

Institutional conditions of technological changes in large regional water transport clusters

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Abstract. The purpose of this research is to study the institutional conditions for changes in the technological structure of the water transport economy from the perspective of large transport clusters. The theoretical and methodological basis of the work is the fundamental concepts of classical institutionalism, institutional-evolutionary economic theory, presented in classical and modern works of domestic and foreign scientists implementing institutional and evolutionary approaches to the analysis of technological and institutional dynamics in the economy. During the research process, categorical, comparative, structural-logical and system-functional methods of scientific analysis were used. Argumentation of conclusions and substantiation of theoretical positions are carried out based on the use of methods of analysis, synthesis, and deduction. The method of schematic representation of the relationships between the categories under study was also used. As a result, the following research results were obtained: changes in the technological structure of the industry determine the state and possible options for its further development; the formed technological base determines the advantages or disadvantages of the industry when positioning it in the international arena, however, the influence of the effect of previous development can neutralize changes in the technological paradigm, therefore, the stimulation of technological innovation is closely dependent on the state of the innovation and production systems.

1 Introduction

The development of technology directly affects the dynamics of economic growth and the competitiveness of products in a particular industry both in the domestic and global markets since the time of the English Industrial Revolution of the mid-18th century. That is, the economic development of sectors of the national economy is closely related to the technological factor [1, 2].

The issues of mutual influence of economic changes and material and technological development were considered by Karl Marx. In 1859, he formulated a thesis about the relationship between productive forces and production relations. Technology serves as the

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basis of productive forces. “In the social production of their lives, people enter into certain, necessary, relations independent of their will - production relations that correspond to a certain stage of development of their material productive forces. The totality of these production relations constitutes the economic structure of society... at a certain stage of its development, the material productive forces of society come into conflict with existing production relations...” [3].

The historical process can be viewed from the point of view of the emergence of technologies with such a wide range of applications that the sectoral and, further, national potential for economic development depends on their implementation and further expansion of the scope of use. Thus, the digitization of data, automation of processes and the introduction of intelligent devices exchanging data in real time have significantly increased labor productivity and determined the transition from a physical to a digital concept of development in ports (see Fig. 1).

A set of technological options and alternatives, determined by organizational forms and options for economic and technological interactions in certain specific areas and sectors of economic activity, constitutes the technological structure of the economy [4-8].

The existing technological structure of an economy or industry dictates specific rules and options for the implementation of economic interactions, taking into account the sectoral characteristics of economic activity, being at the same time the basis for the emergence of technological innovations.

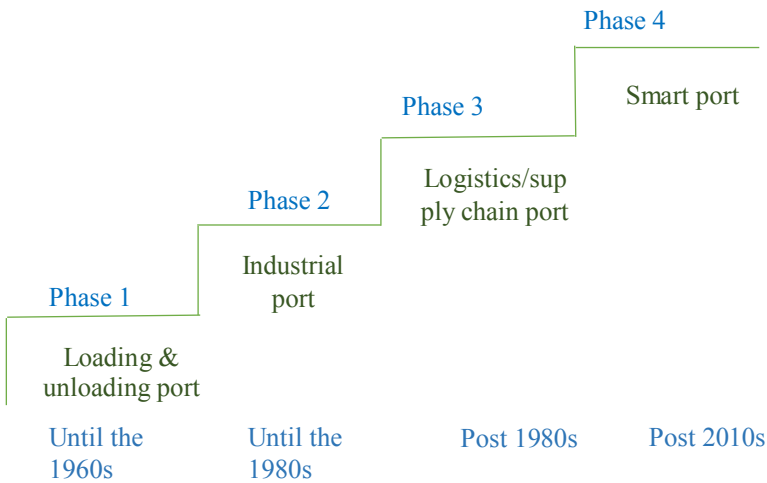


Fig. 1. Stages of port.

The relationship between the main categories that determine the processes of change in the technological structure of the economy is presented in Fig. 2.

