Digital Platforms of Networking in Industry

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Abstract. The article presents the analysis findings of the conceptual approaches by various scientists as per the digital platforms development in industry. Such platforms and technologies make a specific cluster of digital economy responsible for generating competencies that contribute to the development of markets and different economic sectors. The authors single out and make a case for three key approaches to the understanding of the idea behind the digital platforms, i.e. a digital platform as a complex of technologies, a digital platform as a business model and a digital platform as an enterprise providing for the mutually beneficial cooperation between the vendors, producers and customers. The study has shown that while researching the conceptual basis of digital platforms development in industry a major role is played by digital twins. The analysis of Gartner Hype Cycle has proven the role of digital twins in the industrial IoT development. At the same time, the authors define the barriers in the industrial IoT development common for the industrial facilities in Russia. Additionally, it has been concluded that it is necessary to develop a single integrated digital platform for the needs of industry taking into account sector-specific issues. Networking is considered to be an effective strategy for the industry development. The implementation of digital design and modeling of smart digital twin is aimed at the transition of the industrial sector to technological paradigms V and VI.

1. Introduction

The fourth industrial revolution is radically changing the principles of production organization, as well as the relationships between the producer and the customer and transforms the market, industry, society, practices of information exchange and process management. Digital technologies can significantly increase efficiency of all industrial processes. The world community is rapidly entering the era of digital platform economy, in which the available tools and mechanisms functioning on the basis of the Internet and online platforms constitute the foundation of economic and social life [1].

To ensure technological leadership of Russia, robotics technology and information technology are of critical importance. In 2014, 229 thousand robotic complexes were sold for industrial use, 70% of the world sales being accounted for 5 countries – China, Japan, the USA, the Republic of Korea and Germany. These countries have a number of government-sponsored programmes focusing on support and development of the robotics industry. The share of the Russian market of industrial robots amounts to 0.15%. Thus, in 2015 only 550 robots were sold in Russia. In 2016 the sales in China amounted to about 87,000 industrial robots. In the field of information technology development, more than half of the information technology supply in the world is accounted for by the United States. China is not only the world’s second largest economy in terms of expenditures on information technologies, but is also one of the fastest growing markets whose volume is increasing annually by more than
8%. Developing countries are showing annual growth rates, including Brazil, India, and some countries in the Asia-Pacific region. In these countries, the growth rate of expenditures related to information technology significantly exceeds the annual growth rate of GDP, which indicates prioritizing the use of information technology in order to increase the competitiveness of these countries on the global market. In Western European countries, the economic recession has caused a slowdown in the growth of IT costs to the rate of 1.7% per year. The volume of the Russian information technology market amounted to $ 4.27 billion in 2016. Studying the experience of modern China, the history of its technological breakthrough is worth noting. Today, the country produces more than 34% of all global innovative products, and the average annual growth rate of R&D expenditures reaches the exceptional 18.3% next to only 1.4% in the rest of the world with above average income levels. The country's expenditures on R&D amount to 2% of its GDP, i.e. the country invests approximately $ 369 billion in this sector annually. When it comes to Russia, the same indices are much lower as it produces no more than 1% of the world innovative products whereas the share of the expenditures on R&D amounts to 1.1% of its GDP.

The urgency of the problem and the scientific importance of its solution are determined by a number of factors, i.e. the disproportions in the accumulated knowledge, its implementation in the form of technological innovations and a certain lag in the technological development of Russia; unavailability of a diagnostic mechanism (evaluation, analysis and forecasting) of the impact made by the accumulation and transfer of scientific knowledge about various types of digital platforms on the technological leadership of the nation; incomplete and scattered theoretical ideas about cause-effect relationships ensuring the practical implementation of the accumulated knowledge in the technological innovations.

