CHAPTER «NATIONAL SECURITY»

LEGAL REGULATION OF STATES' INVESTMENT IN THE SPACE INDUSTRY WITHIN NATIONAL SECURITY STRATEGIES

Svitlana Koshova[1]

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Abstract. This article analyzes the data on investments of certain countries in the space industry in the period from 2011 to 2021. It is proved that the Space Industry is one of the industries without which it is impossible to imagine the modern world, as it is one of the primary factors of National Security.

After all, with the launch of the first satellites, the Space Program has taken major steps into a new era of technology, significantly expanding the boundaries of the world in which we live.

At present, countries around the world are financing the activities of state space corporations, so that they, in turn, work on the development of leading and promising rocket technologies. As investors realize and understand 'space' products and new technological opportunities allow them to create and operate an ever-expanding range of space technology. Investments in the industry are currently growing worldwide.

Thus, in the period from 2014 to 2020, the European Union invested in excess of 16 billion euros in space activity and technology which indicates that the space industry is an important component of the European economy.

The current investment wave can only be the basis for a future «wave» of investment that can radically transform the space market in the next decade and have a significant impact on the global economy.

The article also examines a problem relevant to the national security of the state – the possibility of using economic and mathematical models to

[1] Candidate of Science in Public Administration,
Associate Professor of the Department of Healthcare Management and Public Administration,
Shupyk National Healthcare University of Ukraine Kyiv, Ukraine
ORCID: https://orcid.org/0000-0002-7637-4311

predict the prospects for the development of the space industry. In modern conditions, the space industry is seen as the basis for innovative development and economic security of the state, which is the driving force of economic development. After all, *in order* to sustainably develop the economy and achieve the indicators planned by the government, it is necessary to have a clear idea of the mechanisms of functioning of the system as a whole and its individual parts. That is why competent forecasting of the main indicators of the development of the space industry with the identification of key factors influencing it is especially relevant at the present stage. Forecasting of indicators is based on the construction of economic and mathematical models of industry development. It is determined that the construction of this model begins with the development of the model specification, which includes a verbal description of the study, followed by a presentation of the process of its functioning in the form of mathematical formulas. *The methodology* is that the study used methods of analysis, synthesis, comparison, deduction and induction. The subject is social relations that are formed in the space industry. *Results*. It is proved that it is important to clearly formulate and define the problem, as well as to identify all the factors and patterns that characterize the functioning of the system. Economic and mathematical models can increase the efficiency of the planning system of the industry and increase the accuracy of the process of forecasting its development. The successful development of the space industry is today becoming a necessary condition for preserving national sovereignty, both in the military-political aspect and in the field of information security. *Practical implations.* The article identifies the main trends inherent in the development of the global space industry, namely: privatization of space, commercialization of space activities and internationalization processes. It is proved that with the development of the space industry, states ensure strategic stability and security at all levels

1. Introduction

The world is currently facing new pressing problems, which is why they are building their policies differently, changing their attitude to natural resources. And in all this, the constant help from the space industry and its activities are have a positive impact on the daily life of society, opening up new and exciting opportunities with its seemingly, inexhaustible potential.

Space-related human activities are constantly evolving, and they are now entering a new stage of development. Scientists point to three main drivers of innovation in the space sector. These include State Space Programs in science and National security, the expansion of space-related technologies and services, and the pursuit of space exploration.

Geopolitical interests have always played a key role in the development and implementation of space programs. This situation will continue in the future. As with other high-tech industries. Government research orders related to national security will be a major source of innovation, some of which will be available to consumers and the commercial sector in the future. State-sponsored space science and research will also be important drivers for a range of research and development. In addition, the ability to carry out space activities is a matter of prestige.

The priorities of national and international space programs and projects are being clarified and revised, methods of their planning and implementation are being improved, the legal framework for space activities is being expanded, the status of space programs is changing. However, all these objective conditions do not change the main trend, world cosmonautics continues its progressive development, and the amount of its investment in solving current problems facing individual states and their coalitions as a whole is growing steadily, significantly increasing the role of international cooperation. Space activity is a dynamically developing process, which is objectively manifested in the progressive development of civilization on Earth.

