-commerce platforms facilitate faster transactions, broader market access, and more flexible interaction between businesses and customers. These trends contribute to the formation of a new business environment characterized by high adaptability, innovation, and customer orientation (Gamova et al., 2024; Radziikhovska & Vozniuk, 2025).

However, alongside the numerous advantages of digitalization, enterprises also face significant challenges related to cybersecurity risks, market volatility, technological dependence, and the necessity for continuous innovation. Sustainable functioning in such conditions requires enterprises not only to adopt advanced digital solutions but also to develop effective strategic management systems capable of ensuring long-term competitiveness and resilience (Hutsaliuk et al., 2026; Verhoef et al., 2021). Financial stability, organizational flexibility, quality of services, and efficient use of digital resources become essential components of sustainable enterprise development.

The relevance of this topic is determined by the growing importance of internet marketing and e-commerce as strategic drivers of enterprise competitiveness and economic sustainability. Trade and service enterprises increasingly depend on digital communication channels and online sales systems, which makes the study of sustainable business functioning in the digital economy particularly important (Gamova et al., 2024; Svietailo, 2024). Moreover, global economic challenges and the intensification of digital competition require enterprises to search for innovative approaches to

maintaining market positions and improving customer satisfaction.

The purpose of this chapter is to investigate the theoretical and practical aspects of ensuring the sustainable functioning of trade and service enterprises in the context of the development of internet marketing and e-commerce. Particular attention is devoted to identifying the key factors influencing enterprise sustainability, analyzing modern digital marketing instruments, and determining effective mechanisms for integrating e-commerce technologies into business strategies. The chapter also explores the role of innovation, digital transformation, and customer-oriented approaches in strengthening enterprise resilience and long-term development (Hutsaliuk et al., 2025; Verhoef et al., 2021).

Scientific Objectives

The main scientific objectives of this study are:

1. To investigate the theoretical foundations of sustainable functioning of trade and service enterprises in the conditions of digital transformation.
2. To analyze the impact of internet marketing and e-commerce development on the competitiveness and efficiency of trade and service enterprises.
3. To identify the key factors influencing the sustainable development of enterprises in the digital business environment.
4. To examine modern internet marketing tools and determine their role in improving customer engagement, market expansion, and enterprise resilience.
5. To evaluate the effectiveness of e-commerce technologies in optimizing business processes and increasing operational flexibility.
6. To explore the influence of digital transformation on strategic management systems of trade and service enterprises.
7. To determine the main risks and challenges associated with the implementation of internet marketing and e-commerce technologies, including cybersecurity, market volatility, and technological dependence.
8. To develop practical recommendations for ensuring the sustainable functioning and long-term competitiveness of trade and service enterprises through the integration of digital technologies and innovative marketing strategies.

9. To substantiate the importance of customer-oriented approaches and digital innovation in strengthening enterprise sustainability in the modern economy.

Materials and Methods

The methodological basis of the study is formed by a systematic analysis of scientific publications, monographs, articles, analytical reports, and empirical studies devoted to the sustainable functioning of trade and service enterprises, internet marketing, e-commerce, digital transformation, and customer-oriented business models. This approach made it possible to identify the main theoretical provisions, current trends, and practical tools that determine the competitiveness and resilience of enterprises in the digital business environment (Dwivedi et al., 2021; Li et al., 2021; Verhoef et al., 2021).

The research also uses comparative and analytical methods to examine the influence of internet marketing instruments and e-commerce technologies on business efficiency, market expansion, customer engagement, and operational flexibility. Particular attention is paid to the analysis of digital marketing tools such as social media marketing, search engine optimization, content marketing, targeted advertising, web analytics, and electronic payment systems (Svietailo, 2024; Li et al., 2021). The application of these methods allows for assessing how digital technologies contribute to the optimization of business processes and the strengthening of enterprise sustainability.

In addition, the study applies elements of case analysis to consider practical examples of the implementation of e-commerce platforms and internet marketing strategies in trade and service enterprises. The analysis of successful digital business practices helps to determine key success factors, possible risks, and barriers to the effective use of online technologies (Gamova et al., 2024; Radziikhovska & Vozniuk, 2025). The combination of these methods provides a comprehensive understanding of the mechanisms for ensuring the sustainable functioning of trade and service enterprises and makes it possible to develop practical recommendations for their long-term development in the context of digitalization.

Results and Discussion

In the first place, it is necessary to investigate the theoretical

foundations of the sustainable functioning of trade and service enterprises under the conditions of digital transformation. This involves clarifying the essence of enterprise sustainability, determining its key components, and identifying the specific features of business stability in the digital economy. Particular attention should be paid to such aspects as economic resilience, organizational adaptability, technological readiness, customer orientation, and the ability of enterprises to respond effectively to changes in the market environment (Hutsaliuk et al., 2025; Verhoef et al., 2021).

