

Network concept of intelligent digital supply chain

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Abstract. All over the world, the innovation process is considered to be a separate process of interaction between the elements of the national innovation system, the result of which is the commercialization of a new product or technology. However, consideration of the innovation process in the digital intellectual supply chain network grid within the framework of the smart factory concept allows to put forward a hypothesis about the immanence nature of innovation in all parts of the supply chain network. The main purpose of the research is to study both the place and the role of the innovation process describing the concept of intelligent digital supply chain network grid. A new method of research is presented in the paper fundamental problems of innovations theory in the modern consideration of the theory of logistics and supply chain management. The authors developed a specific approach to considering the digital supply chain as an intelligent logistic network based on the researching the wide range of different compound connections instead of linear structure of traditional supply chain. It is proved that the research of influence of the new technological mode regarding the theoretical concept of implementation of digital and virtual technologies in the economy of the digital industry could be stemmed into the theoretical problem of determining the place and role of innovation in economic dynamics. From this point of view the model of network representation of an intelligent digital supply chain is substantiated. The results of the research involve the types of supply chains, the place and role of innovation process life cycle models in an intelligent digital supply chain. The conclusion is drawn that it is necessary to consider a continuous process from an innovative idea to product support. The necessity for further studies of the digital core of economic relations arising from the development of innovations in the network representation of a digital intellectual supply chain could be discussed.

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1 Introduction

The most common interpretation of the innovation process life cycle model is the triple helix model by Henry Itskowitz and Loyet Leidesdorf. The main idea of this model is to consider the innovation process as a process of interaction between universities, business and the government, focused on developing new forms of production, transfer and application of knowledge. The main role in this interaction is given to universities, which are considered as a basis for scientific and technological R&D and innovative projects. According to the methodological aspects of the digital economy considered by O. Kalinina the concept of digital economy stretches over the sharing-economy, human resource management to the perspective of the theory of logistics [15-18]. In the conditions of the technological revolution, the transition to virtualization and digitalization the questions whether economic dynamics is attributable to innovation activity, whether the consideration of innovations as one of the initial stages of the product life cycle is reasonable, whether the consideration of the innovation process, as a separate element of the value chain is right and whether the innovation process ends with the stage of launching a new product or technology into the market arise. The main purpose of this paper is to study the place and role of the innovation process in new technological conditions using the example of a digital intelligent supply chain network grid. A digital supply chain is an important element in a smart factory value chain. The advanced capabilities of the digital supply chain allow creating more efficient business models and transfer the supply chain from the category of "cost center" to the network, which is the "center of opportunity" [12, 13]. Most of the new features are focused on providing quality customer service, providing breakthrough innovations and gaining market share. The network representation of the intelligent digital supply chain allows to combine information from different sources and places to control the physical process of production and distribution, which leads to the emergence and spread of innovations within all parts of the network, thus the hypothesis of immanence of innovation is put forward in this study.

2 Materials and methods

The research methodology regards both the logistics and the theory of innovations in view of Industry 4.0 concept. In the conditions of a deceleration in the global economic growth, growing geopolitical conflicts, and a slowdown in labor productivity growth, innovations play the role of the world economic development drivers. According to the N.D. Kondratiev 's theory of long waves and the J. Schumpeter's theory of innovation, economic (market) processes are divided into wave-like (reversible), having a cyclical nature and evolutionary (irreversible), determining the trend of economic development [1]. Wave-like processes consist of an upward phase associated with an acceleration of economic growth, an increase in marginal productivity of labor and other factors of production, and a downward phase characterized by revolutionary changes in technology, increasing social upheaval, increasing entrepreneurial activity, significant transformations in productive forces, and profound changes in economic institutions. The development of technological innovation is the driving force behind economic dynamics and the cause of qualitative changes in production, and, as a result, significant transformations in productive forces. According to the Glazyev's concept of "technological structures" and Yakovets's models of "technological cycles" economic dynamics is formed by successive changes in technological structures, the basis of which is the set of basic technological processes that have been used for a long time in economic sectors [2]. A change in technological patterns is the material and technical basis for the transition to the next Kondratiev's long-term cycle.

Nowadays, a relatively new concept of technological development the concept of "Industry 4.0" has occurred. This term was first proposed in Germany as part of measures to ensure the competitiveness of German industry. However, there are many interpretations of this concept. The most common interpretation of the Industry 4.0 concept is to consider the concept as a new stage of the industrial revolution from mechanization using water and steam (the first industrial revolution), mass production and assembly lines using electricity (the second industrial revolution), the introduction of computers and automation (the third industrial revolution) to digitalization based on artificial intelligence technologies, machine learning, development of SMART factories, etc. [3] According to Kondratiev's long wave theory, the Industry 4.0 concept could be considered as a new driver of world economic development, marking the transition to the sixth wave of the Kondratiev's cycles [4] and a change in the technological mode of textile mills, the industrial usage of coal (first cycle), technological innovations in coal mining and ferrous metallurgy, railway construction, the emergence of a steam engine (second cycle), the development of technologies in heavy engineering, electric power, inorganic chemistry, technological innovations in the production of steel and electric engines (third cycle), the development of technologies in automobile production, the oil refining industry, the emergence of internal combustion engines, mass production (fourth cycle), the development of electronics, robotics, computing, laser and telecommunications equipment (fifth cycle) [5] to digitalization, the advent of digital counterparts, SMART factories, cyberphysical systems and virtualization, the development of the concept of the Internet of things, augmented reality tools. It should be noted that in [6] a decrease in the duration of the Kondratiev's waves from 60 years to 20-30 years was noted due to the accelerated development of technologies. So, it is proposed to consider the time boundaries of the sixth cycle of Kondratiev from 2015-2020 until 2035.

