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Assessment method of the development level of personnel structural characteristics of the strategic project effectiveness to create high-tech products in the aviation industry

Método de evaluación del nivel de desarrollo de las características estructurales del personal en la efectividad de proyectos estratégicos para crear productos de alta tecnología en la industria de la aviación

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ABSTRACT:
The purpose of this study is to develop and describe a methodology for assessing the level of development of personnel structural characteristics of the strategic effectiveness of aviation industry projects. There is a list of features of selection and a balanced system of indicators to assess the development level of the structural characteristics of the strategic effectiveness of the project. The practical implementation of the method is presented on the example of creating a composite wing of Russian single-aisle twinjet airliner MC-21.
Keywords: Aviation industry, high-tech products, staffing of the project

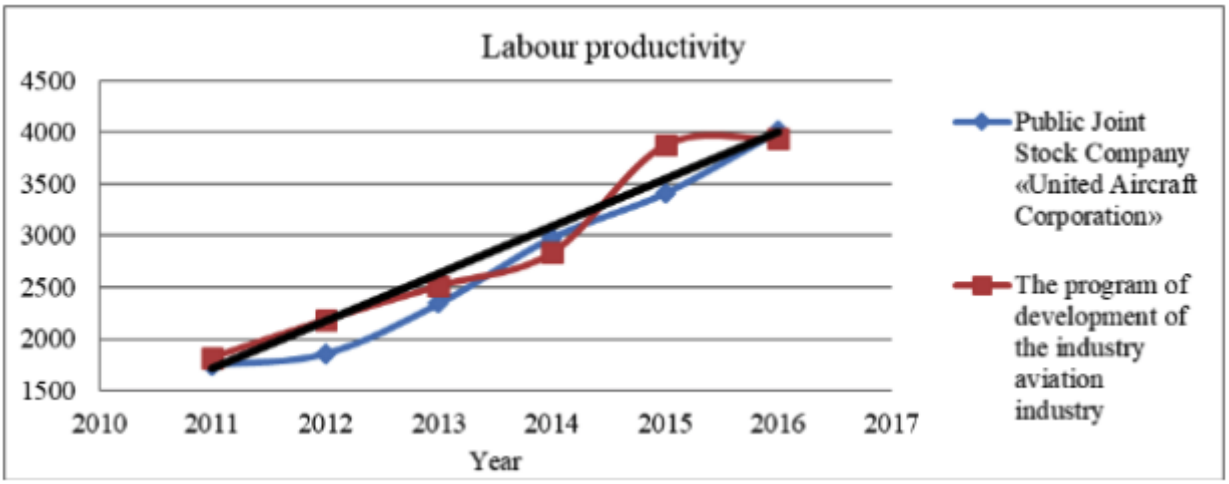
RESUMEN:
El propósito de este estudio es desarrollar y describir una metodología para evaluar el nivel de desarrollo de las características estructurales del personal de la efectividad estratégica de los proyectos de la industria de la aviación. Hay una lista de características de selección y un sistema equilibrado de indicadores para evaluar el nivel de desarrollo de las características estructurales de la efectividad estratégica del proyecto. La implementación práctica del método se presenta en el ejemplo de la creación de un ala compuesta del avión de pasajeros de jet único ruso MC-21.
Palabras clave: Industria aeronáutica, productos de alta tecnología, características estructurales de la eficacia estratégica del proyecto.

1. Introduction

The project activities of the aviation industry of the Russian Federation and the competitiveness of manufactured or high-tech products are determined by the development level and quality of use of personnel, material, technological and service support, which are the structural characteristics of the strategic effectiveness of the project (Bondarenko, 2019). One of the most important factors determining the prolonged sustainable development of the aviation industry is their staffing. Economic potential of the country, pace of development of production, improve the standard of the life depend on how fully and effectively we use labour resources (Chemerisova&Kaloshina, 2016).

