

Status and Trends in Small Aviation Development using Examples from Russia and the USA

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Abstract. The article examines and describes in detail the sphere of small aircraft. It differs from other types of aviation in that it includes relatively small aircraft: planes with a takeoff weight of up to 8600 kg of power, with a capacity of up to 19 passengers; helicopters with a takeoff weight of up to 4500 kg of power; drones with a takeoff weight of up to 8600 kg. During Soviet times, the sector was rapidly developing, and vessels were used for passenger transportation, medical purposes, forest protection, aerial patrolling of certain areas, reconnaissance, mail transportation, firefighting, and other purposes. The study summarizes the indicators characterizing the state of small aircraft in Russia and the United States, and a comparative analysis of the dynamics of small aircraft development of these two countries is made. The numerical indicators characterizing the number of small aircraft, pilots and airfields are considered. It is proved that the sphere of small aviation in Russia is in decline at the moment; concrete examples such as low level of pilots training, insufficient number of aircraft, runways, and others are considered. Possible prospects for the development of this sphere are identified and ways of solving the existing problems are proposed.

1 Introduction

The analysis of problems related to the development of small aviation is a very relevant aspect at present, since small aviation is a strategically important part of the global transport system and it significantly affects both the economy of a country and the living standards of the population of a particular region. As Schlegl, T., Moser, M., Loss, T., and Unger, T. "...approximately one million small and light aircraft in operation worldwide" [1]. It is divided into passenger and cargo aviation. Passenger aviation is subdivided into small aircraft for personal use and for transport services (Figure 1).

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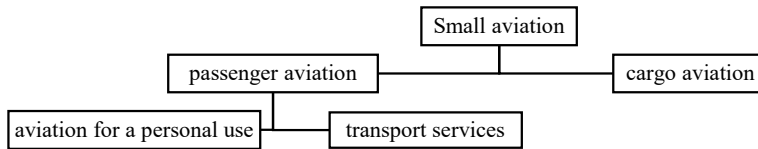


Fig. 1. Types of small aviation.

At present Russian small aviation (as well as large aviation) is in decline. There are now only 7,500 small aircraft in Russia, which is very low, and the volume of traffic is also declining every year. Nevertheless, the potential of the industry is very high, if states would make the effort to develop it. In many large countries, small aviation is much more profitable than large aviation, as currently almost 90% of all aircrafts belong to the category of small aviation. In addition, this sector provides a lot more jobs for citizens. Small aviation plays a huge role both for Russia and for the world as it performs many different functions (Figure 2).

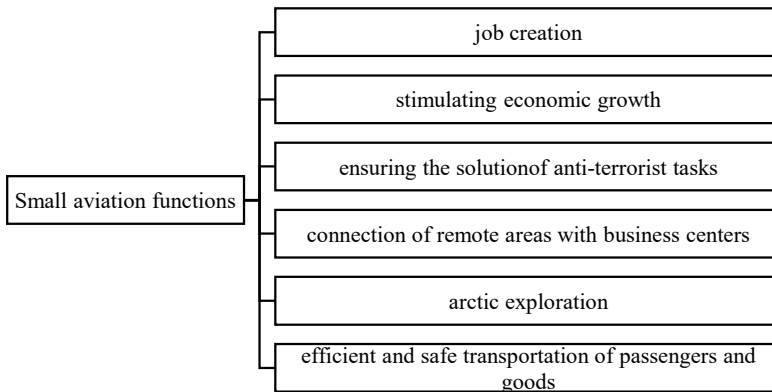


Fig. 2. Small aircraft functions.

1.1 Literature review

The study considered the works of foreign authors, covering the issues of small aviation development in Russia and the USA, as well as the issues of state regulation of this sphere and the problems that hinder the development of small aviation. Also these works propose possible ways of solving the problems, the implementation of which could contribute to the improvement of aircraft condition, simplify the obtaining of licenses by pilots and solve the issues with the implementation of commercial air transportations with the use of small aircrafts.

