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Research on Questions Related to an Assessment About Level of Development of Technological Support of Projects to Create High-Tech Production in the Aviation Industry

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***Abstract*: In this article there are the structural elements of strategic effectiveness of projects. The author reflects the features of technological support of projects to create high-tech products in the aviation industry of the Russian Federation. The article describes an algorithm for assessing the level of technological support for projects to create high-tech products in the aviation industry, considering the factor of their territorial production and installation. There are also levels of development of the structural characteristics of the strategic efficiency of the project and the levels of analysis of the structural elements of the aircraft here.**

***Keywords*: strategic efficiency, structural characteristics of strategic effectiveness of projects, aviation industry, development level, high-tech products, aircraft, technological support, algorithm for assessing about development level of technological support of projects.**

I. INTRODUCTION

The aviation industry is a sector of industry in which development, production, tests, repair and utilization of the aircraft equipment are carried out. The rate of development of the aviation industry of the Russian Federation will outpace the growth of the market of Russia and the countries of the CIS, so one of the main requirements of development of the domestic market of aviation equipment is the output of Russian aviation products to the world market, where, in addition to Europe, there are alternative markets such as India, China and Southeast Asia.

To strengthen the position of the Russian Federation in the world market of aviation equipment it is necessary to solve the following key tasks:

- creation of the scientific and technical reserve providing the world leadership in aviation technologies;
- strengthening the human resources of the industry;
- promotion of aviation equipment of the Russian Federation in the domestic and foreign markets, development of the network and improvement of the quality of service, after-sales service of aviation equipment and services;
- localization of production of foreign companies and import substitution, thereby strengthening the material, technological and economic security of the country.

II. METHODOLOGY

In modern conditions in the scientific environment there is a demand for research related to the assessment of the development level of the whole set of structural characteristics of the projects´ strategic effectiveness to create high-tech products in the aviation industry, planned for implementation under the State Development Program, including technological support [1, 2].

The strategic effectiveness of projects is the final characteristic of the effectiveness of the management process of development and project implementation, considering the planned long-term goals and development strategy of the enterprise, industry and country in the production, technological, socio-economic and environmental areas of the project, and expressed by the ratio of its useful end results to the resources expended [3].

One of the authors of this article, Bondarenko A.V. proposes to identify the following groups of elements of strategic effectiveness of projects in the aviation industry [4]:

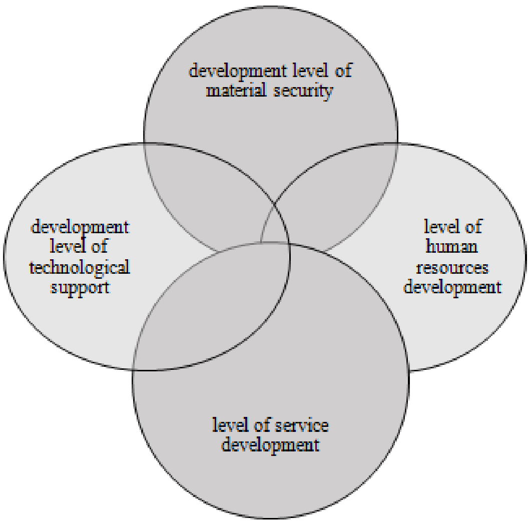

Figure - 1: Elements of the strategic efficiency of projects

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These elements should be considered as SCSE of aviation industry projects. The level of development of technological support should be classified into:

- level of development of processing technologies of details from various materials;
- level of development of production technologies and installation of units, aggregates;
- level of technological support for the final installation of the production facility.

In modern conditions, the aviation industry is forced to develop against the backdrop of a prolonged economic downturn and market volatility. At the same time, the competitive and market environment has changed, new competitor countries and fundamentally new technological solutions in the aircraft industry have appeared. Technology creates strategic advantages of products in international competition, changing the structure of consumption and living standards of the population. So, for today, in the engine industry sector of the Russian aviation industry, gas turbine engines produced by JSC "UEC-Perm engines" there is a are lagging behind Western analogues in terms of the following: efficiency, overhaul life, NOx and CO emissions, maintainability (modular repairs). Further development of Western technologies can lead to a decrease in the competitiveness of the industry's products, and, consequently, reduce the volume of orders. The structural characteristics of the strategic effectiveness of the project "technological support" is one of the main competitive advantages in the creation and implementation of Russian aviation products in the domestic and international markets, and one of the main factors in ensuring the strategic effectiveness of the projects of the aviation industry [1].

