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Formation of a Regionally Oriented Structure and Number of the Airline's Helicopter Fleet Based on Consumer Preferences of Customers

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ABSTRACT

The aim of the work is to develop conceptual directions for the structure formation and the number of airline's fleet based on satisfying consumer preferences of enterprises-customers of helicopter operations. The helicopters currently in operation cannot fully satisfy the requirements of customers in terms of their flight technical and economic characteristics, which leads to a decrease in their use and it negatively affects the economy of the airline and corresponding economic region. There is a real need to update and expand the type and fleet of Russian-made helicopters, which will better meet the requirements of the helicopter operations market. To solve it, a helicopter manufacturing enterprise needs to carefully study the market requirements for existing and new types of helicopters, its volumes, formation trends, prices, operating costs, service systems, etc. The work presents a model that makes it possible to formulate for each airline the need for helicopters of various types and specializations for each year of the forecasting period has been developed, depending on the dynamics of changes in the level of socio-economic development of the region and the corresponding changes in the airline's flight operations, considering the effective demand. It also makes it possible to predict promising types and helicopter fleet.

Keywords: Airline; Aerial work; Helicopter fleet; Promising type; Market requirements.

INTRODUCTION

One of the main features of the Russian helicopter fleet is the regionality of its basing. Basically, up to 70% of the fleet is concentrated in industrially underdeveloped and climatically harsh regions. The main goal of the development of these regions is the creation and further development of the fuel and energy complex (FEC). These are the regions of the North, Siberia and the Far East. There are about two-thirds of the helicopter airlines there. Helicopters perform, at the request of customers, various types of work, the volume and nature of which vary depending on the region, its economic orientation and degree of economic development of the territory by one or another customer (Calado *et al.* 2019; Mustaev *et al.* 2021).

Table 1 shows the distribution of flight hours on helicopters between the main customers of helicopter operations (Fomin 2019).

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Table 1. Distribution of helicopter operations by main customers.

Customers	Share of flying hours in the total flying hours of the helicopter fleet, %
Vertically integrated oil companies, oilfield services and petrochemical companies	58
State and regional customers	14
Construction companies	11
Energy companies	9
Transport companies	6
Other	2

Source: Elaborated by the authors using data from Fomin (2019).

As we can see from the data in e Table 1, the main customers of helicopter services are enterprises of the fuel and energy complex. Among the main types of work, one can single out the transportation of goods, passengers, air patrolling and sanitary transportation.

Enterprises-customers of helicopter operations indicate that for a wider use of helicopters it is necessary that their type is more consistent with the nature of the work performed and the cost of their operation should be reduced. Analysis of the structure of the Russian helicopter fleet in these regions shows that the bulk of aviation work is carried out by medium-class helicopters of Mi-8 / Mi-17 type. For the light helicopters of Mi-2 type and heavy helicopters Mi-26, there is a smaller amount of work (Butov 2018). The state of the existing fleet of Russian helicopters, namely, its aging and decommissioning, with a significant share of new foreign light helicopters, indicates that there is a real need to update and expand the type and fleet of Russian-made helicopters in airlines, which will be more consistent with the requirements of the market for helicopter operations (Butov 2018; Kuprikov *et al.* 2019). The problem of forming a promising type and fleet of helicopters in airlines poses a task for a helicopter manufacturer to independently thoroughly study the market requirements for new helicopters, its volumes, formation trends, prices, operating costs, service systems, etc. (Kochergina 2017). Conducting marketing research and, on their basis, formation of a regionally oriented competitive strategy for the development of new helicopters will reduce the risk of creating an unacceptable helicopter for the market, more efficiently use its own resources, determine optimal volumes and terms of production and, ultimately, outstrip foreign competitors (Keivanpour and Ait Kadi 2017; Tikhonov 2020). On the basis of these studies, it is realistic to create a model for the formation of the structure and number of the airline's helicopter fleet, using it becomes possible to determine the need for helicopters of various takeoff weights and specializations for each year of the forecasting period, taking into account forecast models of the socio-economic development of the region and the dynamics of changes in the volume of flight work on each regional airline. A number of scientific works of the following authors are devoted to the development of the helicopter fleet and the helicopter services market: RUCON AFK (2022), Baklanov (2007), Demin (2014), Kravchenko (2013), Maslov and Krivolutsky (2009), Lesnichiy (2009), Litvinov (2003), Pripadchev and Sultanov (2009), Smirnova and Erdnieva (2020) and Sobolev (2018). The high relevance of such scientific research is explained by the insufficient scientific elaboration of this problem area.

