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IMPACT OF THE INFORMATION AND COMMUNICATION TECHNOLOGY MARKET ON THE CLUSTERIZATION OF UKRAINE'S ECONOMY

ВПЛИВ РИНКУ ІНФОРМАЦІЙНО-КОМУНІКАЦІЙНИХ ТЕХНОЛОГІЙ НА КЛАСТЕРИЗАЦІЮ ЕКОНОМІКИ УКРАЇНИ

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Currently, information and communication technologies (ICT) are a key factor in the economic development of national economies, as they not only transform economic structures but also define new approaches to organizing production and service processes, contribute to the overall improvement of business efficiency, and stimulate innovative development. The role of ICT is particularly significant in economic clustering processes. Therefore, the article aims is to investigate the impact of the information and communication technology market in Ukraine on the formation and development of clusters in the economy. Based on the study results, it was found that the ICT market significantly influences economic clustering, as enterprises and organizations with shared interests shift toward digital and continuous interactions, allowing them to exchange knowledge and resources more rapidly than those operating in isolation.

Keywords: information and communication technologies; market; cluster; economic clustering; value creation; information infrastructure; computer networks; servers; software.

Наразі інформаційно-комунікаційні технології (ІКТ) є ключовим чинником економічного розвитку економік держав, оскільки вони не лише трансформують її структуру, але й визначають нові підходи до організації виробничих і сервісних процесів, сприяють загальному підвищенню ефективності бізнесу та стимулюють інноваційний розвиток. Особливо значущою є роль ІКТ у процесах кластеризації економіки, де формуються спеціалізовані територіальні та галузеві об'єднання підприємств та організацій, що взаємодіють для підвищення конкурентоспроможності та створення доданої вартості. Метою даної статті є дослідження впливу рин-

ку інформаційно-комунікаційних технологій в Україні на формування та поширення кластерів в економіці. За результатами дослідження констатовано, що ринок ІКТ суттєво впливає на кластеризацію економіки, оскільки підприємства та організації зі спільними інтересами переходять на цифрові, постійні взаємодії, що дозволяють їм цифровізуватися та швидше обмінюватися знаннями та ресурсами. У межах цифровізованих кластерів учасники можуть миттєво обмінюватися технологіями, кадрами та результатами наукових досліджень, використовуючи спільні хмарні платформи, лабораторії, інноваційні хаби, освітні та аналітичні інструменти. Тісніший контакт між науковими установами, підприємствами та організаціями, забезпечений доступністю даних і цифрових ресурсів, сприяє швидкому впровадженню нових технологій, підвищенню ефективності спільних проєктів, процесів закупівель і маркетингових кампаній. Приклади спільної діяльності, зокрема об'єднання учасників для участі в міжнародних виставках, свідчать про ефективніше використання ресурсів і зростання потенційного прибутку. Крім того, держава, венчурні та міжнародні фонди охочіше надають ресурси об'єднаним групам підприємств, ніж окремим організаціям, що підкреслює важливість інтеграції в межах кластерів. Таким чином, розвиток цифровізованих кластерів під впливом ринку ІКТ сприяє зростанню конкурентоспроможності, підвищенню ефективності та розширенню інноваційного потенціалу економічних об'єднань. Перспективи подальших досліджень полягають у вивченні механізмів оптимізації цифрових взаємодій у кластеризованих економіках для підвищення ефективності обміну знаннями, ресурсами та впровадження інновацій у різних галузях.

Ключові слова: інформаційно-комунікаційні технології; ринок; кластер; кластеризація економіки; створення доданої вартості; інформаційна інфраструктура; комп'ютерні мережі; сервери; програмне забезпечення.

Problem statement. Currently, information and communication technologies (ICT) are a key factor in the economic development of countries, as they not only transform the structure of the economy but also define new approaches to organizing production and service processes, contribute to the overall improvement of business efficiency, and stimulate innovative development. The role of ICT is particularly significant in the processes of economic clustering, where specialized territorial or sectoral associations of enterprises are formed that interact to enhance competitiveness and create added value.

For Ukraine, which is striving to actively integrate into global economic and technological processes while simultaneously experiencing the negative consequences of Russian military aggression, the development of the ICT market acquires special strategic importance. In fact, the development of cluster structures based on high technologies enables a more effective utilization of scientific potential, improves the speed and quality of innovation transfer, and also stimulates regional development – even in territories close to active combat zones.

Analysis of research and publications. In this context, the issues of developing the information and communication technology (ICT) market and its impact on the economy have been systematically examined in the works of H. Alekseevska, M. Chaikovska [1], M. Ye. Markov [4], Yu. O. Ohrenych, and V. S. Kurdyp [6].