In the European Union, industry generates 80% of private innovation and 75% of exports. The global share of European value added manufacturing declined from 36% in 1991 to 25% in 2011. Currently, only about 19% of the total gross value added is accounted for the EU manufacturing industry [2]. Technological leadership is ensured both by new knowledge and by the innovation intensity, while the connection between these two main factors of technological leadership is provided via the process of transfer. The need for knowledge should be based on the needs of the economy. Thus, in case the accumulated knowledge is reflected in innovation, economic growth is ensured. For the time being, Russia still belongs to the outsiders of scientific and technological development due to not only the lack of working mechanisms for the transfer of knowledge into the real economy, but also due to the lack of quantitative diagnostics of such processes.

According to experts, Industry 4.0. is supposed to lead to the creation of a new industrial value due to the development of vertical and horizontal network effects [3, 4, 5, 6]. In this regard, the industrial landscape will undergo significant changes and challenges [7]. Industry 4.0. development determines the technological, economic and social consequences for industrial companies, which affects the transformation of the traditional industrial value of companies into a digital ‘platform’ value [8, 9].

2. Methodology
The following methods have been applied in the carried out research: the method of comparative scientific and economic studies to assess the results of the scientific knowledge accumulation in Russia and the results of its transfer into the real economy; structural and logical approach to the identification of digital platforms of networking in industry; a systematic approach to the formation of the methodological classification framework of digital platforms of networking and Gartner Hype Cycle methodology.

3. Discussion
The formation of digital platforms in Russia is institutionally based on the “Digital Economy Program of the Russian Federation” and the regulatory laws and legal acts governing its implementation [10, 11]. Platforms and technologies form a certain level of digital economy, where competencies are generated for the further development of markets and sectors of the economy (activity areas). Since in the digital economy the development of markets and economic sectors, including industry, is possible
providing there are developed platforms, technologies, institutional and infrastructural environments, it is important to study the nature and types of digital platforms.

Besides the total digital transformation of the economy into a “digital economy” and a high-tech industry into a “digital industry”, the model of digital development also presupposes making allowance for the triad of the requirements made by the modern global markets connected with reduction of the decision-making time (Time-to-Decision, T2D), a significant reduction in time of project execution / implementation (T2E) and a significant reduction in time to market (Time-to-Market, T2M); the market shall herein be understood as the global market [23]. The development and production of the globally competitive customized products of the new generation within the shortest time period are possible today due to Factories of the Future – systems of complex technological solutions having “smart” mathematical models and smart digital twins of objects/manufactured goods/products, production and technological/manufacturing processes as their key elements.

A breakthrough in innovations can provide an optimal and effective combination of various world best and best-in-class technologies laced with the original cross-industry intellectual know-how that, as a rule, is developed in the process of working with different industrial companies – world leaders in the framework of the international system of division of labor and participation in global technological chains [23]. As a result, an integrated high-tech solution emerges as a priori the best possible solution and, what is most crucial, it ensures the design and production of globally competitive products of the new generation in the shortest possible time. Such integrated solutions – Digital, Smart and Virtual Factories of the Future – have a triad-based road map which involves ‘digital design and modeling & new materials & additive technologies’; such road map is driven by a new paradigm of digital design and modeling, Smart Digital Twin – [(Simulation & Optimization)-Based Smart Big Data] – Driven Advanced (Design & Manufacturing).

Digital platforms provide an integrated information environment due to innovative IT solutions implemented in order to reduce operating costs. The task of analyzing, optimizing and restructuring relations between the participants is considerably simplified. Such platforms allow creating new products and services while shaping ecosystems. It should be noted that this approach is fully aligned with the ideology of Industry 4.0., both in terms of business and in terms of education and science [17].

A large number of definitions can be found in the scientific literature as the authors attempt to reflect the nature and structure of digital platforms. Hence, three groups of definitions can be singled out:

1. Digital platform is a group of technologies used as the basis of a detailed and specialized system of digital interaction. Platforms have unique features that provide for the network effects. Network effects make the dominant feature of a digital platform and their increment depends on the number of network users. In addition, most modern platforms are digital, i.e. they receive, transmit and monetize data, including personal data of users, via the Internet. At the same time, platforms cannot be called digital per se as tangible goods/products also become the subject of transactions [12]. Virtually, an IT company creates a communication platform for the participants in a certain market and equips it with basic and special services. According to the authors, "from the technical point of view, digital platforms include digital devices, software products and information services" [13, p. 9]. A. Zatsarinnyy and A. Shabanov believe that the digital platform is a complex organizational and technological aggregate comprised of a set of information systems, repositories, processes, analysis and tools of information visualization [14].