METHODOLOGY

Intensive progressive development of a helicopter company can be ensured only through the accumulation of scientific knowledge obtained in the process of creating new helicopters, realizing which, in Russian and foreign markets, receives new incentives for its development (Droff and Bellais 2016; Kotler and Armstrong 2017). Extensive development, as a rule, is inherent in the processes of creating various modifications. For example, Mi-8 helicopter has at least about 10 different modifications.

Currently, the problems of selling new helicopters and updating the helicopter fleet have become more acute. Under these conditions, it is not realistic to maintain the previously won market shares and ensure a high level of competitiveness of helicopters based on the assumed homogeneity of demand. A strategic decision could be the maximum possible adaptation of existing and new development helicopters to the requirements of various market segments and the manufacturing of products of diverse characteristics and, thus,

stimulating demand. To solve this problem, it is advisable to carefully analyze the market for helicopter operations and their customers in order to identify target segments and then study the segments themselves according to various characteristics (Shatova 2017). Under the segmentation of the helicopter operations market, we will understand the task of dividing a set of helicopter operations, as a certain set, into segments that have common main characteristic features at different levels according to the depth of segmentation. This will make it possible to establish the territorial-geographical and regional distribution of helicopters, the main customers of helicopter operations, the types of work, etc. Helicopter segmentation levels can be arranged in the sequence shown in Table 2.

Table 2. Helicopter segmentation levels.

Levels	Segmentation levels
1	Territorial-geographical
2	Regional
3	Intra-regional economic zones
4	Main service industries
5	Main types of work
6	Scope of work and its stability
7	Dominant loading parameters by type of work
8	Natural and climatic conditions for the performance of work

Source: Elaborated by the authors.

An example of a structural grouping of the helicopter operations market is shown in Table 3.

Table 3. Structural grouping of the helicopter operations market.

Tier Segmentation Options	Helicopter market segments		
Territorial-geographical	North	Siberia	Far East
Regional	Northwest	West Siberian, East Siberian	East
Intraregional business zones	Arkhangelsk, Murmansk, Syktyvkar, Ukhta	Tyumen, Surgut, Khanty-Mansiysk, Nefteyugansk, Krasnoyarsk	Yu zhno-Sakhalinsk, Okha, Khabarovsk, Vladivostok
Main service industries	FEC, Geology, Medicine	FEC, Medicine	Geology, Fisheries and Forestry, Medicine
Main types of work	Transportation of goods, passengers, patrolling, sanitary transportation	Transportation of goods, passengers, patrolling, sanitary transportation	Transportation of passengers, patrolling, forest protection, sanitary transportation
Possible scope of work and their stability	In accordance with the development of the region's economy. Permanent and periodic	In accordance with the development of the region's economy. Permanent and periodic	In accordance with the development of the region's economy. Permanent and periodic
Prevailing helicopter loading parameters by type of work	Distribution of cargo transportation (passengers) and the number of patients by range zones, patrolling time	Distribution of cargo transportation (passengers) and the number of patients by range zones, patrolling time	Distribution of cargo transportation (passengers) and the number of patients by range zones, patrolling time
Natural and climatic conditions of work performance	Unprepared sites, low temperatures in winter, high in summer, polar night, flights over the sea	Unprepared sites, low temperatures in winter, high temperatures in summer, flights over the tundra and taiga	Unprepared sites, low temperatures in winter, high in summer, flights over the sea, hills, tundra

Source: Elaborated by the authors.

A helicopter company can act in several market segments, developing a separate offer for each of them in the form of a new type of helicopter (Crivelli and Rubini 2020; Xinyu Zhang and Xinai Zhang 2020). This refers to the lowest level of segmentation: types of work and their characteristics.

The task is that according to the results of the study, the developer must choose: which market segments are most attractive to him in terms of potentially high demand, and how many of them are proposed to borrow from the point of view of the company's capabilities (Kotler and Armstrong 2017). The most profitable segment should be distinguished by a potentially high level of sales of helicopters and their annual load in airlines, a low level of competition from other market participants and be quite attractive from an economic point of view for helicopter operators and helicopter customers.

Enterprises - customers of helicopter work differ in the types and volumes of ordered work, the dimensions of the goods transported, the number of passengers, the method of performing work (for example, gravimetric survey by geologists), the necessary suitability of the helicopter to perform a particular work (for example, sanitary transportation), the frequency of work, the solvency, etc. The nature of these works varies depending on the region, within the regional economic zones and the degree of economic development of the territory by one or another customer. This determines the main requirements on the part of customers for the main technical and economic indicators of helicopters, such as payload, speed and flight range. The marketing theory assumes that in terms of their level these indicators should correspond to the modern market evolution of Russian air transport market, which implies continuous modernization and renewal of the helicopter fleet.