The question of the small aircraft industry is relevant throughout the world, so works in this area can be found in a wide range of countries [1-12]. Their works address a variety of issues, from the modernization of small aircraft models and increasing the productivity of aircraft building, to the introduction of artificial intelligence systems in aircrafts,

improvement of legislation regulating the sphere of small aircraft and the development of infrastructure for ground handling of aircrafts.

In our opinion, one of the most outstanding works is the article by Schmeleva A. and Bezdelov S., who in their work considered the mechanisms to increase the productivity of Russian aircraft building, focusing on the system of state regulation of this sphere [16]. However, the authors did not fully disclose the issue related to the reduction of costs of aircraft use and repair. We would also like to mention the study of Ghițescu I. M. et al [11], in which the authors discuss and elaborate on the design, optimization and modelling of commercial aircraft, which is a very important aspect in the development of the field of small aircraft, as currently in Russia there are huge problems associated with the production of new small aircraft.

We believe that high taxes on aircraft purchases are not sufficiently addressed in the literature, while other issues of public management of the small aviation sector are dealt with in depth. This is problematic because the issue of high taxes, as well as other small aviation issues, is quite acute. The topic of pilot training and obtaining licenses to operate aircraft is also insufficiently covered. Moreover, although the issues of insufficient number of airfields and possible ways of increasing their number are among the key ones, they are also covered superficially.

1.2 Problem statement

As a result of the analysis of the cited and other scientific works in the field under study, it has been established that the main problems requiring priority solutions include the problems of insufficient number of aircraft, airfields and runways, as well as the problem of small aviation pilots training and shortcomings in state regulation of this sphere.

At the same time, these crucial problems require constant attention, especially in the field of their further scientific research and improvement of pilot education system, legal acts regulating the field of small aviation and improvement of the condition of aircrafts, airfields, airports and airstrips.

The analysis also identified additional challenges for Russian small aviation: difficulty in maintaining aircraft in good condition; high demands on those who use aircraft; lack of commercial air transport capacity; high taxes; problems in obtaining licenses and certificates for pilots as well as registration of aircraft and helicopters; and the problem of producing new aircraft.

1.3 Aim, objectives and hypothesis of the study

The objective of the study is to determine the dynamics of development of small passenger and freight aviation, to compare domestic and foreign experience and to identify promising ways of development of small aviation in the Russian Federation.

The set goal of the research requires solving a number of tasks in the field of analyzing the development of small aviation:

- to summarise the indicators characterising the state of small aviation in Russia and the USA;
- to conduct a comparative analysis of the development of small aircraft in Russia and the USA
- to identify the problems in the development of small aircraft in Russia;
- to determine possible solutions to the problems identified.

The hypothesis of the study is that the sphere of small aviation in Russia is in an extremely difficult condition at the moment, but this can be corrected by using a

comprehensive approach and implementing a modernization strategy, which will help to realize its great potential.

2 Methods

Materials from various sources relevant to the topic were chosen as a basis for this paper. Various research methods were also used, mainly experimental, in particular the comparison method, as well as empirical-theoretical methods involving analysis and comparison.

3 Results

As Mahdi Yousefzadeh Aghdam, Seyed Reza Kamel Tabbakh, Seyed Javad Mahdavi Chabok and Maryam Kheyraadi state, "Among various travel methods, air travel is of particular interest in terms of quality, speed, security, and comfort" [2]. However, despite this and the fact that small aviation is one of the most common forms of aviation in the world, in Russia this form of transport has become inaccessible to most of the population.

There are about 400 airfields and landing sites in Russia dedicated to small aircraft, of which only 60 are well equipped, with about 9000 aviation specialists at the moment. Moreover, approximately 25 enterprises manufacture small aircraft. On the whole, such low figures give us to understand that Russia is still very far behind other developed countries in this sphere. The main problem that has caused Russia to lag so far behind other countries is the severely neglected and degraded infrastructure left behind by the USSR. Most of the airfields have become unusable and are in need of major repairs. To compare: in 1991 there were some 1,300 airfields in the country and in 2020 their number has been reduced to 400.

