

# Competitive Advantage Management enterprises with a focus on NBIC components



Svitlana Lehomina, Ruslan Dymenko, Olga Romashchenko, Olga Loban

**Abstract.** The article developed the conceptual framework for managing the competitive advantages of an enterprise with a position of a holistic approach with NBIC components, which corresponds to the tendency to enter to the sixth technological order. The development of priority technological areas is argued, which will lead to breakthrough strategies of the enterprise due to the implementation of high technology in the economic and organizational activities. The most important characteristics of the development of the business environment, as factors of influence on the activation of innovative development of the enterprise in order to increase its competitiveness, are revealed. The main clusters of the future economy of Ukraine are considered and the priority of their contribution to economic growth is determined. The NBIC component block is defined as a competitive strategy that ensures the sustainable development of the enterprise. The indicators characterizing each of the convergent NBIC components have been developed: nanotechnologies, biotechnologies, information and cognitive technologies. Nano-, Bio-, Info-, Cogno-components are determined by indicators: the level of use of nanotechnology in telecommunication equipment and business processes; level of implementation of Nano-development; safety level of technology use for human health;

The level of effectiveness of actions to protect the environment; the level of reduction of harm to humans from radiation; the presence of self-organization in the enterprise; the introduction of artificial intelligence in the organizational structure of the enterprise; level of use of high-speed technologies NGN, POST-NGN; implementation of innovative standards of information support activities; implementation of information and software in business process management; level of cognitive flexibility of senior and middle managers; staff complementarity level. A strategy for managing the company's competitive advantages has been developed.

**Keywords:** Competitive Advantages; NBIC Components; NBIC directions of Competitive Advantages; Enterprise; Sixth Technological Way.

## I. INTRODUCTION.

The main pattern of technological structure is the development of a certain set of basic science-intensive industries and technologies, organizational and economic integrity, a certain organization of production and its management mechanism, which is the characteristic of the corresponding period and is reflected in the achievements of scientific and technological progress. The main criteria for the development of this trajectory is the availability of the corresponding scientific and technical potential of the country (scientific, personnel, investment), the availability of production capacities, rationally centered use of intellectual and technological resources, taking into account modern external and internal conditions. But the problem of managing the competitive advantages of enterprises in the context of the transition from one technological structure to another has not been sufficiently studied by scientists and requires more attention [1].

## II. BRIEF LITERATURE REVIEW.

Domestic and foreign scientists pay attention to the problems of developing technological structures and their components: Akayev A. [2], Vasilenko V. [6], Zgurovsky M. [7], Korotaev A. [2], Grinin L. [4]. Modern technological directions of development: NBIC, GRAIN, MANBRIC, as vectors of innovative development and the formation of competitiveness at the macro and micro levels, are covered in the scientific works of Jotterend F. [3], Grinin L. [4; 5], Korotaev A. [4; 5], Grinin A. [5].

## III. THE PURPOSE.

Definition of conceptual foundations and practical recommendations on the strategy for managing the competitive advantages of enterprises in the transition to the sixth technological way with the introduction of NBIC components,

Revised Manuscript Received on December 30, 2019.

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which will contribute to the harmonization and development of efficiency of both industries and the country's economy as a whole. The main objective of the study should be to further deepen the theoretical and methodological provisions of the process of increasing competitiveness, taking into account modern technological trends, which are based on increasing the economic efficiency of national enterprises as a result of their innovation strategy. The main drivers for the development of the sixth technological way, the identification of the potential of the Ukrainian economy and the formation of priority areas for managing technological and economic breakthroughs of enterprises are proposed to be considered as part of a holistic approach with NBIC components.

### VI. RESULTS

The lowest point of the global economic downturn was reached in 2017-2018, and then a new acceleration of the world economy growth will begin on the upward wave of the sixth big cycle of Kondratiev (2018-2050). This rise will depend on the development of the sixth technological mode, the core of which is created using NBIC convergence (that is, the joint use of nano, bio, information and cognitive technologies) [2]. Global economic and technological crises are impulses for further development, requiring the implementation of basic innovations of the era. The competitiveness of the most important goods and services in world and national markets within the framework of the sixth technological order will spread rapidly, concentrating attention and stimulating the use of appropriate technologies.

According to F. Jotterend [3], in the movement of the modern vector of development, these are technological directions such as GRAIN (genomics, robotics, artificial intelligence, nanotechnology). According to the authors [4], the leading technological areas will be medicine, additive-, nano- and bio- technologies, robotics, information and cognitive technologies. They will form a complex system of self-regulating production - a complex of MANBRIC technologies (according to the first letters of the above technological areas - MANBRIC technologies). NBIC convergence, GRAIN, MANBRIC technologies have a common goal - reformatting the technological structure, overcoming the economic crisis and creating the conditions for a breakthrough of leading enterprises. Technological patterns are distinguished by the development of high-tech industries and technologies, the characteristics of the organization of production.

