Methodology for assessing the competitiveness of space services

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Abstract. The main components of the competitiveness of space services are their price and quality, as well as the ratio of these parameters. These indicators are determined by the values of technical and economic parameters of the service. The competitiveness of a space service refers to its ability to meet the requirements of a particular consumer in a given market and period of time in terms of quality and consumer costs for the acquisition and operation (or consumption) of this service. In order to increase the competitiveness of space services and their commercialization in the domestic and international markets, it is necessary to have an objective assessment of their competitiveness and ability to solve economic problems with a high accuracy. The article contains developed methodology for assessing the competitiveness of space services that used to solve specific economic problems in the interests of various sectors of the economy. Based on the assessment of the competitiveness of space services aimed at solving sectoral economic problems, the growth trends of economic sectors can be identified, and economic growth scenarios due to the emergence of highly competitive space services can be formed, replacing traditional methods of solving problems.

1. Introduction
All economic processes are subject to economic laws (laws of demand, supply, increasing marginal costs, decreasing productivity of factors of production etc.), which to varying degrees affect the course of these processes [1, 2]. Thus, one of the most well-known laws of economics - the law of demand - is expressed in changes in demand for products, and hence the revenue of an organization, due to changes in the price competitiveness of goods or services (pricing policy, optimization of production costs, logistics, administrative and other factors, included in the price of goods or services). In the competitiveness management system, there is a close interdependence between all levels of competitiveness: products or services, organizations, industries and the state. Country-level and industry-level competitiveness ultimately depend on the ability of a particular organization to produce competitive goods or services, which consumer, price and quality characteristics (in comparison with similar products) determine its success, both in the domestic and foreign markets [3]. At the macro level, the economic effect of producing highly competitive products and services is expressed in the creation of new markets for competitive products or services or in obtaining a significant part of the existing market. Ultimately, the economic effect of producing highly competitive products or services has a positive impact on GDP growth [4].

The competitiveness of a space service refers to its ability to meet the requirements of a particular consumer in a given market and period of time in terms of quality and consumer costs for the acquisition and operation (or consumption) of this service.
The main components of the competitiveness of space services are their price and quality, as well as the ratio of these parameters. These indicators are determined by the values of technical and economic parameters of the service [5].

Naturally, a high quality and but low-price service in relation to market leaders will have the highest competitiveness. But in the modern world there is a tendency for the price component not always being a decisive factor even for a service produced using innovative technologies with such unique competitive advantages [6, 7].

2. Research methods and implementation

In order to increase the competitiveness of space services and their commercialization in the domestic and international markets, it is necessary to have an objective assessment of their competitiveness and ability to solve economic problems with a high accuracy.

To obtain a quantitative assessment of the competitiveness of space services, it is necessary to conduct a comprehensive analysis of factual information about the prospects of space services in meeting the economic challenges in the interests of various sectors of the economy. The effective use of space services to solve specific economic problems in various sectors of the economy helps to increase the competitiveness of these industries through the introduction of innovative technologies that increase labor productivity, reduce costs, and increase demand for products, and also there is an increase in demand for products.

Since the concept of competitiveness implies comparing various offers of space services, it is necessary to develop a methodology that makes it possible to establish quantitative assessments of competitiveness against competitors. Its purpose is to assess the competitiveness of space services used to solve specific economic problems in various sectors of the economy. As a result of the use of this technique, the goal of obtaining an objective assessment of the competitiveness of space services in the market is achieved.

The methodology for assessing the competitiveness of space services solves the problems related with obtaining assessments of the competitiveness of various space services when solving specific economic problems. At the same time, the important task of group and individual assessment of the competitiveness of various space services offered by Russian space industry enterprises in comparison with similar services provided by foreign companies is solved.

The methodology for assessing the competitiveness of space services used to solve specific economic problems in various sectors of the economy is applied in several stages.

Let us consider in detail the algorithms for the methodology’s implementation stages.

Initial data preparation

To assess the competitiveness of space services, it is necessary to generate initial data that should describe the services used to solve economic problems in various sectors of the economy. To do this, it is necessary to highlight the industries intended for space services.

Once industries have been identified, it is necessary to select the space services that will be used to solve the economic problems in these industries.

It should be noted that when using this technique, it is assumed that the considered space services include not only obtaining space information about objects on Earth, but also its processing by mathematical intellectual methods to obtain the necessary economic information about objects for solving specific problems.