On the database of the State Program of the Russian Federation "Development of the aviation industry for 2013-2025" (Decree of the Government of the Russian Federation, 2014) and on the consolidated financial statements of the Public Joint Stock Company "United Aircraft Corporation" for 2011-2017 (United Aircraft Corporation, 2019). there was the analysis of development tendencies of aircraft industry sector of the Russian Federation from the perspective of staffing with use of two key indicators: "labour productivity" and "profitability of personnel on net profit" (Decree of the Government of the Russian Federation № 303, 2019). The results of the analysis show that Russian aircraft companies in terms of "productivity" do not reach the planned values. As for the second indicator, from 2011 to 2014, the values were higher than it was planned, and the situation was deteriorated. In the aviation industry there was a strong "failure" in 2014-2016.

Figure 1
Dynamics of labour productivity of the Public Joint Stock Company "United Aircraft Corporation" in accordance with the program of development of the aviation industry for 2011-2017.



Source: authors

Figure 2
Dynamics of staff profitability by net profit of the Public Joint Stock Company "United Aircraft Corporation" in accordance with the program of development of the aviation industry for 2011-2017.

Source: authors

The aviation industry of Russia and its staffing has a number of features:

Table 1
Specific features of staffing projects for the creation of high-tech products in the aviation industry of the Russian Federation.

№	Characteristic
1	increasing complexity of labour due to the continuous increase in the level of technical equipment of labour and production
2	high share of the number of industrial and production personnel
3	special innovative activity and susceptibility of personnel
4	high share of intellectual activity
5	aging of personnel potential during many years in the aviation industry
6	uniqueness of scientific, engineering and technological schools, experimental bases, production facilities, workforce and systems of air traffic
7	average age of employees is more than 40 years
8	share of employees with higher professional education is 43%
9	share of employees with complete secondary or secondary vocational education is 57%
10	more than 50-60% of the total number of personnel are workers of the main production

Source: authors

In the era of advanced scientific and technological progress, the value and importance of staffing strategic efficiency (SE), which they implemented is determined by a system of balanced qualitative and quantitative indicators (Bondarenko, 2016). In order to eliminate duplicate indicators or provide excessive and incorrectly structured information, it is necessary to develop an optimal system of indicators, which is a ready methodological tool for assessing the staffing of the project, considering the specifics of the industry and the characteristics of the activities of enterprises participating in project cooperation. In this regard, in the scientific environment there is a demand for research related to the assessment of the development level of the personnel structural characteristics of the SE project on the creation of high-tech products in the aviation industry, the results of which will serve to guide the base of management decisions.

It is necessary to develop and present a methodology for assessing the development level of the personnel structural characteristics of the strategic project effectiveness to create high-tech products, considering the peculiarities of the aviation industry.

2. Theoretical basis

Theoretical foundations of sustainable development of enterprises, countries and regions have become one of the most popular and studied at the moment. These issues devoted to the work of scientist such as Iskakov N., Chimitova A. B, Mikulchinova E. A., Bautin V. M., Serebryakova N. A., Sidorov, V. M., etc. (Iskakov, 2008; Chimitova,Mikulchinova, 2007; Bautin, Serebryakova,Sidorov, 2011). The evaluation of investment, commercial, budgetary, social, labour efficiency is devoted to the work of the following authors: Daft R., Adamchuk V. V., Lapygin Yu. N., Lapygin D. Yu.,Chinenov M. V. (Daft, 2017; Adamchuk, 2012; Lapygin, 2009; Lapygin, 2009; Chinenov, 2016). At the same time, only two authors (Ermolina L. V. and Hussein L. M.) show a new type of

efficiency "strategic efficiency" and consider it in the context of the enterprise (Ermolina, 2015; Hussein, 2018). Assessment method of investment projects are devoted to the work of Krylov E. I., Vlasova V. M., Zhuravkova I. V., Lapygin D. Yu., Lapygin Yu. N., Chinenova M. V. (Krylov, Vlasova,Zhuravkova, 2006; Lapygin et al., 2009; Chinenov, 2016). In the modern literature there are no scientific papers on the issue of assessing the strategic effectiveness of the project to create high-tech products and assess its structural and personnel characteristics.