At the same time, these scholars primarily focus on analyzing the structural characteristics of the ICT market, the mechanisms of its functioning, and the overall impact of digitalization on economic efficiency and the dissemination of innovative technologies across various sectors.

Identification of previously unresolved aspects of the overall problem. However, the role of this market specifically in the cluster-based transformation of Ukraine's economy has remained outside the scope of their research.

Moreover, such fragmentary research creates numerous problems both in the theoretical and practical domains of economic management. At the theoretical level, this leads to incomplete models of clustering, the absence of methodologies to assess the impact of ICT on cluster efficiency, and a limited capacity to forecast the spread of waves of innovation. At the practical level, the fragmented knowledge complicates cluster management, reduces the synergy effect of participant collaboration, hinders the integration of digital tools, and creates difficulties in shaping state policies and programs for supporting innovation.

Formulation of the article's objectives. This article aims to investigate the impact of the information and communication technology (ICT) market in Ukraine on the formation and development of economic clusters.

Summary of the main research material. The development of the information and communication technology (ICT) market in Ukraine is driven by a combination of diverse factors. Among them, the most significant is the continuous growth in demand for digital services, process automation, and communication, which stimulates investment in the ICT sector. At the same time, rapid technological progress in hardware and software exerts a

considerable influence, as it creates conditions for the constant updating and expansion of the market's product portfolio. Additionally, the trend of market integration promotes the exchange of technologies and the dissemination of innovations, enhancing competition and further stimulating market development. Finally, government support, venture capital investments, and international ICT development programs create a favorable environment for rapid market growth and the implementation of innovative solutions.

At the same time, the main trends in the development of the information and communication technology market include the widespread adoption of cloud technologies, online services, and e-commerce, which contribute to improving enterprise efficiency. In particular, the IaaS cloud services market in Ukraine was estimated at UAH 2.7–2.8 billion in 2023, and according to forecasts, its volume could increase to UAH 3.6–3.8 billion by 2026, partly due to free services provided by Western providers. Moreover, the consumption of Microsoft Azure cloud services in Ukraine over the same period increased nearly sevenfold, indicating the active implementation of cloud technologies in business processes and the digital transformation of enterprises.

Regarding e-commerce, in 2023 the market volume in Ukraine exceeded USD 6 billion, with an average annual growth rate of approximately 20% [2].

In addition to the aforementioned trends, the development of the ICT market is characterized by:

– Development of telecommunications infrastructure. At the beginning of 2023, 96% of Ukraine's population under government control had access to 4G networks, and 79.2% were internet users. Furthermore, in 2025, Ukraine became the first European country to launch mobile internet via Starlink satellites in areas where traditional networks are unavailable. By mid-2026, the full implementation of mobile satellite broadband internet and voice services via Starlink is planned, which will further promote digitalization and improve access to modern services.

– Implementation of innovative technologies. Artificial intelligence, machine learning, blockchain, and the Internet of Things are being actively applied in business and public administration. Over the past ten years, the number of AI specialists in Ukraine has increased fivefold, and in 2023 there were 243 startups and technology hubs engaged in AI solution development. This contributes to the introduction of new products and services, enhances enterprise efficiency, and fosters the development of innovative economic clusters.

Trends in the development of the ICT market in Ukraine indicate its strategic role in the transformation of the economy. In particular, the active implementation of digital technologies, the development of telecommunications infrastructure, and innovative clusters create a foundation for enhancing the country's competitiveness at the global level.

Thus, the information and communication technology market acts as a key factor in the clustering of Ukraine's economy, as it creates conditions for effective interaction among enterprises, research institutions, and government bodies within clusters, as illustrated in Figure. 1.

It can be noted that the ICT market not only generates new clusters but also transforms existing (traditional) ones.

In fact, based on the above-mentioned specifics, economic clustering can be viewed as a transition from the isolated functioning of enterprises to networked interaction (within specific formations – clusters), where producers, research institutions, and government bodies jointly create added value (as we have already noted in previous studies [5]).

Such interaction becomes possible due to the development of a number of key conditions that form the foundation of the cluster environment, namely:

1. Development of technological infrastructure, which ensures the advancement of production equipment, machinery, technological lines, laboratories, research centers, and technical communications. These components form the foundation for the stability and reliability of innovations and communications among economic actors.

2. Development of information infrastructure, which ensures the advancement of computer networks, servers (including cloud-based), software, databases, analytical platforms, corporate portals, cybersecurity tools, and knowledge management systems. These components form the foundation for information interaction, analytical support for managerial decisions, and the digital transformation of enterprises within clusters.