The government of the Russian Federation plans the following measures to develop the industry and to increase its competitiveness [5]:

- creation of a system of strategic planning for the development of aviation activities in the Russian Federation, including the formation of scientific and technical reserve or the creation of Russian-made aircraft;
- cardinal increase of efficiency of research, development and technological works;
- formation of an effective mechanism of interaction between research, design, production and operational organizations, including the organization of the process of transfer of scientific and technical developments in industrial production (technology transfer).

Let us consider some of the features of technological support for projects to create high-tech products in the aviation industry of the Russian Federation:

1. Close relationship of the production plants with the design bureau will introduce design changes in standard product, providing increase consumer value of it, until the new life of the old product, and successfully master the production of new products with the assistance of modern structural materials, the development and the application of which requires the use of new technologies [6].
2. Expansion of the presence of new products on the market should be ensured by a high degree of unification with existing samples. With a variety of products and different markets, the similarity of technologies in production exceeds 95%. The unity of technological solutions gives the opportunity of using the advantages of series production, allows the implementation of new projects to cheapen the cost of the production process (reduce the costs of their creation, development of production and operation), increases the profitability of sales [7]. Thus, the preconditions are created both to meet the current and future needs of consumers, and to improve the social conditions of employees, thereby increasing the strategic efficiency of the industry projects.
3. One of the key problems in the development of the aviation industry in recent years is the lack of a regulatory system for assessing the achievement of the established targets at the key stages of the creation (modernization) of aviation equipment. As a result, the technical (technological) solutions embedded in the developed and modernized models of aviation equipment are often suboptimal, and the cost of implementing the relevant programs is overstated [8]. In order to solve this problem, the Program of Development of the aviation industry provides for the task of developing and implementing a set of measures aimed at implementing a system of mandatory assessment of the level of scientific and technical perfection in the creation of Russian aviation equipment [9]. Existing methods in economic theory and practice evaluation do not allow a comprehensive assessment [10, 11].

The algorithm for assessing the level of development of technological support for projects to create high-tech products in the aviation industry includes the following stages:

1. The classification of structural elements of the aircraft for functional purposes.

The final and, therefore, the main object of production in the aviation industry is the aircraft. At the first stage, it is necessary to determine the level of development of technological support for aviation industry projects for each structural element of the production facility. The aircraft is a complex object of production and its structural elements can be divided into two levels. Consider the type of aircraft "airplane", it is the first level of analysis. There are seven main structural elements of the basic configuration of it. It is the second level:

1) engine;
2) airframe;
3) landing gear;
4) empennage;
5) beam fairings;
6) half-wing;
7) electronic-digital equipment.

Each structural element of the second level also has its own structural components, they are the components of the third level. For example, the gas turbine or turboprop engine consists of blades, working-shaft of the shaft case and shaft bearing, gearbox of the propeller, combustion chamber and tubular, combined compressor, single-stage and two-stage turbine drive propeller, generator, cone jet nozzle, turboprop and tubes, and sound absorbing construction.

2. The structural characteristics of the strategic effectiveness of the project are divided into two types on the basis of "production stage¨.

The process of creating an aircraft and analyzing the strategic effectiveness of the project can be broadly divided into two processes: 1) production and installation process of components and aggregates (the production stage and the stage of primary installation); 2) overall final installation of the aircraft (the final installation stage).

3. The type of classification of structural elements of the aircraft is introduced considering the levels of technological support of the project.

It is necessary to allocate four levels of development the structural characteristics (grading scale):

1) low level of technological support of the project;
2) average level of technological support of the project;
3) level of development above the average technological support of the project;
4) highest level of technological support of the project.

4. We conduct quality assessment of the structural elements of the aircraft and the level of development of technological support considering the degree of country risk using the point method for the production stages. There are some stages of this analysis in more detail.

4.1. A unified system of indicators characterizing the level of technological support of the project is being formed. Further, on the basis of the developed system of indicators using questionnaires matrices for each component of the m -th structural element of the aircraft the level of development of its technological support is determined. Herewith, for each component of the m-th structural element of the aircraft it is possible to select an individual list of indicators characterizing the level of development of technological support, considering the factor of importance. A particular example of a system of quantitative and qualitative indicators to assess the level of development of processing technologies of parts from different materials is presented in tables 1-2.

