BUSINESS ECOSYSTEMS IN THE MODERN GLOBAL ECONOMY: FROM PLATFORM LOGIC TO AI-ORIENTED DEVELOPMENT

Oleksiy Stupnytskyy[1]
Volodymyr Verhun[2]
Oleksandr Dykyi[3]

DOI: https://doi.org/10.30525/978-9934-26-673-7-16

Abstract. The transformation of the global economy in the 21st century is increasingly characterized by the transition from traditional hierarchical models of economic organization to network-based and platform-oriented business ecosystems. These ecosystems represent complex, adaptive systems that integrate companies, institutions, technologies, and users into unified value-creation environments. The relevance of the study is determined by the growing role of business ecosystems as key drivers of innovation, digital transformation, and global competitiveness, as well as by the need to conceptualize their structural features and development trajectories at both global and national levels. *The purpose* of the paper is to analyse the evolution, typology, and functional characteristics of business ecosystems in the global economy, as well as to substantiate the strategic directions for the formation of a resilient innovation-driven business ecosystem in Ukraine. The research objectives include: systematization of theoretical approaches to defining business ecosystems; comparative analysis of the American, Chinese, and European models of ecosystem development; identification of key performance indicators (KPIs) for assessing ecosystem effectiveness; and development of a conceptual UaRoad Map for Ukraine's transition toward a sustainable innovation ecosystem. The *methodology* of the study is based on a combination of general scientific and special

[1] PhD (Economics), Professor of the Department of International Business,
Institute of International Relations, Taras Shevchenko National University of Kyiv, Ukraine
[2] Doctor of Sciences (Economics), Professor of the Department of International Business,
Institute of International Relations, Taras Shevchenko National University of Kyiv, Ukraine
[3] Doctor of Sciences (Economics), Professor of the Department of International Business,
Institute of International Relations, Taras Shevchenko National University of Kyiv, Ukraine

methods, including analysis and synthesis, comparative analysis, system approach, structural-functional analysis, and abstraction. These methods are used to identify the key characteristics of business ecosystems, evaluate their performance, and determine the institutional, economic, and technological factors influencing their development. The *results* of the study demonstrate that the global economy is shaped by the competition of three dominant ecosystem models: the decentralized and innovation-driven American model, the state-coordinated and platform-integrated Chinese model, and the regulatory-institutional European model oriented toward sustainable development. Each model has its own structural features, competitive advantages, and limitations, which define the dynamics of global economic transformation toward AI-driven ecosystem economies. The study also reveals that the effectiveness of business ecosystems should be evaluated through a multidimensional system of indicators, including economic, innovation, network, institutional, digital, and resilience metrics. A generalized Ecosystem Performance Index (EPI) is proposed as an integrative tool for assessing ecosystem performance. Special attention is paid to Ukraine's innovation potential, which is characterized by strong human capital and IT sector development but constrained by institutional weaknesses, limited access to financing, and fragmented innovation infrastructure. The proposed UaRoad Map outlines a strategic framework for building a resilient innovation ecosystem in Ukraine based on ecosystem integration, digitalization, EU alignment, and smart specialization. *Practical implications.* The results of the study can be used by policymakers, researchers, and business stakeholders for designing innovation policies, developing ecosystem strategies, and improving the effectiveness of national innovation systems. *Value/originality.* The paper provides a comprehensive comparative analysis of global business ecosystem models and proposes an integrated conceptual framework for Ukraine's transition to a resilient and innovation-driven ecosystem economy under conditions of high uncertainty and global competition.

Introduction

The modern global economy is undergoing a profound transformation driven by digitalization, technological innovation, and the increasing importance of network interactions. Traditional models of economic organization, based on hierarchical structures and linear value chains, are gradually being replaced by more flexible, dynamic, and interconnected systems known as business ecosystems. These ecosystems объединяют companies, startups, research institutions, investors, and public authorities into integrated environments where value is co-created through collaboration, data exchange, and innovation.

The concept of business ecosystems has gained significant attention in recent decades as a result of the rapid development of digital platforms, artificial intelligence, and global technological networks. Unlike traditional firms, which operate as isolated economic agents, participants of business ecosystems function as interdependent actors whose success depends on the quality of interactions within the network. This shift fundamentally changes the logic of competition – from rivalry between individual companies to competition between ecosystems, platforms, and integrated innovation environments.

In the context of globalization and technological competition, business ecosystems have become key instruments of economic power and innovation leadership. The United States, China, and the European Union have developed distinct models of ecosystem organization, each reflecting different institutional frameworks, governance mechanisms, and strategic priorities. The American model is characterized by strong private sector leadership, venture capital dominance, and rapid scaling of digital platforms. The Chinese model is based on state coordination, integration of digital and industrial sectors, and the development of super-app ecosystems. The European model, in contrast, emphasizes regulatory frameworks, sustainable development, and the integration of innovation systems through institutional mechanisms.

At the same time, the increasing fragmentation of the global economy into competing ecosystem blocks creates new challenges and opportunities for emerging economies. Countries like Ukraine face the need to integrate into global innovation networks while simultaneously developing their own resilient business ecosystems. This requires not only the strengthening of institutional capacity and innovation infrastructure but also the adoption of a systemic ecosystem approach that ensures effective interaction between the state, business, science, and investors.

Ukraine possesses significant potential for the development of business ecosystems due to its strong human capital, развитий IT sector, and growing integration into global technological value chains. However, this potential remains largely underutilized due to institutional instability, insufficient development of financial markets, limited access to investment, and fragmentation of innovation initiatives. In addition, external challenges, including geopolitical risks and wartime conditions, further complicate the process of ecosystem formation and scaling. In this context, the study of business ecosystems becomes particularly relevant for understanding the mechanisms of innovation-driven growth and for developing effective strategies of economic transformation. The transition from fragmented initiatives to sustainable and integrated business ecosystems is a key prerequisite for enhancing Ukraine's competitiveness, attracting investment, and ensuring long-term economic resilience.

Thus, the aim of this paper is to provide a comprehensive analysis of the evolution and typology of business ecosystems in the global economy and to develop a conceptual framework for the formation of a resilient innovation ecosystem in Ukraine. The study contributes to the existing literature by integrating comparative analysis of global models with practical recommendations tailored to the Ukrainian context, thereby bridging the gap between theoretical research and policy-oriented applications.

1. Evolution and Conceptual Foundations of Business Ecosystems: Typology and Logic of Functioning in the Digital Economy

Today, business ecosystems are studied by numerous scholars, research centers, and companies, as this field is becoming increasingly relevant and important for shaping and developing the innovative potential of advanced economies and developing countries. Currently, research on business ecosystems can be divided into two main directions. The first direction focuses on analyzing the transformation of ecosystems into a new form of competition, where companies act as centers of networks of partners and complementary services [1], as well as on the specific features of how firms build innovation ecosystems to ensure the continuous generation of new ideas and innovations through ecosystem-based partner networks. It has been demonstrated that ecosystem-based companies (Apple, Google, Amazon, Tencent, Alibaba) exhibit greater adaptability during crises compared to traditional vertically integrated corporations [2]. The second direction is related to the study of ecosystem strategies in the context of value creation and distribution mechanisms, as well as partnership models [3], the expansion of value creation sources compared to traditional supply chains [4], and the role of entrepreneurial ecosystems and digital ecosystems in the development of an innovation-driven economy [5; 6].

In recent years, domestic scholars have intensified research on business ecosystems as multi-level complex adaptive systems of socio-economic development. On the one hand, studies analyze the relationships between ecosystems and economic growth, innovation activity, and competitiveness [7]. On the other hand, they explore approaches to the formation and development of innovation ecosystems in the context of the importance of public policy as a tool for coordinating ecosystem processes and adapting international experience to Ukrainian conditions [8]. A number of authors examine the institutional conditions and innovation infrastructure of business ecosystems in Ukraine (including environmental fragmentation, development barriers, insufficient funding, and weak coordination among participants) [9], as well as identify promising directions for the development of Ukraine's startup ecosystem, particularly digitalization, transformation of partnership models at the regional level, and spatial differentiation of startup activity as a driver of economic growth and modernization [10]. Some studies focus on the functioning of Ukraine's startup ecosystem (particularly in defense technologies) and the adaptability of Ukrainian startups under martial law and in post-war recovery conditions, considering business relocation, human capital losses, and increased uncertainty [11]. However, the dynamism, multidimensionality, and global nature of modern business ecosystems necessitate further research in this field, particularly in the context of business model transformation, hybrid approaches, and platform thinking.

Modern business ecosystems represent an evolutionary phenomenon that emerged as a result of the transformation of local enterprise networks into dynamic open systems of relationships among business, government, science, investors, and consumers. The nature, scale, key objectives, and mechanisms of interaction among ecosystem participants determine their successful functioning and depend not so much on size or financial resources as on the ability to establish effective connections, respond to technological challenges, and jointly implement innovation and investment projects. The emergence of new technologies, the development of startups, and the dynamics of business ecosystems in the modern global market – as powerful drivers of economic development – are intensifying and demonstrating the capacity to transform international business, create new industries, and stimulate innovation.