The presence of these key components ensures the creation of enabling conditions for economic actors within clusters (including

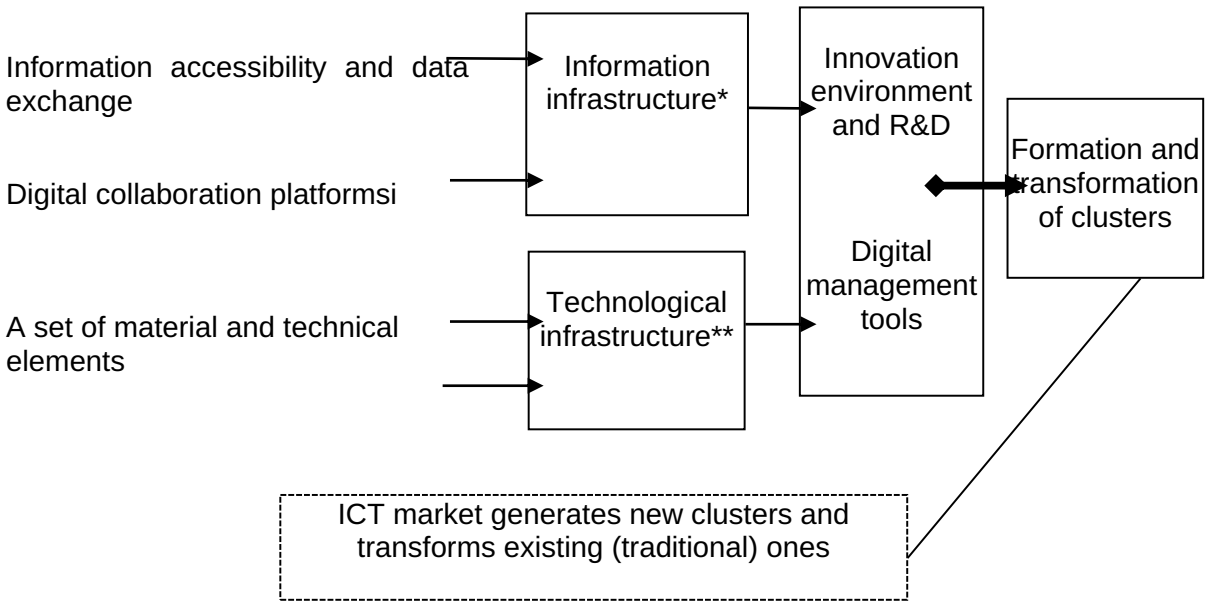

Fig. 1. Specifics of the ICT market's impact on the development of economic clustering in Ukraine

Note:

* A system for collecting, storing, processing, and transmitting information that ensures management, analysis, and communication within an organization.

** A set of material and technical elements that ensure the creation, implementation, and functioning of technological processes in an enterprise or industry.

Source: created by the authors based on [1; 3; 6]

those that support the transformation of existing clusters), namely [1; 3–4]:

1. Information accessibility and data exchange. Enterprises and research institutions can quickly share research, statistics, market data, and analytics. This accelerates decision-making and reduces the costs of information retrieval.

2. Use of digital collaboration platforms (CRM systems, cloud services, online projects, open government data). Based on these platforms, enterprises create joint projects and pool resources from different cluster participants.

3. Innovation environment and R&D. It creates conditions for establishing research and technical laboratories and startups within clusters, providing support from the government and venture funds through digital platforms.

4. Digital management tools (ERP systems, logistics systems, electronic document management). These tools enhance the efficiency of coordination between enterprises and government bodies.

It should be noted that the effectiveness of the key conditions outlined above is due to the fact that they provide a foundation for the most efficient interaction among enterprises, research institutions, and government bodies within clusters – remote, flexible, and transparent. Under such conditions, a cluster ceases to be merely a grouped association of economic actors; it becomes an environment where participants, through information and communication technologies, interact with each other, enhancing their own competitiveness and efficiency.

Regardless of whether such clusters are sectoral (e.g., IT, mechanical engineering, or agro-industrial) or regional (i.e., associations of various enterprises and institutions within a specific city or region), they are characterized by common functional features: shared infrastructures (technological and informational), active interaction among business, science, education, and government, innovation-oriented activities, and the presence of a synergy effect (meaning that the overall efficiency of the cluster exceeds the sum of the effects of its individual participants).