Another point of view on the concept of "Industry 4.0", as a new technological way, was proposed by American economists Eric Brinolfsson and Andrew McAfee, who consider the concept as a transition from the first era of machines, characterized by the invention of the steam engine and the subsequent age of technological innovations everywhere to the second era of machines, characterized by the appearance of computers, automation and digitalization.

The formation of each new technological structure is formed during the development of the previous one, thus the development of a new technological structure is preceded by the stage of emergence and diffusion of technological innovations using the resources of the previous technological structure. The sequence of interrelated actions from the emergence of an idea to its transformation into a specific result (innovation) and the diffusion of this innovation is considered as the life cycle of the innovation process [7].

3 Results

Nowadays, there are six generations of life cycle models of the innovation process. The first generation model ("from science") considers the life cycle of the innovation process as a sequence of actions from obtaining innovation as a result of fundamental and applied researches and development to its entry into the market. The second generation model of the innovation process life cycle ("from the market") is based on the analysis of consumer preferences as the initial stage of the innovation process, and, like the "from science" model, considers innovation's entering the market as the last stage. Both of these models are linear. Rothwell, Rogers, Wilwright, Clark, Cooper [8] put forward many criticisms regarding to the linearity of models. In particular, the models under consideration ignore the many feedbacks and loops that arise between the various "stages" of the innovation process life cycle. Problems arising at different stages of the innovation process life cycle can lead

to a revision of earlier stages, which may result in innovation. The model of the third generation of the innovation process life cycle arose in connection with the above criticisms and is considered as a combination of “from science” and “from market” models. This model is based on the recognition of the interaction between the various elements and the feedback between the stages of the market research and the research and development of the previous linear models. The fourth-generation model (interactive model) is a combination of push-pull models, its characteristic feature is integration within the company, emphasis on external relations. The fifth generation model of the innovation process life cycle (network) is characterized by the accumulation of knowledge and external relations, system integration and extensive networks. The last (sixth) generation of innovation life cycle models is the open innovation model, which reflects the dominant focus on previous network innovation models, but is not limited to the creation and development of internal ideas, since internal and external ideas are in addition to internal and external ways of entering the market (licensing, resource mobilization, etc.) can be combined to promote the development of new technologies.

However, from our point of view, in the conditions of a new technological structure, the innovation process should not be considered as a separate process of interaction between the elements of the national innovation system, but as a continuous process of interaction between the “connected” client and all of the digital supply chain parts during the product life cycle within the framework of smart factory concept. This paper proposes a new approach in considering the innovation process life cycle as an integral part of the digital supply chain, implemented in the concept of a smart factory. The main advantage of a smart factory is the achievement of flexible and open value chains in the production of complex mass products for individual customization, and in small batches, which is not possible with existing production methods and organizational structure. In [9, 10, 11], the concept of “Industry 4.0” is considered as a new level of production organization, value chains management and management of the entire product life cycle. Smart factory is one of the key aspects of this new industrial revolution. The basis of the digital factory concept is to digitize the product development process, use flexible manufacturing and logistics structures, intelligent solutions in the supply chain, and integrate these processes. One important element of a smart factory value chain is a digital supply chain. The advanced capabilities of the digital supply chain allow creating more efficient business models and transfer the supply chain from the category of “cost center” to the network, which is the “center of opportunity” [12, 13]. Most of the new features are aimed at providing quality customer service, providing breakthrough innovations and gaining market share. Ensuring the quality of customer service is the most significant factor in changes in the digital supply chain and creates a number of problems:

Products are becoming more personalized, the number of options that need to be supported is growing exponentially, while order volumes are shrinking. Options for the direct consumer (D2C) transforms the supply chain from product support to being (at least part of) the product.

New products account for a larger percentage of revenue; the supply chain should be an incentive for innovation, not a brake. The network view of the smart digital supply chain is focused on increasing resilience to potential external influences on the supply chain. The traditional representation of the supply chain is linear, with a discrete sequence of design, planning, source, manufacture and delivery (Fig. 1).