2. Digital platform is a high-tech business model that creates value by facilitating exchanges between two or more interdependent groups of participants. The recognized opportunities and advantages encourage numerous industrial companies to experiment with innovative business models based on digital technologies [18]. According to research [19], these business models create and record the value during the product life cycle in accordance with a certain solution (for example, payment per unit of service based on productivity growth rates). In order to take the practical advantage of the obtained benefits, companies need to update their business model by building it on the basis of digital technologies, such as artificial intelligence, digital platforms and big data analysis. In fact, bringing together
the participants and their interaction are carried out according to the industrial and commercial principle in the business model via the platform. Platforms create value in two main ways. The first one is related to the creation and development of transaction platforms providing for the interaction and establishing connections between individuals and organizations. Examples of such transactional platforms include Uber, Google Search, Amazon Marketplace and eBay. Transactional platforms are also known as multi-sided markets [15]. Along with transactional platforms, there are innovative platforms that consist of technologically interconnected units forming the basis for the development of complementary services or products by innovators. It should be mentioned that geographically innovators can stay anywhere in the world while forming all together an innovative ecosystem around the platform. For example, the iPhone has hundreds of thousands of applications that are being developed by innovators everywhere in the world. At the same time, the innovators (developers) using Apple technology are developing applications based on software connectors (APIs – application programming interfaces – or software developer kits) in order to ensure the continuity of the innovation and growth cycle.

3. Digital platform is an enterprise that provides mutually beneficial interaction between third-party manufacturers and consumers. Originally, the platforms have owners who have organized the activities of the business entity while creating an open infrastructure for the participants and setting the rules of cooperation. In confirmation of this, among the indicators of the successful fulfillment of the tasks declared in “The Digital Economy of the Russian Federation” Program by 2024 the following has been specified [10]:

– successful operation of at least 10 sectoral (industrial) digital platforms for the main focus areas of the economy;
– successful operation of at least 500 small and medium enterprises in the fields of creating digital technologies and platforms and providing digital services.

Digitalization offers a large number of new opportunities for balanced and sustainable development, and the platforms create a digital infrastructure of markets eliminating intermediaries and hierarchies and spreading innovative business models [16, p. 311]. V. Parida, D. Sjödin and W. Reim have carried out a systematic review of scientific publications on digitalization, innovative business models and sustainable development of industrial enterprises [20].

In their study, P. Evans and A. Gawer identify four types of digital platforms: transactional, innovative, integrated and investment platforms [12]. According to the scientists, a transactional platform is a technology, product or service that acts as a channel (or intermediary) to improve the exchange or transactions between different users, customers or suppliers. An innovative platform is a technology, product or service that serves as a platform on the basis of which other enterprises (within a poorly organized innovation ecosystem) are developing additional technologies, products or services. An integrated platform is a technology, product or service that performs as a transaction and innovation platform (for example, Apple, the App Store, etc.). Investment platforms are comprised of companies that have developed a platform portfolio strategy and act as holding companies, active investors of the platform.

While grouping the platforms according to their types, it is important to differentiate their specific features:

1) the purpose of the platform – the main activity that is carried out using the digital platform;
2) groups of participants, or parties using the digital platform, as well as the main beneficiary;
3) the level of information processing in the platform.

According to the core activity on the platform, the following types are distinguished [6, p. four]:
– instrumental platforms – used for the development of software and hardware-software solutions;
– infrastructure platforms – used to provide IT services and information;
– applied platforms – used for conducting exchange of economic value.