For the sake of clarity, a table describing the state of small aviation in Western Europe, the USA and Russia is presented below (Table 1).

Table 1. Small aviation of Western Europe, USA and Russia in figures [3].

Indicators	Western Europe	USA	Russia
Number of aircraft	110 000	211 743	7500
Total flight time		25 million hours	≈ 700 000 hours
Number of aerodromes and airfields	4200	19 300	≈ 400
Number of pilots	170 000	273 500	≈ 9000
Aggregate indirect contribution to the European economy	€ 30 billion	\$ 247 billion	nobody ever counted

The table demonstrates that the level of small aviation development in Western Europe and the USA is much higher and better compared to Russia (the figures for the number of vessels differ by more than 14 times). Comparing the number of pilots in the USA and Russia, it can be noticed that the figures differ 30 times and the total indirect contribution to the economy in Russia has never even been counted, while in the USA and Western Europe the amounts are \$247 billion and \$30 billion respectively. We also see the huge difference in the number of airfields and fields: an exaggeration of 48.25 times in the U.S. and 10.5 times in Western Europe compared to Russia. The total number of hours flown per year in the U.S. is 25 million, while in Russia it is about 700,000 hours, an excess of 3,500 times.

Despite such a lag between Russia and the developed countries it cannot be said that the Russian authorities have completely forgotten about the Russian small aviation industry and do not take any measures to develop this sector. There are two state programmes:

"Development of Aviation Industry 2013-2025" and "Development of Transport System" (this programme pays special attention to the Far East region).

The first programme includes a number of sub-programmes, including the sub-programme "Small aircraft", which aims to create new types of aircraft. Its funding amount is 10.4 billion roubles. The second programme is aimed at the development of infrastructure and includes the sub-programme "Civil Aviation and Air Navigation Services". The implementation of this programme will involve the beginning of construction and reconstruction of airports and airfields. Some constituent entities of the Russian Federation have developed their own programmes for the development of small aviation or are in the process of creating such programmes. In particular, such regions as Rostov or St. Petersburg have their own programmes. These state programmes certainly look quite promising, but their implementation is unlikely to radically change the situation with Russian small aircraft, as these problems have been solved for many years, but no significant improvements have been seen. Among other things, the concept of "small aviation" in Russia has not been legislated, which is why specialists interpret the concept in their own way and it is becoming more and more vague. This, in turn, prevents the government from regulating the mechanisms associated with the registration of flying clubs and aircraft and the issuing of certificates to pilots.

Many aviation centres in Russia are currently incapable of operating due to a large number of requirements. Because of this, many private training establishments either close down as they do not have the appropriate certificate or operate illegally. Obtaining a certificate in such centres may lead to problems in the future as it would be impossible to legally fly the aircraft. On the whole, there are very few flying schools in Russia - only eight. There are even fewer higher education institutions - 3: in Moscow, St. Petersburg and Ulyanovsk. Training, theoretical and practical exams, and a medical examination are some of the requirements which have to be met in order to become a private pilot in Russia. If a person does not have higher or specialized secondary education, he will not be able to fly a private aircraft and get a licence for it. If we consider the experience in the USA, everything is much simpler there. According to Douglas D. Boyd, Mark Scharf, David Cross, "for general aviation operations the majority of general aviation airmen (Federal Aviation Administration, 2015) hold a private pilot (PPL) certificate" [4]. In the USA, one can easily complete the whole training path from scratch in 4-6 weeks. The cost of training in Russia is about \$18,000, in the USA - about \$10,000. Such significant differences in training of Russian and American pilots explain the fact that American aircraft are much less likely to crash because, according to Douglas D. Boyd, "advanced airman certification reduces accident risk" [5].