2. Administrative and legal characteristics of the space industry and directions of world space activities

The global space market is a significant segment of the global high-tech market. In each country, the space industry is one of the most competitive, because it includes a large number of high-tech enterprises that represent the country on the world market.

It is worth noting that in many countries involved in space activities, national, social and economic problems are not yet fully resolved. But these countries allocate significant budget funds for space activities, as they see the space industry as a source of scientific and technological progress, as well as a factor in ensuring national security. Therefore, the modern

development of civilization is closely and objectively connected with the further development and use of outer space.

The topical issue at present is the stable development and prospects of the space industry, as this industry belongs to the important strategic sectors of national security and occupies a leading position in the economy of each country. Achievements in space activities provide the state's leading position in the international space technology market, as well as add some weight to the development of outer space.

Space technologies guarantee technological, military, scientific, political and economic advantages, increase the efficiency of reconnaissance, provide communication and navigation, environmental protection and climate change monitoring [1, p. 263]. Therefore, undoubtedly, investing in the space industry is an urgent and important issue to ensure the effective development of this high-tech segment, which in a globalized environment is able to provide prerequisites for long-term strategic growth and technological leadership.

The purpose of this article is to analyze the general trends of state investment in the space industry within the strategic national security programs for the period 2011–2021.

The tasks are to conduct a thorough analysis of the legal regulation of state investment in the space industry within the framework of national security strategies.

At present, the development of the world space market has covered almost all regions of the world. Entry into space activities of new states, development of new space programs, and as a result of increased competition, stimulate the development of this industry, increasing its commercial potential, developing new technologies and opening new areas of its application [1, p. 263]. The main issues of space sector development are:

– formation of state space policy;

– search for vectors of conservation and development of the space industry;

– development of the management structure of enterprises in this sector.

The space activities of the leading space powers are one of the highest state priorities and have a complex structure in which all its types are to some extent interconnected. This approach to the classification of space activities is presented in Figure 1.

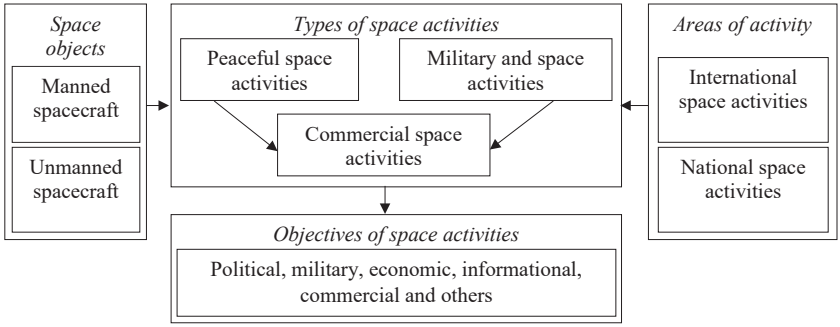


Figure 1. Classification of space activities

Source: [4, p. 58]

Important areas of world space activities are:

– study of outer space, near and far space;

– solving national security problems;

– solving socio-economic problems with the use of space;

– use of scientific and technical results of astronautics in all spheres of development of modern society;

– solving problems of creation and development of promising spacecraft, etc. [7, p. 55].

Military-space activity is an activity related to access to space, directly in space, through space and from space in the interests of defense and military security of the state [2, p. 5].

The main areas of military and space activities include:

– orders and works related to the creation of military rocket and space technology, space infrastructure facilities;

– deployment and maintenance in proper composition and working condition of orbital groups of space systems and communication complexes;

– solving certain tasks of deterring aggression in space and from space in the event of a threat to national interests [3, p. 249].

The space industry has become a major commercially attractive component of the global economy, employing more than a million people worldwide. Space and business have already become an integral part of each other. Participation in space activities determines the prestige of the state, its power [5, p. 64]. The main problem is the need for large investments

in this industry. It requires significant costs, as well as a certain level of technological development of the country. This complicates the entry of underdeveloped countries into the market of space goods and services, while highly developed countries are still in their development [6, p. 40]. Currently, the space industry has the following main trends:

– privatization of space;

– commercialization of space activities;

– processes of internationalization [6, p. 41].

