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Flight Delay Prediction System Based on Bayesian Networks

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Abstract: *In recent years, China's civil aviation industry has been growing, and the ensuing impact has been both beneficial and detrimental, with various causes of flight delays coming one after another, resulting in the creation of a flight delay prediction system. In order to improve the quality of flight convenience and reduce the losses caused by flight delays, the system will make a study of the reasons for the emergence of a series of response plans to form a set of increasingly perfect flight delay early warning system. This paper provides a more in-depth discussion of the problem of civil aviation delays and ways to respond to them, clarifying the current situation of airport flight delays, analyzing the main factors that lead to flight delays, focusing on the airport management of emergency. The paper also examines and analyses the problems of airport management in terms of emergency planning, management agencies and crisis management.*

Keywords: *flight delays, forecasting system, approach mechanism*

1. Introduction

In response to the above summary, as civil aviation becomes more and more powerful, we are facing more and more problems. The convenience of flights has led to more and more people using them as their first choice for travel, which has led to an increase in the daily workload of airlines, which can lead to errors if they are not done properly, coupled with weather, military and other uncontrollable factors that can lead to flight delays. In order to avoid more delays and save airport flight resources, we will apply the flight warning system to solve the above problems.

1.1 Background of the study

While flights are becoming more convenient for people's lives, flight delays have also increased in recent years, especially in some important transportation hubs, and this situation is even more obvious. These delays have been increasing in recent years, especially in Shanghai, Beijing and Guangzhou.

1.2 Significance of the study

The significance of developing civil aviation is to facilitate the people and strengthen the country, transportation is the foundation of the people and the development of aviation is also an important strategic industry for China's economic and social development. For the analysis of the problem of flight delays, the development of flight delay prediction system to reduce the impact of flight delays on people's travel has important practical significance. This paper is on five major aspects of the problem analysis: airline operations management, flow control, bad weather, military activities and the airport guarantee. For different problems we developed a flight operation analysis and early warning subsystem, air traffic flow management system and backup transport molecule. We have developed five major systems for flight operation analysis and warning, air traffic flow management system, back-up carrier system, active real-time flow control, implementation of targeted flow control and its contingency plan, which have perfectly achieved the prediction of flight delays with an accuracy rate of 93.25%.

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2. Analysis of Flight Delay Problems

2.1 Operational management of flight companies[1]

At present, the issue of air traffic control will mainly focus on safety and security issues, which is not to be blamed, but in the allocation of personnel, work efficiency is too aware of the weakness of this can never be. Most airlines, with the need to develop and travel the needs of the people, have started to open new civilian routes, focusing only on efficiency and neglecting high efficiency, failing to reasonably allocate staff and positions, wasting management and staff costs.

2.2 Flow control[2,3]

Aviation flow control mainly includes departure flow, route flow and approach flow, which is necessary to effectively protect air traffic safety, and also the main cause of flight delays. However, there are many objective factors about flow control problems that generating flight delay, for example, the flight cannot take off on time due to the weather, the plane is delayed due to the ground transportation equipment, and the passengers themselves are not registered in time, which will produce a series of chain reaction flight delays.

2.3 Impact of bad weather

The impact of bad weather is one of the main reasons for flight delays and passengers are understandably concerned about this reason. We need to consider the departure, destination, en-route and the impact on the ground after the above bad weather before we can judge whether to take off normally.

2.4 Impact of military activities

Military activities on the issue of flight delays have a certain impact, which is objective, the relevant departments said that the impact of military activities on flight delays accounted for about 7%, shown in Figure 1. China's airspace can be used by both military and civilian, based on anti-collision considerations, to ensure air safety, civilian aircraft are naturally to give way to military transport aircraft, the cause of such flight delays at the same time in the consideration of air safety, people's safety.

2.5 Airport security

Airport security accounts for a relatively small percentage of flight delays, and is mainly present in the inspection and maintenance of equipment by staff to ensure normal operation. Figure 1 below presents the flight delay statistics of relevant departments.

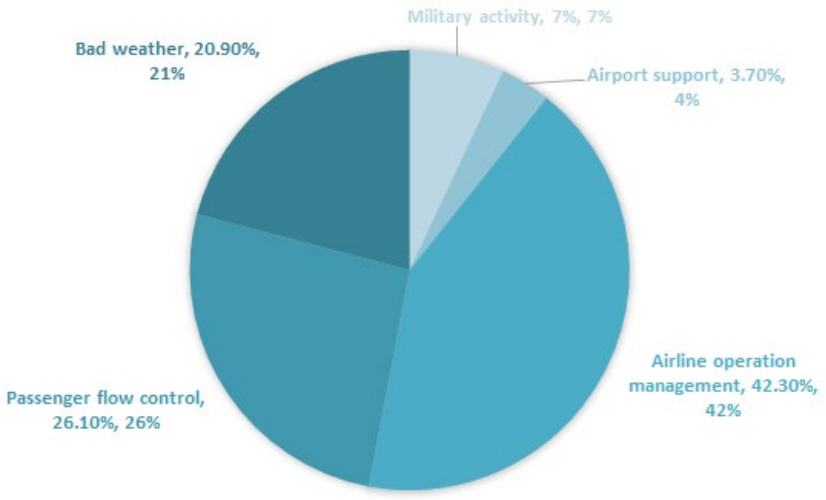

Figure 1: Flight delay statistics of relevant departments

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3. Early Warning System Response Programme