It should be remembered that aircraft crashes are a serious problem. In particular, "quite a significant number of less well-trained amateur pilots have appeared", as P. Rzućidlo, G. Jaromi, T. Kapuściński, D. Kordos, T. Rogalski and Piotr Szczerba [6]. Therefore, quality training of today's pilots needs special attention. A striking example of comparing US and Russian pilot education system is a flight school owner Andrey Borysevich. He was trained to fly in the United States, because one could become a pilot in 6 to 8 months, unlike Russia, where training takes 3-4 years. Nevertheless, he was disappointed with the American education and his plans did not come true. He said that the education, which is given to future pilots in the United States is not as ideal as it seems. Borysevich also said that American flight schools are very small. There are only two planes at best. Everything was unorganized and unserious, classes could be cancelled for no reason. So he returned home, decided to establish a private flying school, studied the industry for two years and saved up money, then with the help of an investor he bought the flying school in Fort Lauderdale and started his own business. [7] There are many communities in the USA that are difficult to reach by car or bus, which is why the government has created a special

subsidy programme to enable them to participate in the airline service. The Essential Air Service (EAS) programme was introduced in 1978 and enables people to travel from literally anywhere in the country. According to Yongha Park and Morton E O'Kelly, "The Essential Air Service (EAS) program was established to provide a minimum level of air transport service for those smaller communities, usually subsidizing the operating costs of two roundtrip flights a weekday to connect their regional airports with large or medium sized hubs designated by the Federal Aviation Administration (FAA)" [8]. Under the program, government support is provided to aviation communities on the "Eligible list of small communities. The Department of Transportation oversees the expenditures made by the state budget. Figure 3 shows the amount of subsidies allocated since 1978.

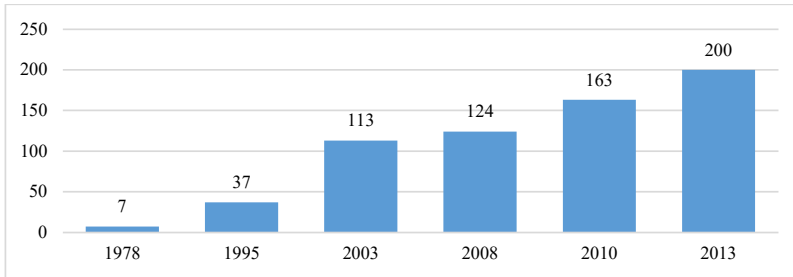


Fig. 3. Amount of subsidies allocated under the EAS program, million \$.

Every year the amount of subsidies increased significantly, from 1995 to 2003 - 3 times, from 2008 to 2010 - almost 1.3 times, and in 2013, the amount was a record, reaching \$200 million.

The growth of subsidies for EAS is constantly increasing, due to the growth of costs for existing communities and the inclusion of new ones (new types of aircraft, fuel). Subsidies are paid to airlines on a monthly basis, based on their reports [9].

Aircraft registration in Russia and in the USA has its own peculiarities due to the differences in the legislation of these countries. The procedure of aircraft registration in Russia and the USA is presented in Table 2.

Table 2. Aircraft registration procedure in Russia and the USA.

Country	Registration procedure
Russia	In Russia, aircrafts are registered in certification centers. To do this, you need to: write an application to the Department of State Aviation Supervision; sign a contract for carrying out work on the certification of the single instance of an aircraft; pass the technical commission; pay the state fee. Based on the conclusion of the commission, you will be issued an airworthiness certification, which must be renewed every year.
USA	In the United States, aircraft are registered with the Aircraft Registration Office. For this you need to: submit documents for the sale and purchase; attach Application for aircraft registration; pay the registration fee. The documents are submitted to the US Federal Aviation Administration. After 2 months, the aircraft will be ready for operation.

It should be noted that only 5% of Russian aircraft owners have registered their aircraft in Russia. There are several reasons for this: high VAT on imports (18% of the customs value); low quality of aircraft maintenance; and unstable government laws. Registering an aircraft in the U.S. has several advantages that attract aircraft owners: a simple procedure for buying and selling an aircraft; the owner has the right to be incognito; a huge choice of

charter airlines and aircraft equipment; high quality of maintenance; low prices for maintenance and materials to maintain the aircraft.