The sustainable functioning of trade and service enterprises in the conditions of digital transformation represents an important area of modern economic research. Rapid technological development, the expansion of digital communication channels, and the growing role of online commerce have significantly changed traditional business models and management approaches. In this context, sustainability is understood as the ability of enterprises to maintain stable operations, adapt to market changes, ensure competitiveness, and achieve long-term development through the effective use of digital technologies and innovative management solutions (Gamova et al., 2024; Verhoef et al., 2021).

The theoretical foundations of sustainable enterprise functioning are based on the integration of economic stability, organizational flexibility, technological innovation, and customer-oriented strategies. Digital transformation creates new opportunities for improving operational efficiency, optimizing business processes, and expanding market access through internet marketing and e-commerce tools (Dwivedi et al., 2021; Verhoef et al., 2021). At the same time, enterprises face challenges related to cybersecurity, increased competition, and the necessity for continuous adaptation to changing consumer behavior (Hutsaliuk et al., 2025b). Therefore, the study of theoretical approaches to sustainable enterprise development in the digital environment is essential for identifying effective mechanisms that support resilience, competitiveness, and strategic growth in modern market conditions.

Secondly, it is necessary to analyze the impact of internet marketing and e-commerce development on the competitiveness and efficiency of trade and service enterprises. This involves determining how digital promotion channels, online sales platforms, customer

data analytics, and electronic payment systems influence market positioning, sales growth, service quality, and the ability of enterprises to attract and retain consumers (Svietailo, 2024; Li et al., 2021).

The development of internet marketing and e-commerce has become a significant factor influencing the competitiveness and operational efficiency of trade and service enterprises. Digital technologies provide businesses with broader opportunities to promote products and services, communicate directly with consumers, and expand their market presence beyond geographical limitations. Internet marketing instruments such as social media advertising, search engine optimization, content marketing, and web analytics enable enterprises to better understand customer needs, increase brand awareness, and improve customer loyalty (Dwivedi et al., 2021; Li et al., 2021). As a result, enterprises gain important competitive advantages in increasingly dynamic and saturated markets.

At the same time, the implementation of e-commerce technologies contributes to improving business efficiency by optimizing sales processes, reducing transaction costs, and accelerating communication between enterprises and consumers. Online platforms and digital payment systems allow companies to provide faster and more convenient services, increase operational flexibility, and respond more effectively to changing market conditions (Gamova et al., 2024; Radziikhovska & Vozniuk, 2025). However, the growing dependence on digital technologies also creates new challenges related to cybersecurity, technological adaptation, and intensified competition (Hutsaliuk et al., 2025b). Therefore, analyzing the impact of internet marketing and e-commerce development is essential for understanding how digital transformation influences enterprise competitiveness, productivity, and long-term sustainability.

As the next step, it is necessary to identify the key factors influencing the sustainable development of enterprises in the digital business environment. This requires determining the internal and external conditions that affect the ability of trade and service enterprises to remain competitive, adapt to market changes, and ensure stable functioning under the influence of digital transformation (Hutsaliuk et al., 2026a; Hutsaliuk et al., 2025).

The sustainable development of enterprises in the digital business environment depends on a combination of economic, technological, organizational, and social factors that determine the ability of businesses to adapt to rapid market changes and maintain long-term competitiveness. One of the key factors is the level of digital transformation within an enterprise, including the integration of modern information technologies, e-commerce systems, and internet marketing tools into business operations (Gamova et al., 2024; Verhoef et al., 2021). The effective use of digital technologies improves operational efficiency, enhances communication with customers, and enables enterprises to respond quickly to changing consumer demands and market trends.

Another important factor influencing sustainable enterprise development is strategic management and organizational flexibility. Enterprises must continuously innovate, improve service quality, and invest in staff development to remain competitive in the digital economy. Financial stability, cybersecurity protection, customer-oriented approaches, and data-driven decision-making also play a crucial role in ensuring sustainable business growth (Hutsaliuk et al., 2025a; Hutsaliuk et al., 2025). At the same time, external factors such as market competition, technological progress, regulatory policies, and global economic conditions significantly affect enterprise sustainability. Therefore, identifying and analyzing these key factors is essential for developing effective strategies that support resilience, adaptability, and long-term success in the digital business environment.

