A Review of Research Literature on "Management Reform and Low-altitude Opening of Low Air Space" in Recent Years

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**Abstract.** Low altitude open a worldwide topic and the use of low altitude airspace resource exploitation. Through the reading and analysis of the existing literature, this paper combs the related research results of low-altitude airspace management reform and low-altitude opening in recent years. To sum up, the current research results related to low-altitude airspace management reform and low-altitude opening focus on market potential analysis, general aviation industry development forecasting, air traffic supervision and risk prevention.

**Introduction**

Low-altitude opening is a worldwide topic on the development and utilization of low-altitude airspace resources. It is an important area for modern industrial development and market expansion. The so-called low-altitude opening refers to the use of international practices to draw lessons from the National Air security and defense and military and civil aviation flights, and to the airspace below 1,000 meters. Regional and sub-categories are divided into three types of low-altitude airspace and visual flight routes: controlled airspace, monitored airspace, and reported airspace. Airspace operating standards are formulated, safety responsibilities are clearly defined, and classification management is implemented in different modes. That is to say, opening up at low altitude means that through the reform of the management of low airspace, some aircraft will be lifted from the blockade, ban and restrictions on the activities of certain low-altitude airspace, and the rational development and full use of low-altitude airspace resources will be ensured. Consult relevant literature, low-space management reform and low-altitude open research literature and main results, focusing on market potential analysis, general aviation industry development prospects forecast and air traffic supervision and risk prevention.

**Possible Economic Growth Points and Market Potential of Low-altitude Openness**

The low-altitude airspace resource is a strategic resource which not only relates to national security but also has huge market potential. In the United States, where large areas of low altitude are free to fly, there are 200,000 private aircraft, millions of people have flight licenses, and a huge aviation industry has been cultivated. Similarly, with the concept of "maximum use, minimum restrictions", Europe and vast countries such as Russia, Australia, and Brazil also adopt loose management of low altitude. In view of the fact that China's low-altitude airspace is subject to restrictions and all airspace is subject to control, the State Council and the Central Military Commission issued in August 2010 the Opinions on Deepening the Reform of the Low-altitude Airspace Management System, and decided to carry out the pilot project of low-altitude airspace management reform starting in 2011. It clearly defines low-altitude airspace as three types of controlled airspace, monitored airspace, and reported airspace, and implements classified management, and requires the National Civil Aviation Administration to study and demonstrate with the Air Force that the current route is within an altitude
of four kilometers or less, in accordance with the "monitoring airspace" management measures. Provide air traffic services for general aviation flights.

Regarding the market potential of low-altitude development, Gongxiaohong(2012) believes that with the gradual deregulation of the government, a large market of trillions of people will be created for employment. Liuhualin, Lihaibin, and Wang Yong(2013) believe that after the low-altitude opening up, the domestic market prospects are extremely broad, both in the navigation field and in the air traffic management field serving it. According to the analysis of Soochow Securities(2016), the opening of low-altitude airspace will accelerate the development of the general aviation industry, making the commuting and official travel needs of high-income people greatly promote the huge demand for transport helicopters and business jets. "Air traffic control systems and airport equipment will benefit directly. From operating hosting, leasing and training services to aircraft operation and maintenance, they will bring huge economic benefits." After the low-altitude opening, the number of airports and flight operations will be expected to reach a compound growth rate of 30-50 %. The total space for the "air traffic control system and airport and airport equipment market during the 13th Five-Year Plan" period will exceed 12 billion yuan. The market space for operating hosting, leasing and training services will exceed 70 billion yuan. " Bupeng(2013) believes that China's general aircraft market has great potential. According to statistics from 2011, the United States has 222,560 aircraft of various types, and China has a total of 1,154 aircraft of various types, which is only 0.5 % of the United States. Liutiejun(2014) believes that the downstream application market for civilian drones in China is very wide, including agricultural plant protection, oil and gas pipeline inspection, power line inspection, counter-terrorism stability, land and marine remote sensing and other aspects, and it is expected that the potential market will reach 300 to 50 billion yuan.

Regarding the cultivation of new economic growth points, Gongxiaohong(2012) believes that the establishment of a navigation industry chain integrating scientific research, manufacturing, operation, maintenance, intermediary services, finance, insurance and leasing can create new growth points for the local economy. Yurong(2013) believes that the construction of a low-altitude tourism development model has spawned not only a tourism industry, but also a new economic growth point. Yangbai(2007) believes that as an inland province that is "not along the coast or not along the river", Guizhou has a strategic depth of geographical security and is a major advantage for the "free flight" pilot. Once successful, the opening of low-altitude airspace may become a breakthrough in the development of Guizhou. He particularly emphasized that the demand for the opening up of low-altitude airspace will inevitably accelerate the transformation of third-line military enterprises, gain a clear sense of direction, find a huge market nearby, and form a manufacturing, maintenance and service capacity.

**Prospects for the Development of General Aviation Industry after Low-altitude Opening**

Regarding the opportunities and attractive prospects for the development of the general aviation industry brought about by the low-altitude opening, Yurong(2013) pointed out that Maikeer·woershi, the president of Asia's largest private aircraft seller, estimates that in the next 10 years, The size of the Chinese private aircraft market will grow by 20 % to 25 % a year, and within 10 years China will surpass the United States as the world's largest private aircraft owner. Liutiejun(2014) believes that with the gradual "ice-breaking" of air traffic control policies, China's general aviation industry will be expected to enter the "fast track" of development. He pointed out that in the next 5 to 10 years, China will usher in the industrialization of civilian drones.