Small aviation in Russia is not at its best. The main reasons for the decline of this sector are the precipitous drop in passenger and cargo traffic. Russia also does not make small aircraft, which slows down the development of this sector considerably. W. Grimme, A. Paul, S. Maertens, J. van Wensveen state that in the EU small aircraft are practically not produced as "the small market size can be seen as a key factor to the lack of innovation, as manufacturers and investors apparently do not see a business case for major investments in a sector where only a small number of aircraft can be sold" [10]. The situation in Russia is similar.

Indeed, the production of new aircraft is an energy- and resource-intensive process, but, according to Ion-Marius Ghitescu, Maria Luminita Scutaru, Marilena Ghitescu, Paul Nicolae Borza and Marin Marin, "there are several solutions to this feature of modern production-the most used being the implementation of new tools and technologies to support the approach of the project without significantly affecting the time of implementation or the quality obtained". [11]. 90% of aircrafts are imported, so Russia lags far behind the USA. The existing aircrafts are already obsolete and the new ones are too expensive.

Other causes of decline are as follows (Figure 4):

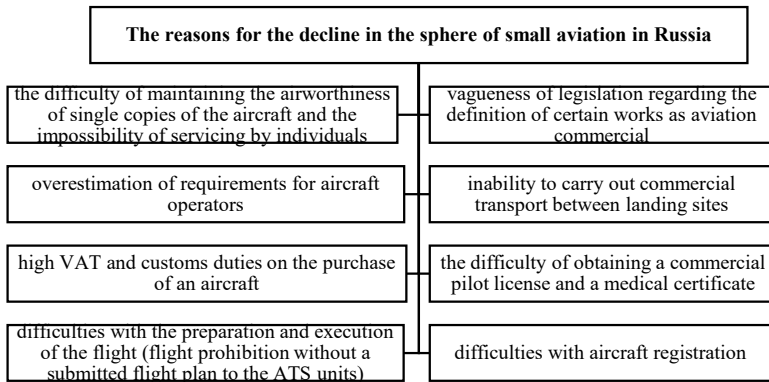


Fig. 4. The reasons for the decline in the sphere of small aviation in Russia [12].

It is easy to observe that almost all of these problems are related to the mismanagement of processes in the small aviation industry and, more importantly, these problems are solvable. Some of the problems can be solved by passing new laws, and some by improving technical means.

As mentioned earlier, small aviation in Russia is a fairly promising industry, which, if properly developed, can bring huge profits and a lot of benefits to the country. According to Vladimir Tsutkarev, Pavel Pegin, "Due to having a large territory, the Russian Federation also has the largest airspace in the world" [13]. [13]. It needs to be effectively used and developed. The question is what should be included in the programme for the development

of this industry The main possible directions of solving the identified problems are presented below (Table 3).

Table 3. Possible solutions to the identified problems in the field of small aircraft.

Solution	A comment
Development of new aircraft models	New aircraft can play a big role in the development of small aircraft, travel between villages, settlements, with better quality for passengers, safety and reliability
Subsidies	Subsidies can help accelerate the process of upgrading aircraft, airports and airfields, as well as the creation of new aircraft models
Development and implementation of high-quality government programs for the development of the industry	It can ensure an integrated and balanced development of all elements of the air transport system - organizations that carry passengers and perform aviation operations; ground aviation infrastructure, including air traffic control system and airfield (airport) infrastructure; aircraft and other types of aviation equipment intended for local and regional air transportation; the regulatory and legal framework governing relations in the development, production and operation of aircraft, as well as stimulating the development of this market segment
Modernization of airports, airfields, aircraft	It will help to use aviation equipment and technology more widely and effectively for the goals set in the field of small aviation and, accordingly, can help improve the state of the sphere as a whole
Improvement of the legal framework governing relations in the field of small and regional aviation	New laws could help simplify processes for obtaining pilot licenses, aircraft registration and other poorly regulated processes in the industry