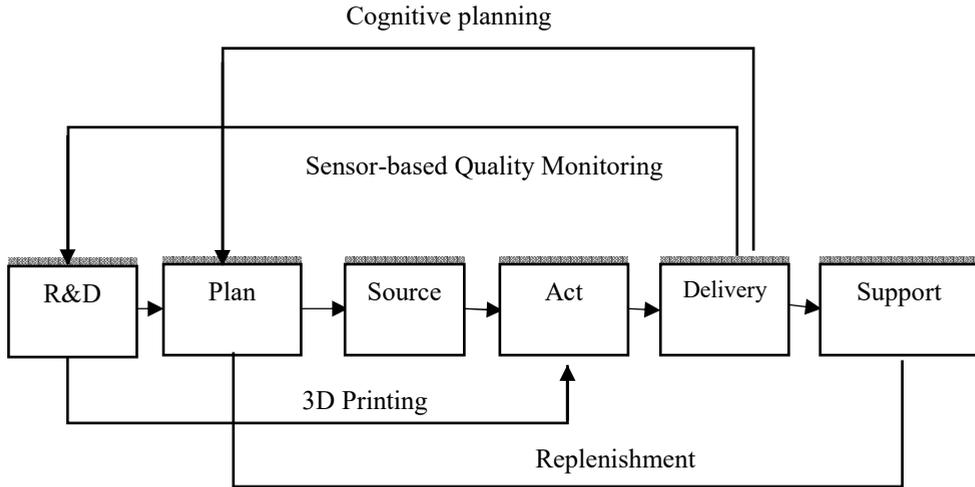


Fig. 1. Traditional supply chain [13, 14] Deloitte analysis.

However, nowadays many supply chains are transforming from a static sequence into a dynamic, interconnected system - digital supply network - a term that characterizes the growing potential of reaching a network of partners in the ecosystem and eventually changes to a more optimal state. Digital supply networks allow you to combine information from different sources and places to control the physical process of production and distribution (Fig. 2) [13, 14].

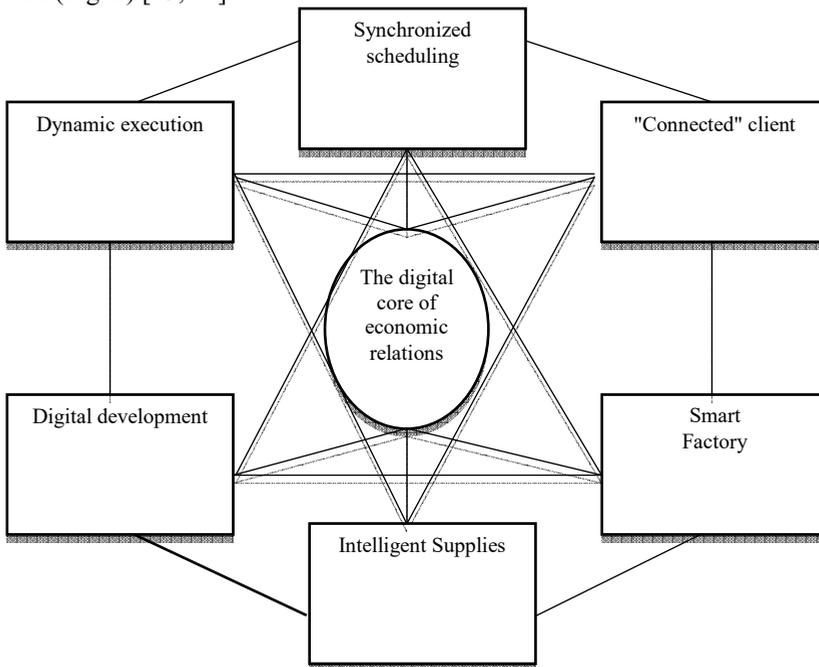


Figure 2. Network representation of an intelligent digital supply chain [14] Deloitte analysis

The place of the innovative process in the intellectual digital supply chain should be considered in relation to the network representation of the intellectual digital supply chain

consisting of the digital core of economic relations.

4 Discussion

It could be discussed the perspective of both the logistics and the theory of innovations in view of Industry 4.0 concept. The interconnected grid of the digital supply networks new model is visible, with the digital core in the center. There is the possibility of interaction between each node and any other point in the network, which allows you to expand the connectivity between areas that did not previously exist. In this model, communications are multidirectional, creating a link between traditionally unrelated links in the supply chain.

Then, as part of the economic theory problems study, it is possible to introduce the digital core of economic relations that is correlated with the concept of the digital grid of interconnected processes (using supply chains as an example) as a new economic category.

5 Conclusions

Based on the results of the study, the following conclusions can be drawn.

1. The types of models of the life cycle of the innovation process are reviewed and analyzed.
2. A new approach is proposed to consider the life cycle of the innovation process, as an integral part of the digital supply chain, implemented in the concept of a smart factory.
3. The model of network representation of an intelligent digital supply chain is substantiated.
4. The hypothesis of immanence of innovation is formulated
5. The necessity of considering an innovation process as continuous process from an innovative idea to product support is substantiated.

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