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DOI: <https://doi.org/10.30838/EP.205.139-145>**Maslyhan Olena**

Dr. of Economic Sc.

State Higher Educational Institution «Uzhhorod National University»

Маслиган О.О.

доктор економічних наук

ДВНЗ «Ужгородський національний університет»

<https://orcid.org/0000-0002-8465-548X>**Holovachko Vasyl**

PhD in Economic Sc.

Mukachevo State University

Головачко В.М.

кандидат економічних наук

Мукачівський державний університет

<https://orcid.org/0000-0002-5993-0873>**Bondar Hanna**

PhD in Political Sc.

Higher Educational Institution «Uzhhorod National University»

Бондар Г.Л.

кандидат політичних наук

ДВНЗ «Ужгородський національний університет»

<https://orcid.org/0000-0003-4112-263X>

ECONOMIC DEVELOPMENT OF THE INFORMATION AND COMMUNICATION TECHNOLOGIES MARKET IN UKRAINE DURING THE WAR AND THE POST-WAR RECONSTRUCTION

This research seeks to identify the key components of economic development within Ukraine's information and communication technology (ICT) market, emphasizing its structural and functional features in the context of wartime disruption and post-war recovery. It has been established that the dynamics of the ICT market's development are determined by dual transformability—objective and subjective. The research findings demonstrate that, in fact, the objective and subjective transformability of the ICT market ensures its economic development during the war and in the post-war reconstruction period. This development is defined through the acceleration of these processes and the emergence of specific models of market presence of participants (large corporations, small and medium-sized enterprises, state and public institutions) and their cooperation. The practical significance of the study lies in the possibility of applying the obtained results to a deeper analysis of the interaction between objective and subjective transformation processes of the ICT market in wartime and post-war periods, to determine effective models for its sustainable and innovative development.

Keywords: post-war recovery strategies; information goods and services; international supply chains; producers of scientific and technological products; information and communication technologies; market; cooperation.

JEL classification: M30.

ЕКОНОМІЧНИЙ РОЗВИТОК РИНКУ ІНФОРМАЦІЙНО- КОМУНІКАЦІЙНИХ ТЕХНОЛОГІЙ В УКРАЇНІ ПІД ЧАС ВІЙНИ ТА ПІСЛЯВОЄННОЇ ВІДБУДОВИ

Стаття присвячена аналізу складників економічного розвитку ринку інформаційно-комунікаційних технологій (ІКТ) в Україні, зокрема в умовах війни та післявоєнної відбудови. Отримані результати виявили подвійний характер трансформації ринку — об'єктний та суб'єктний. Авторами показано, що об'єктна трансформація проявляється в ускладненні циклів змін: від лінійних та тривалих до паралельних, взаємозалежних і

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безперервних, що підвищує складність архітектури ринку інформаційно-комунікаційних технологій. Воєнний період прискорює ці процеси, сприяючи швидкому впровадженню технологій, модернізації сервісів та інфраструктури, а також оперативній адаптації ринку. Авторами показано, що суб'єктна трансформація ринку інформаційно-комунікаційних технологій забезпечує розвиток ринку через конкуренцію, перерозподіл ринкових часток і інвестиційних потоків, зміни моделей співпраці та пріоритетів, зокрема акцент на функціональній стійкості критично важливих сервісів. У воєнний період спостерігається зміна моделей співпраці: акцент зміщується від інноваційних проєктів на забезпечення функціональної стійкості та безпеки критично важливих сервісів і інфраструктури. Встановлено, баланс ринку інформаційно-комунікаційних технологій під час війни змінюється: зростає роль великих гравців та державних/громадських інституцій у підтримці критично важливих функцій, тоді як малий і середній бізнес стикається з викликами виживання через обмеження ресурсів та зміни пріоритетів. Констатовано, що післявоєнна відбудова передбачає стабілізацію ринку та його структурну реорганізацію через інтеграцію новітніх технологій, перерозподіл ролей і часток між учасниками, зміцнення позицій малих і середніх компаній та формування гнучких і стійких моделей співпраці, спрямованих на інноваційний розвиток. Наукова цінність дослідження полягає у визначенні особливостей об'єктної та суб'єктної трансформаційності ринку інформаційно-комунікаційних технологій, що забезпечує його економічний розвиток як у період війни, так і під час післявоєнної відбудови. Цей розвиток проявляється у прискоренні трансформаційних процесів та формуванні специфічних моделей ринкової присутності великих корпорацій, малих і середніх підприємств, державних та громадських інституцій та їх ефективної співпраці.