The most important characteristics of development are the following [5]:

- an increase in the amount of information and complexity in the analysis of these systems (in particular, the ability of systems to communicate and interact independently);

- sustainable development of the regulatory system and self-regulation;

- mass use of artificial materials that previously did not have the appropriate architectural properties;

- a qualitatively growing controllability of: a) systems and processes that change in their structure (including living material); b) new levels of management of the organization

- of matter (to subatomic levels, as well as the use of tiny particles as building blocks);

- miniaturization as a trend of continuous reduction in particle sizes, mechanisms, electronic devices, implants and the like;

- resource saving and energy saving in every area;

- individualization as one of the most important technological trends;

- introduction of smart technologies and the trend towards the humanization of their functions (use of a common language, voice, etc.).

In a study [7], the main drivers for the development of the future economy of Ukraine for the medium-term (2015–2020) and long-term (2020–2030) perspectives determined that Ukraine can succeed in the international division of labor, based on geographical location, available human potential, and natural resources, developing these clusters of the economy (Table 1).

**Table 1. The main clusters of the future economy of Ukraine and the priority of their contribution to economic growth [7]**

Economy cluster	Contribution to overall economic growth, (%) 2015-2020	Contribution to overall economic growth, (%) 2020-2030	Assessment of the contribution to the overall economic growth (1-10) 2015-2020	Assessment of the contribution to the overall economic growth (1-10) 2020-2030	Economy cluster growth interval (years)
Agricultural sector	14	17	6.0	7.0	2015–2020
Military-industrial complex	13	15	5.0	6.0	2015–2030
Information and communication technology	8	12	4.0	5.5	2015–2020
Creation of new substances and materials, nanotechnology	7	12	4.25	5.5	2020–2025
Energetics	7	11	4.0	4.5	2017–2025
high-tech engineering	6	8	3.5	4.0	2020–2025
Transit infrastructure development	2	5	2.0	2.5 2.0 3.0	2020–2030
Life Sciences (biomedical engineering, cell medicine, pharmacy)	1	5	1.5	3.0	2020–2025
Tourism	2	5	2.0	3.0	2017–2025
Other economic clusters	40	10	9.5	4.25	2017–2030

Expert scientists [7] conducted a detailed study based on data from international organizations and research and educational centers, in particular the International Council for Science (ICSU) [8],

UNIDO (UNIDO - United Nations Industrial Development Organization) [9] and leading higher educational institutions and research universities: University of Oxford, NISTEP (National Institute of Science and Technology Policy, Japan), Institute for Critical Technology and Applied Science (VirginiaTech), Wageningen UR (Research University, Netherlands), based on reports from Global Technology 2020 Revolution, In-depth Analysis, World future society: "The 20 Most Important Pro Gnosis for 2010-2025 ", " Technology Foresight towards 2020 in China: the Practice and its Impacts ", European commission Community research" Scenarios for future scientific and technological developments in developing countries 2005-2015 ") [10; 11; 12; 13], the structure of the components of the competitive advantages of the sixth technological structure is determined (Table 2).

**Table 2. Predictions of the main components of the competitive advantages of the sixth technological order by 2020–2025 [7]**

Expert organization (document) / technology of the sixth way	ICSU, UNIDO, University of Oxford, NISTEP, Institute for Critical Technology and Applied Science (VirginiaTech)	2020 Global Technology Revolution, In-depth analysis, 20 Top forecasts for 2010-2025, "Scenarios for future	Expertise from the US Statistical Office (U.S. Bureau of the Census)	Analysis of stock exchange activity
1	2	3	4	5
New Energy Technologies	energy, alternative energy and resources, nuclear energy systems, hydrogen energy		nuclear technology	-
Biotechnology and modern agricultural	biotechnology, genetically modified organisms, synthetic speech		-	GMO
A new generation of information and Life sciences	cloud technologies, global wireless internet, search services, remote control, industrial control, business applications, cable technologies, satellite technologies, telemedicine, nanobiology, biologically imitating implants, stem cells		-	telemedicine
Robotics		robotics and artificial intelligence technologies		-
Nanotechnology and new substances and	functional nanostructures; nano-measurement and analysis, composite materials		-	-
New Generation Electronics		silicon, bio-, molecular, organic and photon radio electronics, digital and analog		
New industrial technologies		digital home, textiles with unique characteristics (engineering of multifunctional fabrics), robotic unmanned vehicles, power equipment for research institutes, food		
Aerospace technology		space exploration, Earth monitoring, unmanned		-
Transport and logistics		technology of a new transport system and road safety, automatic (unmanned)		
1	2	3	4	5
Recirculation technology	water recycling systems, waste reuse		-	-
Knowledge dissemination technologies	knowledge management and production system, backing up data arrays, preventing and preventing natural disasters		-	-
Sociocultural technology	advanced manufacturing technologies for the development of social infrastructure		-	-

