Factors determining the decision on spatial location of mechanical engineering production forces

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Abstract. The article deals with the search for the optimal spatial location of mechanical engineering production systems at the present stage of economic development of Russia. Spatial location is considered as an important investment issue that requires careful economic justification as part of choosing the appropriate strategy. The search for the most suitable place for spatial placement depends largely on what the mechanical engineering production system itself is. The article presents the approaches of various researchers, which are still relevant and valid in modern Russia, since they are focused on territories with a predominantly rural type of economy and are well correlated with the current system of administrative and territorial management of our country. The article describes a number of factors that affect the choice of spatial location of mechanical engineering production facilities, among which are the natural, historical, social, technical, economic, as well as governmental and political factors. The article concludes that the final decision on the specialization of the Russian Federation subject and the spatial location of machine-building production in the region depends on the requests of the entrepreneurs in a particular industry and the level of development of productive forces.

1. Introduction

One of the most important issues faced by the owners and managers of mechanical engineering enterprises is the selection of their location. Placement is related to searching for the most optimal geographical location of production and service facilities. Decisions on the placement of elements of mechanical engineering systems are extremely important, as they affect the performance of their activities for many years, i.e. they have a strategic and long-term character. At the same time, significant capital investments are made with a fairly long payback period, which requires ensuring that it is possible to obtain a stable income for a long time as a result of activities at the chosen location. And if the location of the machine-building production system turns out to be unsuccessful and unsuitable, but the significant funds have been already invested in it, then it will not be easy to correct the situation by finding a new place. This will require large financial, labor, and time expenditures and will lead to loss of clientele, freezing of capital, and lower competitiveness.

However, the optimal location does not guarantee success in business, but it is a necessary condition for it. The values of fixed and variable costs of production systems are important for choosing the location. Depending on the type of product produced, the transport costs for delivering the product to the consumer places can reach up to 25% of its price [1]. Other costs that are affected by the location of mechanical engineering production systems are taxes, wages, and raw materials costs. The selection of
location can change production and distribution costs by increasing or decreasing them by 10% of the total cost. Therefore, reducing costs as a result of finding the optimal location may be a simpler solution than reducing production costs by the same 10% by improving the enterprise management system with another less successful location. The costs carried by a machine-building enterprise at the placement stage and determined by the specifics of the location have a certain payback period and it is difficult to reduce them (or any component part) at an earlier time. For example, if the company is supposed to be located in a region with a high cost of energy resources, even the most advanced strategy for using energy resources will not give a starting advantage. This is also true for the strategy of using labor resources, if the hired labor in the region chosen for machine-building production is characterized by high cost, poor professional training or low labor discipline.

2. Problem statement

The search for optimal spatial location of machine-building production systems can be considered as an important investment direction that requires careful economic justification in the selection of the appropriate strategy. The choice of a strategy aimed at finding and implementing the most effective and optimal placement option depends largely on what the machine-building production system that requires placement is. For Russia, with its huge scale and great diversity in natural, resource, socio-economic conditions, issues of spatial location of machine-building production are of sustained importance.

The location of production on the territory (in space) is often due to historical factors. It also depends on the characteristics of the social system. It changes in accordance with the level of productive forces development and industrial relations. Under the factors of industrial production placement in the region, it is proposed to understand the set of conditions and resources of the territory that have a direct or indirect impact on the socio-economic performance indicators of the production facilities located on them and, thus, on the sectoral structure of the territory. In the practice of scientific research, various classification groups are used. Thus, highlighting the important group of social factors, some researchers suggest to take into account the traditions and national culture when deciding on the rational allocation of productive forces. [2, 3]. Shilova and Bezaev offer a synthesis of six different but interconnected socio-economic indicators [4]. A number of researchers are studying single-factor models of spatial development. Thus, Bakhteev and Kudyusheva use physical, social, and economic factors in their work [5]. Novikov and Chaly consider the specifics of the formation of human capital in local territories [6].