In the case when FEC enterprises, as well as enterprises associated with the exploration and production of minerals (geology), prevail among the main customers, it is interesting what type of helicopters they require at different stages of the technological processes of territory development inherent in these industries (Table 4).

Table 4. Types of helicopters used by stages of the technological process of territory development at FEC and geology enterprises.

Stage of technological process of territory development	Predominant type of work		Types of helicopters used	
	FEC	Geology	FEC	Geology
Mineral exploration	Freightage	Gravimetric survey	Heavy	Heavy, light and medium
Industrial development of deposits	Transportation of people and goods at the same time	Transportation of people and goods at the same time	Heavy and medium	Light and medium
Field operation	Air patrols	Transportation of people, transportation of people and goods at the same time	Light and medium	Light and medium

Source: Elaborated by the authors.

The data given in the Table 4 show that in the initial stages of economic development of the territory for the exploration and production of energy resources, the use of heavy transport helicopters (transportation of equipment, drilling rigs) prevails, in the future, the joint transportation of people and cargo begins to prevail and medium and light helicopters are used. In the field operation mode, the main type of helicopter work is air patrolling of pipelines.

Since we have already determined that potential customers of helicopter services will be enterprises of FEC, we will study market segments primarily from the point of view of meeting the needs of these enterprises.

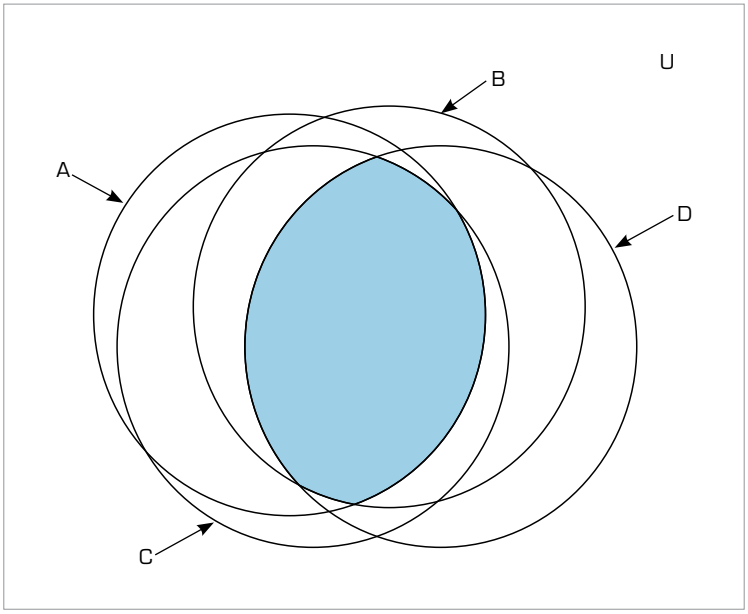
We define a set of possible helicopter models using the defining property *P(X),* common to all elements of the set, and denote (Eq. 1):

$$X=\{x \mid P(x)\} \tag{1}$$

As a defining property for helicopters performing various types of work, we take the mass of the payloadG_p^l, transported over a certain distance. Then Eq. 1 can be written as follows (Eq. 2):

$$X=\{G_p^l \mid P(G_p^l)\} \quad (2)$$

To visualize the relation between subsets *A, B, C, D* (types of work) of any universe *U* (set of admissible objects) we use Euler circles. Crossing $A \cap B \cap C \cap D$ is a set of elements belonging to *A, B, C, D* simultaneously by the defining property: G_p^l (in Fig. 1, there is the shaded area) (Droff 2017; Vascik *et al.* 2018).



Source: Elaborated by the authors.

Figure 1. Image of the relation between individual types of work on the defining property

To identify the defining property $P(G_p^l)$ helicopters, it is necessary to consider the value of this characteristic for the works most inherent in the enterprises-customers of FEC.

RESULTS

Analysis of the segment structure of the helicopter market by characteristic quantitative features

When studying the segmental structure of the market for air transport operations performed with the help of helicopters, quantitatively homogeneous aggregates can be distinguished using a small number of features. These include the mass of cargo transported and the number of passengers by range zones, the characteristics of loading and the range of helicopter flights during air patrols and sanitary transportation. These data are presented in Table 5.