Modern internet marketing tools have become essential instruments for enhancing the performance and competitiveness of trade and service enterprises in the digital economy. The rapid growth of online communication technologies has enabled businesses to establish more effective interactions with consumers through social media marketing, search engine optimization, content marketing, email campaigns, influencer marketing, and targeted advertising (Dwivedi et al., 2021; Li et al., 2021). These tools allow enterprises to personalize communication, better understand customer preferences, and create stronger relationships with target audiences, which significantly improves customer engagement and loyalty.

In addition, internet marketing technologies contribute to market expansion by enabling enterprises to reach wider audiences beyond traditional geographical boundaries. Digital platforms provide businesses with opportunities to promote products and services in global markets, increase brand visibility, and improve the efficiency of promotional activities through analytical and data-driven approaches (Svietailo, 2024; Dwivedi et al., 2021). The use of web analytics and customer behavior monitoring also supports more effective strategic decision-making and resource allocation.

Furthermore, modern internet marketing tools play a crucial role in strengthening enterprise resilience in conditions of market uncertainty and intense competition. The ability to rapidly adapt marketing strategies, respond to changing consumer behavior, and maintain continuous communication with customers enhances business flexibility and sustainability (Li et al., 2021; Verhoef et al., 2021). As a result, the integration of advanced internet marketing instruments into enterprise management systems becomes an important factor in ensuring long-term development, competitiveness, and stability in the digital business environment.

The next step is to evaluate the effectiveness of e-commerce technologies in optimizing business processes and increasing the operational flexibility of trade and service enterprises. The effectiveness of e-commerce technologies in trade and service enterprises is primarily reflected in their ability to optimize key business processes and improve overall organizational performance. The implementation of online trading platforms, automated order processing systems, digital payment solutions, and customer relationship management systems significantly reduces manual operations and minimizes transaction time (Gamova et al., 2024; Radziikhovska & Vozniuk, 2025). As a result, enterprises achieve higher levels of efficiency in procurement, sales, inventory management, and customer service, which contributes to improved productivity and cost optimization.

Moreover, e-commerce technologies enhance the operational flexibility of enterprises by enabling them to quickly adapt to changes in market demand and consumer behavior. Digital platforms allow businesses to operate continuously without geographical or time limitations, expanding access to customers and suppliers. Real-

time data exchange and analytics support faster decision-making and more accurate demand forecasting, which improves resource allocation and reduces operational risks (Radziikhovska & Vozniuk, 2025; Verhoef et al., 2021). Consequently, the integration of e-commerce solutions strengthens the adaptability of enterprises and ensures their stable functioning in a highly competitive and dynamic digital environment.

The next stage of the study is to explore the influence of digital transformation on the strategic management systems of trade and service enterprises. Digital transformation has a profound influence on the strategic management systems of trade and service enterprises by reshaping decision-making processes, organizational structures, and competitive strategies (Verhoef et al., 2021). The integration of digital technologies into management activities enables enterprises to shift from traditional, experience-based decision-making to data-driven approaches. Big data analytics, artificial intelligence, and digital monitoring tools provide managers with timely and accurate information, which enhances strategic planning, risk assessment, and performance evaluation (Hutsaliuk et al., 2026a; Verhoef et al., 2021).

In addition, digital transformation fosters greater flexibility and adaptability within strategic management systems. Enterprises are increasingly required to respond quickly to changing market conditions, evolving consumer behavior, and technological innovations. As a result, strategic management becomes more dynamic, customer-oriented, and innovation-driven (Dwivedi et al., 2021; Verhoef et al., 2021). Digital platforms also support improved coordination across departments, better resource allocation, and enhanced communication with stakeholders. Consequently, the influence of digital transformation strengthens the overall effectiveness, responsiveness, and long-term competitiveness of trade and service enterprises.

Conclusions

The study of ensuring the sustainable functioning of trade and service enterprises in the context of the development of internet marketing and e-commerce confirms the growing importance of digital transformation as a key driver of modern economic development. It has been established that the integration of digital technologies significantly changes traditional business models,

enhances market accessibility, and strengthens competitive positions of enterprises in increasingly dynamic and uncertain market conditions.

Internet marketing and e-commerce tools play a decisive role in improving enterprise performance by optimizing business processes, expanding customer reach, and increasing operational efficiency. Their application contributes to the development of customer-oriented strategies, improves communication with target audiences, and supports more effective promotion of goods and services in both domestic and international markets.

The research also demonstrates that the sustainable development of trade and service enterprises depends on a combination of internal and external factors, including technological readiness, financial stability, managerial flexibility, and the ability to adapt to rapid changes in the digital environment. In this context, digital competencies, innovation potential, and effective strategic management become essential prerequisites for long-term success.