3. Methodology

Criteria for recognition of goods, works and services, high-tech products and their full list was approved by the order of the Ministry of Industry and Trade of Russia (Order of the Ministry of Industry and Trade of Russia № 1618, 2012). In the process of forming a balanced system of qualitative and quantitative indicators to assess the development level of the structural characteristics of the SE project, we used the following features of the selection of indicators (table 2):

Table 2
Characteristic of screening
(selection) of indicators.

№	Characteristic
1	complexity of the calculation and high cost
2	availability of initial information for the indicator calculation
3	importance and accuracy of the indicator for decision-making
4	information content of the indicator
5	speed of aging
6	unambiguous interpretation of the indicator
7	ability to influence the value of the indicator (manageability)

Source: authors

In the process of analysis of the staffing it is proposed to allocate periods of recession, sharp growth and the period of increase. It is also proposed to analyze the time levels: past, present and future. The author proposes to assess the personnel structural characteristics of the SE project using the following indicators (table 3-5):

Table 3
System of qualitative indicators for assessing the development level
of staffing of industrial and production personnel of the project.

Indicator
average length of service in accordance with the specialty
average age of employees of the project
share of students involved in the project
share of young people involved in the project
share of employees with higher professional education

share of employees with complete secondary or secondary vocational education
share of employees with academic degree
professional competence of employees
fundamental knowledge of engineering disciplines
special knowledge and experience of the specialist working out of technological processes and materials aimed at improving the design of products
ability to apply computer-aided design technologies in design and production preparation
ability to design, manufacture and installation of equipment using modern control and measuring systems
use of technology of high-speed laser and abrasive waterjet cutting (parts, blanks)
use of technology of the high-life sealed blind rivets to riveting machines
possession of high-speed machining with the development of group methods of machining
ability to apply effective paint coatings and preventive inhibiting compounds for anticorrosive protection of structures
ability to control the manufacturing process using laser optical measurement systems
ability to develop and implement quality control systems for cast, welded, machined parts and parts made of purchased materials by modern methods of nondestructive testing
knowledge and skills of personnel to produce aircraft, flight technical and operational characteristics of which exactly correspond to the technical task
design and manufacturing skills of measuring and cutting tools and technological equipment for work with new materials and products
knowledge and skills in the development and debugging of new technological processes for the manufacture of products from new modern materials

Source: authors

Table 4
System of qualitative indicators for assessing the development level of personnel management of the project.

Indicator
ability to build formal management systems
management style of senior management
management compliance with the requirements
ability to work with modern automated IT
level of foreign language proficiency (English)

ability to provide training, create a training center to work with new technologies, materials
skills of negotiations on the organization of sale of finished products in leasing, experience in creating optimal financial and leasing schemes
ability to form a portfolio of solid orders, ensuring a uniform production load in accordance with the schedule of return on investment
ability of management to comply with the terms of technical re-equipment, the tender for the selection of suppliers of equipment and contractors
ability to develop and implement programs of effective system of technical support of operation on all product life cycle around the world
knowledge of tax legislation
experience in the preparation of technical solutions for the layout of components

Source: authors

Table 5
System of quantitative indicators to assess the development level of personnel support of the project.

Indicator
rate of permanence of employees in the calendar year
staff turnover rate
rate of staff stability
index of the share of industrial and production personnel in the total number of employees
indicator of implementation of the plan on the level of productivity of the project
indicator of implementation of the plan for the wage fund of industrial and production personnel
implementation rate of the plan in terms of cost of production
labour productivity
profitability manpower payroll
coefficient of variation of average wages of the staff of the average wage of the industry
samplitude revenue
salary capacity for manufactured products

Source: authors

Assessment method of the development level of personnel structural characteristics of the SE project to create high-tech products in the aviation industry includes the following four main stages:

1. Classification of structural elements of the object of production (high-tech products) for functional purpose.

2. Classification of the process of creating high-tech products:

– stage of production and primary assembly of purchased components;

– final build stage.

In this regard, the personnel of the structural characteristics of the SE of the project is characterized by:

– development level of quality of work of personnel with materials;

– development level of quality of work of personnel on production and assembly of knots and units;

– development level of staffing of the final assembly.