Table - I: The system of qualitative indicators for assessing the level of development of technologies for processing parts from different materials

TYPE OF ANALYSIS	INDICATOR
Qualitative characteristic	1. Means of ensuring and controlling the process of manufacturing and processing of parts
	Availability of technological equipment for production in the digital environment
	Level of technical support used in the design and preparation of production
	Software level
	Level of methodological support
	Level of control and measuring complexes
	Possibility of revision, upgrading of substandard products after the launch of mass production
	Possibility of modification of production with individual requirements of the customer
	2. Production of billet
	Level of casting technology
	Degree of compliance of the level of foundry technologies with the level of materials
	Possibility of application of production technologies in the work with the materials, preserving the high quality of the finished workpieces
	Technology level of processing of materials pressure
	Level of laser and waterjet cutting technologies (parts, billets)
	Level of technologies of production of billets by welding
	3. Machining of surfaces of details
	Availability of metal-cutting machines and tools
	Degree of conformity of the level of machines and equipment to the level of materials
	The possibility of using these machines and equipment to work with the materials while maintaining the high quality of finished parts
	Level of machining technologies
	Level of technologies of paint coatings and preventive inhibitory compositions for anticorrosive protection of structures

Table - II: Quantitative system indicators of assessment of the development level of technologies of processing of details from various materials

TYPE OF ANALYSIS	INDICATOR
Quantitative characteristic	Material consumption of products
	Coefficient of validity of the active part of fixed assets
	Ratio expiry of the fixed assets
	Coefficient of renovation of fixed assets
	Coefficient of renewal of the active part of fixed assets
	Coefficient of disposal of fixed assets
	Disposal ratio of the active part of fixed assets
	Share of the active part in the total cost of fixed assets

The values of indicators are average for the aviation industry or we can find them in the Program of Development of the industry. According to the formula 1, the assessment of the level of technological support of the i_m-th component of the m-th structural element of the aircraft is determined. With the use of the system of indicators presented in the tables 1-2, we calculate the assessment of the development level of technological support of the i_m-th component of the m-th structural element of the aircraft at the production stage:

$$K_{i_m}^{j_{TS}}(\overline{X^t}) = \sum_{q=1}^{n} I_{i_m}^{j_{TS}}(\overline{X^t}) * B_q. \quad (1)$$

4.2. Assessment of the development level of technological support of m-th structural elements of the aircraft with the factor of their territorial production, that is, the country risk. Strategically effective are those components and structural elements of the aircraft, which are produced using the technological base of Russian enterprises in Russia.

The scale of country risk factors includes two values of variables (Boolean variables):

0 - production and installation is carried out outside the territory of the Russian Federation;

1 - production and installation is carried out inside the territory of the Russian Federation.

Assessment of the level of technological support development of the m-th structural element of the aircraft at the production stage is carried out according to the formula:

$$KV_{i_m}^{j_{TS}}(\overline{X^t}) = \sum_{i_m=1}^{n_m} K_{i_m}^{j_{TS}}(\overline{X^t}) * B_{i_m} * CR_{i_m}. \quad (2)$$

Comprehensive assessment of the aircraft structural element at the production stage:

$$KV_{i_m}^{TS}(\overline{X^t}) = \sum_{i_m=1}^{n_m} KV_{i_m}^{j_{TS}}(\overline{X^t}) * B^{j_{TS}}. \quad (3)$$

4.3. Assessment of the technological support development level of the m-th structural element of the aircraft with the factor of their territorial primary and final installation.

This stage begins with determining the technological support level for the m-th structural element of the aircraft (engine, airframe, landing gear, empennage, beam fairings, half-wing, electronic-digital equipment) $K_m^{TS}(\overline{X^t})$, which is defined similarly $K_{i_m}^{TS}(\overline{X^t})$ (formula 1) using an appropriate system of indicators.

Next, we determine the country risk factors for the installation of purchased components (structural elements of the aircraft) and the final installation of the aircraft as a whole. It is believed that the final installation is carried out exclusively on the territory of the Russian Federation, that is, the country risk coefficient of the final installation is zero and is not reflected in the formula.

