CLUSTER BASED PROSPECTS FOR UNMANNED TRANSPORT TECHNOLOGIES

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ABSTRACT

The evolution of approaches to the concept of a cluster is shown. On the basis of studying their diversity, the distinctive features of the cluster from the group of enterprises are highlighted. An analysis of specifics of formation of a structure, depending on a type of a cluster, has been made, and a distinction has been established between a production, transport-logistical and innovative cluster in terms of their structural features. The prospects for using a cluster method for development of unmanned transport technologies are considered. The structure of an innovative production cluster for creating a technological base for unmanned vehicle management is proposed.

Keywords: cluster, evolution of approaches, innovations, unmanned technologies, transport.

Background. *In the 21st century, characterized by dominance of information technologies, creation of an ecosystem for development and implementation of innovative technologies play a decisive role in strengthening the country's competitiveness. Guidelines for technological development of the Russian Federation are formulated in the program of the national technological initiative (NTI), presented to the Federal Assembly in 2014 by the President of the Russian Federation [1].*

One of the key areas of NTI is Autonet – market for development of intelligent transport systems and unmanned transport technologies. At the same time, the technology of unmanned vehicle management is recognized as one of the breakthrough technologies, that will result in qualitative changes in various sectors: transport, construction, trade and many others.

That is why for Russia it is strategically necessary in the shortest possible time to create conditions for development of enterprises in the field of unmanned transport technologies. Clustering can become a method of accelerating development and implementation of innovative technologies. Within the clusters – territorial associations of enterprises, it is possible to connect technology companies, their suppliers, as well as various organizations that provide them with research, personnel, administrative support.

Objective. *In this regard, the key goal of the study is to assess the prospects for development of unmanned vehicles with participation of one of the existing innovation clusters, that could be facilitated by creation of a cluster concept, analysis of the structure of clusters of various types, and specifics of their development focusing on innovative clusters in the transport sector.*

Methods. *The authors use general scientific methods, comparative analysis, evaluation approach, economic methods.*

Results.

Evolution of a cluster concept

The development of the theory of clusters was due to the interest in development of clusters around the beginning of the 1980s. The first cluster-building programs have been tested in Germany, Italy and Austria. By 2000, cluster development programs appeared in almost all EU countries, as well as in the USA, Canada, Japan, India, and South Korea, which led to a rapid growth in the number of clusters: by 2005, there were about 1500 of them [2].

Today, the number of clusters, according to various sources, ranges from 3 thousand to 5,5 thousand [3], of which 168 are in the UK, 96 in France, 380 in the USA, 206 in Italy, 32 in Germany [4]. Such a range of statistical data is primarily due to the lack of a clear definition of the term «cluster». A common opinion, «which territorial association of enterprises» can be called a cluster, does not exist.

In a general sense, the term «cluster» refers to «congestion» and represents unification of similar objects [5] with its inherent specific properties.

The origin of theoretical foundations of economic clustering is associated with the name of the American economist M. Porter, who in 1990 introduced the concept of «cluster» and defined it as «geographically concentrated groups of interrelated companies, specialized service providers, firms in related industries, and related with their activities of organizations (for example, universities, standardization agencies, trade associations) in certain areas, competing, but at the same time carrying out joint work» [6].

Thus, initially the cluster approach, pointing to the tendency to geographical concentration, was used to solve a range of problems in analyzing the competitiveness of the state, region, industry, territory. In accordance with the trend M. J. Enright, another American scientist, suggested that competitive advantages are created not at the macro or world level, but at the meso-level or the level of individual regions. The regional cluster is considered as an industrial cluster, where the organizations which are part of it are in close proximity to each other [7].

However, some aspects of the clustering process were studied in 19th century: the economist A. Marshall, in «Principles of Economics», studied the relationship between the close location of market actors and their economic efficiency. And in the 1970s, Soviet economists A. Gorkin and L. Smirnyagin used the term «cluster» when describing organizations concentrated in space [8].

Further development of the theory of clustering was due to the studies of such foreign economists as H. Schmitz, P. Swann, M. Prevezer, D. Stout, M. Enright, S. Rosenfeld, M. Steiner, E. M. Bergman, E. J. Feser, D. Maillat, G. Villumsen, S. Young, R. Coase, T. Andersson and others.