Furthermore, the study highlights that e-commerce technologies significantly increase operational flexibility by automating processes, reducing costs, and enabling real-time interaction with customers and partners. At the same time, enterprises must address challenges related to cybersecurity risks, market volatility, and continuous technological advancement.

Overall, it can be concluded that the sustainable functioning of trade and service enterprises in the digital economy is achievable through the systematic implementation of internet marketing tools, e-commerce solutions, and innovative management approaches. These elements together form a solid foundation for competitiveness, resilience, and long-term development in the modern business environment.

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ENVIRONMENTAL SUSTAINABILITY DETERMINANTS OF AGRICULTURAL PRODUCTIVITY IN THE BALTIC STATES

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Abstract
Agriculture faces growing sustainability challenges due to increasing environmental pressures and the need to ensure long-term food security. This article examines the impact of environmental sustainability indicators, such as ammonia and greenhouse gases, nitrogen and phosphorus fertilisers, water consumption, area under organic farming, energy consumption and waste generation, on agricultural productivity in the Baltic countries. The research methodology involved a comparative analysis and the calculation of Pearson's correlation coefficients, as well as the application of simple linear regression, using Eurostat data from 2012 to 2022. The results showed that productivity is most strongly influenced by greenhouse gases and nitrogen fertilisers in Estonia and Latvia and by the area under organic farming in Latvia and Lithuania. Meanwhile, energy consumption had a positive impact in Latvia and Lithuania, but a negative one in Estonia. These results are important for shaping environmental and agricultural policy in the Baltic region, aiming to balance productivity growth with sustainability goals.

Keywords: *sustainable agriculture, environmental indicators, agricultural productivity, Baltic States, econometric analysis, regression analysis.*

Introduction

In recent decades, sustainability has become a particularly important issue for businesses in various economic sectors due to environmental damage. Although sustainable development encompasses three aspects – environmental, social and governance – the environmental aspect usually receives the most attention. It is important to note that the agricultural sector contributes to global environmental change and faces its consequences (Biagetti et al., 2025). This means that, to ensure the long-term provision of food for the world's population, agriculture must be developed sustainably, particularly regarding environmental considerations.

Throughout most of human history, various technological innovations have been introduced to increase agricultural production with limited resources (Khan et al., 2021). Biotechnology is one such tool, helping to improve crop quality and increase potential yields (Das et al., 2023). Applying green economy principles to agriculture is also important, as balancing economic benefits and sustainability ensures the long-term prosperity of sustainable agriculture (Kausar et al., 2024). Authors such as Biagetti et al. (2025), German et al. (2017), Florea et al. (2021) and Mergoni et al. (2024) have already studied the issue of sustainable development and agricultural productivity. This article aims to examine the impact of sustainable development on agricultural productivity in the Baltic countries.

To assess the impact of environmental sustainability indicators on agricultural productivity in the Baltic States using correlation and regression analysis over the period 2012–2022.

This study is relevant because there is a need to understand how environmental factors influence the productivity potential of the agricultural sector in the various Baltic countries. The analysis provides a foundation for the development of more sustainable agricultural policies, based on the empirical links between sustainability indicators and economic performance.

Literature Review

Over the past decade, sustainable development has received significant attention, as industries and companies whose activities directly harm society and the environment have come under criticism (Darvishi et al., 2023). Soretz et al. (2023) and Mensah (2019) describe it as an approach that seeks to balance environmental, social

and economic issues while ensuring that current societal needs are met without causing additional harm to future generations.

The most pressing environmental issue is climate change, leading to rising temperatures, sea levels and glacier melt, as well as droughts, floods and other uncontrollable natural phenomena (Esmailnejad, 2024). Other issues, such as water and air pollution, greenhouse gases and the use of natural resources, are also highlighted.

As the world's population grows, so does the demand for food. Current crop yields are no longer sufficient, so it is crucial that the agricultural sector addresses the productivity crisis (Shah et al., 2021). While higher agricultural productivity can help to meet the growing global demand for food in the short term, to ensure a long-term food supply, farming must be sustainable (German et al., 2017). When applying sustainability principles to agriculture, two key aspects must be considered: environmental conservation and providing safe and healthy food to the public (Meena, 2023). Furthermore, developing sustainable and climate-resilient agriculture requires not only environmental protection, but also economic and social benefits (Das et al., 2023).

Agriculture is one of the leading sectors responsible for polluting surface and groundwater due to excessive agrochemical use, poor post-harvest waste management and traditional irrigation systems (Rey-Romero et al., 2022). The growing global demand for food is driving the increased use of pesticides in agriculture to reduce crop losses, ensure food quality, and maintain affordability (Tudi et al., 2021).