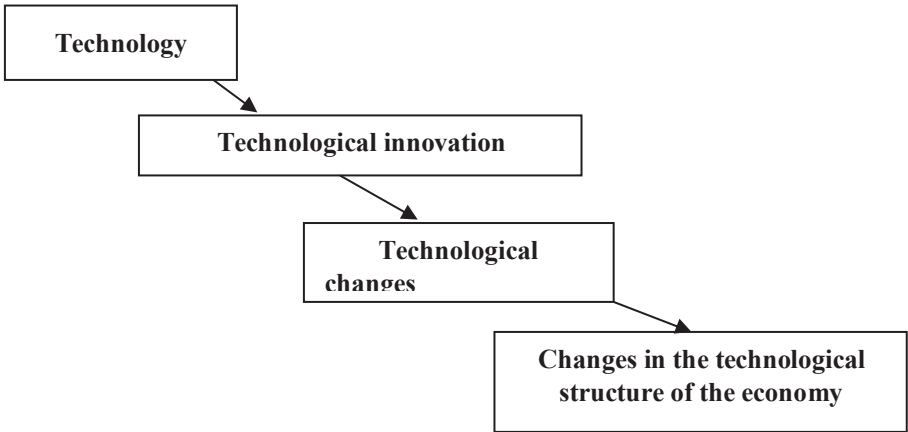


Fig. 2. Relationship between the main categories that determine the processes of change in the technological structure of the economy .

The international community generally recognizes the recommendations regarding the analysis of technological innovation, adopted in Oslo in 1992 and reissued in the fourth edition in 2018, which are called the “Oslo Manual” [9]. In accordance with it, technological innovation is understood as the final result of innovative activity, represented by a new or improved existing product, which is introduced on the market, or a new or improved technological process, also introduced into practical activities. It can be concluded that technological innovations significantly affect many technological processes and lead to changes in the technological structure of the economy [10, 11].

From a historical perspective, the transformation of the technological structure of the economy is a nonlinear process [12]. Periods of stability are replaced by periods of transformation and disruption of old technological structures. The transformation process itself takes place in several stages, reflecting the relationship between investments in improving a product or process and the results of this investmen. In the first phase of changing the technological structure of the economy, experimental and innovative activities lead to the emergence of new technologies, while simultaneously preparing a springboard for their further implementation. the diffusion of innovation leads to an increase in returns to scale of production, selection occurs among technological alternatives, which leads to a gradual transformation of the technological structure with a subsequent slowdown in the rate of change at the fourth stage of the process. This description is an extremely simplified illustration of the process of transformation of the technological structure, but it gives an idea of the complex and multifaceted process of change as a whole

According to the views of researchers of industrial development processes, any historical process of sustainable economic growth was accompanied by a favorable economic environment, including a huge number of institutions accompanying and facilitating this process that determine behavioral norms and public policy [3, 13]. Innovation, including technological innovation, is “not a technical invention accessible to common sense, but an invention of a systemic property: for its implementation, it requires an immediate change not only in production technology, but, first of all, in the principles of its economic organization”.

In the technical and institutional aspect, technological changes were considered by T. Veblen [1]. The emergence of innovation, from his point of view, is an event process that changes the industrial environment, which leads to a change in the prevailing habits and

customs in society. According to Veblen, technological change directly affects the transformation of institutions.

Thus, the purpose of structural transformations in the technological structure of a particular industry to change its technological structure can be the development of those industry areas in which the creation of technological innovations occurs. The opposite scenario is the development of events when the formation of institutions outpaces the pace of formation of a new technological structure.

2 Results

A special place in the Russian transport complex belongs to water transport, which transports goods in different directions at significantly lower costs than rail and road transport. The development of waterways helps to increase the transportation of goods and passengers and reduces the cost of transportation. The total length of the country's inland waterways, through which goods and passengers are transported, is almost 102 thousand kilometers. In the regions of the country where there are inland waterways, 90% of the gross domestic product is created and 80% of the country's population lives. At the same time, 78% of waterways have no alternative for the delivery of goods.