In this regard, analyzing the current state of international business ecosystems and ecosystem entrepreneurship, as well as approaches to their classification, structural features, and levels of maturity in light of contemporary global challenges, requires the use of interdisciplinary approaches. These include elements of systemic, structural-functional, comparative, and foresight analysis, as well as qualitative content analysis and classification modeling to construct a typology of business ecosystems.

The concept of the "business ecosystem" was first introduced in 1993 by James F. Moore, who viewed companies as economic organisms co-evolving within networks of partners, suppliers, and customers [12]. Today, a business ecosystem can be understood, on the one hand, as a structure within which multiple products and services operate together around a single platform or brand to provide consumers with integrated solutions. On the other hand, it is a model of business organization in which a company interacts with a large network of partners, customers, suppliers, developers, and services that collectively create unified value for users. In such a system, companies do not operate in isolation but form an interconnected environment of products and services.

The *primary objective* of business ecosystems is both to scale business operations and generate additional revenue streams, as well as to retain customers within a unified service environment and accelerate innovation through partnerships. In general, as networks of interconnected firms, business ecosystems are characterized by the following *key features*: (a) network effects (the more participants, the greater the value); (b) platform orientation; (c) long-term partnerships; (d) co-creation of value; (e) service integration. The core elements of a business ecosystem include: 1) the core (a company that creates the main platform or infrastructure); 2) partners (other companies that expand system capabilities); 3) users/consumers; 4) developers/innovators who create fundamentally new solutions based on the platform; 5) infrastructure and rules (technologies, standards, APIs, marketplaces, etc.) [13, pp. 21–42].

Regarding the typology of business ecosystems, Boston Consulting Group identifies two main models: "Transaction ecosystems" (platforms that connect market participants, such as Amazon Marketplace or Uber and "Solution ecosystems" (networks of companies providing integrated solutions, such as smart home, mobility, or fintech ecosystems) [14; 15]. Formal ecosystems have clearly defined institutional structures, while informal ecosystems rely on trust-based networks and informal practices. Hybrid systems combine both approaches.

The type of business ecosystem depends on what constitutes the center of interaction – platform, innovation, value chain, customer needs, or industry. In strategic management, both narrow and extended classifications are used. The narrow typology distinguishes four basic types: innovation ecosystems (creation of new technologies); transaction ecosystems (market organization platforms); integrated solution ecosystems (comprehensive customer services); financial ecosystems (marketplaces combined with insurance, mobile services, and investment platforms) [16, pp. 36–42].

The extended typology distinguishes the following types of business ecosystems (according to the existing classification, they are most often divided by function, structure, or the role of participants) [17, pp. 28–47]:

– a ***platform business ecosystem***, which is built around a digital platform (marketplace), is characterized by openness to external developer-innovators and unites various market participants on the basis of an enhanced network effect. Modern, most typical examples are the company Apple (App Store + devices + developers = iPhone, App Store, iCloud, Apple Pay, Mac, Apple Watch), the company Google (Android, Google Play, Gmail, YouTube, Google Cloud), the company Amazon (Marketplace, AWS, Prime, Alexa = producers/sellers + consumers/buyers);

– an ***innovation business ecosystem***, which represents a network of companies/organizations that jointly create new technologies/products and accelerate innovation (universities, startups, corporations, investors, research centers). Today, examples of such business ecosystems in the USA are Silicon Valley and startup ecosystems around companies such as Tesla or NVIDIA;

– a ***value chain business ecosystem***, within which companies are integrated into an extended chain (manufacturers, suppliers, logistics companies, distributors) and form a cooperative network for product creation (for example, the automotive ecosystem around the company Toyota);

– a ***customer business ecosystem***, which is formed around the constantly growing needs of the customer (rather than a single product), while the provider company offers a комплекс of services across different segments of the consumer market. Examples include the company Alibaba Group (e-commerce, finance, logistics, cloud services, media) and the company Tencent (messaging, payments, games, services);

– an ***industrial business ecosystem*** is a network of companies that jointly form an entire industry or technological standard. It includes manufacturers, technological partners, service companies, as well as national regulators (for example, the electric vehicle ecosystem around the company Tesla – batteries, charging stations, software, suppliers).

The features of modern business ecosystems are: a) openness, flexibility, and network character, as well as the ability to self-regulate (each subject/element is interconnected with others and at the same time retains autonomy in decision-making); b) significant transformational potential and the ability to respond to external challenges (digitalization, globalization, changes in consumer behavior); c) creation of added value through cooperation (not only competition) and synergy based on joint innovative activity even under conditions of extraterritorial changes in the global environment; d) the formation not only of a structure with clear rules, incentive mechanisms, and digital infrastructure, but also of a specific "structure of trust" both toward institutions and among partnership participants (knowledge exchange, joint investments, and implementation of long-term development strategies) [18].

Today, the advantages of business ecosystems under conditions of global competition are associated with accelerated integration of new technologies, attraction of intellectual capital, and transformation of value propositions for actual and potential consumers. Currently, according to business ecosystem theory and the concept of strategic management, there exists the so-called "four roles model of companies", which, firstly, explains the features, principles, and forms of business behavior of different firms in the context of conducting their own commercial activities within the ecosystem. Secondly, it describes their roles and strategic positions within the network of partners, suppliers, and customers.

The leading subject is the ***keystone company*** (key organizing company), which creates the platform or infrastructure on which other ecosystem participants operate, but does not control everything; rather, it provides an appropriate environment for the development of other participants in the business ecosystem. Functionally, it establishes rules and standards, coordinates interaction among participants, and maintains the stability of the technological platform for the successful activity of all companies within the ecosystem.

Another subject of the model is the ***dominator***, which seeks to rigidly control most of the ecosystem by displacing other participants. It controls resources, the value creation chain, and vertical integration within the business ecosystem (especially through voluntary and aggressive acquisition of partners), restricts competition, and accumulates the main share of ecosystem profits. This partially weakens the business ecosystem, as cooperation becomes less beneficial for other participants under such conditions.

The most widespread role in the business ecosystem belongs to ***niche players***, which complement the platform, create innovations, specialize in narrowly functional areas, do not manage the ecosystem, but create a significant part of its value (developers of iOS applications, sellers on the Amazon platform, game studios for Android, etc.).

Another subject of the model is the ***hub landlord*** – a company that controls a critical node of the business ecosystem but does not actively invest in its development. It does not stimulate innovation, but generates profit through commissions, rent payments, and access to infrastructure objects within the business ecosystem platform.

As modern practice shows, the most effective business ecosystems today are those that have 1–2 keystone companies (examples include Apple, Google, and Microsoft) and thousands of niche players, which ensures real innovativeness and scale. At the same time, keystone companies do not simply produce a product – they organize a business ecosystem in which others create value [19].

These features fundamentally change the landscape of modern competition. The classical model of competition developed by Michael E. Porter is an industry-based approach, explaining how companies compete within a single industry (the five forces model). However, in the digital economy, companies that build business ecosystems increasingly prevail, because competition has shifted from the level of companies to the level of networks of partners, developers, services, and platforms. The more participants there are, the greater the value of the system, and this is the key factor of success for platforms such as Amazon or Alibaba Group (more sellers → more buyers; more buyers → more sellers), whereas in Porter's classical model it is company ↔ company and industry ↔ industry. In a traditional industry, innovation is created by the company itself, while in a business ecosystem innovations are created by thousands of partners (for example, millions of developers create applications for Android, thousands of startups build services on Amazon Web Services, etc.).

In Porter's model, entry barriers are capital, technologies, and brand, while in a business ecosystem an additional powerful barrier appears – the network of participants. Therefore, it is very difficult for a new company to accumulate millions of users, thousands of partners, and integrated services. Business ecosystems generate enormous volumes of data, which makes it possible to personalize services (the more services a subject uses, the harder it is to switch to a competitor), optimize pricing, and create new products, thereby providing a significant competitive advantage. Thus, competition occurs between entire networks (a network effect is created), platforms often form quasi-monopolies, and the business ecosystem itself evolves faster than a single company. The comparison of classical (industry-based, according to M. Porter) and modern business ecosystem strategies is presented as follows (Table 1).

A modern formed business ecosystem always has a central platform (core platform), which can take the form of an operating or payment system, a marketplace, or cloud infrastructure, around which a technological or market center of attraction is created and a network is formed (for example, Apple: iOS + App Store; Amazon: marketplace + logistics + AWS; Microsoft: Windows + Azure).

The network effect is created through the involvement of participants (partners & developers) – developers, sellers, suppliers, content partners, and startups that develop innovative products and processes based on the provision by the main keystone company of the appropriate infrastructure and tools (API, SDK, developer platforms, marketplaces). Network effects operate only under the condition of a large number of users, a global market, and a strong brand. For example, Apple, Google, and Amazon allow thousands of companies to create their own services based on their infrastructures [20].