Currently, Ukraine is dominated by the key characteristics of the 3rd technological structure. This is the dominance of ferrous metallurgy, railway transport, electric power, inorganic chemistry, coal consumption, universal engineering. The 4th technological structure is represented to a large extent (the development of organic chemistry and polymeric materials, non-ferrous metallurgy and oil refining, automotive and defense industry development, instrumentation and precision engineering, the electronics industry, trucking, and widespread oil consumption). The 5th technological structure, which today determines the post-industrial type of production, accounts for 7-8% of the total structure of the national economy. This includes the development of the aerospace industry, computer science of

complex computer technology, modern weapons, software and telecommunications, robotics and new materials [6]. The development trend is the formation of the structure of the sixth technological way, which will consist of nanotechnologies and new materials, biotechnologies and bionanotechnologies, biopharmaceuticals, alternative and renewable energy (hydrogen, fuel cells, new generation biofuels, global and national information networks (scientific, educational, medical, environmental), corresponds to the introduction of a new technological paradigm of NBIC convergence, which is being transferred from the subject area to solving problematic issues Owing to overcoming cyclical crises, it also gives an impetus to economic growth and the formation of competitive advantages of enterprises.

Factors of rapid growth may be new convergent-interdisciplinary financial, organizational and managerial technologies. The dense convergence of technologies may have a stronger and longer manifestation, but this requires significant changes in the legal field, as an absolute necessity for equalizing the development and leveling of rigid cyclic fluctuations [1].

One of the NBIC technologies is information and communication technologies that form global, national and corporate IT infrastructures, consolidate resources in data centers (DPCs), develop cloud technologies, program-configurable networks, implement a situational service-oriented approach, develop software systems based on client-server and web-oriented architectures, they disseminate a component-based approach.

According to the modern development trajectory, which is aimed at NBIC convergence, the author made an attempt to characterize and determine the NBIC directions of the competitive advantages of telecommunication enterprises, which is divided into four component blocks and allows, if implemented, to achieve a more effective result of enterprises (Table 3).

**Table 3. NBIC directions of the competitive advantages of telecommunications enterprises: a holistic approach with NBIC-components (author's development) [1].**

Index	Content
1	2
<b>The convergent component of NBIC: NANOTECHNOLOGIES</b>	
1. The level of use of nanotechnology in telecommunication equipment and business processes	Inter-machine interaction services (machine-to-machine or M2M) are used to collect and transmit data and allow the exchange of information between different devices without human intervention. Fields of application: POS-terminals, security and safety, monitoring of transport and logistics, industry, navigation systems and the like. In GSM networks, mobile Internet traffic (EDGE / GPRS technology), a voice data channel (CSD technology) or SMS messages are used to transfer information
1	2
	between M2M equipment [14].
2. The level of implementation of Nano-development	The use of quantum-photon circuits, multifunctional chips, devices and technologies based on memory with phase change, fiber optic and silicon cables.