To address the challenge of ensuring long-term food security, it is crucial to adopt sustainable agricultural methods and practices (Muhie, 2022; Das et al., 2023). One approach that could contribute to sustainable agricultural development is organic farming. This method of farming is defined as an environmentally friendly agricultural system that avoids the use of synthetic chemicals and fertilisers (Kumar et al., 2023; Smith et al., 2019).

When comparing different farming methods, it has been observed that traditional farming causes significantly greater environmental damage, severely impacting critical agricultural resources such as soil and biodiversity. This makes growing conditions more

challenging for both organic and conventional farms, leading to soil erosion and degradation (Montgomery & Biklé, 2021). Furthermore, the chemicals used on conventional farms negatively impact not only the environment and ecosystems, but also human health (Yanakittkul & Aungvaravong, 2020; Sapbamrer & Thammachai, 2021).

The sustainable development of farms is most often assessed in terms of three aspects of sustainability. However, the authors Milestad et al. (2024), Nadaraja et al. (2021) and Huck et al. (2024) emphasise that agriculture primarily focuses on environmental protection. The authors Kausar et al. (2024), Milestad et al. (2024), Mitova (2021) and Nadaraja et al. (2021) assess the sustainability of agriculture using indicators such as water and energy consumption, fertiliser use and factors contributing to air and water pollution. When analysing social and economic factors, attention focuses on farm workers and working conditions, while the latter focuses on production output, profits earned and other factors. In assessing farm sustainability, the authors Alonso-Martinez et al. (2024) also sought to identify the factors driving sustainability initiatives. These can be internal factors directly related to the individual farm or external factors indirectly related but capable of affecting the farm.

Huck et al. (2024) emphasise in their study that agriculture negatively impacts the environment and is one of the main industries whose activities generate significant greenhouse gas emissions. Based on a review of existing studies, it can be concluded that the sustainable development of agriculture is a pressing issue. To assess the sector's sustainability, measurable sustainability indicators are employed to inform the progressive pursuit of sustainability initiatives and reduce the negative environmental impact of agriculture.

Correlation and regression analyses are the most commonly used methods for studying the relationship between sustainability and agricultural productivity. Biagetti et al. (2025) found in their study that extensive farming practices may be more sustainable and have a lower environmental impact than intensive farming practices. They also argue that innovative farming practices must be adopted to reconcile agricultural productivity with sustainability and reduce environmental damage, as this would increase food production while reducing the ecological damage caused by agriculture. However,

German et al. (2017) contend that quantifying agricultural sustainability is challenging due to the varying environmental impacts of different farming methods depending on the location of agricultural activity. This study found a strong positive correlation between changes in crop yield and changes in profit (German et al., 2017). Florea et al. (2021) examined the relationships between agricultural productivity and its influencing factors, including human, ecological, economic, social and technological factors. Finally, Mergoni et al. (2024) noted in their study that environmental risks affect the efficiency of the agricultural sector and place a greater burden on more vulnerable countries.

In summary, when assessing the sustainability of the agricultural sector, the greatest emphasis is placed on environmental protection. This is because agriculture contributes to environmental damage and faces its consequences. Addressing environmental issues is particularly important given the growing global population and the resulting increase in food demand. Therefore, ensuring long-term food security makes sustainability in agriculture especially significant.

Research Methodology

An empirical study of sustainability indicators for farms in the Baltic States was conducted to determine the impact of sustainable agricultural development trends on farm productivity. Eight such indicators, presented in Table 6.7, were analysed. These were selected following an analysis of studies by authors such as Milestad et al. (2024), Mitova (2021) and Nadaraja et al. (2021) (Table 6.7).

Secondary data from the Eurostat database was collected for the study. This data was analysed over a ten-year period, incorporating the most recent available data from 2012 to 2022. The value of production in euros for the 2012–2022 period was also analysed. This period was chosen to ensure data consistency and comparability across all three countries.

The empirical analysis is based on a comparative econometric framework. The dependent variable is the value of agricultural output (in EUR), while the independent variables include environmental sustainability indicators such as greenhouse gas emissions, fertiliser use, energy consumption and the area dedicated to organic farming.

Table 6.7

An analysis of sustainability indicators in the agricultural sector

The theme of sustainability	Indicator	Period	Conducted research	Database
Air pollution	Ammonia emissions	2012-2022	Mitova (2021).	Eurostat
	Greenhouse gases		Milestad et al. (2024), Mitova (2021), Nadaraja et al. (2021)	
Fertilizers	Nitrogen fertilizers	2012-2022	Mitova (2021), Nadaraja et al. (2021)	
	Phosphorus fertilizers		Mitova (2021), Nadaraja et al. (2021)	
Water	Water consumption	2012-2022	Milestad et al. (2024), Mitova (2021), Nadaraja et al. (2021)	
Land use	Area under organic farming	2012-2022	Mitova (2021).	
Energy	Energy content	2012-2022	Milestad et al. (2024), Mitova (2021), Nadaraja et al. (2021).	
Waste	Waste generation	2012-2022 (every two years)	Milestad et al. (2024), Mitova (2021).	