Analyzing the data on the transportation of goods with their distribution by mass, it can be noted that 82% of goods have up to 2000 kg, and in 68-83% of cases they move at a distance of up to 400 km.

The mentioned data about passenger traffic indicates that a significant share (up to 35%) is the transportation of small groups of passengers (up to 7 people), and a significant share (59%) are the groups of 8-17 people. For the transportation of this category of passengers, customers are encouraged to use Mi-8 helicopter, although in this case it would be more economical to offer them a helicopter of an "intermediate" class, ideal for this category. Such a helicopter could be used for flights of even small groups of passengers (5-7 people) at a distance of over 400 km.

Table 5. Types of helicopter operations and their characteristics for fuel and energy enterprises in the West Siberian region of the Russian Federation.

Types of works	Cargo weight, kg	Flight range up to 400 km, %	N° passengers, people	N° patients + service staff, people
Carriage of goods	Up to 500 (30%)	75		
	501-1000 (17%)	68		
	1001-1500 (19%)	82		
	1501-2000 (16%)	83		
Transportation of people		68	1-4 (18%)	
		80	5-7 (17 %)	
		88	8-17 (59%)	
Aerial patrol	Up to 100	80-100	1-2	
Sanitary transportation	40-150 (equipment)	70-90		3-4 sedentary patients, 1-3 bed-patients + 1-2 medical staff (70%)
				2-6 sedentary patients, 2-4 bed-patients + 4-6 medical staff (30%)

Source: Elaborated by the authors.

For ambulance flights, helicopters of light and medium classes are mainly used. For light helicopters, the typical load is three sedentary patients and one bed-patient. They are accompanied by one or two doctors. Middle-class Mi-8 helicopters, as a rule, carry 3-4 sedentary patients and 3 bed-patients. At the same time, there is a medical team on board, sometimes up to 6 people. From an economic point of view, this is ineffective, but there is no smaller helicopter designed for such a payload. Mi-8 helicopter is most often used for long-range flights, even with a small number of patients. Almost 90% of sanitary flights are carried out in the range of distances up to 400 km. Knowledge of these values makes it possible to optimize the size and payload within the 1500-2000 kg range of a special ambulance helicopter, which will allow the use of helicopters at lower costs and provide the population with more medical care.

Helicopters are used for almost all types of patrolling: patrolling forests in order to detect fires without rescuers and patrolling forests with a group of rescuers-firefighters for emergency extinguishing of detected fires, forest inspections for pathology (detection of contaminated areas), patrolling river and sea areas (fish breeding), reconnaissance of schools of fish in the ocean, ice reconnaissance and compilation of ice maps, pilotage of ships in ice, patrolling of oil and gas pipelines and roads, patrol, search and rescue operations. Helicopters of light and medium classes are used to carry out patrol work. The average patrol time for light helicopters is 2.5 hours on average, while for Mi-8 helicopters it is about 4.5 hours. Mi-8 helicopters have a significant share of patrol flights due to the possibility of providing a longer duration and range of patrols through the use of additional tanks. It is economically ineffective, but customers have not got another choice. The only way the customers can compensate for the high costs of using Mi-8 helicopters during patrol flights is the execution of parallel tasks for the delivery of passengers and cargo to points lying along the patrol route or not far from them.

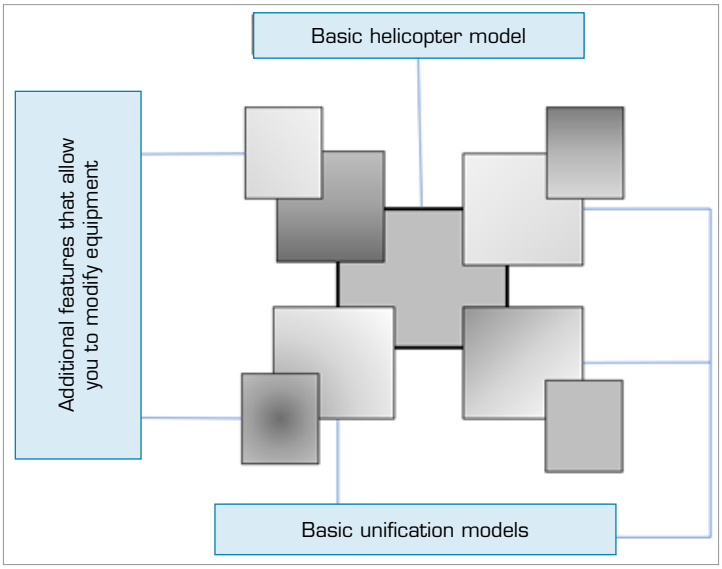
The results of the analysis indicate that the considered segments of the work performed by helicopters have much in common. It has a flight range of up to 400 km, the mass of the transported cargo is in the range of 1.5-2 tons and there are 8-17 passengers. The helicopters currently in operation cannot fully satisfy the requirements of customers in terms of their flight technical and economic characteristics.