Next, we calculate a comprehensive assessment of the technological support level for the creation of the m-th structural element of the aircraft:

$$K_m^{final}(\overline{X^t}) = $$
$$= KV_{i_m}^{TS}(\overline{X^t}) * CR_m * B_{prod}^{TS} + K_{i_m}^{TS}(\overline{X^t}) * B_{final}^{TS}. \quad (4)$$

4.4. Comprehensive assessment of the development level of technological support for the creation of the aircraft:

$$K_{aircraft}(\overline{X^t}) = K_m^{final}(\overline{X^t}) * B_q, \quad (5)$$

III. RESULTS

The practical implementation of the algorithm for assessing the level of technological support development will be shown in fragments (4.2. - 4.3) on the example of serial production of the engine TV7-117SM, which is a modification of the engine TV7-117S, with the power of 2500 horsepower (takeoff mode) for use in regional-haul aircraft with a capacity of 50...70 passengers. Modification TV7-117SM was developed in order to improve the reliability of operation, weight reduction, improve operational adaptability, and to reduce the cost of electronic components. The engine TV7-117SM has a modern automatic control system with the BARC-65 instead of the following units: REE-65, BSCE-65, VM-65-SF1 and ISPM-65 and ECS-34M instead of ECS-34. The engines are equipped with SV-34 by one of the leading Russian firm in the field of development and manufacturing of aircraft propellers named «Aerosila». Screw diameter is 3,6 m. The screws are equipped with an automatic vane venting system in flight.

Using formulas 2-3, we define a comprehensive assessment of the level of development of technological support for the creation of the engine TV7-117S at the production stage:

Table - III: Comprehensive assessment of the level of technological support for the organization of serial production of the engine TV7-117S at the production stage

SCSE	Level of development of technological support					Coefficient of the country risk for the production of purchased components	
	Development level of processing technologies of details from various materials			Development level of production technologies and installation of units, aggregates			
	DE assessment	DE weight	Gr.1*Gr.2 *Gr.7	DE assessment	DE weight	Gr.4*Gr.5*Gr.7	
	1	2	3	4	5	6	7
1. Engine design elements (DE)							
1. Blades	2,00	10%	0,00	3,00	0%	0,00	0,00
2. Working shaft	2,00	20%	0,40	2,00	20%	0,40	1,00
3. Crankcase and shaft supports	1,00	10%	0,10	2,00	20%	0,40	1,00
4. Reducer	1,00	10%	0,00	2,00	10%	0,00	0,00
5. Propeller	1,00	3%	0,03	2,00	3%	0,06	1,00
6. Combustion chamber and heat pipes	2,00	34%	0,68	3,00	34%	1,02	1,00
7. Combined (axial and centrifugal) compressor	1,00	5%	0,05	2,00	5%	0,10	1,00
8. Single-stage and two-stage screw drive turbine	1,00	3%	0,03	2,00	3%	0,06	1,00
9. Generator (heat exchanger)	1,00	3%	0,03	2,00	3%	0,06	1,00
10. Jet nozzle cone	2,00	2%	0,04	1,00	2%	0,02	1,00
11. Turboprop and tubes	1,00	0%	0,00	3,00	0%	0,00	1,00
12. Sound absorbing structures	2,00	0%	0,00	1,00	0%	0,00	1,00
Assessment of the development level of SCSE engine component	1,36			2,12		-	
SCSE weight	50%			50%			
Comprehensive assessment engine	1,74						

Using formula 4 we define a comprehensive assessment of the technological support level for the organization of serial production of the engine TV7-117S at the stage of final installation:

Table - IV: Comprehensive assessment of the technological support level for the organization of serial production of the engine TV7-117S at the stage of final installation

SCSE / DE of the aircraft	Stage of production and installation of units, aggregates		Stage of final installation	Comprehensive assessment of the structural element of the aircraft, with the stage of final installation
	Comprehensive assessment of the structural element of the aircraft	Country risk factor for installation of purchased components	Development level of technological support for the final installation of the aircraft Evaluation of the structural element of the aircraft	
1	2	3	4	5
Engine	1,74	1,00	2,00	1,56
Estimate weight	75,0%		12,5%	

The resulting estimate of 1.56 belongs to category 2, it is the average level of technological support of the project.

IV. CONCLUSIONS

This technique provides a comprehensive technical and economic assessment of the level of technological support for the structural elements of the aircraft, the production facility as a whole, which affects the formation of the strategic effectiveness of the project to create high-tech products in the aviation industry, considering the factor of territorial production and installation.

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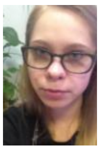

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