According to their functions, platforms can be [7, p. 12]:
– operational – ensuring acceleration of the participants’ operating cycles;
– innovative – used to attract innovators and develop additional products and services;
– investment – used to manage portfolios of platform companies;
– integrated – used to provide access to transactional forms;
– aggregated – used for interaction and commercial transactions;
– mobilization – used to combine information and technical capacities of revitalization;
– social – used for receiving social services;
– training – used for training activities and gaining skills

According to the scale of activities there are such platforms as [7, p. 12]:
– global (world),
– regional (between countries),
– national (within the country),
– industry (industry scale) platforms.

In practice, the following problems in the development of digital platforms in the activity of industrial facilities can be identified:
– insufficient quality of technical and managerial decision-making in managing an industrial facility at all stages of its life cycle; as a result, high cost of ownership of the facility;
– unavailability of immediate access to the current operational characteristics of the equipment; high risk of losing target information;
– real-time decision-makers do not have the big picture of the object of production activities; thus specific operational tasks cannot be efficiently accomplished; this also includes lack of updated and complete information about the current technical, organizational and financial condition of the assets;
– loss of key knowledge due to the employee turnover and nonavailable system of integrated and standardized databases (knowledge).

Digital twins play a pivotal role in the process of studying conceptual framework of the development of digital networking platforms in industry. Therefore, applying Gartner Hype Cycle analysis is practically justified [22]. According to the report “Hype Cycle for Emerging Technologies” by Gartner, Inc., digital twins are the fourth trend in the technological development of new technologies in 2019 [22]. According to Gartner, technologies undergo several hype cycles (i.e. maturity cycles) – Innovation Trigger, Peak of Inflated Expectations, Trough of Disillusionment, Slope of Enlightenment and Plateau of Productivity, Plateau of Productivity being the stage of broad market applicability. However, not all the technologies are going to reach the stage of broad market applicability. It is noteworthy that digital twins, being the fourth trend in the development of leading technologies, are at the peak of hype cycle. In fact, this means that creation of digital twins is the main factor ensuring the competitiveness of an industrial company in present-day conditions.

Digital twin is a digital model of a real object or system. A digital twin is implemented as an encapsulated software object or a model that reflects a unique physical object. Data from several digital twins can be aggregated to form a complex representation of a number of real objects, such as a power station or a city. The concept of digital representation of the real world of an entity or system is not new as it originates from the computer design of the physical assets representation or representation of individual customers’ profiles. Well-designed digital twins of assets can significantly improve decision making in a separate enterprise.

The economic evaluation of implementing platform solutions is a rather complicated process as difficulties arise in defining a system of evaluation criteria. Below there is an account of successful business practices of implementing platform solutions at Russian enterprises.

Successful business practices applied to improve industrial efficiency:
1. “Neosynthesis” platform solution can be an example of model development that targets improving efficiency of managing complex industrial facilities. This platform solution allows increasing management efficiency of complex industrial facilities as a modern domestic information system for managing the life cycle of an industrial facility is used [21]. The system integrates all the information necessary for operating the facility in an updatable structured electronic data repository, thereby ensuring management of engineering data at all stages of the life cycle of the infrastructure facility. Moreover, all those participating in the process of managing diverse information about the facility are also engaged into the integrated information environment (including operating, construction and design
organizations, repair contractors, research institutions and subcontractors). The potential customers of the system are the vertically integrated holdings, engineering companies and design and construction organizations.

The following results of digital platforms development can be expected:

– integrated, standardized and available in real time equipment databases; available digital profile of an industrial facility;
– reduced human factor impact;
– reduced number of equipment failures and downtime;
– reduced cost of complex repair work;
– increased level of emergency preparedness and response;
– ensuring compliance of the result of the construction and installation works (SMR) with the project;
– reduced construction time/reconstruction and non-production costs;
– reduced number of equipment failures and downtime;
– reduced cost of complex repair work;
– increased level of emergency preparedness and response;
– ensuring compliance of the result of the construction and installation works (SMR) with the project;

2. The Operator system of monitoring industrial equipment can serve as a workable case of increasing efficiency of industrial manufacturing. This system allows increasing efficiency of the industrial facilities in the region and, therefore, creating conditions for increasing tax revenues paid by the industrial enterprises due to the implemented modern technologies of automation, optimization and digitalization of business processes and manufacturing equipment [21].