Conceptual directions for updating the helicopter transport complex

We single out two conceptual directions of the helicopter fleet renewal strategy: adaptation of the existing helicopter fleet to market requirements and development of a new type of helicopters.

Adaptation

Customer orientation is a kind of "customer fit", i.e. this is a search in its activities for the direction where the company can prove itself in the best way compared to competitors. Many companies, especially those operating in the industrial equipment market, carefully divide their clients into multiple segments due to its limitations, thereby achieving the ability to deliver products and services tailored to the place. For example, Boeing company considers each of its customers a separate segment of the market. Such an account of the requirements of each specific consumer of new technology turns out to be very effective. Since all the considered segments cannot fully satisfy these indicators, it is proposed to adopt a multi-purpose helicopter as a compromise solution, which, in its basic basis, will be specialized in performing a certain type of work and, at the same time, will be able to perform other types of work quite efficiently. Modifications of Mi-8 helicopters in transport, passenger and ambulance versions can serve as an example. In modern conditions, in order to retain market share and stimulate sales, a more accurate determination of the desires of consumers in various market segments is required. If the basic model is available, it is possible to create modifications of a deeper level, which differ not only their purpose, but also have additional features (options) that allow modifying the equipment and choosing the option that is most suitable for the purposes of the operator. These can be various equipment configurations, engine types, flight performance, maintenance options, repairs, etc., which are most suitable for performing the types of work prevailing in this particular segment, in this airline, and to a greater extent satisfying customers. The scheme of such basic unification is shown in Fig. 2.



Source: Elaborated by the authors.

Figure 2. Scheme of combining the characteristics of helicopters based on the development of the basic version and additional features that allow the modification of equipment.

For an airline, as a buyer of helicopters, with limited financial resources, one of the economic conditions for the implementation of such a strategy is the fulfillment of the following ratio (Eq. 3):

$$\sum_{i=1}^{n} \quad (P_{bas} + \Delta P_i) \times N_i \leq P_{univ} \times N_{univ} \tag{3}$$

where:

P_{univ} is the price of a helicopter, universal in its configuration, "for all occasions", for all segments, rub.; P_{bas} is the base price of a helicopter in a standard configuration, excluding additional "fitting" of a helicopter to the requirements of a certain segment, rub.; ΔP_i is the surcharge to the base price of a helicopter for "fitting" a helicopter to the requirements of consumers of a certain i-th segment, rub.; N_{univ} is the volume of purchases of helicopters, universal in their configuration, excluding market segmentation,

pcs.; N_i is the volume of purchases of helicopters, completed taking into account the requirements of consumers of each i-th segment, pcs.; n is the number of market segments considered.

As an example, we can cite the fact that at one time, during the first three years of serial production of Boeing-707 aircraft, Boeing company delivered seven modifications to the market, differing from each other in wingspan, fuselage length or engine types. Thus, the installation of the Rolls-Royce engine instead of American-made engines contributed to the promotion of the Boeing-707 aircraft to the British market. When creating the Airbus, European firms proposed three variants of this aircraft, each of which was optimized for a certain range and a certain passenger flow, which met the requirements of various customer groups. It should be noted that it takes less time to create modifications than to develop a new aircraft.

Development of a new type of helicopter

When choosing the parameters of a new helicopter as a multi-purpose system, it is necessary to use its efficiency indicator as the main criterion. Two approaches are possible here. Firstly, the efficiency of a multi-purpose system can be estimated as the sum of the efficiencies of performing single tasks (the rule of integral evaluation), and secondly, it can be estimated as the limiting efficiency of performing single tasks (the rule of guaranteed evaluation).

We consider a model for the formation of the structure and number of helicopter fleets in an airline, taking into account the consumer preferences and forecasts of socio-economic development of the regions, determining the volume of flight work of the regional airline. In the proposed economic-mathematical model as a criterion for the optimality of the structure of the helicopter fleet, we take the maximum return on invested capital for the forecasting period (efficiency) (Eq. 4):

$$Eff = \frac{P}{E} \rightarrow max \tag{4}$$

where:

P is the profit from the operation of various types of helicopters for various types of work; E is the amount of expenses for the purchase, operation and repair of various types of helicopters in the airline.