Source: compiled by the authors

Pearson correlation analysis is applied to identify linear relationships, followed by simple linear regression models to estimate the marginal effects of each indicator. Only statistically significant relationships ($p < 0.05$) are considered.

This approach is consistent with that used in prior empirical studies (e.g. Florea et al., 2021; Biagetti et al., 2025), in which regression models were employed to quantify the linkages between sustainability and productivity.

Results

To evaluate agricultural performance in the Baltic States, the analysis relies on the value of agricultural output over the period 2012–2022 (Figure 6.3).

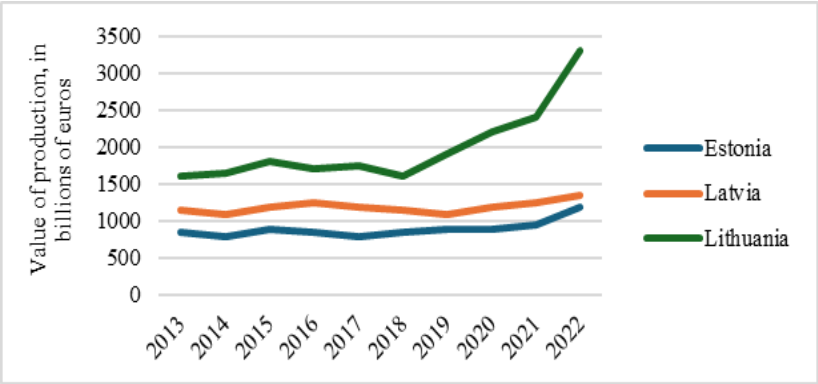


Figure 6.3 Agricultural output in the Baltic States (2012–2022)
Source: compiled by the authors

The data reveal notable differences in productivity dynamics across countries. Estonia exhibits higher volatility in output values, whereas Latvia demonstrates consistently higher production levels, with output on average 1.86 times greater than that of Estonia. Lithuania follows a similar trajectory to Latvia, with synchronized fluctuations observed across both countries. Notably, common growth peaks are identified in 2015, 2019, and 2022, suggesting the presence of shared external or structural drivers affecting agricultural performance in the region.

To examine the relationship between environmental sustainability indicators and agricultural productivity, Pearson correlation analysis was conducted (Table 6.8).

The results indicate substantial heterogeneity between countries in the strength and direction of relationships.

In Estonia and Latvia, for example, a moderate negative correlation was observed between ammonia emissions and agricultural output ($r = -0.60$ and $r = -0.59$, respectively), suggesting that higher emissions are not directly associated with increased

productivity. Conversely, greenhouse gas emissions exhibit a strong positive correlation with output in both countries (r = 0.67 in Estonia and r = 0.80 in Latvia), suggesting that higher production levels are closely linked to more intensive farming practices. This relationship is not observed in Lithuania, where the correlation is negligible.

Table 6.8

Correlation coefficients between agricultural output and environmental indicators

	Agricultural production in Estonia	Agricultural production in Latvia	Agricultural production in Lithuania
Ammonia emissions	**-0,60**	**-0,59**	-0,28
Greenhouse gases	**0,67**	**0,80**	0,05
Nitrogen fertilizers	**0,60**	**0,69**	-0,31
Nitrogen fertilizers	0,30	0,49	-0,25
Water consumption	0,16	0,36	0,08
Area under organic farming	**0,57**	**0,70**	**0,64**
Energy content	**-0,71**	**0,65**	**0,86**
Waste generation	**0,63**	-0,22	-0,32

Source: compiled by the authors

Similarly, the use of nitrogen fertilisers shows a strong positive relationship with productivity in Estonia and Latvia, while in Lithuania there is a weak negative association, implying a potentially different production structure or a transition towards less input-intensive agriculture. Phosphorus fertilisers and water consumption exhibit weak or negligible relationships across all countries and are therefore excluded from further analysis.

The organic farming area is positively associated with agricultural output in all three countries. The strongest relationship is observed in Latvia (r = 0.70), followed by Lithuania (r = 0.64) and Estonia (r = 0.57). This suggests that expanding organic farming does not necessarily hinder productivity and may contribute to output growth. Energy consumption reveals divergent patterns: a strong negative relationship is evident in Estonia (r = -0.71), while positive relationships are evident in Latvia (r = 0.65) and Lithuania (r = 0.86). This indicates different levels of technological efficiency and energy

use across the countries. Waste generation shows inconsistent and generally weak relationships and is therefore excluded from subsequent analysis.