Ключові слова: стратегії післявоєнного відновлення; інформаційні товари і послуги; міжнародні ланцюги постачання; виробники науково-технічної продукції; інформаційно-комунікаційні технології; ринок; співпраця.

Problem statement. In recent years, the information and communication technology (ICT) market in Ukraine has undergone significant transformations, driven by both global and local factors. Global drivers include accelerated digitalization and the innovation-oriented nature of the world economy, the development of cloud services, artificial intelligence, and cybersecurity, as well as the reconfiguration of international supply chains. Local factors encompass the impact of military actions, infrastructure damage, mass migration, the urgent need for remote solutions in education and business, as well as the Strategy for the Development of Electronic Communications in Ukraine until 2030 and state programs supporting digital transformation and innovation in the post-war period (including the *Digital Strategy of Ukraine 2030, Support for Digital Transformation*, among others).

In the context of war and subsequent post-war recovery, the adaptation of economic models and technological solutions to emerging challenges and societal needs acquires particular importance. The spectrum of ICT technologies applied across various sectors of the economy and social life is expanding and becoming increasingly dynamic, which necessitates continuous monitoring of their development and impact on the country's economic stability and competitiveness.

The makeup of market participants is constantly changing. Before the war, transformations occurred gradually and focused mainly on innovation-driven growth. Today, however, these changes have taken on a dynamic, multidimensional, and reactive nature.

Analyzing the economic development of the ICT market during wartime allows for a better assessment of its innovation potential and the formulation of effective strategies for post-war recovery and modernization of key sectors in the economy.

Analysis of research and publications. The specific

features of the formation and functioning of the information and communication technology (ICT) market in Ukraine have been studied by Liba N.S., Korolovych O.O., Proskura V.F. [2], Voitko S.V., Sakalosh T.V. [1], Savran N.V. [4], Chernyshova L., Novikova L. [5], among other scholars.

In the works of Liba N.S., Korolovych O.O., Proskura V.F. [2], and Voitko S.V., Sakalosh T.V. [1], the focus is placed on the analysis of technological innovations and the development of telecommunication and IT infrastructure. Savran N.V. [4], Chernyshova L., and Novikova L. [5] also examine the influence of global and local economic factors on the dynamics and overall variability of the ICT market.

Much less attention in these studies has been devoted to the subjective evolution of the ICT market, particularly the analysis of the roles of its participants, the development of small and medium-sized enterprises, and the impact of crisis conditions (in particular, the war) on models of cooperation and competitive interactions among market players. Therefore, this study emphasizes the importance of a comprehensive examination of these components as key factors of economic development in Ukraine's ICT market during wartime and in the post-war recovery period.

Formulation of the article's objectives. This research seeks to identify the key components of economic development within Ukraine's information and communication technology (ICT) market, emphasizing its structural and functional features in the context of wartime disruption and post-war recovery.

The main results of research. The essence of the information and communication technology (ICT) market in Ukraine cannot currently be regarded as a stable category, as it functions as a dynamic entity continuously shaped by transformative influences from both global and local economic factors. Several approaches to defining it are

highlighted in the scholarly literature:

- As a combination of two interrelated clusters—telecommunications and information technologies industries—which can also be considered as separate markets (Voitko S.V., Sakalosh T.V. [1]; Chernyshova L., Novikova L. [6]). However, this definition is excessively abstract, as it merely outlines the structural elements of the market without accounting for its functional characteristics or its interactions with the external environment.

- As a system of economic, legal, and informational relations governing the purchase and sale of information goods and services (Savran N.V. [5]; Tarasova K.I. [7]). This definition is fragmentary, as it primarily reduces the ICT market to the sphere of exchange, overlooking its production and innovation potential.

- As a unified functioning mechanism based on the general laws of social production, encompassing the economic autonomy and responsibility of producers of scientific and technological products, freedom of entrepreneurship, and the independent purchase and sale of information resources, products, and services, means of information production, labor, financial assets, and securities (Tarasova K.I. [7]). This definition, however, is excessively universalizing, as it effectively equates the ICT market with the overall economic system, making it difficult to differentiate from other markets.

The outlined ambiguity in approaches to characterizing the information and communication technology (ICT) market in Ukraine—particularly their abstractness, fragmentariness, and universalization—is determined by [1; 5-7]:

1. The diversity of economic actors operating within it, which includes large international corporations, national ICT companies, small and medium-sized enterprises, startups, and state institutions, leads to differences in interests, roles, and levels of influence on market development.

2. The broad range of technological innovations and digital services at various stages of development and commercialization does not always fit within established classification frameworks.