Various authors interpret the concept under study, focusing on one or two of the features characterizing the cluster. For example, S. Rosenfeld talks about the synergistic effect inherent in clusters «because of their geographical proximity and interdependence» [9], and E. Feser and his coauthors focus on the existence of interrelations of cluster subjects, both vertical and horizontal [10]. Some note that creation of clusters is due to the need to strengthen collective competitiveness [11].

There is also an opinion that the cluster is a new word for older concepts of industrial areas, specialized industrial agglomerations and local production systems [13]. This approach has its rational sense, since clusters are formed gradually under the influence of historical, resource factors, integration, and economic processes. Clusters are based on existing economic formations, but at the same time transform them through market mechanisms. Compared with other forms of organization, for example, with territorial production complexes, which, unlike clusters, were created and operated on the state's initiative, clusters are formed based on the internal need of enterprises for integration and interaction. Otherwise, clustering will not provide the expected synergistic and other types of effects, which include lower transaction costs and other costs, reduced operational and investment risk, higher productivity and economic performance, market value of companies, new incentives for innovation, etc.

Studying the diversity of approaches made it possible to distinguish the distinctive features of a cluster from a group of enterprises:

(1) territorial concentration formed at the initiative of enterprises;

(2) combination of cooperation and internal competition, which indicates availability of resource and technological interconnection of the cluster entities;

(3) combination of enterprises of different sizes;

(4) critical mass and availability of key competitive enterprises;

(5) existence of coordinating centers, a unified management system withr independence of participants;

(6) high innovative activity of participants as a result of rapid exchange of technologies and information and internal competition;

(7) flexibility of the cluster composition, absence of barriers to expansion or narrowing, while maintaining a clear structure.

Creation of territorial clusters allows to optimize costs, increase productivity of participating companies, and accelerate development and implementation of technologies through interaction of all key companies in one territorial zone.

It should be noted that there are many options for constructing clusters depending on their purpose, scale, path of formation, and other characteristics. Evaluation of the prospects for creating a particular type of cluster is impossible without understanding the principles of creating its structure. This also applies to the use of a cluster model for introduction of unmanned vehicles.

Analysis of specifics of structure formation

The cluster structure consists of three levels: the core of the cluster, the network of suppliers and the business climate. The first level is the key or «anchor» companies. For example, for an automotive cluster, it is a car manufacturing plant. The second level is a set of medium and small companies that supply components or services to key companies. The third level consists of entities that provide key companies with various resources (financial, information, personnel, etc.). A clear structure is not only a sign of the cluster, but also determines its type.

Numerous types of clusters have been identified in the scientific literature, which differ depending on geographical concentration, the degree of state participation, the nature of origin, the degree of cohesion of participants in the cluster, the relation to the industry, the degree of novelty of the output, etc. The main classification feature is the nature of the cluster-forming industry, which divides clusters into discrete, process, tourist, innovation, production.

Discrete clusters involve production of products from individual components, for example, clusters of the engineering industry. Process clusters are formed by enterprises of so-called process branches – chemical, metallurgical, agricultural. The most interesting in the research are innovative production clusters, since introduction of unmanned technologies is a production with an innovative focus.

An innovative component is a sign of any cluster. By what, then, is the innovation cluster different from other species? Its peculiarity is that it is super-systemic, it can cover different types of clusters in the region. The innovation cluster results are innovations not only in production, but also in social, managerial and other spheres. The core of the innovation cluster is enterprises of intellectual capital, and production complexes form the basis for approbation and implementation of the results of innovative projects on an industrial scale. Development of an innovation cluster is largely determined by the information and financial component. Participants in the innovation cluster are more susceptible to change, striving for streamlining business processes, applying the most modern technologies.

Therefore, an innovation cluster is a «special type of cluster that has the properties to accelerate the process of generation, production and commercialization of innovations» [14].

An innovative cluster is «informal unification of the efforts of various organizations (industrial companies, research centers, universities, state scientific institutions, etc.) capable of transferring new knowledge, scientific discoveries and inventions, transforming them into innovations demanded by the market» [15].