Regarding the radiation and driving role of the development of the general aviation industry, Yurong(2013) believes that the development of low-altitude aviation tourism projects is ostensibly only for tourists to travel by plane. However, from the perspective of the composition of the general aviation industry chain, general aircraft manufacturing is the core. The upper reaches are parts manufacturing, the lower reaches are sales, the front end is design, and the back end is test flight; The next is the general aviation operation supporting industry chain, including direct operations,
personnel training and airport services; The final link is maintenance, ensuring flight safety and maintaining aircraft performance. The upstream and downstream links of these industrial chains will be pulled to a lesser extent. International experience shows that the development of an aviation project, the benefits brought to the local area after 10 years, the input-output ratio can reach 1:80, and the employment promotion ratio of General Aviation is 1:12. Gaoshiwei and Liyanhua(2013) believe that with the opening up of low altitude, a huge low-altitude industrial chain will be formed and a low-altitude industrial economy will be spawned. The construction of airports and surrounding facilities, flight license training services, maintenance support services, and aircraft sales will show broad prospects for development. The development of general aviation can drive the development of a series of industries such as machinery, new materials, electronics, communications, and chemicals, and can create a large number of employment opportunities.

Air Traffic Supervision and Risk Prevention after Low-altitude Opening

Regarding the air traffic supervision facing the low-altitude opening, Xian Jing(2017) believes that there are four outstanding issues, namely: the backwardness of the management system is an important influencing factor for the operation of air traffic control, which makes the system construction difficult, greatly increase; The backwardness of infrastructure has greatly increased the difficulty of air traffic control command, especially in terms of monitoring, communication and navigation, which has seriously hindered the development of the general aviation industry; Due to the implementation of comprehensive airspace control system for a long time, the actual experience of low-altitude airspace management in China is relatively lacking. In response to the above problems, she proposed "analyzing the characteristics of China's low-altitude management, absorbing foreign advanced experience, and establishing a perfect management and administrative system" and "combining the opening of low-altitude airspace with the construction of civil aviation infrastructure." We will speed up the development of civil aviation infrastructure, strengthen communication and communication at work, coordinate the relationship between general aviation, military aviation and civil aviation, and make full use of modern science and technology. Raise the level of low-altitude management intelligence, networking", "strengthen the publicity work on low-altitude open knowledge and related systems, and create a good public opinion environment" and other strategic suggestions.

Regarding the possible air traffic risks after low-altitude opening, Zhangxiao(2016) believes that "low-altitude opening will have an important impact on homeland security management" and put forward that "the training of air traffic control personnel and civil aviation crew should be strengthened. Ensure that the aircraft flies in a stable and orderly manner." Zhangxuelei, Feng Jie, and Lizhaoli(2015) believe that low-altitude opening may cause "black flying" problems. Based on the idea of acoustic design, he proposed an acoustic detection method for monitoring aircraft in low-altitude airspace. The target characteristics, acoustic target detection and wind noise resistance of the system were discussed. Zhanghengping and Liuyinghua(2013), based on the low-altitude open pilot situation in China, believe that navigation and economic benefits are in line with security control. In the future, the threat of air defense will no longer be limited to reconnaissance and interference by enemy aircraft from overseas, and should be prevented in a three-dimensional manner. Ensure the safety of low-altitude flights and air defense, emphasize "using the system to standardize navigation and avoid the problem of black flying as far as possible", "adhere to management and service, and maximize the demand for navigation flights", and "find out the bottom line." We will carry out scientific supervision, "strengthen air surveillance and response", "strengthen military and land coordination, improve the construction of legal and regulatory systems", "carry out personnel training to improve the level of low-altitude management", and "strengthen education warnings." We will improve the mechanism for punishing violations, strengthen awareness of combat readiness, and improve emergency response plans. Zhang Jian, Zhang Songxiangbo, Liuoyongxin, and Wangjian(2012) believe that the risks to air traffic supervision after low-altitude opening come from
three aspects. That is to say, "the management system is backward in restricting the operation of air traffic control", "the infrastructure is backward in restricting the command of air traffic control", and "the control experience lacks the ability to test air traffic control", and it is proposed that we should draw on the successful experience and practices of the United States. "Attaching importance to the construction of general aviation safety supervision and regulations", "paying attention to the construction of air traffic control facilities", "paying attention to safety input and the application of new technologies", and "paying attention to air traffic control publicity and education."

Regarding the prevention and resolution of air traffic risks after low-altitude opening, Gao Yang and Liudandan(2014) believe that based on the flight characteristics of aircraft in the airspace of the terminal area, mathematical methods such as random distribution and relative speed vector should be used. The probability of aircraft collision under the influence of airspace factors is studied. Using the reliability theory of the system, they analyzed the impact of pilots, controllers, air traffic control surveillance systems and collision avoidance systems, as well as weather factors and management conditions on collision risk. A general aircraft and route transport aircraft collision risk prediction model(AHMEMC R) involving five dimensions of airspace, humans, aircraft, rings, and tubes was established, and it was emphasized that using the model to calculate the collision risk of a terminal area through Matlab software can reduce the collision risk.

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