According to L. Christensen, O. Nielsen, J. Rich, M. Knudsen, "Air transport therefore plays a central role for the society. The improvement of the infrastructure of the country and the time savings for residents, visiting tourists, and business travellers is substantial" [14]. If the government begins to actively develop this sector, it will soon be seen that the rise of this industry will stimulate economic growth in the country, create many jobs, help optimize and simplify cargo and passenger transportation processes to the most inaccessible areas of our country, facilitate work in preventing terrorist activities, and help strengthen links between the major economic centres and regions of our country. The more invested in the small aviation sector, the more positive impact it will have on the country. Blonigen B. A., Cristea A. D. state that "Communities that benefit from more rapid economic growth tend to also invest more in infrastructure, and in the provision of transportation services" [15]. [15].

Obviously, it is necessary to take into account the impact of the pandemic on the economy, in particular on the small aviation sector. According to A. Schmeleva and S. Bezdelov, "Currently, the pandemic has had an extremely negative impact on the economy, especially in the aviation industry. [16]. But the consequences of this impact are reversible, it only requires enough effort to do so.

4 Discussion

The results of the Russian and US analysis of small aviation indicators and the comparison of these indicators have confirmed the validity of the hypothesis put forward at the beginning of this paper. It was assumed that Russian small aviation is in decline. These results can also be interpreted as relevant at the current stage of small aviation development. We have found that the Russian small aviation industry now needs global

support from the state, because the number of planes is decreasing annually, airfields and landing sites are also becoming fewer and fewer, planes are worn out and fail, and conditions are not good enough to build new planes. Moreover, getting a pilot certificate and quality training is also a huge challenge, which makes the development of the industry even more difficult. State aid and effective implementation of the proposed programmes should help in time and improve the situation.

5 Conclusions

Having analysed the dynamics of small passenger and freight aviation, comparing domestic and foreign experience, we can draw the following conclusions:

1. The indicators characterizing the state of small aviation in Russia and the USA are the following: number of aircrafts, total flight hours of pilots, number of airfields and landing sites, number of pilots.
2. Russia's small aviation sector is not going through the best of times; this is most clearly seen in comparison to the US. For example, the number of small aircraft in the USA is 211,743, while in Russia the number does not exceed 7,500. The total flying time of pilots in the USA amounts to 25 million hours a year, whereas Russian pilots log about 700,000 hours a year. In the USA small aircraft including privately owned aircraft fly on about 19 thousand small airfields and landings. In Russia, there are only about 400 such airfields, and their number continues to decline. The US is also ahead of Russia in the number of pilots: 273,500 against 9,000 - the difference is enormous. To improve the condition of this sector it is necessary to simplify the procedure of education, training, and re-training of pilots to increase the number of pilots at least by half (from 9,000 to 18,000). There are only 50 aircraft manufacturing plants in Russia now, this figure lags 200 times behind the USA, so our country needs to at least gradually increase the number of plants to improve the situation in this sphere to begin with.
3. The study has revealed the problems of small aircraft development in Russia: difficulty in maintaining aircraft in good condition; vague legislation in the field of small aircraft; high requirements for those who use aircraft; lack of possibility to make commercial air transportations; high taxes; problems with obtaining licenses and certificates for pilots, with registration of aircraft and helicopters; insufficient number of aircraft manufacturing companies.
4. The sphere of small aviation needs to be developed and brought to a new level, strengthened, and modernized. Small aviation in Russia is a necessary component for the further development of not only the country as a whole, but also for the development of individual aspects, the main being economics. At the end of the study, the following possible solutions were suggested: developing new aircraft models, increasing aircraft production to the level of the Soviet Union (about 20,000 aircraft compared to the current 7,500); subsidizing the industry, with the government support exceeding 10.4 billion roubles; developing and implementing quality government programmes to develop the industry, regulating and properly establishing fuel prices; modernising airports, airfields, aircraft, increasing the number of aircraft, and improving the efficiency of the airports.

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