In turn, P and E are defined as follows (Eqs. 5 and 6):

$$P=\sum_{t=t_0}^{T} \quad \sum_{n=1}^{m} \quad \sum_{i=1}^{S} \quad Q_{gener}\,(t)*\gamma_i * \eta_i * P_i \frac{1}{(1+\alpha)^{T-t_0}} \tag{5}$$

where:

$Q_{gener}(t)$ is the annual volume of all types of airline work in flight hours in year t; γ_i is the share of the i-th work in the total volume of work of the airline; η_i is the specific weight of the i-th work attributable to the n-th type of helicopter; P_i is the profit received by the airline from performing the i-th job of n-th type of helicopter; m is the number of types of helicopters available in the airline; S is the number of types of work performed.

$$E = \sum_{t=t_0}^{T} \sum_{n=1}^{m} \{C\,[\Phi_P\,(m,t)] + O[\,\Phi_P\,(m,t)] + R[\Phi_P\,(m,t)]\} \frac{N_n\,(t)}{(1+\alpha)^{T-t_0}} \tag{6}$$

where:

C is the capital expenses for the purchase of helicopters; O is the helicopter operating costs; R is the helicopter repair costs; $\Phi_p(m,t)$ is the array of parameters that determine the amount of costs (prices of helicopters, their equipment, operating features, etc.); α is the standard for bringing different costs; t_0, T is the first and the last years of the forecast period, respectively; $N_n(t)$ is the number of n-type helicopters used to perform a certain amount of work in year t.

The system of restrictions is the following (Eq. 7 and 8):

$$\sum_{n=1}^{m} \quad \sum_{i=1}^{S} \quad N_p\,(t)\,\tau_i\,(t) \geq Q_{gener}(t) \tag{7}$$

$$\sum_{n=1}^{m} \sum_{i=1}^{c} C\,[\Phi_p\,(m,t)]\,N_n\,(t) \leq \bar{C}\,(t) \tag{8}$$

In Eq. 7 and 8, we use the following notation:

$\tau_i(t)$ are the flying hours of n-type helicopter in year t at the i-th job; $\underline{C}$ (t) is the amount of capital investments allocated by the airline for the purchase of helicopters in year t.

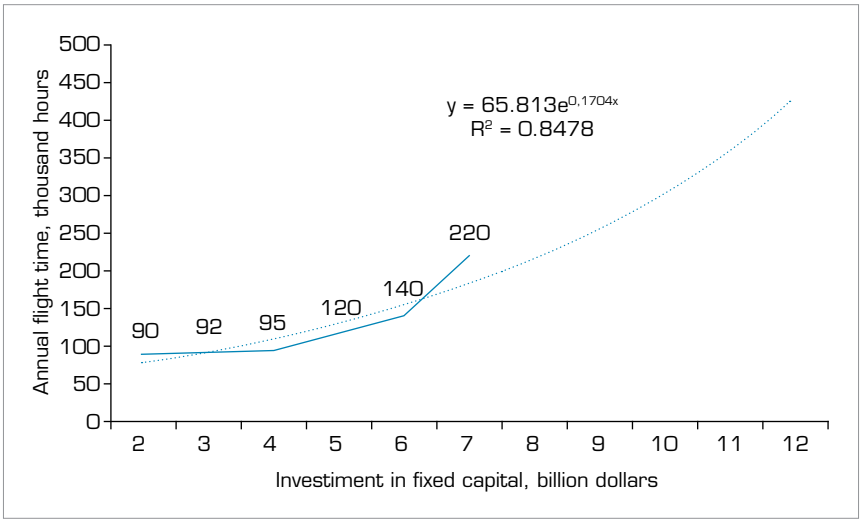
According to Eq. 7, in each year of the prospective period, the helicopter fleet must perform the amount of work $Q_{gener}(t)$, determined by exploratory or normative forecasting methods taking into account the indicators of socio-economic development of the region.

Equation 8 stipulates that the volume of capital investments for the purchase of helicopters should not exceed the value $\underline{C}$ (t) allocated for this in the year t.

As a result of using this model, it becomes possible to determine the need for helicopters of various takeoff weights and specializations for each year of the forecasting period, taking into account the dynamics of changes in the volume of flight operations of each airline.

It should be noted that the demand for various types of helicopters and their number obtained from this model is not the actual demand for helicopters, but the effective demand, which follows from the system of restrictions.