Consequently, the market hosts actors and offers technological innovations and digital services that, in some cases, have not yet undergone formal classification, complicating the creation of a unified system for their accounting, regulation, and integration into the broader economic structure. In particular, difficulties arise in tracking who offers which services or technologies on the market, as well as in establishing rules, licenses, and standards for new technologies and companies. Moreover, new services and technologies are challenging to integrate into the overall

economic system due to the absence of established mechanisms for their interaction with other market segments [2]. Simply put, the market is evolving rapidly, and legislation and accounting systems do not always keep pace with these changes, creating a degree of disorder and complicating effective governance and sectoral development [3].

To establish a consensus regarding the content of the ICT market in Ukraine, the author has attempted to classify its components according to subjectivity (i.e., a characterization of the market actors, or subjects) and objectivity (i.e., a characterization of what the actors' activities are directed toward—products, services, digital solutions, and technologies that are exchanged or implemented in the market). The specifics of this classification are presented in Table 1.

Thus, the ICT market in Ukraine represents a dynamic economic entity, operating under the influence of both global and local economic factors and characterized by the interaction of diverse subjects and objects. Considering its dynamic subjectivity and objectivity, this market develops in cycles of:

- Transformations driven by accelerated changes in the software, infrastructure, product, technological, and information components of the ICT market;

- Transformations driven by accelerated changes among market actors, affecting competition, market share distribution, investment flows, and the nature of interactions between participants.

It is precisely the subjective and objective transformability that drives the dynamics of economic development in the ICT market, triggered by both local and global factors [3]. In practice, this results in continuous responsiveness, refinement, and renewal of the market's structural and functional elements through the emergence and progression of transformative cycles.

Regarding transformations driven by the accelerated changes in the software, infrastructure, product, technological, and information components of the ICT market (objective evolution), this refers to the continuous updating and modernization of key market elements [1–4]: the development of new software and digital platforms, the implementation of innovative technologies, the expansion and upgrading of telecommunication and IT infrastructure, the creation of new products and services, as well as the accumulation and processing of information resources. These transformative cycles facilitate the market's evolution by increasing its complexity in terms of technological, economic, and social changes, which have been particularly accelerated during the war (Table 2).

Table 1

Classification of the ICT market components in Ukraine by subjectivity and objectivity

Components characterizing the ICT market *	Systematization of objects by core attributes
Direction – Classification of ICT market components by subjectivity	
International ICT Companies	Large international economic entities (e.g., Microsoft, Oracle, Cisco, Amazon Web Services, Google, Samsung) operating in the Ukrainian market through local offices and partner networks.
Large National ICT Companies	Major enterprises in the field of computer and information technologies (ICT) that develop products and services at the national level, exert significant influence on the country's economy, and often form the foundation of the export-oriented IT sector (e.g., SoftServe, EPAM Ukraine, GlobalLogic, Luxoft, N-iX, Infopulse).
Small and Medium-sized ICT Enterprises (SMEs)	Economic actors with a limited number of employees, revenue, and asset value, specializing in outsourcing and product-oriented solutions.
Startups in Fintech, e-commerce, EdTech, AgriTech, DefenseTech	Innovative young companies operating in the ICT segment, creating new products, services, or technological solutions classified as information and communication technologies.
State institutions and Government bodies	Government agencies, offices, and institutions that establish regulatory frameworks, ensure ICT regulation and development support, and implement digital services for citizens and businesses (e.g., Ministry of Digital Transformation of Ukraine, State Service for Special Communications and Information Protection, National Commission for State Regulation in Electronic Communications, Radio Frequency Spectrum, and Postal Services).
Civil society organizations and business associations	Non-governmental structures representing the interests of companies and promoting industry development, rather than commercial enterprises; they support the establishment of professional standards and certifications in IT, foster communities and knowledge-sharing networks among companies and startups, and organize events, conferences, and training programs to advance the digital economy.
Direction – Classification of ICT market components by objectivity	
Software and IT Products (1)	Packaged and customized software, operating systems, enterprise solutions, business and consumer applications, software platforms, and services.
Hardware and telecommunication equipment (2)	Servers, computers, networking equipment, mobile devices, cloud infrastructure hardware, and telecommunications networks.
Digital services and platforms (3)	Offerings that provide users with information, communication, and technology products via digital platforms or networks.
Technological innovations (4)	Cutting-edge technologies implemented in the ICT sector, including artificial intelligence, blockchain, big data, virtual and augmented reality, and process automation.
Information resources (5)	Collections of data, databases, or content created, stored, processed, and utilized by market actors.