Table 1

Comparison of classical and business ecosystem strategy approaches

Classical strategy	Business ecosystem strategy
competition of companies	competition of networks
industry boundaries	cross-industry platforms
own resources	partners' resources
linear value chain	value creation network
slow innovations	mass co-innovation

Source: developed by the authors

At the same time, a successful business ecosystem must, firstly, have a beneficial revenue model for all participants (revenue sharing, transaction payments, commissions, etc.) – partners must generate profit together with the platform. Secondly, it must be governed accordingly through platform algorithms, standards and rules, certification, and quality control, while the keystone company carries out coordination interaction in the process of value creation. Thus, an ecosystem is not just a business, but a complex hierarchical network of "organizations of shared interests." If a company begins to compete with its partners, the business ecosystem collapses – partners fear that the platform may copy their product and displace them from the market or change the rules; therefore, a "balance of power" and a fundamentally new managerial logic are required to avoid conflicts of interest.

One of the main trends of the modern global economy is the formation of a new type of business ecosystems – AI ecosystems, in which, unlike previous platforms (mobile, social, or e-commerce), the center is formed by AI models, Big Data, and advanced computing infrastructure (developers and startups, end AI applications, etc.). According to existing forecasts, in the medium term (the 2030s), they will become a significant driver of economic development of advanced economies [21]. An AI ecosystem is an "operating system of intelligence," a kind of network of companies, developers, and services that function on the basis of a shared AI platform.

The foundation of the architecture of an AI business ecosystem is computing infrastructure (GPUs and data centers of NVIDIA, Microsoft, Amazon, and Google) plus large language models or multimodal systems (foundation AI models). The key players in this market today are the "core of intelligence" of the ecosystem – companies such as OpenAI, Anthropic, Google DeepMind, and Meta Platforms, which use AI platforms for developers (for example, Azure AI and Google Vertex AI, which are analogous to the App Store for AI applications).

AI startups, using these models, develop thousands of services – AI design, AI programming, AI medicine, AI finance, AI marketing – thus effectively forming the economy of AI applications. At the same time, Big Data is transformed into the main resource – the more data an ecosystem has, the better the models, the stronger the network effects, and the greater the competitive advantage.

The formation and development of AI business ecosystems significantly change the principles, social orientations, and, in general, the structure of Industry 4.0. Firstly, AI is becoming a new general-purpose technology similar to electricity, the Internet, or computers, as it penetrates all industries – from manufacturing and finance to medicine, education, and logistics. Secondly, new AI platform monopolies are gradually emerging, similar to Google (dominance in information search) and Amazon (cloud technologies). Thirdly, new markets are "born," as AI creates entirely new industries: AI agents, autonomous robots, personal AI assistants, AI design, AI medicine. The structure of companies is also significantly changing – AI enables the creation of small firms (10–20 employees), while powerful companies, using AI, can create products/services that previously required hundreds of employees [22].

AI business ecosystems may become a new stage in the development of the digital economy, meaning that the economy may shift from a "platform economy" to an "AI ecosystem economy," where key assets will be computing resources, Big Data, and AI models, and where companies compete not simply through platforms but through intelligent systems that create and coordinate thousands of AI services. Structurally, the AI economy can be represented as a four-level pyramid: level 1 – infrastructure; level 2 – AI models; level 3 – AI platforms and developers; level 4 – thousands of AI applications and billions of users.

According to forecasts, by 2030 the formation of global AI ecosystems will most likely be concentrated around several companies that already control these key elements. Analysts identify approximately eight companies that have the greatest potential to become the "cores" of such business ecosystems (Table 2).

Table 2

Companies as "cores" of AI business ecosystems in the modern global technology market

Company	Key assets	Strategy
Microsoft	partnership with OpenAI, Microsoft Azure platform, AI in Microsoft 365, integration of AI into Windows and GitHub	AI for work and business infrastructure
Google	Google DeepMind, Google Cloud AI platform, Android ecosystem, YouTube and search data	AI as the foundation of internet services
Amazon	Amazon Web Services, AI tools for developers, large-scale e-commerce infrastructure	AI infrastructure for business
NVIDIA	majority of GPUs for AI models, CUDA software platform, AI computing systems	development of most AI models for business
OpenAI	large language models, AI applications ecosystem, APIs for developers, mass use of AI assistants	creation of a universal AI platform of intelligence
Meta Platforms	Llama models, social platforms, large-scale data sets, VR/AR platforms	AI + social networks + metaverse
Apple	iPhone, Mac, proprietary chips, device ecosystem	on-device AI (AI directly on user devices)
Tencent	WeChat super-app, gaming industry, financial services, cloud platforms	AI ecosystem within a super-app

Source: [23]

2. Global Architecture of Business Ecosystems and New Drivers of Competition among Technological Blocs

Today, the global economy is increasingly organized around several large digital business ecosystems that control platforms, Big Data, users, and markets. In fact, several distinct types of business ecosystems have emerged, which differ depending on what the platform is organized around: technology, finance, consumer services, industry, etc. In strategic management, it is usually customary to distinguish approximately seven main models [24, pp. 42–66]:

I. *BigTech ecosystems* – currently the most influential type of business ecosystems, formed on technological platforms that combine hardware/devices, software, cloud services, marketplaces, and digital services. Their features include global scale, enormous network effects, and effective control over platforms. Examples of BigTech business ecosystems today include: Apple (iOS, App Store, iCloud); Google (Android, Google Play, cloud); Microsoft (Windows, Azure, Office); Amazon (marketplace + AWS);

II. *Super-app ecosystems* – platforms that integrate many services within a single mobile application and include payments, delivery, e-commerce, and social functions (they are widespread in the Asian region, for example, WeChat by Tencent, Grab, Gojek);

III. *FinTech ecosystems*, which are formed around banking and payment services (insurance, investment, lifestyle services, etc.). Today, examples of financial business ecosystems include Ant Group, PayPal, JPMorgan Chase;

IV. *E-commerce ecosystems* are built around online trade, act as commercial infrastructures for thousands of businesses, and include marketplaces, logistics, payments, advertising services, and cloud services (Amazon, Alibaba Group, MercadoLibre);

V. *Industrial ecosystems* – networks of companies that create complex technological systems (with technological standards and production networks/chains of manufacturers, suppliers, engineering companies, and service providers). Modern examples include the electric vehicle ecosystem around Tesla and the industrial platform Siemens;

VI. *Media-content ecosystems* are created by thousands of independent participants around content and the creative industry, combining studios, authors, streaming services, and advertising platforms (Netflix, Disney, YouTube by Google);

VII. *Smart-life ecosystems* combine digital services for everyday life – smart home, transport, finance, medicine, entertainment. Examples include the Apple device ecosystem, Google smart-home platform, and Xiaomi IoT ecosystem.

Currently, a new trend in the development of business ecosystems is that the strongest corporations attempt to combine several types of ecosystems simultaneously and effectively create *hybrid business ecosystems*, which allows them to control not only a market or an industry, but an entire digital ecosystem of user life. Therefore, today it is no longer about competition through products/services, but about competition between business ecosystems with their users, platforms, Big Data, and AI models.

Indeed, the modern world economy is gradually shifting from a globalized economy to ecosystem-based technological blocs, the main actors of which are American platforms, Chinese platforms, and European technological chains, which effectively form three different digital economic systems. These are informal economic "spheres of influence," where key technological platforms, data, and digital standards are controlled by large corporations of a particular region – this reflects the ecosystem fragmentation of the global economy. The drivers of their formation include technological sovereignty (states seek to control data, AI, and digital infrastructure), the geopolitics of technology, and the achievement of advantages by national companies through network effects (platforms create their own standards and closed ecosystems) (Table 3).

The *American technological bloc* is the global standard of the digital economy and the most powerful digital business ecosystem in the world. Its main platforms today include Apple, Microsoft, Amazon, Google, Meta Platforms, and NVIDIA, which control cloud computing and operating systems, mobile platforms and social networks, AI infrastructure, and global developer ecosystems. The geographical scope of influence of this bloc extends to North and South America, Japan, South Korea, and Australia.

The elements of Apple's personal digital device business ecosystem include App Store, iCloud, Apple Music/Apple TV+, Apple Pay, Mac, iPad, and Apple Watch. The key strategy of Apple's business ecosystem platform is the integration of devices and services through control over premium smartphone markets, mobile applications, digital services, and wearables.

Table 3

The largest global ecosystems and the spheres of the global economy they control

Sphere	Who dominates
smartphones and digital devices	Apple (USA)
corporate software	Microsoft (USA)
e-commerce	Amazon / Alibaba Group (China)
internet infrastructure	Google (USA)
social networks	Meta Platforms (USA)
super-apps	Tencent (China)
content algorithms	ByteDance (China)
electric vehicles	Tesla (USA)
IoT and smart-home	Xiaomi (China)

Source: [25]

As an ecosystem of the corporate digital environment, Microsoft controls corporate IT infrastructure, business productivity, and cloud services (enterprise software + cloud), with components such as Windows, Office/Microsoft 365, Azure, LinkedIn, GitHub, and Xbox.

The business ecosystem of Amazon as a global commercial infrastructure controls online trade, cloud computing, and e-commerce logistics, with elements including Amazon Marketplace, Amazon Prime, AWS, Alexa, and Twitch.

Google – as an Internet infrastructure business ecosystem – controls search, digital advertising, mobile operating systems, and video platforms through components such as Android, Google Search, YouTube, Google Maps, Google Cloud, and Chrome.