The space industry is an important component of the European economy. It involves more than 230,000 professionals. The European space market has a turnover of about 50 billion euros, which is one fifth of the amount of transactions in the global space market. The volume of investments of the European Union in space activities for the period from 2014 to 2020 exceeds 16 billion euros. The European Union has world-class space systems created as part of the Copernicus, EGNOS and Galileo programs, which include 18 satellites in orbit and more than 30 planned to be launched in the next 10-15 years [9].

Thanks to large investments, the European space industry is already one of the most competitive in the world. The European Union's promising space program calls for increased investment in the space industry and new technologies in order to further ensure Europe's autonomous access to space. According to European Commission officials, EU investment in space is already yielding tangible results for European citizens and businesses. More than 10% of EU GDP is already related to the space industry.

The European Space Agency (ESA) is the main regulator in the European space market. Its mission is to manage the development of Europe's space industry and ensure that public investment will ensure socio-economic impact and national security [13].

The strategic mission of the European Space Agency is based on the peaceful use of outer space by all states and pursues the following goals (Figure 2).

ESA is currently implementing three space programs:

– Copernicus is the world's leading climate monitoring system focused on climate monitoring;

– Galileo, Europe's own European global navigation satellite system, which provides highly accurate global positioning data, consists of a grouping of 24 operating satellites;

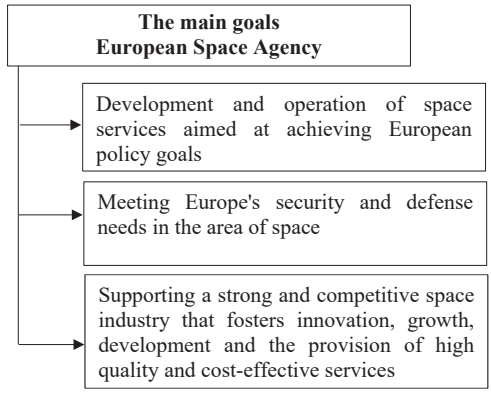


Figure 2. Strategic mission of the European Space Agency

Source: [13]

– EGNOS – European Geostationary Navigation Service, a pan-European safety and navigation system for aviation, maritime and ground users in most European countries [13].

The economy and security of Europe and its citizens depend to a greater extent on space assets, which must be protected from destruction. Within the existing principles and institutional competences of the European Union, Europe will significantly improve the coordination between its defense and civilian space programs while maintaining responsibility for end-user funding.

An illustrative example of the formation of a new system of relations between the participants in space activities is the interaction during the creation of the European global navigation system Galileo. The main impetus for such a system was Europe's desire for full independence from Russia and the United States in the space navigation sector, which is now an important infrastructural element in ensuring the efficiency and safety of transport, providing services to a wide range of users and national security. Unlike the American and Russian systems, technically similar to the European one was supposed to be created at the expense of private sector investment, which would later recoup the investment by providing paid services to consumers.

Implementation of a single European strategy for space exploration will solve the following tasks:

– support for European manufacturers of critical space technologies and systems;

– ensuring the long-term nature of measures to support the space industry in Europe;

– stimulating the formation of a stable supply chain in the system of European industrial and technological cooperation;

– promoting producers' access to export markets, while providing a level playing field for European companies;

– intensifying efforts to eliminate internal technological and regulatory barriers at EU and national level;

– expanding access to venture capital.

The state space programs in the total space economy in 2020, according to Euroconsult, amount to about 70 billion US dollars. For comparison, NASA's annual budget is 22.6 billion US dollars [9].

According to the Euroconsult report on state space programs in 2018, the cost of all countries in space around the world amounted to 70.9 billion US dollars. Investments in space activities are growing by an average of 5.75% annually after reaching a low of $ 62.5 billion in 2015 [9].

Of the $ 70.9 billion spent on space activities in 2018, 63% was spent on civilian and scientific programs. In total, 44.5 billion US dollars were spent on them. Civilian expenditures – including research, technology development and manned flights – have been the driving force behind growth in recent years. Expenditures have increased in the United States, Asia (at the expense of China) and the Middle East and Africa (thanks to UAE investment) [12].