3. Classification of structural elements of high-tech products, considering the development level of personnel support of the project (scale of assessments):

1 – low development level;

2 – average development level;

3 – development level above the average;

4 – the highest development level.

4. Assessment of the quality of the structural elements of high-tech products and the development level of staffing, considering the degree of country risk using the point method is carried out in several stages:

4.1. We form the unified system of indicators characterizing the development level of the structural characteristics of the SE project. Further, on the basis of the developed system of indicators using questionnaires-matrices for each i_m-th component of the m-th structural element of high-tech products we determine the development level of its staffing. Herewith, for each i_m-th component of the m-th structural element of high-tech products it is possible to select an individual list of indicators characterizing the development level of staffing, considering the factor of importance. Next, we determine the initial assessment of the development level of staffing of i_m-th component of the m-th structural element of high-tech products at the stage of production, not considering the territorial factor:

$$O_{i_m}^{j_{staffing}}(\overline{X^t}) = \sum_{q=1}^{n} I_{i_m}^{j_{staffing}}(\overline{X^t}) * B_q, \quad (1)$$

where $O_{i_m}^{j_{staffing}}(\overline{X^t})$ is the assessment of the level of human resources development of i_m-th component of the m-th structural element of high-tech products at the production stage;

$i_m = 1 \dots n_m$ is the component of m-th structural element of high-tech products;

$j_{staffing} = 1 \dots 3$ is the element describing a structural characteristic of the SE ¨staffing¨:

1) development level of quality of work of personnel with materials;

2) development level of quality of work of personnel on production and assembly of knots and units;

3) development level of staffing of the final assembly.

$q = 1 \dots n$ is the number of indicators in the system of them, characterizing the development level of staffing of i_m-th component of the m-th structural element of high-tech products at the production stage;

$I_{i_m}^{j_{staffing}}(\overline{X^t})$ is the assessment of the indicator category, characterizing the development level of staffing of i_m-th component of the m-th structural element of high-tech products at the production stage, it is determined by expert means using the appropriate system of indicators.

B_q is the weight of the indicator in the overall system of indicators, characterizing the development level of staffing of i_m-th component of the m-th structural element of high-tech products at the production stage, in shares. The significance of the indicator is determined by its place in the system of indicators and how accurately (directly or indirectly) and fully it characterizes the analyzed object of study. It is determined by expert way.

4.2. Assessment of the development level of personnel support of structural elements of high-tech products, considering the factor of their territorial production, that is, the country risk. Strategically effective are those components and structural elements of high-tech products that are produced using the staffing of Russian enterprises in Russia. The scale of country risk factors includes two values of variables (Boolean variables):

0 - production and assembly is carried out by personnel of the Russian Federation;

1 - production and assembly is not carried out by personnel of the Russian Federation.

The final assembly is carried out exclusively by the personnel of the Russian Federation, that is, the country risk coefficient of the final assembly is equal to one and is not reflected in the formula.

Assessment of the development level of staffing of the m-th structural element of high-tech products at the production stage is carried out according to the formula:

$$OC_{i_m}^{j_{staffing}}(\overline{X^t}) = \sum_{i_m=1}^{n_m} O_{i_m}^{j_{staffing}}(\overline{X^t}) * B_{i_m} * CR_{i_m}, \quad (2)$$

where $m = 1 \dots m'$ is a structural element of high-tech products;

B_{i_m} is the weight of i_m-th component of the m-th structural element of high-tech products at the production stage, in shares. The key structural elements (from the point of view of their SE) are revealed;

CR_{i_m} is the coefficient of the country risk for the production of i_m-th component of the m-th structural element of high-tech products at the production stage and assembly of knots and units.

Comprehensive assessment of the structural element of high-tech products at the production stage is the following:

$$OC_{i_m}^{j_{staffing}}(\overline{X^t}) = \sum_{i_m=1}^{n_m} OC_{i_m}^{j_{staffing}}(\overline{X^t}) * B^{J_{staffing}}, \quad (3)$$

where $B^{j_{staffing}}$ is the structural feature weight.