Note: / * Software component (1); Infrastructure component (2); Product component (3); Technological component (4); Information component (5).

Source: compiled based on [4-5; 8]

While the initial cycles of objective transformation were linear and extended over time [1; 7], the objective evolution of the ICT market has led to their becoming parallel, interdependent, and continuous today [1-2]. Each new cycle of transformation not only increases the market's architectural complexity—since changes in one component automatically affect others—but also becomes progressively shorter.

It should be noted that during wartime, the cycles of objective transformation in the ICT market accelerate in atypical ways [7]. In particular, new technologies are being implemented more rapidly, services and infrastructure are being modernized more efficiently, and the ability to adapt to change is becoming critical for market functionality. For

example, during Russia's full-scale invasion of Ukraine, the deployment of the Starlink system was accelerated to ensure continuous Internet access amid the destruction or shutdown of traditional telecommunications infrastructure. While the implementation of such technologies under peacetime conditions would normally require lengthy procedures for approvals, licensing, and gradual infrastructure build-out, during the war, the process was completed within an exceptionally short period—just a few weeks. This rapid deployment enabled critical sectors (military, government agencies, businesses, and hospitals) to adapt swiftly to new conditions and ensured the continuity of ICT market operations.

Table 2

Stages of objective evolution and increasing complexity of transformations in the ICT sector

Evolution stage	Evolution specifics		Complexity
	Main focus	Transformation cycles	
Initial stage (1970s–1980s) — Formation of basic infrastructure	Hardware: computers, mainframes, servers. Software: primarily of an instrumental nature (operating systems, basic packages). Telecommunications: telephone networks, early local area networks.	Relatively slow and linear: new hardware is introduced first, followed by new software.	Each new cycle required a complete hardware replacement and an extended implementation period.
Network stage (1990s) — Internetization	Expansion of the Internet, email, and web technologies. Increasing role of software solutions and client-server architecture. Formation of a global information infrastructure.	More dynamic: software updates begin to occur more frequently than hardware changes.	The need to harmonize standards and protocols emerges, complicating integration.
Digital platform stage (2000s) — Mobility and globalization	Mass deployment of mobile Internet and smartphones. Formation of large ecosystems (Google, Apple, Microsoft, Amazon). Development of cloud services and the SaaS model.	Rapid and continuous: software is updated “over-the-air,” and services are constantly expanding.	Software, product, and information components transform in parallel, with their interdependence becoming increasingly close.
Innovation acceleration stage (2010s) — Big data and automation	Massive accumulation of information resources (Big Data). Widespread implementation of AI, machine learning, and business process automation. Modernization of IT infrastructure through cloud data centers and virtualization.	Multidimensional: software, infrastructure, services, and data management evolve simultaneously.	Cycles become nonlinear — innovations may emerge simultaneously from multiple directions, forcing businesses to continuously adapt.
Accelerated evolution stage (2020s–present) — AI and cyber-physical systems	Integration of AI and machine learning into most products. Large-scale deployment of 5G, IoT, and edge computing, which has accelerated particularly during the war. Development of metaverse applications, AR/VR, and blockchain solutions. Cybersecurity and information flow management have become top priorities.	Ultra-fast, parallel, and self-reinforcing: new technologies do not merely replace old ones but intertwine, creating entirely new ecosystems.	Continuous modernization is required simultaneously across all dimensions: software, infrastructure, product, technological, and information.

Source: compiled based on [1; 4-5; 7]

During the post-war reconstruction period, the ICT market is expected to undergo stabilization and structural reorganization, including:

- Integration of advanced technologies and solutions that were implemented under crisis conditions;
- Modernization of infrastructure in line with new standards and security requirements;
- Enhancement of market resilience to future challenges through the development of a more flexible and adaptive architecture.

Regarding transformations driven by accelerated changes in market actors (subjective evolution), this refers to the continuous evolution of the composition of participants: the entry of new startups, shifts in the roles and strategies of national and international companies, and increased activity of small and medium-sized enterprises, government institutions, and civil society organizations. These transformative cycles drive market development by intensifying competition, redistributing market shares and investment flows, and altering the nature of interactions among participants [8]. During wartime, these changes not only generate new models of cooperation, partnership, and

market behavior but also fundamentally modify their character (Table 3).

Subjective evolution is the process of continuous change in the composition of participants, their roles, and strategies. Whereas such changes previously occurred gradually and in a centralized manner, they are now dynamic, parallel, and multidimensional. These transformative cycles create new models of collaboration and market behavior, while also ensuring the ongoing renewal of the market through competition and innovation [6].