The total global defense space budget in 2018 amounted to 25.4 billion US dollars, of which 19 billion – US. At the same time, in 2008–2018, the share of the United States in world spending on military space decreased from 81% to 72%. This was largely due to the intensification of China. Russia has the largest share of the military budget in astronautics, 47%, the United States 46%, China 37%, the United Kingdom 35%, Japan 34% and France 20%. Compared to 2017, investments in the military space industry increased by 8.3% [11; 13].

In 2018, the list of countries in the world in terms of spending on space programs was as follows:

– ESA's budget was almost $ 6.5 billion. It is planned to allocate almost 18.5 billion US dollars for 2021–2027;

– China does not publish its spending on space, but experts estimate it at $ 3 billion a year;

– the budget of the French Space Agency was 2.8 billion US dollars;

– Japan funded its strategic space program for $ 1.389 billion;

– the budget of the Canadian Space Agency for 2018-2019 was set at 264.6 million US dollars [11].

3. Analysis of space industry financing

Currently, there is also a qualitative increase in the financing of space activities through private capital investment. Some countries, such as the United Kingdom, Ireland and Finland, have managed to achieve significant private investment in the space industry against the background of relatively small budget allocations (Table 1, Figure 3).

Table 1

Indicators of financing space programs of individual countries as of 2018, million euros

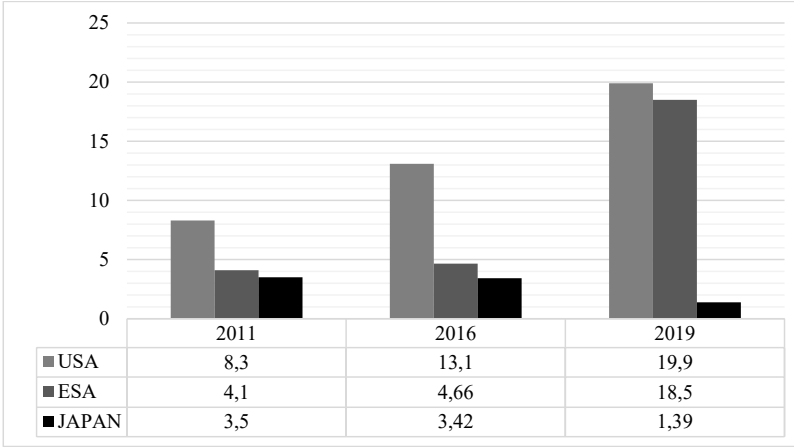
Country	State budget for the space industry	The volume of private investment
UK	255	344
Ireland	15	56
Finland	19	50

Source: [8; 9]

The main trend of the modern space industry is the interest of state defense structures in participating in commercial projects to launch satellite teams, as they are an ideal option for implementing the country's space priorities.

Investment activity in the space industry has been at a consistently high level recently: investment in space startups in 2015 amounted to 2.8 billion US dollars, 3 billion US dollars in 2016, 2.6 billion US dollars in 2017 and 3.2 billion US dollars in 2018 [10].

In the total amount of US allocations to the space industry, the article «space technology» predominates. Its share is at the level of 93-95% (the share of missile weapons – 5-7%). In 2021, the US federal budget has allocated $ 25.2 billion for space exploration activities. The share of secret programs in the total allocations is estimated at 69-78% [12].



	2011	2016	2019
USA	8,3	13,1	19,9
ESA	4,1	4,66	18,5
JAPAN	3,5	3,42	1,39

Figure 3. Funding of the space industry by the world, billion US dollars

Source: [11; 13]

According to a report by the American company Space Capital, US business has invested more than 186 billion US dollars in the space industry over the past 10 years, in 2020 alone almost 30 billion US dollars, of which 8.9 billion US dollars were investments in infrastructure projects and satellites, the volume became a record for this direction). In these volumes, start-up services accounted for 6.5 billion US dollars [10].