To analyze the inland water transportation market, it is necessary to determine the current market conditions and assess the prospects for market development. To do this, it is necessary to consider the statistics of the inland waterway freight transport industry, inland waterway passenger transport and inland waterway transport infrastructure. The main activity in the field of cargo transportation belongs to transport enterprises that provide transport services to individuals and legal entities as their main activity. In Russia there are about 704 enterprises engaged in inland water freight transportation, and the number of inland water passenger transport enterprises is about 859 enterprises (Table 1). Most enterprises are private [14].

Table 1. Number of inland waterway freight and passenger transport enterprises by type of ownership in Russia in 2022.

Inland water freight transport		Inland water passenger transport	
Form of ownership	Number of enterprises	Form of ownership	Number of enterprises
Private	663	Private	810
State	1	State	16
Municipal	1	Municipal	8
Other	39	Other	25
Bottom line	704	Bottom line	859

The rolling stock of inland water transport consists of self-propelled and non-self-propelled cargo, dry cargo and liquid cargo. According to the Federal Agency for Maritime and River Transport, the number of units of rolling stock of inland water freight transport over the past 5 years has tended to decrease by 15% compared to the previous year. This is primarily due to the aging fleet and low financing of the industry. These trends affect the entire rolling stock of inland water transport. The state's main investments are aimed at supporting the industry as part of the formation of the country's port infrastructure, namely through the modernization of large regional water transport clusters and access infrastructure. Therefore, if we talk about port activities, I would like to note that technological innovations and structural transformations influence the development of the industry. And innovative institutional transformations are formed on the basis of the transformation of the technological structure and indicate an imbalance in the transformation of port activities in different regions.

To develop Russia's inland waterways, it is necessary to modernize and create large regional water transport clusters in the Sea of Azov; Baltic Sea; Western Arctic; Caspian Sea; Sea of Okhotsk and Tatar Strait; Primorsky Krai and the Eastern Arctic; Sakhalin, Kuril Islands and Kamchatka; Black Sea (Table 2). Thanks to the introduction of new technological structures when creating regional clusters, a certain paradigm for the interaction of transport enterprises of the cluster is being formed, consolidating the interaction of the seaport with access roads (motor transport, railway transport); consumers of transport services; government bodies (Ministry of Transport, Ministry of Economy, Ministry of Regional Development); regional administration; associations (Association of Sea Trade Ports, Coordination Council of the Transport Hub, Association of Russian Forwarders); infrastructure affecting the port's activities (transport infrastructure, auditing and consulting companies, customs companies, credit organizations); auxiliary industries (logistics, instrument making, shipbuilding and repair, ship supply, container repair).

Table 2. Division of ports by sea basins.

Sea pools	Ports
Ports of the Azov Sea	Rostov-on-Don Taganrog Azov Mariupol Caucasus Berdyansk Genichesk
Baltic Sea ports	Kaliningrad Vyborg Primorsk Vysotsk Ust-Luga Saint Petersburg
Ports of the Western Arctic	Murmansk Naryan-Mar Mezen Varandey Sabetta Dixon Dudinka Khatanga Arkhangelsk Onega Vitino Kandalaksha Lavna Liinahamari
Ports of the Caspian Sea	Astrakhan Olya Makhachkala
Ports of the Sea of Okhotsk and Tatar Strait	Magadan Okhotsk Elga Nikolaevsk-on-Amur Cape Lazarev De-Kastri Vanino Sovetskaya Gavan
Ports of Primorsky Krai and Eastern Arctic	Tiksi Pevek Carrying out Egvekinot Anadyr Bering
Ports of Sakhalin, Kuril and Kamchatka	Nevelsk Prigorodnoye Korsakov Kholmsk Poronaysk