During wartime, the cycles of subjective transformation in the ICT market are characterized by a shift in collaboration models—from purely innovation-driven approaches focused on developing new products and technologies to models aimed at ensuring the functional resilience and security of critical services and infrastructure. Moreover, wartime conditions altered the market balance: the role of large players and government/civil institutions in supporting critical functions increased, while small and medium-sized enterprises faced significant challenges to survival and growth, including the reallocation of resources to critical projects and infrastructure support.

Table 3

Stages of subjective evolution and increasing complexity of transformations in the ICT sector

Evolution stage	Evolution specifics		Complexity
	Main focus	Transformation cycles	
Initial Stage (1970s–1980s) — Dominance of large corporations	The market was dominated by a few large companies (IBM, DEC, Microsoft in the early stage). Small and medium-sized participants had limited influence. Government institutions acted as regulators and providers of core networks.	Slow and centralized; changes occurred primarily through the introduction of new products by major players.	The presence of a small number of key players simplified integration but slowed down innovation.
Network Transformation Stage (1990s) — Emergence of startups and global players	Entry of the first Internet startups (Yahoo, Amazon, Google). Active expansion of international companies into new markets. Shift in roles: some national companies evolved into global players.	More dynamic, driven by new participants and innovative business models.	The market becomes networked, with changes in one player's behavior affecting many others.
Multipolar Stage (2000s) — SMEs and platforms	Increased activity of small and medium-sized enterprises (IT consulting, SaaS, mobile applications). Growing role of platforms connecting various participants (App Store, Google Play). Initial formation of partnership ecosystems.	Parallel: new startups and SMEs rapidly alter market shares.	Increased complexity in coordinating among a large number of participants. Roles and strategies are constantly evolving.
Stage of Intensive competition and innovation (2010s)	Entry of international startups and venture capital firms. Active involvement of government and civil society organizations. Redistribution of investments and market shares among participants.	Accelerated and unpredictable: the market responds rapidly to new technologies, shifts in strategies, and changes in partners.	Multiple interaction scenarios: competition, partnerships, alliances, and coalitions.
Accelerated subjective evolution stage (2020s–Present)	Entry of AI startups, innovative platforms, and startups in cybersecurity and the metaverse. Continuous shifts in the roles of large international players, ranging from competition to strategic partnerships. Growing importance of cooperative models (open-source, shared platforms).	Continuous and multidimensional: investment flows, partnerships, and collaboration models are constantly evolving.	The market becomes a dynamic ecosystem, where participants rapidly enter and exit, reshaping structure and interactions. Emergence of new models of market behavior and digital partnerships.

Source: compiled based on [4; 6-8]

In the post-war reconstruction period, the market is expected to see a redistribution of roles and shares among participants, driven in part by the entry of new startups and the strengthening of small and medium-sized companies, as well as the development of flexible and resilient collaboration models focused on innovation.

Conclusions. It has been established that the dynamics of ICT market development are determined by dual transformability—both objective and subjective.

Objective transformation of the ICT market is characterized by the gradual complication of transformation cycles. While these cycles were previously linear and extended over time, they have now become parallel, interdependent, and continuous, complicating the market architecture as changes in one component automatically affect others. It has been demonstrated that the wartime period accelerates objective transformation, manifested in the rapid implementation of technologies, modernization of services and infrastructure, and the need for prompt adaptation to changes to ensure the market's functioning.

Subjective transformation of the ICT market drives its development through competition, redistribution of market

shares, and investment flows. During wartime, collaboration models shift: the focus moves from innovation-driven projects to ensuring the functional resilience and security of critical services and infrastructure. The market balance changes during war, with an increased role for large players and government/civil institutions in supporting essential functions, while small and medium-sized enterprises face survival challenges due to resource constraints and changing priorities.

The post-war reconstruction period is expected to involve market stabilization and structural reorganization, integration of advanced technologies, redistribution of roles and shares among participants, strengthening of small and medium-sized companies, and the development of flexible and resilient collaboration models aimed at innovative growth.

The study demonstrates that both objective and subjective transformability of the ICT market underpins its economic development during wartime and post-war reconstruction. This development is characterized by the acceleration of these processes and the emergence of specific market participation models for key actors—large

corporations, SMEs, and government and civil institutions—and their collaborative interactions.

Future research should focus on a deeper analysis of the interplay between objective and subjective transformations

of the ICT market during wartime and post-war periods to identify effective models for its sustainable and innovative development.

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