The scope and content of airline operations in different regions and the composition of the main customers for helicopter operations may differ due to the fact that the regions have, as a rule, different sectoral structure, different rates and trends of their economic development (Regions of Russia; Socio-economic indicators 2023; Federal State Statistics Service 2015). Therefore, the efficiency of updating the type and fleet of helicopters in a regional airline and bringing them in line with market requirements may vary. On the basis of data on the socio-economic development of the regions, models for calculating the volume of airline flight operations in the region can be built. An example of building such a model is shown in Fig. 3.



Source: Elaborated by the authors.

Figure 3. An example of determining predictive estimates of the total flying hours of an airline's helicopter fleet depending on investments in fixed assets in the region.

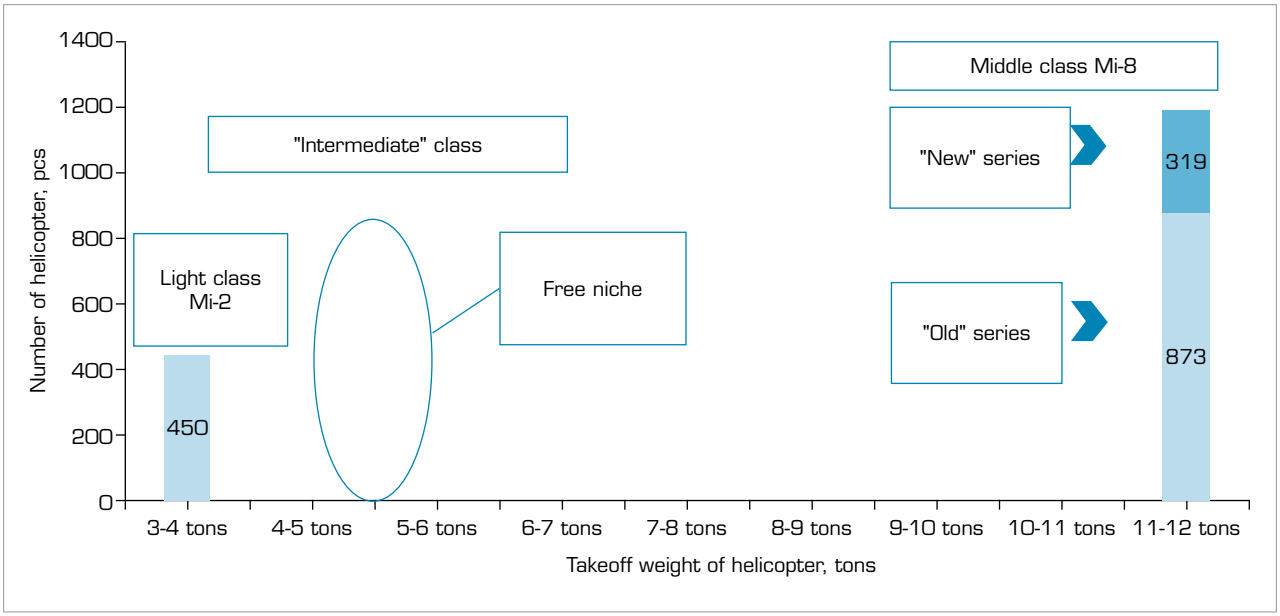
For a developing helicopter company, such a parametric analysis for most Russian airlines will make it possible to more objectively judge the structure and size of the required type and fleet of helicopters, its expansion, saturation due to the creation of new models or modifications of existing helicopters and, accordingly, possible costs of development and serial production.

DISCUSSION

To ensure the successful operation of airlines in the near future, it will be necessary to update the type and fleet of helicopters and, on this basis, expand their use among existing and potential customers of helicopter operations. Due to the fact that 87% of Russian helicopter fleet is over 25 years old, the issue of replacing the most common Mi-8T(P) helicopter with its new modifications Mi-8AMT / MTV-1 and limiting the service life of Russian helicopters to 25 years is being intensively discussed. It is assumed that such a replacement will make it possible to load the production capacities of serial enterprises and ensure their technical re-equipment. As counterarguments, they cite the high flight safety characteristics of Mi-8T helicopters, financial difficulties with the acquisition of new helicopters and increase in the cost of their flying hour, which is unacceptable for airlines. Statistical data on the flight safety of Mi-8T (P) and Mi-8 MTV (AMT) helicopters indicate that the accident rate of the "old" Mi-8T helicopter ($0.52*10^{-5}$) is significantly lower (2.4 times) than the more modern Mi-8MTV-1(AMT) ($1.26*10^{-5}$). The comparative values of the "risk of mortal injury" criterion for these helicopters are $0.17*10^{-5}$ and $0.93*10^{-5}$, respectively, i.e. according to this criterion, Mi-8T helicopter is 5.5 times safer than Mi-8MTV (AMT) helicopter. If we consider the economic aspects of the use of helicopters, it can be noted that the price of the new Mi-8 MTV (AMT) helicopter is about 10 times higher than that of Mi-8 T (P) helicopter and amounts to 550 million rubles, and the cost of a flight hour 1.7 times higher (Khudolenko 2014). With a lack of funds from helicopter operators due to low profitability of their business, high prices for new Russian helicopters and a limited range of helicopters produced today, airlines in their current state are not able to upgrade their fleet of helicopters.