	Shakhtersk Moskalvo Alexandrovs-k-Sakhalinsky
Black Sea ports	Sevastopol Yalta Feodosia Taman Anapa Novorossiysk Gelendzhik Tuapse Sochi Evpatoria Sevastopol Skadovsk Kherson
8	65

In accordance with the transport development strategy, one of the conditions for increasing the efficiency and competitiveness of the country’s transport system is to build a unified concept of effective cargo delivery schemes and the development of logistics transportation schemes while minimizing operating costs and time lag [6]. Therefore, it is necessary to use all available tools of the transport industry management system, which will allow the triad of interaction to be implemented: water, rail, and road transport.

During the implementation of the project, work traffic on the bridge over the Akhtuba River was opened and the renovation of the Tikhoretskaya station, the largest railway junction on the way to the ports of the Azov-Black Sea basin and the North-South transport corridor, was completed. In 2022, 9.3 km of stationary tracks have already been put into operation during the reconstruction of Tikhoretskaya, Bursak, Poroshinskaya, Rovnoye and Gumrak stations.

At the same time, the first stage of creating a dry cargo area of the seaport of Taman (railway infrastructure facilities of federal property, providing access to the transport crossing through the Kerch Strait) has been completed. At the moment, the project has already significantly increased the carrying capacity of sections of the western bypass of the Saratov hub. According to the development of transport infrastructure, it is necessary to develop a transport and logistics corridor in the Azov-Black Sea direction, which will increase trade exchange, provide transport services to the resort area of the South of Russia, and ensure employment in the region [14].

A comprehensive development plan for the Arkhangelsk transport hub has also been approved. It is planned to build a new terminal in the seaport of Arkhangelsk. For it, a deep-sea marine area will be created in the Dvina Bay of the White Sea. The capacity of the new terminal will be 25 million tons. in year.

The construction of this terminal should take place in several stages: - in 2024, investors and the government of the Arkhangelsk region must develop an investment declaration, and Rosmorrechflot must review it; - in 2025-2026, the development of project documentation should be completed and construction should begin; - in 2031, the commissioning of a new terminal and deep-water area of the seaport of Arkhangelsk is planned.

Five largest projects worth 139.1 billion rubles are being implemented in the Murmansk region: “Liinakhamari Port” - a tourism cluster on the Kola Peninsula with the ability to receive cruise ships; port "Novatek-Murmansk" - investment project "Center for the construction of large-capacity offshore structures"; “Sea Terminal “Tuloma” - a terminal for mineral fertilizers and apatite concentrate in the seaport of Murmansk; "Murmansk

Region Development Corporation" - an investment project to create an international cultural and business center; "Sea trade port "Lavna" is a coal terminal on the western shore of the Kola Bay.

Thanks to the national project "Modernization of Transport Infrastructure", a decision was made to build the sea trade port "Lavna" - the largest construction project in the North-West of the country. It is planned to commission the Lavna universal port in the Murmansk region in 2024. The construction of both the port itself and the railway approaches to it will be carried out. The port area is 120 hectares on the shore of the ice-free, deep-water Kola Bay of the Barents Sea. When the port is launched, the socio-economic development of the Arctic part of Russia will increase. One of the main advantages of the port is direct access to neutral waters, which will allow Russian exporters to open a sales market to the countries of the Asia-Pacific region. And the railway will open up labor traffic, Lavna will begin to fill coal sites and, in turn, this will help redirect the cargo base to domestic port facilities. The Lavna Coal Transshipment Complex project itself is an integral part of the Integrated Development of the Murmansk Transport Hub project. The main goal is to create a year-round operating deep-sea maritime hub - a center for processing oil cargo, transshipment of coal and mineral fertilizers, integrated into the international transport corridor "North - South".

Another advantage of the port is that there is no need for dredging; the coastline is already 15 meters, which will allow it to receive large-capacity vessels with a deadweight of up to 150 thousand tons.