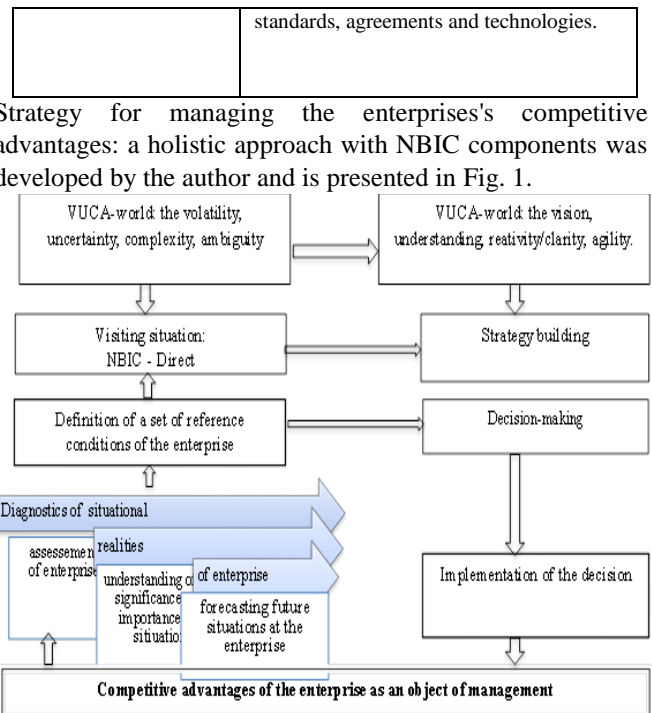


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The convergent component of NBIC: BIOTECHNOLOGIES	
1 The level of safety of the use of technology for human health	Reducing the danger when using the radio frequency resource of Ukraine, the legality of installing electronic equipment (RES), the procedure for using RES. The main problem is radiation and harm to human health and measures to level the impact, which requires attracting attention and solving the problem. With the increase of digital cellular communication operators and the introduction of IMT-2000 (UMTS) digital cellular radio communication radio technology, the deployment of broadband radio access networks, the risk of human life is increased and requires monitoring by the Ukrainian State Center of Radio Frequencies (UCRF).
2 The level of focus on environmental protection	
3 The level of reduction of harm to humans from radiation	
4 The presence of self-organization in the enterprise	
5 The introduction of artificial intelligence in the organizational structure of the enterprise.	

Converged component of NBIC: INFORMATION TECHNOLOGIES	
1. The level of use of high-speed NGN technology, Post-NGN	1. Using high-speed broadband radio access technologies, CDMA and UMTS provide mobile Internet traffic, telecommunications and communications services. There is an increase in telecommunication networks that operate using CDMA EV-DO technology.
2. Implementation of innovative standards of information support activities	2. The introduction of intelligent information networks capable of self-adaptation and self-organization.
3. Implementation of information and software in the management of business processes.	3. Further introduction of promising fourth-generation radio technologies (LTE), (ensuring electromagnetic compatibility and collaboration of special users and radio electronic means of common LTE users, introducing the principle of technological neutrality based on generally accepted 3GPP specifications (peak data rates up to 173 Mbit / s , and data transfers up to 48 Mbit / s. [14].
	4. Introduction of cloud technologies, mobile technologies, information security technologies, creation of modern data processing centers, maintenance of the Internet of things, open programming interface (API).

Converged component of NBIC: COGNITIVE TECHNOLOGIES	
1. The level of cognitive flexibility of senior and middle managers	1. The use of intelligent support systems for management decisions;
2. Staff complementarity level	2. The use of components based on artificial intelligence;
3. Enterprise knowledge management system	3. The introduction by telecommunications operators of various packages of convergent services and tariff plans with the combination of voice telephony, Internet access and television services, in particular, the organization of unlimited access to popular social networks and information resources, an increase in the volume of Internet access services and digital broadcasting programs, etc. d. [14].
	4. The use of self-regulating systems with programming for feedback on the external impact, which provides for the participation or complete absence of human intervention (process control, business processes).
	5. Smart-education involves the combination of educational institutions and faculty for joint educational activities on the Internet based on common



**Fig. 1. Strategy for managing the competitive advantages of an enterprise (author's development)**

We consider it appropriate to agree with the methodology for the sequential implementation of the stages of managing the competitive advantages of an enterprise, which was proposed by N. Belopolsky [15], namely:

1) a comprehensive analysis of enterprise efficiency: carried out on the basis of indicators of turnover, indicators of the duration of turnover and other indicators of assessment. At this stage, the causes and factors that hamper the effectiveness of development are identified and the task of management is set to achieve the necessary state of effectiveness;

2) assessment of the generation of the main processes of the financial and economic activity of the enterprise: the degree of preparation for the direct implementation of the processes (production, marketing, investment, innovation) according to the tasks of performance management is assessed. Process evaluation is needed to identify problem areas that slow down performance management tasks;

3) the performance management functions of the enterprise occurs throughout the entire term of the performance of the performance management tasks until the completion of the implementation of a specific task. Based on the management functions, the achievement of the goal of managing the enterprise's efficiency by increasing the volume of activities and maintaining a stable position is ensured.

4) the formation of potential opportunities for the implementation of management tasks: in the process of carrying out operational activities, potential opportunities are determined by achieving the planned volume of production for technological resources, technical means, financial resources and other types of resources; potential sales opportunities - by competitive features, the effectiveness of marketing activities.

The formation of potential capabilities of the enterprise contributes to counteracting external threats in the future, and ensures the competitiveness of the enterprise.