Impact of Environmental Indicators on Agricultural Output in Estonia

Regression analysis was conducted using agricultural output as the dependent variable and the most strongly correlated environmental indicators as independent variables. The results indicate that only greenhouse gas emissions, nitrogen fertilizer use, and energy consumption have statistically significant effects on output ($p < 0.05$).

The estimated regression models are:

- $PV = 136.696 + 36.504 \times GHG$
- $PV = -323.98 + 0.0204 \times NF$
- $PV = 1226.527 - 6.603 \times EC$

where:

– PV – production value;
– GHG - greenhouse gas emissions;
– NF - nitrogen fertilizers;
– OFA - organic farming area;
– EC - energy consumption;

The findings reveal that greenhouse gas emissions and nitrogen fertilizer use have a positive and statistically significant impact on agricultural output, suggesting that higher productivity in Estonia is associated with more intensive agricultural practices. In contrast, energy consumption exhibits a significant negative effect, indicating potential inefficiencies in energy use or structural differences in production technologies.

Impact of Environmental Indicators on Agricultural Output in Latvia

In Latvia, regression analysis identifies four statistically significant determinants of agricultural output: greenhouse gas emissions, nitrogen fertilizer use, organic farming area, and energy consumption.

The estimated regression equations are:

- PV = -997.75 + 93.817 × GHG
- PV = -1090.9 + 0.0252 × NF
- PV = -161.7 + 75.832 × OFA
- PV = -243.8 + 6.2604 × EC

where:

– PV – production value;
– GHG - greenhouse gas emissions;
– NF - nitrogen fertilizers;
– OFA - organic farming area;
– EC - energy consumption;

All identified relationships are positive and statistically significant ($p < 0.05$), indicating that both intensive inputs (fertilizers, emissions, energy) and sustainability-oriented practices (organic farming) contribute to productivity growth in Latvia. This suggests a hybrid development pattern, where productivity gains are driven by both intensification and structural transformation towards more sustainable practices.

Impact of Environmental Indicators on Agricultural Output in Lithuania

In Lithuania, regression results indicate that only two variables – organic farming area and energy consumption – have a statistically significant impact on agricultural output.

The estimated equations are:

- PV = 135.64 + 243.289 × OFA
- PV = -3797.045 + 52.304 × EC

where:

– PV – production value;
– EC - energy consumption;
– OFA - organic farming area;

EC – energy consumption Both relationships are positive and statistically significant, suggesting that agricultural productivity in Lithuania is increasingly linked to structural changes, particularly the expansion of organic farming and increased energy use. Compared to Estonia and Latvia, traditional intensification factors such as fertilizers and emissions do not play a significant role, indicating a different development trajectory.

Cross-country comparison

Overall, the results highlight distinct patterns across the Baltic States. Estonia and Latvia exhibit productivity models strongly associated with intensive agricultural inputs, particularly greenhouse gas emissions and fertilizer use. In contrast, Lithuania demonstrates a shift towards sustainability-oriented productivity, where organic farming and energy use play a more prominent role. These findings indicate that the relationship between environmental sustainability and agricultural productivity is not uniform across countries and reflects different stages of structural transformation within the agricultural sector.

The explanatory power of the models ranges from moderate to relatively strong (R^2 = 0.36–0.74), indicating that environmental indicators explain a substantial share of agricultural productivity variation, although other structural factors remain relevant.

Discussion

This study reveals substantial cross-country differences in environmental sustainability indicators and their impact on agricultural productivity in the Baltic States. Overall, the results corroborate previous studies indicating that agriculture contributes to environmental degradation while remaining highly sensitive to environmental conditions (Biagetti et al., 2025; German et al., 2017).

A key pattern that emerged from the analysis was the strong association between productivity and input intensification in Estonia and Latvia. In both countries, greenhouse gas emissions and nitrogen fertiliser use are positively related to agricultural output. This indicates that higher productivity is largely achieved through the increased use of environmentally intensive inputs. This finding is consistent with the work of Florea et al. (2021) and German et al. (2017), who emphasise that productivity growth in agriculture is frequently driven by increased input rather than efficiency improvements. However, this relationship also indicates a dependency on intensive farming practices that could generate long-term sustainability risks.