It is important to note that the states that have a national space strategy and a rocket and space industry are entering a new level of development. The space industry occupies a special place in the military-industrial complex, becoming an increasingly powerful stimulus and an effective tool for growing economic, scientific, technical and military potential of the world. The development of space technologies, which are based on high, critical, mostly dual technologies, makes a significant contribution to ensuring strategic stability and security at all levels. For example, in China, India and Japan, the breakthrough in space is an important factor in the transformation of the national military-industrial complexes of these countries, which contributes to the deep modernization of their armed forces and increase military and economic capacity.

One of the conditions for the successful development of a sovereign state in the modern world is the development of high space technology as a factor in intensifying the development of domestic sources of progress. Factors that ensure the high competitiveness of the state with the use of space means of national security have a significant impact on the development of states.

The space industry is an important factor in ensuring national security, it directly contributes to solving a number of socio-economic and scientific and technical problems, plays a role in ensuring innovative development and international prestige of the state. The field of space activities is associated with large-scale opportunities and significant economic benefits, the use of space in developed countries can already be considered as a global trend.

The space industry is part of the domestic defense-industrial potential and plays an important role in public policy, has a decisive influence on the military and economic security of the state, the military, economic and scientific potential of the country. Space activities are among the most complex human activities, and its strong focus on broad international cooperation makes a significant contribution to global processes. Space industry forecasting occupies an important place among other types of space management [14, p. 14].

Interest in the development of the space industry in modern conditions is primarily due to the fact that this industry is part of the defense industry of the country, which affects the defense of the state and its security. At the present stage, the development of the space industry is largely determined by the efficiency of resource provision of enterprises in this industry.

Domestic enterprises of the space industry organize their research and production activities in a dynamically developing market, intensifying competition for access to resources, which requires conceptual scientific and practical solutions in the management of the industry and its structures. The implementation of state policy on the development of the space industry is possible under the condition of sustainable development of research and production activities, which in turn is determined by its resources [15, p. 221].

The main specific features of the space industry are the following:

– the complex nature of the activity, which necessitates the solution of many problems: from research and development to the creation of equipment and its subsequent operation;

– the focus of promising research and development of fundamental purpose on the end result in the form of a science-intensive product;

– regular updating of fixed assets, development of the experimental base in connection with the need to change technology and maintain a high scientific and technical level of products;

– significant length of the life cycle of space industry products, which complicates the process of industry management and increases the responsibility for the selection and implementation of development strategies;

– intensive innovation and investment process as an important factor in achieving the goals of research and development that accompanies the implementation of projects;

– high degree of uncertainty and the use of predictive estimates of future technologies;

– the key role of the state in the support and development of the space industry [15, p. 222].

4. Characteristics of forecasting as an integral part of the functioning of the space industry

The function of forecasting is very important for the development of space assets and systems as elements of the global life support system of society, and planning and forecasting can predict the possibility and consequences of all changes. Forecasting and planning, along with coordination and control, are important elements in the formation of a holistic space management system. Real economic regulation of space development in general is expressed in determining the degree and methods of influence on all subjects of economic relations. It is especially important to be able to reduce (or eliminate) the impact of negative factors on economic processes and stimulate the impact of positive factors. Forecasting itself can ensure the identification of such relationships.

Forecasting is one of the forms of indirect influence of the state on the creation of space infrastructure. Forecasting is a process of forecast development, the essence of which is to use certain methods to process available information about the object of forecasting and to form an idea of its evolutionary trends based on the analysis of trends in its development [16, p. 3].

Among the principles on which the forecasting process is based, we can highlight the following:

– scientific validity of the forecast (development with the help of scientific methods, taking into account the laws of development of the material world, society and thinking);

– continuity of forecasting (the forecast must be constantly adjusted to take into account changes in the situation in the country, the world economy);

– combination of long-term and current forecasting (these types of forecasting are interrelated, but the priority remains on long-term forecasting);

– consistency of forecasts (developed forecast should correlate with related forecasts);

– multivariate, alternative forecast (it is necessary to make several options for the forecast) [16, p. 4].

The purpose and main task of the analysis of forecasting objects is the formation of a forecast model. The analysis of the object of forecasting begins with its description. The description should contain information about the most key indicators, characteristics of the object, the structure of the object and the relationship between the elements of this structure.