3.1 Flight operation analysis and warning sub-system

To ensure the normal operation of flights, it is important to ensure that there is a good analysis system in the "back office" to rationalise the allocation of operations. The system has its own set of operating systems for staff allocation, daily work completion progress, flight running times and response times to unexpected situations. The early warning sub-system automatically alerts and plans better, time-saving and efficient alternative solutions. For example, it monitors and warns of major and critical aspects of flight operations by scheduling, monitoring the progress of each aspect in a time-based sequence and issuing warnings of possible flight delays and alternate solutions when they are not completed on time. The pre-defined time points required are: time to load the gear - unloading baggage - unloading cargo - refuelling completed - loading cargo - loading baggage - passenger boarding - time to remove the gear.

3.2 Establishment of an air traffic flow management system[4-6]

There are many unavoidable reasons for air traffic control, which is also difficult for us to change artificially, for this aspect, what we can do is to establish an air traffic flow management system, in the case of flight process to protect the safety of personnel, improve the technical equipment to monitor the flow, and at the same time implement different time periods flow management: advance flow management, pre-flight flow management, dynamic flow management and the implementation of different locations Traffic management: terminal area traffic management, airport traffic management, flight path traffic management, in time and space together to establish a system more efficient, this part cannot be rushed, to ensure the overall system synergy. The regression analysis method is used to do the processing of information and data for flight times, airport capacity, transit times, flight delays, etc., to clarify the airport flight in and out of the delay time. The Bayesian grid method is also used to clarify the mathematical relationship between various factors associated with flight delays and flight delays for information such as flight data, weather data, run-in capacity, flight time slots, domestic and international, airlines, flight schedules, flight numbers, departure airports, landing airports, scheduled departure times, scheduled landing times, delay times in flight chains, and airport busyness in flight chains, so as to The mathematical relationship between various factors related to flight delays and flight delays is clarified using the Bayesian grid method to derive accurate flight delay probabilities and achieve flight delay prediction.

3.3 Back-up transport system

The backup cloud molecular system is the most secure sub-system for flight delays, but for airlines profit is the ultimate goal, so too much backup will lead to excessive waste of resources, too little backup will fail to achieve the effect of early warning, and ultimately a loss of effort, for this mechanism in the flight operation before we require a clear group of crew and backup crew attendance rate and the incidence of unexpected situations, scheduling Staff working time system table, strictly in accordance with the system table to ensure that the maximum utilization rate of personnel, to achieve job matching, the best use of things and people to avoid flight delays.

3.4 Active real-time traffic control

This mechanism is mainly used in two ways, one is to monitor and control the flight aircraft in a specific flight area within a fixed time frame, and the other is to limit the departure time of the airports in the field or the region. This active real-time traffic control mechanism can avoid flight delays in some cases, but the avoidance effect is really minimal.

3.5 Implementation of targeted flow control

As the previous mechanism only worked to prevent a small number of delays, targeted flow control will be used to enable one-to-one monitoring to avoid delays caused by flow control. At the same time, targeted traffic control will not only allow us to observe traffic but also help us to monitor bad weather and to anticipate delays in the event of unknown weather or unexpected conditions. Bad weather is becoming one of the main causes of aircraft delays. According to statistics, 80% of the world's flights are delayed or cancelled due to adverse weather conditions such as lightning, high winds, heavy rain,

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low clouds and low visibility. Some passengers also questioned why they were told by the airline that the flight was delayed due to weather conditions when the skies were clear. In fact, the so-called "weather conditions" include the possibility that the weather conditions at the departure airport are not suitable for take-off, the weather conditions at the destination airport are not suitable for landing, and that there are weather conditions on the route that affect flight safety, all of which are unsuitable for flight if the time is long. In addition, strong thunderstorms, thundershowers and heavy rainfall are at the top of the list of the most severe weather conditions that can affect the normal take-off and landing of flights. Aircraft flow control refers to the maintenance of safe air traffic flow by limiting the number of aircraft entering an air traffic control node per unit time. As civil aircraft can only take off, land and fly in a limited space, time and under limited conditions. In the event of extreme weather such as thunderstorms air traffic control controls the flow of aircraft to avoid dangerous approaches or airborne collisions between individual aircraft. In the sky, pilots need to communicate with ATC via radio at all times to confirm every aspect of the flight, and every flight must have a "standard manoeuvre". In fact, pilots, like passengers, would love nothing more than to hear a command from the tower: "Clear for take-off." Every instruction issued by ATC is closely related to the passenger, including take-off, landing, speed, heading, wind direction, wind speed and altitude. Because the instantaneous decision of the air traffic control is about the life and safety of every passenger on an aircraft.

