UDC 334.7

Korohodova O.
Candidate of Sciences in Economics (Ph.D), Assos. Prof.,
Associate Professor at the Department of International Economics
National Technical University of Ukraine
«Igor Sikorsky Kyiv Polytechnic Institute»,
Kyiv, Ukraine
ORCID: 0000-0003-2338-365X

TRANSFORMATION OF THE PRODUCT LIFE CYCLE MANAGEMENT BUSINESS MODEL: SYNERGY OF TNCS AND STARTUPS IN THE DIGITAL ECONOMY

The modern world economy has been changing for a decade due to the Fourth Industrial Revolution. Digitalization is no longer just an auxiliary tool. It has become a basic condition for business. As noted in [1], in 2023, “the Industry 4.0 market was valued at $114.3 billion. According to forecasts, it is expected to grow by 20.2% from 2023 to 2032, reaching an estimated value of $555.1 billion.” Such rapid growth is explained by the fact that Industry 4.0 is more than just a set of technologies. It is a process of digitalizing various sectors of the economy. The key ideas are automation of systems and processes, digitalization, and data exchange between enterprises [1]. At the heart of this change is a shift in the product lifecycle management (PLM) business model. TNCs, which once dominated markets due to scale, now face challenges that old methods cannot solve. Here, the need for synergy with small innovative businesses, such as startups, became clear. Startups, driven by innovation, can act faster and bolder.

A startup is an organization with strong innovation capabilities and a robust technological base. It can accelerate growth and persist for a certain period. The main value of a startup for TNCs is flexibility. A startup needs new management that is well-adapted to uncertainty. In contrast, TNCs often develop innovations slowly due to adjustment and production standardization. The synergy between these entities creates a win-win model. Startups offer high innovation, flexible product development, and dynamic decision management. TNCs provide resources, a customer network, and risk reduction in the early product life cycle, due to brand confidence and established relationships [2; 3].

In the digital economy, the product creation process has changed direction. Production previously started from factory capabilities and moved to the market. Today, developing products that meet customers’ needs, wants, and wishes is getting more focus. The shift is from direct production to understanding the reasons for consumption and the utility of products [2; 3]. Now, a need—meaning a customer—triggers the product life cycle. Unlike Industry 3.0, where product development and marketing were separate, modern TNCs use models in which both are part of a single process. Integrated product development now relies on cross-functional teams focused on meeting needs. Environmental concerns are key. In Industry 4.0, green solutions support energy-efficient, eco-friendly production. This is integral to sustainable corporate strategies.

The technical implementation of new business models uses cyber-physical systems (CPS), the Internet of Things (IoT), and the Internet of Services (IoS). CPS integrates computing into production, enabling new levels of control, monitoring, transparency, and efficiency [1]. IoT turns physical objects into smart things capable of machine-to-machine (M2M) communication (tab. 1). This allows smart manufacturing and makes production processes more flexible. Computerized machines are highly adaptable to requirements. The main goal is on-demand production. Consumers now directly affect process design. When a customer places an order, the manufacturer can start building it according to the specified characteristics. They do not spend resources on products with only basic features before the order comes in. This enables mass customization of short production series, which was not profitable before.

Table 1 – The roles of TNCs and startups in terms of key technological components of Industry 4.0

Component	Characteristic	Function regarding the production process	The role of TNCs	The role of startups
1	*2*	*3*	*4*	*5*
CPS	CPSs enable the integration of computing with physical production processes	A new level of control, monitoring, transparency and efficiency of the production process	Formation of a global IT infrastructure and integration of complex hardware and software complexes at the level of the entire corporation	Development of unique control algorithms, creation of specialized software and adaptive interfaces for individual CPS nodes

Table 1 (continued)

1	*2*	*3*	*4*	*5*
IoT	IoT is the technology of transforming physical things into so-called smart things with the help of computers connected to the Internet	A new generation of products can provide independent information exchange (for example, smartphones), trigger actions and control each other over the Internet using M2M	Standardization of communication protocols, use of Big Data to manage global supply chains and creation of IoT platforms.	Creation of specific sensors, mobile applications and identification solutions (RFID) adapted to the individual needs of the customer.
Smart production	A decentralized production system based on the integration of IoT and IoS	The integration of CPS and IoT into the production process provides dynamic tracking of material flows in real time, faster and improved transportation of products, resources, as well as accurate risk management	Scaling the Smart Factory model internationally, financing capital-intensive automation and robotics systems.	Implementation of modular solutions, predictive analytics systems and green energy-efficient technologies for flexible line reconfiguration.

Source: developed based on [1], with the addition of the roles of TNCs and startups

PLM transformation leads to servitization. Baltova defines servitization as a growth strategy in the service sector. Manufacturing companies shift focus from selling goods to providing integrated product-service solutions [4]. Services now matter at every stage of production, from design to sales. In Industry 4.0 conditions, TNCs offer more than equipment. They provide intelligent services, including remote monitoring, preventive maintenance, and training. This lets them diversify portfolios, innovate constantly, and build strong customer partnerships. The product life cycle now includes impacts during production and in use. Servitization allows control over these impacts. It extends the product life cycle by updating and supporting it with services [4].

TNCs have a unique tool: the ability to influence product life cycles through international expansion. Technological levels vary by country. Corporations can extend a product's lifecycle by entering other markets. For example, when a product declines in the inventor's markets, TNCs export capital and technology to other countries. There, the product again moves through growth and maturity. However, in the digitalization process, this life cycle becomes shorter due to rapid scaling of new solutions, especially in ICT [3]. The COVID-19 pandemic acted as a catalyst, accelerating TNC adaptation. It introduced more incentives and requirements for digitalization. Enterprises also needed better technology for social distancing, remote monitoring, and management. To increase transparency and security, TNCs use blockchain to enhance value chain visibility and enable secure transactions via smart contracts. They use Big Data for flexibility and integration in global supply chains. Middleware serves as a software layer that connects devices (such as sensors and RFID tags) and people.

PLM transformation leads from rigid production to a flexible, customer-focused ecosystem. The synergy of TNCs and startups drives this change. Corporations gain innovation speed; startups gain market power. Industry 4.0 tools help relay customer feedback to manufacturers quickly. This enables rapid adjustments in production. It results in smart factories making products on demand, just in time, and with less environmental impact. The future of PLM is integration of real machines with virtual Internet environments, where each product life stage adds value for consumers and society.

References

1. Sergii Savchenko, Olena Korohodova, Oleksandr Zhenvachev. Design of production processes in the context of industry 4.0.*«Наука і техніка сьогодні»*, Серія «Економіка». 2024. Вип. 4(4). С. 634-645. 255-267. DOI: https://doi.org/10.52058/2786-6025-2024-6(34)-255-267
2. Olena Korohodova, Kateryna Onopriienko, Daniela V. Kuzhel. The interaction of transnational corporations with startups in Industry 4.0. *Економічний вісник НТУУ КПІ*. № 17 (2020). DOI: https://doi.org/10.20535/2307-5651.17.2020.216393
3. Olena Korohodova. Transnational Companies` Product Development In Industry 4.0. № 19 (2021): *Економічний вісник НТУУ "КПІ"*. 2021. DOI: https://doi.org/10.20535/2307-5651.18.2021.231168
4. Baltova S. Servitisation: A Strategic Service Business Model for Growth. ARTTE – Applied Researches in Technics, Technologies and Education. Trakia University, Faculty of Technics and Technologies. 2013. Vol. 1, No. 2. ISSN 1314-8788 (print), ISSN 1314-8796 (online).