Development of characteristics of services to calculate competitiveness factors

After identifying the industries and the list of space services to solve specific economic problems in the interests of these industries, it is necessary to determine the characteristics of the services, and obtain numerical values of these characteristics based on the source data.

To work with the methodology, it is supposed to utilize the following characteristics of space services:

- quality of service (U);
efficiency of service provision (T);
the cost of preparing the necessary infrastructure for service rendering in the interests of a particular industry (S_{inf});
relative cost of providing a unit of service (S);
assessment of the impact of the use of space services on the competitiveness of the intended industries (\sigma);
assessment of the risks associated with the provision of space services to solve problems in the interests of a particular industry (R).

When using the methodology for assessing the competitiveness of space services in the interests of certain sectors of the economy, the above list of characteristics can be adjusted for each specific situation.

The methodology deals with the numerical values of these characteristics, but since the classification automatically regulates the numerical values of the characteristics, when compiling the initial data, the natural values of the characteristics can be indicated.

After the formation of the characteristics of services, it is necessary to calculate their numerical values. In this case, we will utilize natural values, or scale.

“Quality of service” (U) is evaluated on the basis of an assessment of the completeness and accuracy of the economic description of an object based on space information and its subsequent intellectual processing. Thus, the parameter is \( U \in [0, 1] \) where the unit value indicates the ability of the space service to build a digital double of the economic object of the problem being solved and to solve the problem as accurately as possible. Based on the approach to determine the quantitative measure of the utility of space information and the results of its processing by space service algorithms based on information entropy, the quality of the service can be estimated by the formula:

\[
U = 1 - H_n,
\]

where \( H_n \) is the entropy value corresponding to the completeness of the description of the economic object and space service based on space information.

"Efficiency of service provision" (T) is estimated as the ratio of the time to solve a problem using a space service to the value of the time to solve this problem through traditional methods:

\[
T = \frac{T^*}{T^0},
\]

where \( T^* \) is the time to solve the problem using the space service, \( T^0 \) is the time to solve the problem by traditional methods. If the problem was not solved by traditional methods, the value of T should be assumed to be zero.

“The cost of preparing the necessary infrastructure for service rendering in the interests of a particular industry” (S_{inf}) is estimated by the value from the interval [0, 1], which is calculated as the ratio of the cost of creating the infrastructure for solving a problem using a space service to the value of the infrastructure cost necessary to solve this problem through traditional methods:

\[
S_{inf} = \frac{P^*}{P^0},
\]

where \( P^* \) is the cost of creating the infrastructure for solving the problem using the space service, \( P^0 \) is the cost of the infrastructure for solving the problem through traditional methods. If the problem was not solved by traditional methods, the value of \( S_{inf} \) should be assumed to be zero.
“The relative cost of providing a unit of service” ($S$) is calculated similarly to the efficiency of the service as the ratio of the cost of solving a problem using a space service to the value of the cost of solving this problem through traditional methods.

“Assessment of the impact of the use of space services on the competitiveness of the intended industries ($\sigma$)” is calculated as the change in average productivity in a given sector of the economy as a result of the use of space services, i.e. a change in the created value per unit of labor and per monetary unit of the invested capital (or, in other words, a change in the average cost per unit of finished goods for organizations in this industry as a result of the use of space services). The value is measured as a percentage. In practice, the cost or labor method can be used to assess productivity, depending on the specifics of the task being solved.

“Assessment of the risks associated with the provision of space services to solve problems in the interests of a particular industry” ($R$) is equal to the failure probability from 0 to 1 to solve an economic problem using a space service. It is estimated by means of expert method or by means of known techniques [8] if there is the necessary set of initial data.

The indicated parameters must be set for each sector of the economy in which the service in question will be applied. After that, for each service, an integral indicator of the competitiveness of this service is calculated according to the following formula:

$$Q = \sum_{i=1}^{N} U_i \sigma_i (1 - T_j)(1 - S_{inf,j})(1 - S_j)(1 - R),$$

where $N$ is the number of industries in which the service in question is applied.

Based on the obtained value of the integral indicator of the competitiveness of space services, they can be ranked.

3. Conclusion and discussion

The developed methodology for assessing the competitiveness of space services is used to solve specific economic problems in the interests of various sectors of the economy. Based on the assessment of the competitiveness of space services aimed at solving sectoral economic problems, the growth trends of economic sectors can be identified, and economic growth scenarios due to the emergence of highly competitive space services can be formed, replacing traditional methods of solving problems.

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