Meta Platforms is the world's largest social communication ecosystem, functioning based on elements such as Facebook, Instagram, WhatsApp, Messenger, and VR platforms.

A distinctive feature of the formation of the American business ecosystem is its *innovation-market model* – a bottom-up model, in contrast to the EU (policy-driven) and China (state-driven). It combines, firstly, the state as a catalyst (rather than a dominant actor) in creating institutional conditions (law, investor protection, competition) and utilizing key institutions (DARPA, NSF, SBIR/STTR programs). Secondly, private capital (under conditions of its dominance), primarily providing venture financing. Thirdly, a university-innovation base, where a key role is played by the “triumvirate” of higher education institutions – MIT, Stanford, and Harvard – in the context of implementing the Triple Helix model (University – Industry – Government). Fourthly, a cluster structure that functions through both major existing hubs – Silicon Valley (AI, BigTech), Boston (biotech), Austin (startup ecosystem), New York (fintech, media) – and AI ecosystems in mid-sized US cities (deconcentration – the rise of regional hubs) [26, pp. 33–46].

The US innovation-technological business ecosystem is characterized by clearly structured “rules of the game,” long-term state strategies for supporting entrepreneurship, and systemic interaction between government bodies, universities, and the private sector. Its main goal is a “technological breakthrough,” growth of venture capital, scaling of startups, attraction of investment, and technological expertise. The United States continues to dominate the global innovation system – it remains the leading country in the accumulation and use of venture capital and a center of AI innovation, which is becoming a fundamental component of Industry 4.0 infrastructure and a driver of productivity and efficiency. Currently, the main principles of functioning of the American business ecosystem are as follows [27]:

– the principle of *open innovation* (companies actively cooperate with startups, universities, and venture funds);

– the principle of *platformization* (Platform Economy) – dominance of platforms such as Amazon, Google, Apple;

– the principle of *scalability* – orientation toward global markets and exponential growth;

– the principle of *entrepreneurial risk* – tolerance to failure (fail fast → scale fast);

– the principle of *network effects* – value increases with the number of participants;

– the principle of *talent-driven economy* – focus on human capital (today 73% of US companies invest in talent development).

The *latest trends* in the American business ecosystem are associated with transformations of corporate models under conditions of rapid development of platforms and ecosystem hubs. They can be structured as follows:

AI as the core of ecosystems (more than 70% of companies actively implement AI as new economic infrastructure) and the transition to generative AI and agent-based systems;

Platform + AI convergence (formation of AI-platform ecosystems and automation of business processes, marketing, and customer service);

DeepTech and dual-use technologies in the context of increasing influence of national security on innovation (growth of quantum tech, defense tech, space tech);

Creator economy (development of individual small and medium platform entrepreneurship, e.g., Substack, Patreon);

D2C and hyper-personalization (Direct-to-Consumer models and use of AI for personalization);

Green and Sustainable Tech (green economy + AI + clean energy → reduction of harmful emissions) [28].

Thus, the American business ecosystem today is a network-based, decentralized, innovation-oriented system based on private capital, technological leadership, open innovation, and platform logic. Its structure evolves according to the following trajectory: *"Industrial economy → Digital economy → Platform economy → AI-driven ecosystem economy"*.

The *Chinese digital bloc* is a parallel technological business ecosystem, whose main platforms are Alibaba Group, Tencent, ByteDance, Huawei, and Xiaomi. The key features of their formation and functioning include enhanced state support, proprietary technological standards, the combination of e-commerce and FinTech, and the integration of payment systems. In terms of geographical influence, this refers to Southeast Asia, parts of Africa, and certain countries in Latin America.

Alibaba Group is a Chinese commercial ecosystem with more than 1 billion users within its trading ecosystem, which includes Taobao, Tmall, AliExpress, Alibaba Cloud, Cainiao logistics, and financial services. Tencent is a super-app business ecosystem centered around WeChat ("a digital operating system of life in China") with the following components: payments, social networks, games, content, and cloud services. ByteDance is a digital content business ecosystem that is currently one of the fastest-growing media ecosystems, including TikTok, Douyin, CapCut, an advertising platform, and AI algorithms. Xiaomi is a smart-life ecosystem connecting hundreds of thousands of devices and functioning through components such as IoT devices, smart home solutions, wearables, and electric transport.

China's business ecosystem is a centralized (state-coordinated), integrated (platform-oriented), and strategically managed system that combines state governance with market mechanisms. The evolutionary trajectory of this highly dynamic model is as follows: "industrial economy → digital platform economy → state-driven AI ecosystem" [29, p. 33-42]. Government initiatives (in particular industrial development programs) define technological priorities, which direct investment flows and shape the architecture of the business ecosystem. A significant factor is the scale of the domestic market, which allows rapid testing of innovations, scaling of business models, and achieving network effects without critical dependence on external markets.

The functioning of the business ecosystem is based on the centralized definition and coordination of actions among key organizing entities of digital platforms (Alibaba Group, Tencent, Huawei), which form *super-ecosystems* that integrate finance, trade, communications, and services, operating in close interaction with state institutions. Priority is given to the rapid implementation and replication of innovative solutions by large technology companies [30]. At the same time, the ecosystem covers the entire value creation chain – from production to digital services – while large volumes of data ensure the development of AI, analytics, and real-time system management. The spatial organization of the ecosystem is based on *megaclusters*, among which the key ones are Shenzhen, Beijing, Shanghai, and Hangzhou. These combine manufacturing, science, and digital platforms into a single system, and their strategic goal is to reduce dependence on imported technologies.

Today in China, digital platforms are increasingly covering manufacturing, logistics, financial technologies, public administration, and healthcare. The green transformation is associated with increasing investments in renewable energy, electric transport, and energy-efficient technologies, while priority areas of DeepTech development include semiconductors, quantum technologies, and the space sector. All of this forms part of the *"dual circulation" strategy* – the combination of the domestic market and controlled globalization [31]. It is expected that China's business ecosystem will develop toward strengthening technological autonomy, expanding state innovation clusters, global expansion of digital infrastructure, and leadership in industrial AI.

The *European ecosystem bloc* represents a different model – less platform-based and more regulatory and industrial – whose main players include SAP, Siemens, ASML (a monopolist in EUV lithography for microchip production), Spotify, and Adyen. Europe does not dominate in Big Tech but controls critical technological segments in industrial technology, semiconductor equipment, enterprise software, FinTech, and DeepTech.

The network of interconnected economic actors within the European business ecosystem includes companies and corporations, startups and innovative enterprises, universities and research centers, financial institutions, government regulators, development institutions, and innovation funds. In essence, this is an innovation ecosystem / triple helix model, which involves creating an innovation environment where business, government, and science function as a unified system. Unlike other models, in Europe the state actively shapes the conditions for business development through key institutions such as the European Commission, the European Investment Bank, the European Innovation Council, and the European Institute of Innovation and Technology, which finance innovation, startups, technological clusters, and the green economy. Thus, the European model focuses on sustainable development and is based on the concept of a Green + Digital + Inclusive Economy, implemented through key programs such as the European Green Deal, Horizon Europe, and the Digital Europe Programme [32].

Today, European business is organized into regional innovation clusters (for example, Silicon Saxony, Sophia Antipolis, Cambridge Science Park), which combine universities, corporations, startups, and investors. The main development trends of the European business ecosystem include the green economy, DeepTech, quantum technologies, digital sovereignty, and AI regulation. At the same time, the European business ecosystem is characterized by high competition standards, strict antitrust control, and data protection ensured by the key regulatory framework – the General Data Protection Regulation (GDPR). A distinctive feature is that European companies actively operate in transnational networks, while startups are financed through venture funds, business accelerators, and EU grant programs for national governments and regional institutions. Currently, the EU invests approximately 2.2–2.3% of GDP in R&D (compared to 3.4% in the USA and 2.6% in China); more than 35,000 technology startups operate within EU countries, and venture investment during 2020–2025 amounted to approximately $90–110 billion annually [33].

Unlike the entrepreneurial model of the U.S. business ecosystem (strong venture capital, rapid startup scaling, low regulation) and the Chinese state-corporate innovation model (state planning, large-scale investment, rapid digitalization), the European business ecosystem is an institutionally balanced model. First, it combines government regulation, innovation markets, a scientific base, and social responsibility; second, it is less aggressive than the U.S. model and less centralized than the Chinese model, yet it ensures sustainable long-term innovation development.

Currently, the EU is implementing a strategic model for the development of the innovation economy called "*European Innovation Ecosystem 2030*" (EIE-2030): "technological sovereignty + sustainable development + digital integration," which is based on the transition from fragmented national innovation systems to a unified supranational European innovation business ecosystem. The main goal of EIE-2030 is to create an innovation platform that ensures: 1) technological independence of Europe; 2) acceleration of innovation commercialization; 3) integration of science, business, and government; 4) formation of globally competitive technological corporations.