The implementation of the above-mentioned monitoring system of industrial equipment would allow solving a number of difficult problems, namely:

– insufficient tax revenues going into the budget due to the low efficiency of industrial production;
– low efficiency of industrial production due to poor quality of the management system; as a result
– poor monitoring of the production cycle of the enterprise, low level of production efficiency, numerous manufacturing defects and lengthy equipment downtime;
– low level of digitalization and automation of production;
– high production cost;
– low quality of the final products.

The results of digitalization include the following:

– production control is automated and carried out in real time;
– technological processes are optimized; the work of the equipment and personnel is scheduled; all equipment and workplaces are connected to the information network of the enterprise; the transfer of the production data to the workplaces is digitized, the result being an increased product quality, reduced production cycle as well as reduced overhead costs and materials and equipment stored in warehouses, increased share of orders meeting the target date, reduced production costs and growing economic viability, high level of management and production efficiency;
– growth of efficiency indices: increase in the duration of the work output on CNC machines by 20-30%; labor productivity growth up to 70%; reduction of the lead time of experimental products turnover by 10%.

3. The digital platform can be used to increase the efficiency of industrial production of large oil-producing companies, iron and steel holdings, chemical holdings and ore mining and processing enterprises [21]. This model allows increasing the efficiency of industrial enterprises in the region, ensuring improvement of product quality, reducing its production cost, extending lifetime of the equipment, increasing production efficiency as a whole by automating collection and analysis of information about the current state of the technological process, decision support system for the operator to achieve targets (energy efficiency, quality, efficient performance) and use of artificial intelligence technologies.

The feasibility of this model arises from the following challenges:
– low efficiency of industrial production; as a result, a decrease in tax revenues going into the budget;
– low efficiency of industrial production due to poor quality of production management; its high dependence on the human factor;
– interference of inefficient technological processes and complexity of their optimization;
– high energy consumption (fuel, electricity) and auxiliary materials (catalysts, inhibitors, etc.) for carrying out technological operations;
– numerous production faults and low quality products of the continuous output; complexities of the continuous control of the product.

Presumably, digitalization should result in the following:
– automated collection and analysis of information about the current state of the technological process;
– ensuring giving recommendations to the operator in order for the specified targets (energy efficiency, quality, efficient performance) to be achieved using artificial intelligence technologies, which should result in better product quality, its reduced cost, extended lifetime of the equipment and increased production efficiency.

Efficiency indices include: reduction in production operators’ errors – up to 50%; lower rates of production faults – reduction by 10-20%; shortened faults detection and calculation procedure – time reduced by 30%; growth of the target product yield by 2-5 percentage points.

4. The Digital Laboratory can be used in order to improve the efficiency of laboratory research at the food industry enterprises, oil producing, oil refining and logistics companies, iron and steel holdings, chemical holdings, pulp and paper and ore mining and processing enterprises [21]. This platform solution allows increasing the efficiency of laboratories at the industrial enterprises of the region, of the state laboratories and environmental standards; it ensures an increase in product quality, reduces the overall time of research by automating collection and analysis of information on the technological or analytical process.

Applying the Digital Laboratory platform solution is feasible in case enterprise performance shows the following problems:
– low efficiency when performing laboratory tests and high complexity of analytical operations;
– multiple requests for research are manually processed in the form of applications;
– nonavailability of the schedule of analytical control in the organization or subdivision that performs research.

Digitalization results in:
– ensuring automated collection and analysis of information about laboratory tests as well as ensuring automatic issuance of recommendations to the operator for the specified targets (energy efficiency, quality, efficient performance) to be achieved using artificial intelligence technologies and resulting in better product quality, its reduced cost, extended lifetime of the equipment and increased production efficiency;
– reduction of research time by 20%;
– establishing an integrated center of research management;
– optimization of document management (reduced volumes).