Table 1 shows the researches that identify classic factors of production placement. Despite the fact that the main works of these researchers have been published since the beginning of the twentieth century, the proposed approaches are still relevant in modern Russia, since they are focused on the territories with a predominantly rural type of economy and correlate well with the current system of administrative and territorial management of our country.

| Researcher name | Theory content | Factors | Theory weak points |
|-----------------|----------------|---------|--------------------|
| Wilhelm Launhardt | Theory of Standort. Geometrically, the optimal place is determined for the location for the processing enterprise within the weight triangle (two sources of raw materials and one market). Another Launhardt model made it possible to determine sales zones for several manufacturers in case of equal distribution of consumers. | transportation costs | Lawndart does not take into account production costs (consider them equal for all cases) |
| Alfred Weber | Theory of Standort. Improved Launhardt's methodology, in addition to transportation costs, used additional factors | production costs for raw materials, energy and fuel, wages, agglomeration effect | the method can be applied only at the micro level, pointwise, without reference to the economic zones of the region, and even more so, the country. |
| Walter Cristaller, August Losch | The theory of "Central places" about the functions and location of a system of localities | market zones | they don't count the “pioneer” development areas, they have |
The model was based on the hierarchical order of territories (small, medium, large, and largest), the rank of which determines both the differentiation of their functions and the optimization of the surrounding market structure [7, 8].

### Torsten Hägerstrand

Theory of "diffusion of innovations": because of frequent change of leading industries production during the "long waves" of Kondratiev, the innovations initially occur only in some regions ("foci"), and their spread ("diffusion") is a spatial and temporal process in economic space. Time is of the essence, not transport costs, raw material sources, or sales markets. It does not take into account the speed of innovation spread depending on the degree of importance of the industry for the economy.

### Planned economy

The economic geography of that time studied two main areas: territorial structure of the national economy and its industry aspects. Each territory specialized in production of a particular type of industrial products taking into account the transport component. Economically reasonable specialization is a key concept in this context. Centralization of economic power, absence of competition factor.

### Present stage of economy

When studying the conditions for industrial production locations the natural, climatic, resource, infrastructure, labor potential, the forms of production organization and social characteristics of some territories are analyzed. Economically reasonable specialization is a key concept in this context. Government agencies in Russia have lost the tools for predictive spatial development of industrial production sectors. In most cases, we are talking about an inertial version of the spatial-industrial specialization of the region, which in a highly volatile competitive environment is not always an effective development scenario.

## 3. Research results

It is necessary to make the right decision regarding not only the amount of production facilities, but also their location and layout. Many factors influence the choice of location for machine-building production facilities. However, among the variety of factors of production territorial location, the following factors should be highlighted:

First of all, these are natural factors, including spatial and economic assessment of natural and climatic conditions and resources. Mechanical engineering production facilities can be located near sources of raw materials and materials that are consumed in large amount or have certain large features (high weight, large dimension, volume etc.).

Secondly, it is a group of social factors that are understood as historical features of the settlement system, the availability of social infrastructure (hospitals, schools, kindergartens, sports, cultural and leisure facilities), the level of social tension (morbidity, crime, unemployment, etc.), the availability of territories with labor resources. A local source of labor that has the necessary skills, competencies, or is ready to be trained is an essential prerequisite for business success. At the same time, one can engage staff from other territories, as it is done in large-scale construction projects. Labor costs are often a determining factor when deciding on the location of an enterprise. At the same time, the availability of cheap labor quickly leads to the industrialization of a country or region, to an increase in its welfare and, as a result, to an increase in the cost of labor.

The category of technical and economic factors includes the basic conditions and resources necessary for the organization of the production process: electric, water, and gas disposal systems; an accessible base of raw materials and components; the availability of roads and railways [9]. In industrial production...
and trade, transportation of raw materials and finished products is of great importance and the availability of the goods sale place for buyers. The importance of accessibility of roads, storage, transportation, security, and other infrastructure facilities depends on the size of the enterprise [10]. Small enterprises are interested in a developed infrastructure, while large ones are interested in allocating free space where their own infrastructure can be created at their own expense.

It is also necessary to take into account the dynamics of the studied processes. In addition, the study of placement factors should also take into account the specifics of mechanical engineering industry: some industries have a pull to the consumer, the others to resources or energy sources.

These factors may contradict each other. Therefore, the placement of machine-building production facilities is a non-trivial task, it requires close consideration. Summarizing the above, we can conclude that modern methods of spatial research are not limited to the analysis of the studied phenomena and factors, but engaged in their search, study them in development, search for complex cause-and-effect relationships, assess from the point of view of practice and justify objective laws, principles and factors of mechanical engineering production placement.