The architecture of the EIE-2030 model includes five structural levels [34; 35]:

– the *research sector* involving universities, research centers, and laboratories, including institutions such as the Max Planck Society, Fraunhofer Society, and CERN;

– the *startup ecosystem*, which provides major EU startup hubs in Berlin, Paris, and Stockholm;

– *venture capital*, financing innovation through venture funds, development banks, and institutional investors (key institution: the European Investment Fund);

– *industrial technological clusters* integrating production, innovation, and startups (e.g., Sophia Antipolis, Silicon Saxony);

– *digital infrastructure* as the foundation of the new innovation ecosystem (cloud technologies, supercomputers, and quantum networks), within the framework of the EuroHPC Joint Undertaking.

The EIE-2030 model is based on four key principles. First, the principle of technological sovereignty, aimed at reducing EU dependence on external technologies in AI, quantum technologies, semiconductors, and cybersecurity (key program: the European Chips Act). Second, the principle of integrated innovation networks, which involves creating pan-European innovation hubs combining universities, tech companies, venture funds, and startups (e.g., EIT Digital, EIT InnoEnergy). Third, the principle of green technological transformation, aimed at achieving climate goals through hydrogen energy, smart grids, circular economy solutions, and new materials. Fourth, the principle of open innovation, under which the European model actively utilizes joint research, technological alliances, and transnational startup ecosystems [36].

Key technological areas of EIE-2030 include:

1. Artificial Intelligence (with an ethical and regulated approach under the EU Artificial Intelligence Act);

2. Quantum Technologies (quantum computing, cryptography, and sensors under the Quantum Flagship program);

3. GreenTech (hydrogen technologies, renewable energy, smart cities);

4. BioTech (genomics, biopharmaceuticals, and medical innovations).

Thus, the main strategic goal of EIE-2030 is to transform the EU into one of the three global centers of technological development alongside the United States and China through accelerated development of digital infrastructure and international cooperation. At the same time, key internal challenges include fragmentation of innovation markets and a shortage of venture capital, while external challenges include strong competition from the U.S. and technological expansion from China.

Currently, the EU has begun developing the concept of the "*Pan-European DeepTech Ecosystem 2040*" (PEDE-2040) as an integrated supranational innovation system aimed at creating and commercializing breakthrough technologies (DeepTech) by combining scientific potential, venture capital, industrial clusters, and digital infrastructure into a single ecosystem [37]. DeepTech refers to technologies based on fundamental scientific discoveries with long commercialization cycles (quantum technologies, AI, biotechnology, new materials, nanotechnology, space technologies, photonics, and neurotechnologies).

The PEDE-2040 concept envisions a transition from regional innovation clusters to a fully integrated European technological space operating under the principle: “open innovation + strategic autonomy + transnational scientific cooperation.” Its strategic goal is to form by 2040 a unified pan-European DeepTech space capable of competing with the technological ecosystems of the U.S. and China through stronger integration of research into production, accelerated commercialization, scaling of DeepTech startups, and creation of next-generation technological corporations.

It supposed the creation of a Pan-European Research Grid (a network of universities and laboratories), specialized technological clusters (15–20 pan-European DeepTech clusters by 2040), and startup scaling (“startup-to-scaleup gap”) on a powerful digital base including supercomputers, quantum networks, and cloud computing (EuroHPC Joint Undertaking initiative). Overall, the architecture of PEDE-2040 consists of six functional levels [38]:

1) fundamental science (generation of new knowledge);
2) technological platforms (technology transfer institutions responsible for patenting, prototyping, and commercialization);
3) DeepTech startups acting as technological innovators;
4) venture capital (venture funds, sovereign funds, development banks);
5) industrial corporations scaling technologies;
6) global markets as arenas for integration into the world economy.

According to forecasts, implementation of this concept will enable the EU to establish itself as a global center of technological innovation alongside the U.S. and China.

Regarding the main drivers of the EU DeepTech economy, by 2040 R&D spending is expected to increase to 4% of GDP, and innovation investment to approximately €1.5 trillion annually. It is projected that from 2025 to 2040 the number of DeepTech startups will grow sixfold (from about 25,000 to 150,000), venture investment will increase about 4.5 times (from approximately €110 billion to €500 billion), and the number of DeepTech companies will rise from about 350 to around 2,000. The overall share of DeepTech in GDP is expected to reach 15–18% [39] (Table 4).

Table 4

Comparative characteristics of business ecosystems in the USA, EU, and China

Parameter	USA	EU	China
Model type	Market-platform	Regulatory-industrial	State super-app
Governance	Decentralized	Multi-level	Centralized
Coordination	Market-based	Political-institutional	State-driven
Platforms	Global	Limited	National
Key driver	Private capital	Institutions and policy	State strategy
Key actors	BigTech + startups	DeepTech + institutions	State + digital conglomerates
Clusters	Competitive	Regional	Megaclusters
Innovation logic	Disruptive (open innovation + venture capital)	Cooperative (collaborative innovation + regulation)	Strategic (state-directed innovation)
Structural differences	Dominance of venture capital, global platform leadership, high innovation flexibility	Strong regulatory environment, focus on sustainable development, fragmented but integrated structure	State strategic governance, rapid scaling, integration of digital and industrial economy
Competitive advantages	Technological leadership, scalability, talent concentration	Regulatory strength, leadership in sustainability, industrial base	Speed of implementation, market scale, strategic coordination
Weaknesses	Social inequality, BigTech dominance	Slow innovation, market fragmentation	Dependence on the state, geopolitical risks
Future development trajectories	AI ecosystem economy	"Green" digital economy	Technological sovereignty

Source: compiled based on [40; 41]

Thus, the modern global economy is transforming toward an ecosystem-based development model (Ecosystem Economy), while at the same time preserving three dominant models: the decentralized and innovation-driven American model, the regulated and sustainability-oriented European model, and the centralized and strategically managed Chinese model. It is precisely the competition among these models that shapes the architecture of the global economy in the 21st century. These models highlight the dynamism and flexibility of business ecosystems, their ability to evolve, adapt, and transform their missions in accordance with the market environment and global challenges.

According to existing research, the performance of business ecosystems is measured through a *system of multidimensional indicators (KPIs/metrics*) that cover economic, innovation, structural, and institutional efficiency. Unlike traditional companies, business ecosystems are evaluated not only by financial results but also by the quality of interaction among participants and the creation of shared value. The systematized model of indicators is as follows [42]:

– *Economic performance metrics,* which reflect value creation within the ecosystem – total value added (Value Creation), total revenues of ecosystem participants, level of investment (VC, PE, corporate funding), ecosystem ROI (return on ecosystem investment), ecosystem share in GDP/industry, ecosystem valuation. The key indicator is: *Ecosystem Value = Σ (Value generated by participants + network effects);*

– *Innovation metrics,* characterizing the ability to generate new solutions (number of startups/scale-ups, R&D expenditures (% of revenue), number of patents/licenses, speed of innovation commercialization (time-to-market), number of DeepTech projects, Technology Complexity Index);

– *Network and connectivity metrics*, assessing the structure and quality of interactions – network density, number of partnerships/alliances, collaboration index, level of participant integration (platform integration rate), strength of network effects;

– *Productivity metrics* – revenue per participant/employee, innovation productivity (innovation output per input), operational efficiency (cost reduction, time efficiency), scaling rate;

– *Institutional and governance metrics* – quality of the regulatory environment, level of state support, trust index among participants, presence of standards and interaction rules, degree of intellectual property protection;

– *Digital ecosystem metrics* – number of platform users, activity levels (DAU/MAU), volume of data exchange, API integrations, scalability index;

– *Socio-economic impact indicators* – number of jobs created, level of human capital (skills index), regional development, sustainability index (ESG), level of inclusiveness;

– *Resilience metrics* – resilience to crises (resilience index), diversification of participants, cybersecurity, adaptability rate.

In modern studies [43; 44], a generalized index is used – the *Ecosystem Performance Index (EPI)*, defined as:

$$EPI = f\,(Economic + Innovation + Network + \\ +Institutional + Digital + Resilience)$$

or in formalized form:

$$EPI = w1E + w2I + w3N + w4G + w5D + w6R$$

where:

– E – economic efficiency
– I – innovation
– N – network connectivity
– G – governance (institutions)
– D – digitalization
– R – resilience

Thus, since these indicators are interdisciplinary, the performance of business ecosystems is determined not only by economic and financial results but also by network and social effects – *interaction synergy*, where the key metric is the ability of the ecosystem to create and scale shared value faster than individual/isolated companies. In other words, "ecosystem performance = function of shared value creation + network effects + innovation dynamics" [45].

3. Innovative Transformation of Ukraine: From Fragmented Initiatives to Sustainable Business Ecosystems

In Ukraine, interest in the formation of business ecosystems is growing due to the accelerated development of the IT market (both nationally and across its regional segments) and innovation infrastructure. However, institutional instability and a highly turbulent environment limit their practical implementation. Against the backdrop of entrepreneurial initiatives, processes of consolidation and institutionalization remain largely chaotic and, to a significant extent, experimental. Weak integration of efforts between the public, private, and civil sectors results in existing business ecosystems (e.g., UNIT.City, Promprylad.Renovation, Lviv IT Cluster) operating within a single model of governance or financing.