Digital platforms are expected to be highly efficient in the following key areas:
– governmental support and promotion of digitalization of industrial enterprises, including state-subsidized enterprises and enterprises receiving concessional financing;
– promotion of the implementation of modern domestic information systems in industry in the regions, inter alia, on special terms under the program supporting industrial digitalization offered by the Industrial Development Fund of Russia.

Transition to the digital platforms when managing technological processes of the industry is primarily motivated by a set of new requirements for the product: high technological effectiveness, lower production cost and lower life cycle cost. The key task is to find a managerial balance between the
effective stimulation of the development of national digital platforms and regulation of their activities for the benefit of all users’ groups.

The Ministry of Industry and Trade has provided facilities for the development of the state information system of industry (SISI) currently elaborated by the Industry Development Fund. It is comprised of over 75,000 facilities, including industrial and commercial enterprises, public and industry associations, engineering and scientific centers, design organizations and governmental authorities. All the services of the system are divided into four groups: financial services, direct order and cooperation services, technology transfer services and public-private cooperation services.

Current studies and scientific practice consider enterprises entering the area of open interaction with other organizations as a resource for renewal and innovation development. In this sense, networking functions as one of the diverse forms of integration and cooperation involved in the organization and coordination of enterprise performance. According to scientists, “in the framework of a new institutional economy, the network appears to be one of three coordination mechanisms (along with the market and hierarchy) in which partners coordinate their functions and establish long-term relationships” [24, p. 277]. The major advantages of networks (the possibility of achieving cost savings) in terms of digitalization provide for the profitable long-term cooperation, optimization of production and management processes and access to information resources and their better use [25, p. 105]. Networking allows direct contact of participants, use of a common information network resource in order to satisfy the needs of each participant and, at the same time, to distribute production resources with the common task of joint activities and building diverse forms of cooperation. Digital platforms are believed “to retain market leadership due to network effects, according to which the value of the platform increases for new users as the total number of users keeps growing” [13, p. 10].

The development of digital twins is of particular interest in the context of industrial IoT projects. Analysis of the scientific works by scholars and practitioners working in the IoT field [13, 23, 25] has made it possible to identify the following barriers in the development of industrial IoT:

1) data interoperability characterized by the lack of a single form and approach to the digital platforms development;
2) a cultural issue related to the transparency of the digital platforms operation (for instance, there are no technologies for seamless data transmission in the public utilities sector);
3) poor communication quality, not sufficient for the implementation of information technologies at the industrial facilities.

Under current conditions of digital transformation of the industry in Russia, creating an integrated digital platform is seen as the most important stage on the way to the technological leadership. The traditionally used resources require synchronization. The best developments have to be preserved and the integrated system has to be adjusted so that it could aid researchers in their developments while functioning as a navigator. The integrated digital platform will provide a set of tools and services available to all users (as a separate service). The users of these services will be representatives of industry, scientific community, including laboratories and individual scientists, government bodies and business representatives. The digital platform for joint research will allow organizing and conducting joint research in remote access, also with the participation of foreign scientists allowing building virtual teams and laboratories for the implementation of a project of any complexity. The service management system of collective scientific infrastructure will provide users, both employees of scientific organizations and business representatives, with barrier-free access to services ordering, including access to digitized collections and data banks of organizations engaged in scientific research and development.

4. Conclusions
Creation of digital industrial platforms opens up opportunities for the development and growth of industrial cooperation, mutual supplies and investments. Technically, the system is expected to work like this: customers place orders for high-tech products; enterprises doing the final assembly design the optimal scheme of cooperation and control the execution process based on the customers’ needs
and the information on the available facilities and technologies the contractors have. As statistics on order fulfillment accumulates, supplier ratings are drawn. This way the participants are able to immediately see the volume of orders, confine them within their capabilities and build long-term production development plans.

Networking is considered as an effective strategy of industrial development. The implementation of digital design and modeling of smart digital twins are aimed at the transition of the industrial sector to technological paradigms V and VI. Modern capacities of electronic platforms anticipate introduction of digital twins in the development of digital industrial cooperation and implementation of joint digital projects.

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