Transport and logistics clusters (TLC) are «a complex of infrastructure and companies

Table 1

Analysis of structures of production, transport, logistics and innovation clusters

Levels of the cluster structure	Production cluster	Transport and logistics cluster	Innovation cluster
I level	Industrial enterprises	Large enterprises providing transport and logistics services in the field of motor, air, rail, sea and inland water transport.	Infrastructure of intellectual capital: universities, research institutes, technoparks, business incubators, SIC and laboratories, etc.
II level	Suppliers of components, services	Suppliers of fuels and lubricants, equipment, etc. Companies that provide services for maintenance and repair of rolling stock. Companies providing associated transport services – surveyor, stevedore, customs brokers, etc. Provision and maintenance of infrastructure.	Enterprises of the main activity of the cluster. Infrastructure of financial capital: lending institutions, banks, leasing, insurance companies, investment and innovation companies, venture funds.
III level	Personnel, financial, information support	Personnel, financial, information support.	Auxiliary and service organizations of enterprises of the main activity of the cluster.

specializing in storage, tracking and delivery of goods and passengers, that is, implementation of various transport and logistics operations» [15]. Unlike other types of clusters, they require not only availability of key companies providing transport and logistics services, but also creation and development of an appropriate transport infrastructure. It is the development of the transport infrastructure that is the main factor in formation of TLC. As a rule, TLC develop in territories with high transit potential.

Thus, the analysis of the cluster structure gives an idea of its main purpose and makes it possible to establish a distinction between production, transport-logistical and innovative character of the cluster (Table 1).

The cluster, which will ensure development of unmanned transport technologies, along with other innovative transport technologies, must have the resources of each of the types of clusters listed. It should include industrial enterprises with a strong infrastructure of intellectual capital, the results of interaction of which are approved and used by the subjects of the transport and logistics system. Consequently, we can talk about an innovative manufacturing cluster in the transport sector, which is a group of interrelated market players in manufacturing and transport services with inherent features of clustered education, the core of which are key organizations specializing in development of innovative transport technologies.

Prospects of unmanned transport technology

According to Forbes research, this technology has a breakthrough potential and in the long term will dramatically change the life of inhabitants of megacities, making it safer, more comfortable and productive [18]. In most technologically advanced countries, it is already at the testing stage on public roads of cities. Russian companies are also trying to catch up with the largest technological giants.

To create a technological base for unmanned vehicle management, it is necessary to unite the efforts of companies, research institutes, and administrative structures. Moreover, in order to conduct pilot tests, expensive road infrastructure and closed landfills are needed. That is why, in order to optimize the timing of introduction of innovative technology and capital intensity of final development, it is advisable to apply the cluster approach.

The proposed structure of an innovative production cluster in the transport sector is shown in Pic. 1.

Its first level includes automobile concerns that produce the final product, namely an unmanned vehicle. The function of such companies is to integrate various technologies necessary for unmanned vehicle operation: navigation, object recognition, interaction with other cars and the environment, etc.

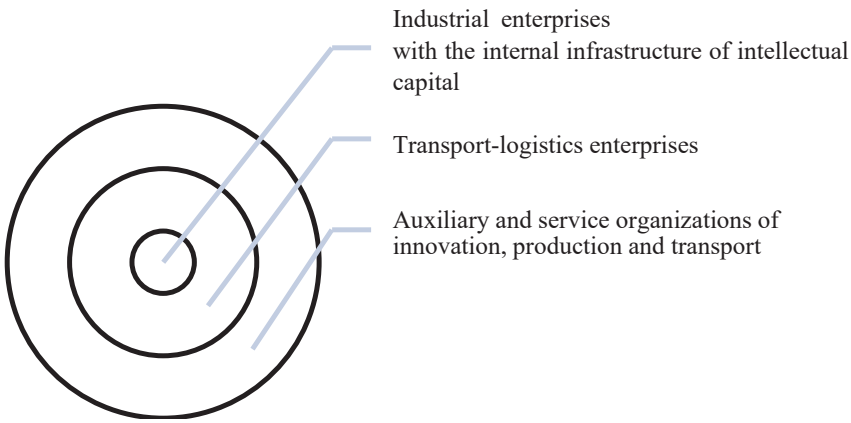
Undoubtedly, for production of unmanned vehicles, first-tier companies must attract developers of:

- *artificial intelligence;*
- *sensors, radars and other physical components of perception of unmanned vehicle information;*
- *unmanned vehicle software decision-making complex.*

The second level of the innovative production cluster includes transport and logistics enterprises that need to use such unmanned technologies. Such enterprises may include cargo carriers, taxi services, route passenger carriers, ports.