By contrast, Lithuania exhibits a different development trajectory. The results suggest that increased agricultural productivity is primarily associated with the expansion of organic farming and

energy use, rather than traditional intensification factors such as fertilisers and emissions, which are not statistically significant. This suggests a structural transition towards more sustainable agricultural practices, where productivity gains are less dependent on chemical inputs and more related to technological and organisational adjustments. This pattern aligns with literature emphasising the role of sustainable practices in enhancing long-term agricultural resilience (Kumar et al., 2023; Smith et al., 2019).

Energy consumption further highlights divergent national pathways. While Latvia and Lithuania demonstrate a positive relationship between energy use and productivity, suggesting that energy inputs reflect technological development, Estonia shows a negative relationship, indicating potential inefficiencies or structural mismatches in energy utilisation. This finding corroborates the argument of Huck et al. (2024) that energy intensity does not invariably lead to productivity increases and may instead indicate inefficiencies within agricultural systems.

Crucially, the results reveal a clear trade-off between productivity and environmental sustainability. In Estonia and Latvia, for example, higher agricultural output is associated with increased emissions and resource use, suggesting that productivity gains come at the expense of environmental pressure. This trade-off highlights the difficulty of balancing short-term productivity goals with long-term sustainability objectives and emphasises the importance of policy interventions that promote efficiency rather than intensification.

From a policy perspective, the findings imply that a one-size-fits-all approach to agricultural sustainability is inappropriate for the Baltic region. Instead, policy measures should be tailored to country-specific development patterns. In Estonia and Latvia, for example, efforts should focus on reducing input intensity, improving resource efficiency and promoting environmentally friendly technologies. In Lithuania, meanwhile, policies should support the continued expansion of organic farming and sustainable agricultural practices, as these appear to boost productivity without putting additional strain on the environment.

However, the study is subject to several limitations. Firstly, the use of simple linear regression models does not capture potential interactions between multiple sustainability indicators. Secondly, the

analysis relies on secondary data, which may not fully reflect structural and institutional differences between countries. Future research could use panel data methods or more advanced econometric techniques to better capture dynamic relationships and causal effects.

Conclusions

This study provides a comparative econometric analysis of the relationship between environmental sustainability indicators and agricultural productivity in the Baltic States. The results show that these relationships are not consistent across countries, but instead reflect different structural development patterns.

In Estonia and Latvia, the findings suggest that agricultural productivity is primarily driven by input-intensive factors, such as greenhouse gas emissions, nitrogen fertiliser use and energy consumption. This suggests that productivity gains in these countries are closely linked to intensification processes, which could present challenges for long-term environmental sustainability. By contrast, Lithuania is on a different trajectory, with productivity being more strongly associated with the expansion of organic farming and energy use. This indicates a gradual transition towards more sustainable agricultural practices.

From a policy perspective, the results emphasise the need for differentiated strategies. In Estonia and Latvia, policy interventions should prioritise reducing environmental externalities by improving input efficiency and promoting low-emission agricultural technologies. In Lithuania, supporting organic farming and sustainable production models could enhance productivity while maintaining environmental performance.

Overall, the findings suggest that achieving sustainable agricultural growth in the Baltic States necessitates striking a balance between productivity goals and environmental limitations. This can be accomplished by implementing targeted, country-specific policy measures that address the unique structural characteristics of each agricultural system. Future research should build on this analysis by incorporating panel data methods and additional explanatory variables to explore the relationship between sustainability and productivity in agriculture more broadly across different regions.

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SUSTAINABLE DEVELOPMENT SYNERGY AND SECURITY: THEORETICAL AND METHODOLOGICAL FOUNDATIONS AND PRACTICAL IMPERATIVES OF ECONOMIC, SOCIAL, AND ENVIRONMENTAL TRANSFORMATION AND INCLUSION

Scientific monograph

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The scientific monograph presents a comprehensive interdisciplinary analysis of sustainable development in the context of contemporary global challenges and security imperatives. The study explores the theoretical, methodological, and practical dimensions of achieving sustainable, inclusive, and secure development through the integration of economic, social, environmental, and institutional transformation processes. Particular attention is devoted to the development of conceptual approaches that facilitate the identification of synergies among the SDGs and enhance the effectiveness of governance mechanisms at local, national, and international levels. The authors investigate the key drivers, challenges, and opportunities associated with economic transformation, emphasizing the role of innovation, digitalization, green growth, circular economy principles, and resilience-building in promoting sustainable and secure economic development. The social dimension of sustainable development is examined through the lenses of equity, inclusion, human capital development, social cohesion, and social security, highlighting their significance for societal well-being and long-term stability. The scientific monograph proposes methodological approaches and practical recommendations for strengthening institutional capacity, improving strategic planning, fostering stakeholder engagement, and enhancing policy coherence in support of sustainable and inclusive transformation.

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