Based on the relationships between industry and long-term forecasting and evaluation and qualitative content of forecasting elements, the structure of the forecast of scientific and technological development of the space industry will be as follows.

Modern economic and mathematical analysis of the national space industry is a single set of initial data and the only result is a set of methods for studying the patterns and trends of this activity, methods for studying the prospects of space development and research models.

In turn, methods of analysis of space activities include modern tools of scientific and technical forecasting, including the development of the concept of space activities, methods of determining the needs for space facilities and services, as well as methods of researching space prospects [17, p. 32].

The study of the prospects for the development of the domestic space industry is based on the use of the model of space potential, from a systemic point of view, combining the processes of functioning of the whole set of

objects and space. The development of methods of scientific and technical forecasting, long-term and program macro-design, as well as the study of program implementation processes allows from a single standpoint to organize consideration of all stages of development of the industry.

Characterizing the forecasting of the space industry, it is necessary to note a number of features:

– the production potential of the space industry is a complex hierarchical system, which is characterized by the development of cooperation, both horizontal and vertical links between them – using existing capacity, common external and internal resources;

– the development of space industry enterprises is endowed with alternatives, one of the goals of their development is to increase the production capacity of enterprises through organizational and technical measures for technical re-equipment of production of different intensity [18, p. 121].

Different types of models can be used to develop forecasts for the development of the space industry: optimization, static (using the time factor) and dynamic, factorial, structural, combined and others. The most common methods of mathematical modeling of forecasts for the development of the space industry are the correlation-regression method, the model of intersectoral balance, optimization models.

The essence of the correlation-regression method of modeling the forecast of the space industry is to determine the dependence of the indicator on various factors. To predict the development of the industry using the correlation-regression method, it is necessary to establish the correlation between the projected indicator and the factors influencing it, determine the form of this relationship, derive a formula (equation) and predict the indicator based on them. The form of communication characterizes the change in the values of one feature from changes in another. It can be linear or nonlinear. The linear form of correlation is expressed by the following equations:

$$Y(X) = A + BX \quad (1)$$

$$Y(X) = A + BX + CZ, \quad (2)$$

where Y (X) is the value of the attribute Y at a given value of the factor (X) or factors (X and Z); A, B, C – parameters of the equation; X, Z – values of factors [19, p. 35].

The static model of intersectoral balance is designed to conduct forecast macroeconomic calculations for the short term (year). In general, it has the following form:

$$(i = 1, n), (j = 1, n), \quad (3)$$

where aij – coefficients of direct costs (average industry standards of production costs of industry i, used as a means of production to produce a unit of output of industry j); xj – production volume j of the consumer industry; Xi – gross output of products (services) and industry; Yi is the volume of the final product and industry-producer [19, p. 35].

Models for forecasting the development of the space industry should provide a calculation of the trajectories of this development for the entire forecast period. The state of the space industry in each year should be characterized by a system of technical and economic indicators, and the trajectory of its development – the estimated values of these indicators in the base year and the years of the forecast period. On the basis of these indicators the analysis of a variant of development of branch which is set by its trajectory and comparison of various trajectories among themselves is carried out [17, p. 31]. Each trajectory of development reflects an alternative version of the forecast of the development of the industry, which determines the sequence of its state with a certain period of quantization.

In order to develop models for assessing the potential of the space industry, it is necessary to identify the main factors that determine its research and production capabilities and technical and economic indicators, fully characterizing their state and dynamics of development. One of the main factors is the synchronization of intensity and achieving a balance of production and reproduction processes. Reproductive structure of capital investments should include technical re-equipment, reconstruction or expansion of enterprises in the industry, construction of new facilities at existing enterprises, which is an integral part of technological support for the production of new products in the forecast period.

The system of technical and economic indicators that characterize the forecasting of the development of enterprises in the space industry should include:

– initial data on their scientific and technical condition;

– economic standards that meet the requirements of intensive and effective development of enterprises in the industry – the task of reducing production costs;

– indicators that reflect the development goals of enterprises in the industry, first of all, the order for production, its cost, price, projected sales, profit;

– data on planned production development projects, introduction of new equipment or technologies, as well as data on possible means of production development in accordance with the expected scientific and technical achievements;

– data on the volume and sources of funding for the development of space industry enterprises [19, p. 40].