The formation of national capacity for building business ecosystems in Ukraine depends on three components: the level of innovative development, a viable startup ecosystem infrastructure, and business incubation. In 2025, Ukraine ranked 66th out of 139 countries according to the Global Innovation Index (GII), which evaluates 80 indicators ranging from human capital and infrastructure to knowledge and technology outputs (in 2023 – 55th out of 132 countries [46]). Overall, the GII consists of two sub-indices: Innovation Inputs and Innovation Outputs. Ukraine's strengths (GII 2025) include:

a) development of the IT sector and IT outsourcing;

b) export-oriented technologies and integration into global value chains;

c) a high level of engineering talent and competencies;

d) strong education and human capital;

e) development of creative digital services, AI and IT design, and GovTech/e-government.

Ukraine's weaknesses (GII 2025) primarily include political instability, weak legal systems (115th place), and low government effectiveness (99th place) – currently the most critical constraint on innovation. The shortage of investment in innovation is linked to underdeveloped financial markets, low levels of venture capital, and limited access to financing. Infrastructure challenges in logistics (76th place) are directly associated with low levels of capital investment (125th place) and critically low R&D expenditures. Additionally, there is weak commercialization of science, regulatory risks, and significant constraints on competition due to the influence of oligarchic structures [47].

Thus, Ukraine demonstrates a structural asymmetry in innovation development (GII 2025), where strong Knowledge & Technology Outputs (education, knowledge creation, intangible assets) coexist with weak institutional environment, investment attractiveness, market maturity, and R&D investment. These structural imbalances in the innovation system are further exacerbated by wartime risks. A critically weak component is also state financial support (credit guarantees, tax incentives for innovative businesses, interest rate compensation). This results in a model of "innovation overperformance" driven by human capital but constrained by limited resources.

In comparing Ukraine and Poland under GII 2025, Poland (40th out of 139 economies) significantly outperforms Ukraine (66th), with a gap of

26 positions. This reflects a more developed regulatory environment, stronger institutional base, and better infrastructure. Poland also demonstrates advantages in stable innovation financing, stronger commercialization of knowledge, closer links between business and industry, deeper integration into European innovation networks, access to structural funds, and a well-developed technology transfer ecosystem. In other words, Poland possesses a more mature and systemically developed innovation ecosystem (Table 5).

Table 5

Comparison of Ukraine and Poland across 7 key GII 2025 pillars

Evaluation Format	GII Pillar	Ukraine	Poland	Interpretation
Strong side of Ukraine	Human capital & research	43	51	Ukraine outperforms Poland in human capital and research potential, indicating a strong educational and scientific base.
Relatively strong	Creative outputs	42	39	Minimal gap; Ukraine nearly matches Poland in creative industries and digital content.
Relatively acceptable	Knowledge & technology outputs	49	33	Ukraine shows decent performance, but Poland is more effective at commercialization.
Weak side	Institutions	105	68	Largest gap relates to institutional quality, regulatory environment, and predictability.
Weak side	Market development	87	32	Ukraine lags significantly in access to finance and capital markets.
Weak side	Business sophistication	78	42	Weaker interaction between business, science, and innovation infrastructure.
Moderately weak	Infrastructure	71	64	Slight lag in innovation, digital, energy, and logistics infrastructure.

Source: compiled from [48; 49]

Therefore, the comparative analysis shows that Ukraine's relative advantage lies in human capital and research potential, while its key structural weaknesses are institutional quality, market maturity, and business sophistication. This means that Ukraine's main challenge is not generating knowledge, but creating an effective environment for its commercialization, scaling innovations, and integration into sustainable business ecosystems. In this context, Poland's experience can serve as a practical *roadmap* (UaRoad Map) for transforming innovation potential into a sustainable ecosystem for economic growth.

The strategic goal of the proposed UaRoad Map is to build a sustainable Innovation & Resilient Business Ecosystem in Ukraine capable of increasing innovation activity, developing technological entrepreneurship, and commercializing scientific research. This will not only improve Ukraine's position in the GII and support integration into the European innovation space, but also ensure the implementation of five core principles:

1. Ecosystem approach – shifting from supporting individual firms to developing linkages among government, business, universities, investors, and startups.

2. Resilience-oriented development – focusing not only on growth but also on adaptability to military, economic, energy, and cyber risks.

3. EU integration logic – aligning innovation policy with EU standards and programs.

4. Digital-first model – prioritizing digital infrastructure, GovTech, DefenceTech, AI, cybersecurity, and DeepTech.

5. Smart specialization – concentrating resources on areas where Ukraine has or can quickly build competitive advantages.

Ukraine's sectoral specialization should focus on high-potential areas with structured support programs for key ecosystems: DefenceTech, AgriTech, AI/GovTech/Cybersecurity, EnergyTech/GreenTech, MedTech/BioTech, and LogisticsTech/Industrial Tech. The expected outcome is the formation of "points of international competitiveness" in these sectors.

The implementation program of the UaRoad Map includes three stages:

Stage I. Short-term (1–2 years):

– audit of innovation infrastructure;
– updating the national innovation strategy;
– launch of KPI monitoring systems;
– tax and regulatory incentives for startups;
– expansion of grant programs for science and startups.

Stage II. Medium-term (3–5 years):

– scaling clusters and technoparks;
– integration into EU programs;
– development of venture capital markets;
– strengthening technology transfer;
– creation of national DeepTech centers.

Stage III. Long-term (5–10 years):

– transition to a mature innovation economy model;
– sustainable growth of high-tech exports;
– positioning Ukraine as a regional innovation hub;
– increasing global competitiveness of business ecosystems.

The proposed UaRoad Map is designed to combine innovation development with ecosystem resilience in conditions of high external turbulence. Formally, it can be expressed as:

Sustainable Innovation Business Ecosystem of Ukraine =
"Institutions + Human Capital + Financing + Infrastructure + Clusters/ Networks + Digitalization + EU Integration"

When implementing the UaRoad Map, it is advisable to use five groups of KPI indicators to measure effectiveness:

1) *Institutional indicators* (Ukraine's position in the GII, quality of the regulatory environment, level of digitalization of public services);

2) *Scientific and educational indicators* (R&D expenditure as a share of GDP, number of patents, number of researcher-to-business projects, share of STEM graduates);

3) *Entrepreneurial indicators* (number of startups, volume of venture investments, number of scale-up companies, share of innovation-active enterprises);

4) *Ecosystem indicators* (number of clusters and innovation hubs, intensity of cooperation between universities and business, level of regional engagement, business ecosystem resilience index);

5) *Economic indicators* (share of high-tech exports, productivity of innovation sectors, contribution of DeepTech/IT/innovation business to GDP, number of jobs in high-tech industries).

Positive dynamics in these indicators will not only improve Ukraine's position in global innovation rankings but also help build a long-term model of a competitive, knowledge-based economy grounded in technology, digital infrastructure, and cross-sectoral cooperation.

Proposals for the practical implementation of the UaRoad Map include six key strategic directions structured as: *"Direction – Goal – Measures – Responsible actors – KPI – Expected result"* (Table 6).

Table 6

Key strategic directions for Ukraine's innovation development and strengthening business ecosystem resilience

Direction/Aim	Measures	Responsible	KPI / Result
1	2	3	4
1. Institutional strengthening of innovation policy / Improving the regulatory, organizational, and coordination environment	Updating national innovation strategy; creating a unified coordination mechanism; aligning policies of the Ministry of Education and Science, Ministry of Economy, Ministry of Digital Transformation, and regions; harmonizing regulations with EU practices; simplifying procedures for startups, spin-offs, and R&D firms	Cabinet of Ministers, Ministry of Economy, Ministry of Education and Science, Ministry of Digital Transformation, parliamentary committees, regional administrations	GII "Institutions" ranking; time to start a business; number of updated regulations; level of public service digitalization → Improved institutional environment and reduced administrative barriers
2. Human capital, science, and knowledge transfer development / Strengthening the scientific and educational base	Modernization STEM-education; support for research universities; grants for young scientists; talent retention programs; creation of technology transfer offices; support for university spin-offs; development of dual education	Ministry of Education and Science, National Academy of Sciences, universities, research institutions, business associations, international donors	R&D share in GDP; patents; university startups; tech transfer projects; STEM graduates → Stronger human capital and better science-business integration

(End Table 6)

1	2	3	4
3. Access to finance for innovation and startups / Building a sustainable financial base	Creation of a co-investment fund; R&D tax incentives; development of venture capital; guarantee programs for SMEs; attraction of Horizon Europe, EIF, EIB, EBRD funding; sector-specific tools (DefenceTech, AgriTech, MedTech, GreenTech)	Ministry of Economy, Ministry of Finance, National Bank, international financial institutions, private investors	Venture investment volume; number of funded startups; innovation-active firms; grants; scale-ups → Increased access to finance and startup ecosystem activation
4. Development of digital and innovation infrastructure / Creating a modern technological base	Expansion of broadband access; cloud infrastructure development; support for technoparks, incubators, accelerators; creation of regional innovation hubs; open data development; scaling digital services	Ministry of Digital Transformation, Ministry of Economy, local authorities, IT companies, donors	Internet coverage; number of hubs and parks; digital service usage; rankings → Strong infrastructure for innovation
5. Formation of resilient business ecosystems and clusters / Transition to network-based cooperation	Support for clusters; development of "university–business–startup–investor–state" platforms; ESG integration; crisis recovery mechanisms; interregional and international cooperation	Ministry of Economy, chambers of commerce, business associations, clusters, universities, local authorities	Number of clusters; joint projects; cooperation levels; resilience index → Stronger adaptability and knowledge exchange
6. Sectoral specialization and EU integration / Focus on priority sectors and integration into EU innovation chains	Support for priority sectors (DefenceTech, AgriTech, AI, Cybersecurity, EnergyTech, MedTech, LogisticsTech); smart specialization; participation in EU programs; integration into EU tech platforms; promotion of Ukrainian firms in EU markets	Cabinet of Ministers, ministries, export promotion office, regional agencies, EU institutions	High-tech exports; international R&D projects; participation in EU programs; GDP share → Stronger global competitiveness and EU integration

Source: developed by the authors

Thus, the systematization of strategic directions shows that improving innovation performance requires simultaneous strengthening across institutional, financial, human capital, infrastructure, and network dimensions. Only their integrated implementation will ensure long-term economic resilience and global competitiveness for Ukraine.