The third level includes organizations that provide resource support to the cluster:

1. Personnel – need for engineers able to carry out software development, to integrate



Pic. 1. Structure of three levels of innovative production cluster in the transport sector.

physical components of unmanned vehicle systems is extremely high. To attract qualified specialists in the next 3–5 years, it is necessary to develop training and retraining programs for the leading technical universities jointly with the companies of the first level.

2. Information – due to the fact that the technology of unmanned vehicle navigation is quite new, there is a shortage of scientific literature on this topic. To fill gaps, as well as accelerate approbation of technologies by cluster companies, it is necessary to accelerate participation of university scientific centers in joint research.

3. Administrative – in addition to technological barriers in putting into operation of unmanned vehicles, there are restrictions related to the legislative framework. To legalize operation of unmanned vehicles and conduct tests on public roads in the next 1–2 years it will be required to change the provisions of the Traffic rules, as well as requirements for liability insurance when using drones.

4. Financial – one of the constraints of unmanned vehicle development is capital intensity of development and testing of technology, so it is necessary to assist companies operating in this area. It is the task of business incubators and venture investors.

5. Infrastructural – creation of a smart road infrastructure becomes one of the fundamental factors for effective functioning of a system of unmanned vehicles.

Having determined the structure of the innovation cluster of unmanned vehicles, it is necessary to assess the possible geographical location of the association being created, since the criterion of territorial proximity causes a lot of positive effects for the cluster.

Let's consider alternatives based on the existing profiling of the regions of the Russian Federation. At the moment, 113 clusters have been created in the country, most of which are located in its European part. At the same time, three clusters are focused on development and production of cars [21]:

1. Kama innovative territorial production cluster.

2. Nizhny Novgorod industrial innovation cluster in the automotive industry.

3. Cluster of the automotive industry of Samara region.

The largest of these is Kama cluster, with 213 participating companies, including KamAZ, Ford Sollers, which can be attributed to the first level – the core of the unmanned vehicle cluster. These companies need to develop software, physical components of unmanned vehicle systems for further integration into their cars. For example, the first in Russia unmanned bus «Shuttle» is already being created by the company Yandex on the basis of KamAZ [22].

However, although Kama innovation cluster includes two national research and one federal universities, the companies that develop artificial intelligence, decision-making programs for unmanned vehicles are still not present here.

Among the companies participating in the second level of the cluster we can quote the most important trucking companies, for example, Kama Traks, PEK. Among the companies interested in development of unmanned technology we can name largest urban transit operators like city bus and taxi companies.

The third level of cluster enterprises should be represented by companies developing smart road infrastructure. For full-scale expansion of unmanned vehicles to public roads, to obtain the maximum effect in terms of throughput and traffic safety, it is necessary to realize communication channels car–car (V2V) and car–surrounding infrastructure (V2I).

Federal Agency Rosavtodor [Federal Road Agency], represented in the region, specializes in development of such a road infrastructure. Moreover, by the end of 2018 the first section of the route Kazan–Naberezhnye Chelny, prepared for testing unmanned vehicles, will be opened [19]. For closed trials, it is also planned to create a training ground in Naberezhnye Chelny [22].

Conclusion. *The study of theoretical foundations of the concept of clusters made it possible to determine the possible direction of development of unmanned transport technologies. This is subject to a partial restructuring of the way to improve the scientific, technical and resource base of one of the existing production clusters in the automotive industry.*

Creation of such an innovative cluster can result not only in a more rapid technological development of unmanned vehicles of the Russian Federation with a reduction in logistics costs, but can also allow to promptly influence the change in the regulatory and legal framework in the sphere of their operation. Due to involvement of universities, it is possible to create training programs necessary to maintain and to further develop technology, to accelerate the process of its adaptation to Russian conditions.

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Article received 27.05.2018, accepted 12.07.2018.