Models of development of the space industry, reflecting the different strategies of its operation, should contain for each of them the calculation of such a set of technical and economic indicators, which allows for various quantitative and qualitative assessments of alternatives to this development. The methodological basis for such calculation of indicators should be common to all enterprises in the industry methodological principles, rules and recommendations that reflect the specifics of production and planning in the industry, including the system of pricing and financing [17; 20].

Each version of the forecast for the development of the space industry should cover a long period (10-15 years) and include various measures to change production opportunities that are strategic for them.

The concepts of products, resources, production processes and circumstances play a key role in the development of tools for forecasting the development of the space industry. These concepts require priority definition in the process of formalizing and modeling the innovative development of enterprises in the industry. Suppose there is a finite number of products created by the space industry. The concept of product can also be used to represent different products of the same type, with different types of the same product can be represented as different products. This leads to the fact that the number of products studied in the model will exceed the number of actually existing products, but the final number of products will be preserved. The totality of all products created by the enterprise, which are taken into account in the development of innovation strategy is the space of products , while all products are considered measurable in the appropriate units [19, p. 41].

The industrial resources used by space enterprises are an element of the resource space x. The notion of limiting factors that limit the possible values of resource sets is formalized in the condition x X, where X – many sets of resources that are available to the company and can be used as source resources. The boundaries of the resource set X are determined by natural, physical properties and can change over time: X = X (*t*) [19, p. 42].

Similarly, the products produced at the enterprise (or projected before release) products are an element of the product space y , the positive components of which show the volume of production of the corresponding type. The totality of all sets of products is the production set $Y \subseteq R_+^l$ The structure and boundaries of the set Y depend on the internal characteristics of the enterprise of the space industry (resource set X, technical and technological capabilities, structural and organizational features, etc.) and external conditions, especially market needs. They change over time: Y = Y (t).

Accordingly, the production processes for the transformation of raw materials into finished products are determined by a set of technologies available to the enterprise – the technological set A $\{a_1, a_2, ... a_m\} =$, ach element a_j hich is one of the available technological processes of the enterprise and formally determines the reflection: a_j X $\rightarrow$. Like the resource set X and the production set Y, the technological set A is not stationary, but a time variable A = A (t), not only in composition but also in the number of its elements. Any of the technologies can be used with different intensity or not used at all. The choice of the set of source resources, the list of applied technologies, the intensity of their use, range and volume of finished products are the content of management decision u (t), which determines the production activities of the space industry. Methane set W (t) $X(t), Y(t), A(t) =$ an identification module of the general model of development of the space industry, and the element w (t) = $x(t), y(t), a(t)$ ets its current state [17; 20].

According to the applied management decisions *u (t)* the dynamic forecast model of development of the enterprise of space industry defines finite or infinite sequence of its possible states $\{x(t), y(t), a(t)\}_{t=0}^{T}$ r $\{x(t), y(t), a(t)\}_{t=0}^{\infty}$ which can be determined using systems theory as a trajectory of its development [17; 21].

The profit of the space industry at time t is a function of the parameters that characterize its internal state and external circumstances: *f(t) = f(w(t), q(t))*. Аналізуючи розвиток підприємства необхідно не тільки досліджувати можливість отримання прибутку в кожний момент часу, але й перспективи її отримання в майбутньому. Для цього слід виконати аналіз та прогнозування найбільш доцільних траєкторій розвитку підприємств галузі.

Analyzing the development of the enterprise is necessary not only to explore the possibility of making a profit at any time, but also the prospects for its receipt in the future. To do this, perform analysis and forecasting of the most appropriate trajectories of enterprises in the industry.