At the present stage of economic development in Russia, we can observe a noticeably increased process of “splitting” the entire economic space of the modern government into multiple local production and economic systems (regions, economic districts, urban agglomerations, etc.) that concentrate the existing production, financial and labor potential of territories and generate new “growth points” while competing with each other for investment and sales markets [11].

The prerequisites for creating local systems in Russia are described farther. First of all, we talk about the absence of the regional policy in Russia aimed at creating a single economic space. As a result, each of the regions developed along its own trajectory, and the situation with spatial asymmetry and an increasing difference in the level of socio-economic development of Russian regions have been worsened [12].

The research conducted by the Laboratory of forecasting of regional macroeconomic proportions of the Institute of economic forecasting of Russian Academy of Sciences showed that in comparison with the soviet period the support for the Far East regions decreased by seven times, the support for the Chernozem Center decreased several times and the support for the European North, Eastern Siberia has not only completely stopped, but resources even began to be taken from them [13, 14].

In addition, it is necessary to pay special attention to the current nature of the development of vast Russian lands, especially Siberia and the Far East [15]. Some quantitative characteristics of spatial differences are shown in the table 2.

| The subject of the Russian Federation | Population density, person / km² | Settlement density, units / thousand km² | Density of paved roads per 1000 km² |
|--------------------------------------|----------------------------------|----------------------------------------|-----------------------------------|
| Krasnoyarsk region                   | 1,2                              | 0,23                                   | 11                                |
| Republic of Khakassia                | 8,6                              | 1,49                                   | 46                                |
| Republic of Tuva                     | 1,8                              | 0,75                                   | 17                                |
| Novosibirsk region                   | 15,1                             | 2,59                                   | 66                                |
| Irkutsk region                       | 3,1                              | 0,57                                   | 20                                |
| Kemerovo region                      | 28,7                             | 2,14                                   | 96                                |
| Omsk region                          | 14                               | 2,78                                   | 76                                |
| Tomsk region                         | 3,4                              | 0,39                                   | 14                                |
| Far Eastern Federal district         | 1                                | 0,20                                   | 6,2                               |

As can be seen from the table, the Siberian regions are characterized by low population. At the same time, Siberia itself covers an area of 9.8 million square kilometers, i.e. more than 56 % of the territory of Russia (over 5.6 % of the entire land area of the planet). In addition, the Siberian regions are characterized by an abundance of small rural settlements. In Siberia, there is a rare network of large cities and only three "millionaire cities" (Krasnoyarsk, Novosibirsk and Omsk).

At the same time, a characteristic feature of the Siberian regions (in comparison with the all-Russian practice) is a relatively equal level of low economic development [17]. As the main result is a clearly
marked fragmentation of spatial development. A significant number of small localities do not have reliable transport links. The main economic activity is concentrated in major cities [18]. The majority of eastern regions of Russia can develop only at the expense of point (focal) “oases” of economic activity [11, 17]. The main reason for this is the historically established practice, when cities played a system-forming role in the formation and functioning of local economic systems [19], and the generator of impulses of economic development at the local level is one or more large enterprises. Of course, a similar situation takes place throughout Russia, although in the eastern part of the country system-forming enterprises are much more common.

The third reason is the deepening centralization of the regional economic development for management system [20]. First of all, we are talking about the redistribution of budget resources in favor of the federal level. As a result, the current financial model of interaction that involves fierce competition among regions and municipalities for federal funding for the development of production complex [14].

In this regard, the study of spatial placement issues highlights the significance of another key factor, and namely the policy of government and local authorities. Both federal and local authorities often force the mechanical engineering enterprises to locate in specific areas. These incentives are usually financial in nature: grants, real estate subsidies, etc. This group of factors includes specific conditions and circumstances that are permanent or temporary in the present, past or future, and are related to the characteristics of social relations: closeness to trade routes, the development level of associated territories, military conflicts, strategic national projects, etc.

4. Conclusion

The presence of key factors for placing the mechanical engineering production on a certain territory determines the sectoral structure of its economy. Moreover, the ultimate “set of factors” and government policies in their development that determine specialization of the Russian subject and spatial location of production in the region, will vary depending on the business query in a particular industry and the level of productive forces development.

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