4. Flight Delay Warning System Practical Application Process and Conclusion

4.1 The process of applying the delay warning system in practice[7]

In the face of the causes of flight delays and the response system solutions, in recent years in various airlines is also put into practical application, in the process of application of the system will also still appear flight delays, but compared to this year's delay rate, is showing a year-on-year decline in the trend, in addition to the unavoidable objective factors, the overall work efficiency has greatly improved. Effectively resolve flight conflicts in busy flight areas. The air traffic control department should further explore its potential and actively do a good job in "removing traffic congestion and ensuring smooth operation". Further enhance command and coordination capabilities, actively coordinate the use of temporary routes and optimise the airspace structure, reduce flight intervals and improve flight release patterns on the premise of ensuring safety, so as to reduce the waiting time after flying through the aircraft doors. Further strengthen the advance preparation of flight resumption plans after large flight delays, inform airlines of the flight release sequence in a timely manner and improve the efficiency of flight resumption operations. Also regulate flow control. Strengthen complex weather monitoring and early warning information release, timely notification of the impact of complex weather on airport operations, scientific flow control: implementation of flow control authority, implementation of flow control for more than 1 hour, must be approved by the Civil Aviation Regional Air Traffic Control Bureau or Air Traffic Control Branch (station) leadership: implementation of flow control for more than 2 hours, must be reported to the Civil Aviation Administration of China Air Traffic Management Bureau (referred to as " Civil Aviation Administration Air Traffic Control Bureau") operation control centre for approval, and promptly announced to the public. Separation of approach and departure routes at backbone airports, delineation of upper and lower flight limits, improvement of flight routes and the use of flight altitude levels, and standardisation of the management of temporary routes. Cooperate with the relevant local departments to improve the management mechanism of aviation operations, adopt the method of "when the peaks and valleys are large", reasonably arrange flight times and long aviation operating hours. Promote the reform of military aviation training flight patterns and actively promote the use of airspace on a time-sharing and stratified basis, so that military flight training airspace can be used more efficiently. Assist the relevant local authorities to speed up the process of implementing radar control in the western region. For areas where radar control has already been implemented, reduce flight intervals as much as possible and improve the efficiency of control operations, provided that the safety interval regulations are met.

4.2 Conclusion on the application of the delay warning system[8]

In a way, the Flight Delay Alert System is a "mentor" that helps us to make great progress in flight operations, and it needs to be improved in certain directions depending on the operating mechanism of the airline, but in general it works fine, so the Flight Delay Alert System should be encouraged The use of delay warning systems in airline companies should be encouraged.

Flight delays are a comprehensive problem formed by the accumulation of various conflicts during

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the rapid development of China's aviation industry, involving many factors such as policies and regulations, operational mechanisms and comprehensive security capabilities. To solve the problem of flight delays, all parties need to work together and manage it comprehensively. The government, airports and companies should establish the concept that airspace is an important strategic resource for the country, and make efforts to promote the efficient and flexible use of airspace and maximise the use of airspace resources, while ensuring safety. At the same time, we should further improve the mechanism for dealing with flight delays, and when large delays occur, form a "one-stop" working mechanism led by the civil aviation regional administrations and supervisory bureaus, with airports unified in deploying various resources to coordinate and command, and airlines, air traffic control, fuel, public security and other units in charge participating, with a unified goal, unified plan, unified command and unified action. The "one-stop" working mechanism.

5. Summary and outlook

In response to the problem of flight delays multiple factors, we use flight delay prediction based on Bayesian networks, apply linear regression models, fusion of daily delay data, coding pre-analysis, extraction of delay features in the network, and finally make multiple rounds of data collection and comparison to establish a flight delay early warning system, analyse the frequency of influencing factors and response initiatives, apply data feedback at clinical time, we We can understand that this early warning system is needed to a large extent in addition to the efforts of the airlines work also need to our passengers own awareness to help avoid their own problems lead to flight delays.

At the same time, it is hoped that with the help of the flight delay warning system the quality of service provided by China's civil aviation companies can be further improved, and that aviation can be developed more and more for the benefit of the people. In recent years, airline delays have been increasing and the development of the domestic civil aviation industry has been seriously affected, and there is an urgent need to improve the delay situation. For busy airports, forecasting the number of delayed flights is of great importance to them. This is because more delays mean more passengers are left behind, and when a certain number of passengers are left behind (or a certain number of delayed flights), airports must intervene with appropriate plans. Therefore, it would be helpful for the airport authorities to be able to provide advance warning of the number of delayed flights. With the advances in society and technology, the amount of data that can be collected is becoming more and more difficult to process and predict. Data mining, an emerging technique for processing large amounts of data, provides a new means of solving this problem of forecasting.

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