Given the peculiarities of the study of the processes of sustainable functioning and progressive development of the domestic space industry, it is advisable to conduct forecasting on the basis of cognitive models [22, p. 88]. According to the general theory, cognitive analysis and modeling of space industry development consists of the following elements:

1. Cognitive structuring – at this stage the cognitive structuring of information about the functioning of the space industry and trends in its development (foreign and domestic policy, socio-economic, etc.), affecting the effectiveness of scientific and industrial activities of the space industry. This stage consists of collecting, analyzing and synthesizing information and developing a cognitive map that conceptually reveals the conditions and mechanisms of the space industry.

Structuring information is performed in order to create a set of basic factors: X = $\{x_1, x_2, ..., x_n\}$ nd identifying causal relationships between them. For each basic factor is located and calculated its trend – the rate of change of the indicator that characterizes the object that is associated with a particular factor. For the identified causal relationships between the underlying factors, the nature (negative or positive) and strength of these relationships are determined. The values of variables are measured on a linguistic scale and determined by a number from the interval [–1, +1].

The development of a cognitive map formally consists in constructing an oriented graph: G (X, A), where X is the set of vertices corresponding to the set of basic factors; A – many arcs that show the interaction of factors [22, p. 90].

At this stage, subsets of control and target factors, as well as the vector of initial trends of basic factors are separated from the set of basic factors. Managers are selected from among the factors related to the external environment or the object of control, which can be influenced by the control object. Targets are selected from factors that characterize the state and objectives of the object of management.

2. Structural analysis of the cognitive map. Effective management of the problem situation requires the study of its structural features, ie detailed characteristics of causal relationships between the underlying factors. Comprehensive analysis of the map, designed to study such properties is to assess the objectives of management for consistency and consistency, the effectiveness of the total impact of control factors on the target.

3. Scenario modeling of the development of the situation can be carried out in the modes of management development and self-development.

4. Evaluation of simulation results. To determine the degree of effectiveness of management decisions, a system of indicators is proposed, which assess the degree of achievement of the goal – the coefficient of goal achievement.

5. Cognitive monitoring of the situation, which allows in case of change of the situation to modify the cognitive map and conduct additional analysis and modeling of the situation [22, p. 90].

The methodology of forecasting and analysis of the space industry as a whole allows to take into account the requirements of new conditions. However, for more complete and detailed research it is necessary to improve the methodology to expand the number of factors, assess the final results of service delivery, build a system of indicators to measure the degree of program implementation, form strategic goals, tactical objectives and quantify budget expenditures.

5. Conclusions

One of the conditions for the successful development of a sovereign state in the modern world is the development of high space technology as a factor in intensifying the development of domestic sources of progress. Factors that ensure high competitiveness of the state with the use of space means of national security have a significant impact on the development of states.

The space industry provides the state with the opportunity to provide a qualitatively new level of solving defense and strategic tasks of international cooperation, stabilizing the domestic economy, strengthening its position on the world stage. Prospects for the development of the space industry are related to:

– meeting the growing needs of government agencies, regions and the population in space and services;

– ensuring compliance with the world level of spacecraft;

– development of international integration in solving vital problems of mankind, expansion of international cooperation;

– expanding and improving the efficiency of the use of outer space in various sectors of activity to address the challenges facing the state.

The space industry is seen as an important component of sustainable socio-economic development and a guarantee of national security. The availability of its own rocket and space assets significantly contributes to a balanced state policy in accordance with the adopted strategies, concepts and programs in the political, economic, social, military, scientific and technological, information and other spheres.

The main problems of development of enterprises in the space industry include:

– lack of funding for the industry;

– lack of effective public policy and legislative support;

– insufficient domestic demand for the results of the space industry;

– aging of fixed assets and material and technical base;

– lack of qualified personnel;

– weak professional management.

Appropriate tools for economic and mathematical modeling of forecast technical and economic indicators of space industry development allows to form alternative options for the development of the industry and choose the best ones. Creation of flexible individually-adapted models on the basis of the special economic and mathematical device helps to reduce an error during forecasting. This significantly increases the efficiency of forecasting and analysis systems used by space companies.

The space industry is an important factor in ensuring national security, it directly contributes to solving a number of socio-economic and scientific and technical problems, plays a role in ensuring innovative development and

international prestige of the state. The field of space activities is associated with large-scale opportunities and significant economic benefits, the use of space in developed countries can already be seen as a global trend.

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