It should be noted that the development of competitive advantages of telecommunication companies depends on the modernization and development of infrastructure, the purpose of which [7]:

- to modernize the national communication network of Ukraine in the sense of complete digitalization of the network;

- create situationally-problem-oriented data processing centers (DPCs) and create a market for information and telecommunication services (IT infrastructure, development and application tools as services, content services);

- introduce next-generation communication networks (NGN - Next Generation Network and FN - Future Networks) based on Internet protocols (IP technologies);

- to develop transport networks of new generations (DWDM, MPLS) on the primary primary networks (in global, national, regional, local information infrastructures);

- provide further development of software-defined network SDN (Software-defined Networking);

- to develop broadband access networks (NGN): corporate, residential access;

- develop standard 3G, 4G, LTE, 5G.

At the same time, multiservice requirements are imposed on telecommunication services; broadband (the ability to flexibly and dynamically change the speed of information transfer over a wide range depending on the current needs of the user); multimedia (the ability of a network to transmit multicomponent information (speech, data, video, audio) with the necessary synchronization of these components in real time and using complex connection configurations); intelligence (the ability to control the service, call and connection by the user or service provider); access invariance (the ability to organize access to services regardless of the technology used); operator activity (the possibility of the participation of several operators in the process of providing a service) [16; 17].

The basis for the formation of competitive advantages of telecommunication enterprises is the presence of a high level of education system and environmental conditions [7]:

- high quality higher IT education and the creation of complexes "Education - Science - Business", combining universities and business;

- quality research institutes;

- wide access to IT resources;

- widespread adoption of mobile standards 2G, 3G, 4G (LTE), 5G;

- increasing the level of consumer access to information services as a result of the unification of methods for presenting information, including 3D-visualization;

- informatization of society;

- development and stimulation of medium-sized businesses in ICT

- European integration and access to shared resources.

But it should be noted and inhibitory factors in the development of information and telecommunications enterprises:

- there is no corresponding state order for ICT and support for high-tech production (software and hardware

systems of its own Ukrainian software for information and communication systems);

- inconsistency of Ukrainian legislation and industry standards with the current level of ICT development;

- institutional gap between university education, academic science and the real needs of world production and ICT development;

- ensuring information security at the level of ICT networks and users, minimizing the possibility of unauthorized access;

- insufficient distribution of modern technologies and services in the country;

- global economic challenges;

- lack of interaction and standards;

- dependence on external technical support.

According to the Association of Information Technologies, Ukraine ranks fourth in the world in the number of certified IT specialists (after the USA, India, Russia) and is in the TOP 30 locations for transferring orders for software development [18].

In the ranking of the IAOP International Association, the top 10 best outsourcing service providers in Ukraine in 2016 more than half were international companies namely: R & D: EPAM, Ciklum, Luxoft, Intetics, Softjourn and TEAM International Services and four local companies: SoftServe, Eleks, Sigma and Miratech, N -iX [18].

The number of Ukrainian companies in the Global Outsourcing 100 rating list is growing every year, which means that the Ukrainian IT industry is on the right track and is the evidence that "success is not ignored by global market players. Our country has gained a reputation as a reliable technical service provider "[19].

## V. CONCLUSIONS.

A study of the conceptualization of the contemporary problems of managing the competitive advantages of enterprises with a focus on strategic management, substantiating the interdependence of competitive advantages and sustainable innovative development of the business environment, developing a holistic approach with NBIC components made it possible to draw the following conclusions:

The main emphasis should be placed on scanning and flexible situational decision-making on the formation of a strategy for managing the competitive advantages of enterprises with the involvement of all interested actors, which increases the likelihood of making effective management decisions that focus on correct interpretations taking into account the time frame.

The NBIC directions of the competitive advantages of telecommunication enterprises are proposed, which are in harmony with the entry into the sixth technological order, the feature of which is NBIC convergence. Four blocks have been developed: Nano-, Bio-, Info-, Cogno-components, which are determined by indicators: the level of use of nanotechnology in telecommunication equipment and business processes; level of implementation of Nano-development;

safety level of technology use for human health; the level of effectiveness of actions to protect the environment; the level of reduction of harm to humans from radiation; the presence of self-organization in the enterprise; the introduction of artificial intelligence in the organizational structure of the enterprise; level of use of high-speed technologies NGN, POST - NGN; implementation of innovative standards of information support activities; implementation of information and software in business process management; level of cognitive flexibility of senior and middle managers; staff complementarity level; enterprise knowledge management system.

The conceptual foundations of managing the competitive advantages of the enterprise have been developed: a holistic approach with NBIC components, within which the NBIC component block ensures the sustainable development of the enterprise in the conditions of entering the sixth technological order.

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