4.3. Assessment of the level of human resources development of the m-th structural element of high-tech products considering the factor of their territorial primary and final assembly. This stage begins with the definition of the development level of staffing of the m-th structural element of high-tech products $O_m^{staffing}(\overline{X^t})$, which is defined similarly to formula 1 $O_{i_m}^{j_{staffing}}(\overline{X^t})$ using an appropriate system of indicators. Next, we determine the country risk factors for the assembly of purchased components and the final assembly of high-tech products. Then we calculate a comprehensive assessment of the personnel development level to create a constructive element of high-tech products:

$$O_m^{final}(\overline{X^t}) = OC_{i_m}^{j_{staffing}}(\overline{X^t}) * CR_m * B_{assembly}^{j_{staffing}} + O_{i_m}^{j_{staffing}}(\overline{X^t}) * B_{final}^{j_{staffing}}, \quad (4)$$

where CR_m is the country risk factor for the assembly of the m-th structural element of high-tech products at the stage of production and assembly of knots and units;

$B_{prod}^{staffing}$ is the weight of assessment of the development level of staffing m-th structural element of high-tech products at the production stage, in shares;

$B_{finalassembly}^{staffing}$ is the weight of assessment of the development level of staffing m-th structural element of high-tech products at the final assembly stage, in shares.

4.4. Comprehensive assessment of the development level of personnel support for the creation of high-tech products:

$$O_{aircraft}(\overline{X^t}) = O_m^{final}(\overline{X^t}) * B_{\square\square}, \quad (5)$$

4. Results

Practical implementation of the method of assessment of the development level of staffing were done according to the project of creation of the composite wing of the MC-21, the production site of which is the Joint Stock Company "AeroComposite-Ulyanovsk". The main customer is JSC Irkut Corporation. The company is equipped with modern automated equipment developed in accordance with the requirements of "AeroComposite" (Official website of Joint Stock Company "AeroComposite", 2019). Modern polycomposite structural materials are used in the production of structural elements.

Using the system of proposed indicators and formulas 2-3, we determined a comprehensive assessment of the development level of personnel support for the creation of a composite wing at the production stage (1.49) and at the final assembly stage (3.3). Further, using formula 4, we determined a comprehensive assessment of the development level of staffing of the creation of the composite wing at the stage of final assembly (1.53). The obtained estimate in the amount of 1.53 belongs to the category 2 – the average development level of the personnel structural characteristics of the SE project to create a composite wing for the passenger medium-haul aircraft MC-21-300. We consider weak staffing of the first production stage, which can affect the effectiveness of the project as a whole.

Thus, this technique provides a comprehensive technical and economic assessment of the development level of personnel support of structural elements of high-tech products and the production facility as a whole, which affects the formation of the SE project, considering the factor of territorial production and assembly, which has no analogues.

5. Discussion

As a result of the study, there is an actual, significant methodology for assessing the development level of the personnel structural characteristics of the SE project for the creation of high-tech products in the aviation industry, used to improve the efficiency of management decisions at the strategic planning level. It is advisable in further studies to develop a mechanism for assessing the strategic effectiveness of projects for the creation of high-tech products in the aviation industry, a feature of which is the ability to plan the direction of development of the personnel structural characteristics of the SE project.

6. Conclusions

The research studied the current state and development trends for 2011-2017, characterizing the staffing of the aircraft sector of the Russian aviation industry. The personnel component of the problem of analysis of strategic efficiency of projects of industrial enterprises for the creation of high-tech products is substantiated. The balanced system of indicators of an assessment of development level of staffing of projects is proved. Specific features of personnel support of projects of the aviation industry of the Russian Federation are reflected. There is a method of assessing of the development level of personnel structural characteristics of the strategic effectiveness of the project to create high-tech products in the aviation industry, considering the

factor of their territorial production and assembly. Practical realization of the methodology for assessing of the development level of the personnel structural characteristics of the strategic effectiveness of the project to create a composite wing for the passenger medium-haul aircraft MC-21-300 is carried out. Thus, the presented method considered the territorial factor of production and assembly of products and it is used to increase the effectiveness of management decisions at the level of strategic planning.

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