From the point of view of expanding the areas of use of helicopters and effective loading of the helicopter fleet, it is necessary, on the basis of marketing research, to determine the consumer preferences of customers of helicopter services, a promising line of a model range of helicopters and their number for each type.

When analyzing the segment structure of the helicopter operations market, one can clearly see the desire of customers in most cases to use helicopters lighter than Mi-8 or the so-called "intermediate" class with a payload from 1.5 to 2 tons and a maximum take-off weight in the range of 4.5-5.5 tons (Fig. 4). They are much cheaper than Mi-8MTV helicopters and, at the same time, have high functionality. An example of foreign helicopters of this class is Bell-212, Bell-214, AW-139, S-76 helicopters (Eshel 2013; Kolesnikova and Kovalchuk 2021). Unfortunately, customers most often have to use Mi-8 medium-class helicopter for almost all cargo in the range over 500 kg, which significantly increases the cost of transportation.



Source: Elaborated by the authors.

Figure 4. Distribution of the Russian fleet of the most common helicopters by take-off weight.

Taking into account the results of the analysis of trends and forecasts of the development of the national economy of Russia and the state of the helicopter fleet, it will make it possible to develop a realistic scenario for the formation of the structure and number of the renewed fleet of Russian helicopters and to optimize the presence of foreign manufacturers in it.

CONCLUSIONS

A meaningful formulation of the management task of a thorough study of the market requirements for new helicopters, from the point of view of meeting the needs of customer enterprises, has been formed. Marketing research of the characteristics of the work performed by customers will reduce the risk of creating a new type of helicopter that is unacceptable for the market, more efficiently use its own resources, determine the optimal production volumes and, ultimately, get ahead of foreign competitors.

In accordance with the theory of sets, the mass of the payload G^{l}_{p}, transported over a certain distance, is taken as a defining property for helicopters performing various types of work. To identify the defining property $P(G^{l}_{p})$ of helicopters, we considered the value of this characteristic for works that are most inherent in the enterprises-customers of FEC in the West Siberian region of Russia and in related industries that make up the elements of the infrastructure of the economic region: air patrolling and sanitary transportation.

The analysis showed that the considered characteristics of the work performed by various types of helicopters have much in common. Firstly, it has a flight range up to 400 km, the weight of the transported cargo is in the range of 1.5-2.0 tons and 8-17 passengers. The helicopters currently in operation cannot fully satisfy the requirements of customers in terms of their flight technical and economic characteristics.

In the near future, for existing helicopters, it is realistic to create modifications of a deeper level, differing in equipment configuration, engine type, flight performance, etc., which are most adapted to perform the types of work prevailing in a given airline and more fully satisfy customers.

The most promising helicopter, capable to a greater extent of meeting customer requests for most types of work and, at the same time, being profitable for operators could be a helicopter of an "intermediate" class with a takeoff weight of 4.5-5.5 tons, highly competitive, promising sales and a real opportunity to renew the existing fleet of helicopters by partially replacing Mi-8 helicopters with a 25-year and more service life.

The model presented makes it possible to determine for each airline the need for helicopters of various types and specializations for each year of the forecasting period depending on the parameters of the socio-economic development of the regions and, accordingly, depending on the dynamics of changes in the airline's flight operations, taking into account effective demand and, on this basis, to predict the number of a promising type and fleet of helicopters.

Increasing the availability and quality of air transport services for consumers can be achieved by developing and optimizing the fleet of modern aircraft, bringing the structure of the supply of air transportation and aviation work to the structure of demand for them and reducing the cost of transportation.

CONFLICT OF INTEREST

The author declares no conflict of interest.

DATA AVAILABILITY STATEMENT

All data sets were generated or analyzed in the current study.

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