Currently, most startups in Ukraine are concentrated in IT, FinTech, and healthcare – sectors actively supported by international companies, investors, accelerators, and clusters. Ukrainian startups such as Grammarly, GitLab, People.ai, Restream, Promova, Ajax Systems, Salesdep.ai, and airSlate represent successful examples of digital business models (SaaS, marketplaces, AI-driven platforms). They demonstrate a shift from outsourcing toward high-value product creation with global scalability. A key feature of Ukrainian startups is their immediate focus on global markets – a “product-first + global-first economy” [50].

Analysis shows that currently in Ukraine, especially under conditions of war and transformational crisis, the existing investment instruments do not allow for fully leveraging the advantages of a hybrid approach: first, to effectively compensate for the weaknesses of certain sectors through the resources of others. Second, to adapt business ecosystems to the rapid scaling of individual solutions and to the ability for learning and interaction with new groups of beneficiaries. Third, to accelerate the transition from informal, unstable initiatives to formalized transparent structures with feedback mechanisms and sustainable procedures. In addition, the lack of a systemic approach to the formation of business ecosystems in Ukraine reduces the country’s competitiveness and investment attractiveness, limits the integration of Ukrainian business both into global and European business ecosystems, and restrains the realization of entrepreneurial potential. Therefore, the issue of Ukraine’s accession to the European Single Digital Market is currently particularly acute, which will allow not only exporting goods/services but also importing modern management practices, technologies, and attracting investment into ecosystem development.

The conducted research also indicates that under current conditions in Ukraine, the most important national trend is *glocalization* (a synthesis of global approaches and standards with local realities and cultural context). It is precisely due to this that Ukrainian ecosystems are increasingly not only implementing international practices (venture financing, acceleration programs, etc.) adapted to national environmental features, but also cooperating with global programs while preserving local identity.

Particular attention should be paid to the integrated system for assessing the sustainability of business ecosystems based on ESG indicators (Environmental, Social, Governance), which combine environmental, social, and governance factors. On the one hand, they are transforming into a key tool of strategic management, determining access to investment, the level of risks, and long-term competitiveness. On the other hand, they create conditions for attracting international investors and strengthening the reputation of Ukrainian business in the global market [51; 52]. In the context of Ukraine's European integration, this makes it possible to form competitive startup ecosystems capable of rapid transformation, technology transfer, digitalization, and entry into international markets, into global innovation networks of the world economy, without losing connection with the local context.

Conclusions

The conducted research makes it possible to formulate a number of generalized conclusions regarding the evolution, current state, and prospects for the development of business ecosystems in the global and national economy. First, business ecosystems have become a new dominant form of organizing economic activity, fundamentally changing the logic of competition – from competition between individual companies to competition between networks, platforms, and integrated value creation environments. Their development is based on network effects, platform architecture, open innovation, and cooperation among a large number of participants. Second, the modern global economy is characterized by the formation of various types of business ecosystems (BigTech, FinTech, e-commerce, industrial, super-app, smart-life, etc.), which are increasingly integrated into hybrid models. At the same time, ecosystem fragmentation of the world economy is taking place, where three key models dominate: the American (decentralized, innovation-driven, market-based, and platform-oriented), the Chinese (centralized, state-oriented, and integrated), and the European (regulatory-institutional, oriented toward sustainable development). It is the competition of these models that shapes the architecture of the global economy of the 21st century and the direction of its further transformation toward AI ecosystems. Third, the assessment of the effectiveness of business ecosystems is comprehensive in nature and includes economic, innovation, network, institutional, and digital indicators, reflecting not only financial results but also the ability to create shared value, scale innovations, and ensure resilience. Fourth, Ukraine has significant potential for the formation of business ecosystems due to strong human capital, the development of the IT sector, and integration into global technological value chains. At the same time, key constraints remain the weakness of the institutional environment, insufficient development of financial markets, low levels of investment in R&D, and fragmentation of innovation infrastructure. Fifth, for the transition to a sustainable model of innovative development, Ukraine needs to implement a systemic ecosystem approach that involves the integration of the state, business, science, and investors, the development of digital and innovation infrastructure, the stimulation of venture financing, and the strengthening of international cooperation, primarily within the European innovation space.

The proposed UaRoad Map forms a conceptual basis for the transition to a model of an "innovative and resilient business ecosystem," which is based on the combination of institutional capacity, human capital, financing, digitalization, and cluster cooperation. Its implementation will make it possible to transform Ukraine's existing structural advantages into long-term competitiveness, ensure integration into global business ecosystems, and form a new model of economic growth based on knowledge, technology, and network interaction. Thus, business ecosystems act not only as a tool of economic development but also as a strategic foundation for shaping a new economy, where the key success factors are innovation, cooperation, digitalization, and the ability to adapt under conditions of global change.

References:

1. Birkinshaw J. (2019). Ecosystem Businesses Are Changing the Rules of Strategy. *Harvard Business Review*, 8 August. Available at: https://hbr.org/2019/08/ecosystem-businesses-are-changing-the-rules-of-strategy?utm_source=chatgpt.com (accessed January 10, 2026)

2. Osterwalder A., et al. (2019). Why Your Organization Needs an Innovation Ecosystem. *Harvard Business Review*, 15 November. Available at: https://hbr.org/2019/11/why-your-organization-needs-an-innovation-ecosystem (accessed January 10, 2026)

3. Jacobides M. G. (2019). The Delicate Balance of Making an Ecosystem Strategy Work. *Harvard Business Review*, 19 November. Available at: https://hbr.org/2019/11/the-delicate-balance-of-making-an-ecosystem-strategy-work (accessed January 16, 2026)

4. Kapoor R. (2018). Ecosystems: Broadening the Locus of Value Creation. *Journal of Organization Design*, vol. 7(12), 29 October. Available at: https://link.springer.com/article/10.1186/s41469-018-0035-4 (accessed January 18, 2026)

5. Audretsch D. B., et al. (2019). Entrepreneurial Ecosystems: Economic, Technological, and Societal Impacts. *Journal of Technology Transfer*, no. 44, pp. 313–325.

6. Subramaniam M. (2020). Digital Ecosystems and Their Implications for Competitive Strategy. *Journal of Organization Design*, no. 9. Available at: https://link.springer.com/article/10.1186/s41469-020-00073-0 (accessed January 18, 2026)

7. Kornetskyy A. (2025). Pidpryyemnytsʹka ekosystema yak bahatorivneva systema sotsialʹno-ekonomichnoho rozvytku: teoretychnyy analiz ta pidkhody do typolohizatsiyi [Entrepreneurial ecosystem as a multilevel system of socio-economic development: theoretical analysis and typological approaches]. *Management and Entrepreneurship: Trends of Development*, vol. 3(33), pp. 194-201. DOI: https://doi.org/10.26661/2522-1566/2025-3/33-15 (in Ukrainian)

8. Zuiev M., Pushak Y. (2025). Practices that can be used to develop innovation ecosystems. *Management and Entrepreneurship: Trends of Development*, vol. 2(32), pp. 168–176. DOI: https://doi.org/10.26661/2522-1566/2025-2/32-131

9. Horban S., Bilenko O. (2025). Biznes-ekosystemy v Ukrayini: stan ta perspektyvy rozvytku [Business ecosystems in Ukraine: status and development prospects]. *Economic Issues of Social Development*, no. 4, pp. 1-11. DOI: https://doi.org/10.70651/3083-6018/2025.4.15 (in Ukrainian)

10. Donets D. (2025). Ukrainian startup ecosystems: regional development and European integration. *Economic Bulletin of Ukrainian State Chemical-Technological University*, vol. 21(1), pp. 189–200. DOI: https://doi.org/ 10.32434/2415-3974-2025-21-1-189-200

11. Duma O., Kachmar H. (2024). Rozvytok ekosystemy startapiv Ukrayiny v chas viyny: problemy ta vyklyky [Development of Ukrainian startup ecosystem in the time of war: problems and challenges]. *Socio-Economic Management and Entrepreneurship (SMEU)*, vol. 6(2), pp. 269–285. DOI: 10.23939/smeu2024.02.269 (in Ukrainian)

12. Moore J. F. (1993). Predators and Prey: A New Ecology of Competition. *Harvard Business Review*, vol. 71(3), pp. 75–86.