At the same time, the ICT market provides enterprises and organizations with access to high-speed internet, cloud services, data exchange platforms, and tools for online collaboration. As a result, clusters whose development is largely

influenced by the ICT market partially operate in a digital format, which reduces, and in some cases completely eliminates, the importance of geographical proximity among participants. In particular [5]:

1. Cluster participants can coordinate activities, share technologies, research, and personnel, even while being located in different geographical areas.

2. Cluster participants can conduct online meetings, webinars, joint projects, and training programs without physical presence, ensuring integration of participants remotely.

It is precisely this partial operation in a digital format that distinguishes such clusters – referred to as digitized clusters – from classical clusters described in M. Porter's models, which are based on the territorial concentration of interrelated companies, suppliers, research institutions, and government bodies.

One of the largest and most successful digital IT clusters in Ukraine is the Lviv IT Cluster, whose emergence and effective operation have been driven by the development and influence of the information and communication technology (ICT) market. The cluster brings together more than 300 companies and over 20,000 professionals. The organization actively develops educational programs, hosts industry conferences, and creates innovative products.

In 2023, the activities of more than 40% of the cluster's participants were partially carried out in the digital environment. This includes, in particular, the presentation of innovative ideas, participation in specialized work and learning spaces, as well as cooperation with government bodies and international partners.

This indicator has been steadily increasing since 2019, indicating the gradual digitalization of interactions among cluster participants and a growing level of integration into the global digital space (see Figure 2).

It should be noted that the increase in the share of participants whose activities partially take place in the digital environment contributes to enhancing the efficiency of interactions among them, stimulates the exchange of technologies, research results, and human resources, regardless of their geographic location.

The key aspects of the ICT market's impact on the Lviv IT Cluster (see Table 1) confirm that the ICT market is a fundamental factor in cluster development, as it provides access to technological infrastructure, communication platforms, development tools, resources for workforce skill enhancement, and opportunities to enter new markets.

Among other examples of clusters whose development is driven by the growth and influence of the ICT market, the agro-industrial cluster "Agrovin" deserves mention. It currently unites leading agricultural companies in the Vinnytsia region with the aim of developing processing, export, and the implementation of innovations in agriculture.

Key aspects of the ICT market's influence on "Agrovin" (see Table 2) confirm that the ICT market is a fundamental factor in the cluster's development. It provides access to modern tools and infrastructure for optimizing logistics, implementing agricultural enterprise management systems, and processing participants' yield data.

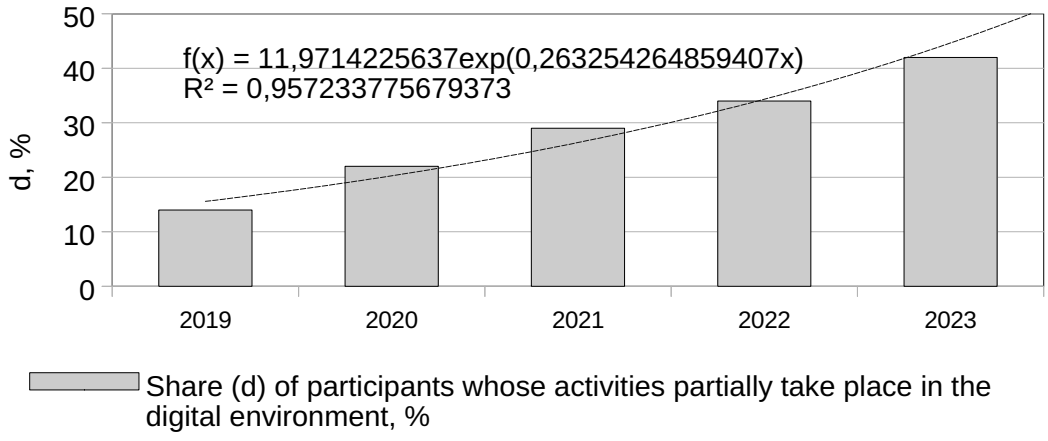

Fig. 2. Changes in the share of participants whose activities partially take place in the digital environment, 2019–2023, %

Source: created by the author based on data from the Lviv IT Cluster

Table 1

Key aspects of the ICT market's impact on the Lviv IT Cluster

Areas of impact	Key aspects of the ICT market's impact	Impact of the ICT market
Access to technological infrastructure.	The ICT market provides the cluster with high-speed internet, cloud services, data centers, and server capacities.	This enables cluster companies to efficiently develop, test, and implement software products and services.
Innovation environment and development tools.	The market offers a wide range of ready-made platforms, programming languages, APIs, frameworks, and DevOps tools.	Cluster companies can rapidly adopt modern solutions, allowing them to scale their products.
Educational and professional resources.	The emergence of online courses, educational platforms, training programs, and ICT certifications directly affects workforce development.	Cluster companies gain access to a large pool of qualified specialists, stimulating cluster development.
Digital communications and collaboration.	Tools for online collaboration, project management, and communication (Slack, Jira, Trello, Zoom, etc.) ensure the integration of companies within the cluster.	This allows cluster companies to increase the efficiency of joint projects and reduce coordination costs.
Access to new markets and clients.	The ICT market provides platforms for marketing, sales, and customer acquisition (App Store, Google Play, B2B platforms).	Cluster companies can quickly expand their presence in international markets.