If we talk about the equipment of the Baltic Sea ports and throughput capacity for 2023: Kaliningrad - 1,064,820 tons; Primorsk - 63,100,000; St. Petersburg - 49,600,000; Vyborg - 1,082,800; Vysotsk - 12,800,000; Ust-Luga - 112,500,000.

The Novatek-Murmansk port is an investment project located in the Murmansk region on the shores of the Barents Sea, which includes the construction of two floating gas storage facilities, an auxiliary berth and coastal infrastructure. The cost of the project is estimated at 70 billion rubles. Thanks to the construction of the port and its infrastructure, it became possible to transship liquefied natural gas on board, which was previously done in Norway at the facilities of the Tschudi company, since the Yamal LNG plant was launched ahead of schedule. Liquefied natural gas terminals with a volume of 360 thousand cubic meters with two side-to-side transshipment points. These terminals allow the transportation of liquefied natural gas by organizing transshipment from Arc7 ice-class LNG tankers to conventional vessels.

3 Conclusions

There are four aspects that influence the process of transformation of the technological structure of the industry:

Changes in the industry: establishing connections between developers and suppliers of new technologies, their providers and users, interaction with financial institutions, in the process of which an understanding of the key factors promoting and restraining changes in the technological system arises; It becomes important in cooperation to study existing and develop new technological standards, which ensures more successful "incorporation" of new technologies and expands the scope of their application.

Technical change: establishing and identifying connections between technologies and their components at various stages of maturity (from emergence to dominance) determines the stage of the transformation process and helps to identify bottlenecks, as well as options for applying technological alternatives; ensuring complementarity in the interaction of technologies contributes to increasing the effect of returns to scale of production.

Changes in the social environment. The existing technological structure can become both an obstacle and the basis for transformation. Positive experience in using a new technology creates demand for products (services) produced using it and, thereby, involves more and more new participants in this process. Initial changes in the system lead to changes in the preferences of end consumers, which accelerates the further process of change.

Political changes as a factor in promoting or restraining changes in the technological structure of the industry: affect the legal and institutional conditions of enterprise activity and serve as either a source of change or an obstacle to development. Both politicians and other stakeholders are able to shape institutional conditions in accordance with their strategic goals and interests [10]. The versatility of the analysis of the processes of transformation of the technological structure of the industry involves the identification of lobbying processes, which makes it possible to obtain reliable and objective information about the dynamics of the industry and to track factors that accelerate and slow down changes.

Factors interacting in the process of emergence of dominant standards are difficult to identify and evaluate [13]. Therefore, the process itself is often viewed as a “black box”, where internal market processes prevail rather than the coordinated actions of market actors. At the same time, many of the alternative standards and norms can be blocked and remain in the shadows for a long time.

According to D. North, “an increment of changes in the technological sphere, once taking a certain direction, can lead to the victory of one technological solution over others, even when the first technological direction ultimately turns out to be less effective compared to the rejected alternative” [4]. An example of ineffective technological development is the problem of QWERTY effects, which confirms the likelihood of the introduction of less effective technologies due to the predetermined future choices and outcomes of existing institutional conditions, and the technology is not chosen because it is effective, but becomes effective because it was chosen [11], while the variety of possible results is reduced to the system of standards existing in society. According to G. Dosi, institutions carry a history and tend to persist even when the conditions that justified their existence change or disappear [15].

As a result, the following conclusions can be drawn. Changes in the technological structure of the industry determine the state and possible options for its development. The already formed technological base also forms the advantages or disadvantages of the industry when positioning it in the international arena. However, the influence of the effect of previous development can neutralize changes in the technological paradigm. In addition, the processes of using technologies, both new and existing ones, involve the participation of many interconnected entities: business organizations, research and educational centers. Consequently, the stimulation of technological innovation is closely dependent on the state of the innovation and production systems.

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