13. Spigel B. (2020). Entrepreneurial Ecosystems: Theory, Practice and Futures. Cheltenham: Edward Elgar Publishing, 200 p.

14. Reeves M., Pidun U., Zoletnik B. (2022). What Is Your Business Ecosystem Strategy? Boston Consulting Group. Available at: https://www.bcg.com/publications/2022/what-is-your-business-ecosystem-strategy (accessed February 10, 2026)

15. Pidun U., Reeves V., Zoletnik B. (2022). Are You Ready to Become an Ecosystem Player? Boston Consulting Group, June 27, 2022. Available at: https://web-assets.bcg.com/7c/48/42b0517449c6922e0f4812adf13b/bcg-are-you-ready-to-become-an-ecosystem-player-jun-2022.pdf (accessed February 10, 2026)

16. Abreu A. (Ed.) (2021). Innovation Ecosystems: A Sustainability Perspective. Basel: MDPI Books, 284 p.

17. Reeves M., Pidun U. (2022). Business Ecosystems: A Management Perspective. Berlin: De Gruyter, 162 p.

18. Santos F., Ferreira J., Fernandes C. (2022). Building sustainable entrepreneurial ecosystems: A holistic approach. *Journal of Business Research,* no. 140, pp. 346–360. DOI: https://doi.org/10.1016/j.jbusres.2021.11.005

19. Stroiko T., Voloshyna-Sidei V., Druz Y. (2023). Formation of business ecosystems as a basis for the development of the IT industry. *Baltic Journal of Economic Studies*, vol. 9(1), pp. 177–183. DOI: https://doi.org/10.30525/2256-0742/2023-9-1-177-183

20. Guerrero R., et al. (2022). A digital business ecosystem maturity model for personal service firms. *Information Systems Frontiers*, vol. 24, pp. 1325–1343. DOI: https://doi.org/10.1007/s10796-022-10246-5

21. Cambe J., et al. (2021). Modelling cooperation and competition in urban retail ecosystems with complex network metrics. *IEEE Access*, no. 9, pp. 65163–65179. DOI: https://doi.org/10.1109/ACCESS.2021.3075205

22. Kretschmer T., et al. (2020). Platform ecosystems as meta-organizations: Implications for platform strategies. *Strategic Management Journal*, vol. 43(3), pp. 405–424. DOI: https://doi.org/10.1002/smj.3250

23. Jacobides M., Cennamo C., Gawer A. (2021). Ecosystems and competition law in theory and practice. *Industrial and Corporate Change*, vol. 30(5), pp. 1199–1220.

24. Kenney, M., Zysman, J. (eds.) (2020). The Digital Transformation of Innovation and Entrepreneurship. Stanford University Press, 350 p.

25.Haki K., et al. (2024). Dynamic capabilities for transitioning from product platform ecosystem to innovation platform ecosystem. *European Journal of Information Systems*, vol. 33(2), pp. 181–199. DOI: https://doi.org/10.1080/0960085X.2022.2136542

26.McIntyre D., Srinivasan A. (2021). Networks, Platforms, and Strategy: Emerging Views and Next Steps. Emerald Publishing, 300 p.

27.Cozzolino A., Corbo L., Aversa P. (2021). Digital platform-based ecosystems. *Journal of Business Research*, no. 126, pp. 385–400. DOI: https://doi.org/10.1016/j.jbusres.2020.12.058

28.Lingens B. (2023). How Ecosystem Management Will Influence Business Model Innovation. *Journal of Business Models*, vol. 11(3), pp. 112-123. DOI: https://doi.org/10.54337/jbm.v11i3.8126

29.Li F. (2020). The Digital Transformation of Business Models in China. Routledge, 250 p.

30.Hein A. et al. (2020). Digital platform ecosystems. *Electronic Markets*, no. 30, pp. 87–98. DOI: https://doi.org/10.1007/s12525-019-00377-4

31. Zhang Y. (2024). Review of Research on the Platform's Ecosystem. *Academic Journal of Business & Management*, vol. 6(6), pp. 201–206. DOI: https://doi.org/10.25236/AJBM.2024.060630

32. Deep Tech dominates VC Funding in Europe – Dealroom 2025 report, 14 March, 2025. Available at: https://en.ain.ua/2025/03/14/deep-tech-dominates-vc-funding-in-europe-dealroom-2025-report/ (accessed February 18, 2026)

33. Europe's deep-tech engine could spur $1 trillion in economic growth. McKinsey Report, October 29, 2025, 17 p.

34. The New European Innovation Agenda. European Comission. 2022. Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733655/EPRS_BRI(2022)733655_EN.pdf (accessed February 18, 2026)

35. Horizon Europe – Work Programme 2025. European Innovation Ecosystems (EIE). European Commission, Decision C (2025) 2779 of 14 May 2025. Available at: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/wp-call/2025/wp-10-european-innovation-ecosystems_horizon-2025_en.pdf (accessed February 22, 2026)

36. Kop M. (2025). *Towards a European Quantum Act: A Two-Pillar Framework for Regulation and Innovation*. Cornell University, 80 p. Available at: https://arxiv.org/pdf/2509.14262 (accessed February 26, 2026)

37. EIC Impact Report 2025. European Innovation Council and SMEs Executive Agency. 3 April 2025. Available at: https://eic.ec.europa.eu/document/download/7b947b36-66cb-4471-a2d0-158d5ae6770f_en?filename=EIC-Impact-Report-2025.pdf (accessed February 26, 2026)

38. Dolan M. (2025). Europe needs to deliver tech promise for more years like 2025. November 12. Available at: https://www.reuters.com/markets/europe/europe-needs-deliver-tech-promise-more-years-like-2025-2025-11-12/ (accessed February 26, 2026)

39. Lakestar D., Catalyst W. (2025). The 2025 European Deep Tech Report. March 2025, 186 p. Available at: https://content.dealroom.co/uploaded/2024/11/2025-European-Deep-Tech-Report.pdf (accessed February 27, 2026)

40. Joo J., Shin M. (2022). Business Ecosystem Management. *Sustainability*, vol. 14(3), pp. 1449-1475. DOI: https://doi.org/10.3390/su14031449

41. Liu Z. et al. (2024). Comparing Business, Innovation, and Platform Ecosystems: A Systematic Review. *Biomimetics*, vol. 9(4), pp. 216-227. DOI: https://doi.org/10.3390/biomimetics9040216

42. Graça P., Camarinha-Matos L.M. (2017). Performance indicators for collaborative business ecosystems – Literature review and trends. *Technological Forecasting and Social Change*, no. 116, pp. 237–255. DOI: https://doi.org/10.1016/j.techfore.2016.10.012

43. Van de Ven M., et al. (2023). Key performance indicators for business models: a systematic review and catalog. *Information Systems and e-Business Management,* no. 21, pp. 753–794.

44. Muncaster A. (2025). Measuring Ecosystem Impact – New KPIs for the Digital Economy. Available at: https://www.linkedin.com/pulse/chapter-

9-measuring-ecosystem-impact-new-kpis-digital-muncaster-3lexe (accessed March 12, 2026)

45. KPI Depot/Digital ecosystem metrics (2024–2025). Innovation Ecosystem Strength KPI. Available at: https://kpidepot.com/kpi/innovation-ecosystem-strength (accessed March 16, 2026)

46. Global Innovation Index 2025. Ukraine ranking in the Global Innovation Index 2025. Available at: https://www.wipo.int/edocs/gii-ranking/2025/ua.pdf (accessed March 18, 2026)

47. Ukraine's Global Rankings and Indices. BDO Ukraine, 2025. Available at: https://www.bdo.ua/en-gb/ukraine-recovery-1/information-guides-from-bdo-in-ukraine/investments-in-ukraine/ukraine-s-global-rankings-and-indices (accessed March 18, 2026)

48. Global Innovation Index 2025. GII 2025 Economy briefs and profiles. Available at: https://www.wipo.int/web-publications/global-innovation-index-2025/en/gii-2025-economy-briefs-and-profiles (accessed March 20, 2026)

49. Executive Summary Global Innovation Index 2025 – WIPO, 4 March 2026. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2025-exec-en-global-innovation-index-2025.pdf (accessed March 21, 2026)

50. 823 Top startups in Ukraine for March 2026. StartUpBlink. Available at: https://www.startupblink.com/top-startups/ukraine (accessed March 21, 2026)

51. Friede G., Busch T., Bassen A. (2021). ESG and Financial Performance: Aggregated Evidence from More than 2000 Empirical Studies. *Journal of Sustainable Finance & Investment*, vol. 11(4), pp. 210–233. DOI: https://doi.org/10.1080/20430795.2021.1907209

52. Berg F., Koelbel J., Rigobon R. (2022) Aggregate Confusion: The Divergence of ESG Ratings. *Review of Finance*, vol. 26(6), pp. 1315–1344. DOI: https://doi.org/10.1093/rof/rfac033