Source: created by the authors based on [1–2; 5–7]

Table 2

Key aspects of the ICT market's impact on the Agro-industrial cluster "Agrovin"

Areas of impact	Key aspects of the ICT market's impact	Impact of the ICT market
Access to technological infrastructure	The ICT market provides the cluster with high-speed internet, cloud services, and platforms for collecting and analyzing data on crop yields, logistics, and production processes.	Cluster companies can efficiently plan production, optimize logistics, and increase the productivity of agricultural operations.
Innovation environment and management systems	The use of software solutions for automating agricultural enterprise management, product quality control, and the implementation of innovative technologies.	The accuracy and efficiency of production processes improve, and the integration of new technologies is simplified.
Educational and professional resources	Online courses, training programs, and certification programs for agronomists, managers, and technologists.	Staff qualifications and the ability to implement modern technologies in production are enhanced.
Digital communications and collaboration	The use of platforms for information exchange among cluster companies, coordination of procurement and supply, as well as joint project planning.	Interaction among cluster participants improves, while coordination costs are reduced.

Source: created by the authors based on [2; 4–5]

As of 2023, over 45% of the cluster's participants operate in the digital environment, enabling the effective exchange of technologies, research results, and human resources, even while being located in different geographic regions. This, in turn, contributes to enhancing the cluster's overall operational efficiency and strengthening its competitiveness in both national and international markets.

The cluster also operates in a digital environment, allowing companies to efficiently exchange technologies, research, and personnel,

even while being geographically dispersed, thereby enhancing overall operational efficiency.

Thus, the main idea of the ICT market's impact on economic clustering is that enterprises and organizations, even if they are not physically close but share common interests, engage in multiple and continuous interactions – partially digitized – which allows them to exchange knowledge and resources more quickly than those operating in isolation. These interactions may include:

1. Information and knowledge exchange. Virtual meetings, forums, and chat platforms for discussing the market or technologies.
2. Process coordination. Joint planning of production, supply, and logistics.
3. Development of joint innovative projects. Creating new products or services within remote teams.
4. Digital financial interactions. Online contracts, payments, and supply chain management.
5. Social and professional networks. Professional associations and communities where experience is shared.

In addition to changing the very nature of each individual cluster through digitalization, the ICT market's influence at a broader level accelerates the dissemination of innovative ideas and technologies, forming so-called innovation waves. At the general level, the ICT market provides enterprises and organizations with:

– Fast communication channels and platforms for knowledge exchange;
– Digital databases and collaboration tools.

As a result, new technologies, methods, and products can spread from one cluster participant to another almost instantly, regardless of the geographical location of the companies, creating a cascading effect of innovative development within clusters and the clustered economy as a whole.

Conclusions. Based on the results of the study, it was found that the information and communication technology (ICT) market significantly influences the clustering of the economy, as enterprises and organizations with shared interests shift toward digital and continuous interactions, enabling them to exchange knowledge and resources more rapidly than those operating in isolation.

Within digitalized clusters, participants can instantly share technologies, personnel, and research outcomes using shared cloud platforms, laboratories, innovation hubs, educational programs, and analytical tools. Closer contact between research institutions and businesses, facilitated by the accessibility of data and digital resources, promotes the rapid implementation of new technologies and increases the efficiency of joint projects, procurement, and marketing campaigns.

Examples of collaborative activities, such as startups joining forces to participate in international exhibitions, demonstrate resource savings and increased potential profits for each cluster participant. Furthermore, government support, venture funds, and international programs provide resources more effectively to consolidated groups of enterprises than to individual organizations, highlighting the importance of integration within clusters.

Thus, the development of digitalized clusters under the influence of the ICT market contributes to enhancing the competitiveness, efficiency, and innovation potential of economic associations.

Prospects for further research lie in studying mechanisms to optimize digital interactions in clustered economies to improve the efficiency of knowledge and resource exchange and the implementation of innovations across various industries.

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