

## Research on Chinese Flight Delay

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**Abstract.** With the development of air transportation, flight punctuality has become the important concern of people when choosing flights. Flight delay caused serious losses hundreds of millions of time, so it is very necessary to solve this problem. Firstly, we rank the punctuality of the main airport in the world through data to assess the level of Chinese flight delay. And compare the situation between domestic and foreign. Secondly, the primary reasons for the flight delay and the importance of each factor is researched. Finally, when the delay occur, how to manage the problem to make the loss to the lowest is the vital thing. If we can predict the risk of the airport, it's true that the loss can be limited well. For we can take some efficient measures to deal with the matter when the risk is high. In order to predict the risks of a airport, a Secondary Fuzzy Evaluation Model is built. It can help predict the possibility of delay and monitor the situation of airport which will decrease the loss after the delay.

### Introduction

Nowadays, more and more people tends to go out by plane which is comfortable and convenience. The plane plays a more and more important role in vehicles and air transport develops a lot. In China, the requirement of air transport is increasing year by year. The consumers demand highly quality of air transport subsequently. There is a survey about the most important factor that consumers care recently made by CARNOC.com, shows that most people care about the punctuality of plane. As we can see, it has become the mainstream question among people.

The problem of flight delay has came to people's vision as the air transportation become more and more common. However, we found the situation of China seem very pessimistic. More research is needed to assess and ease this problem. We hope to build a model to predict the risk and monitor the situation of airport so that the airport can decrease the loss.

### Assumption

The statistical data is valid. We suppose that true value of every index locates right nearby the statistical data. Consequently, we assume that the data is believable.

The statistical data which is used can reflect the situation of the airport. The data we chose is limited, so we hope what we chose can reflect the real situation of the airport.

The main factors of the flight delay can be quantitative correctly. We will create a evaluation system to measure the risk' degree of a airport. Only we quantitative all factors we adopt reasonable can we work out the exact result.

### The ranking of the main airport's punctuality in the world

We acquire the punctuality of main airport in Asia, Europe and North America on June, 2013[1]. Rank the punctuality of airport in these regions and make the histogram among the last last thirty is shown below:

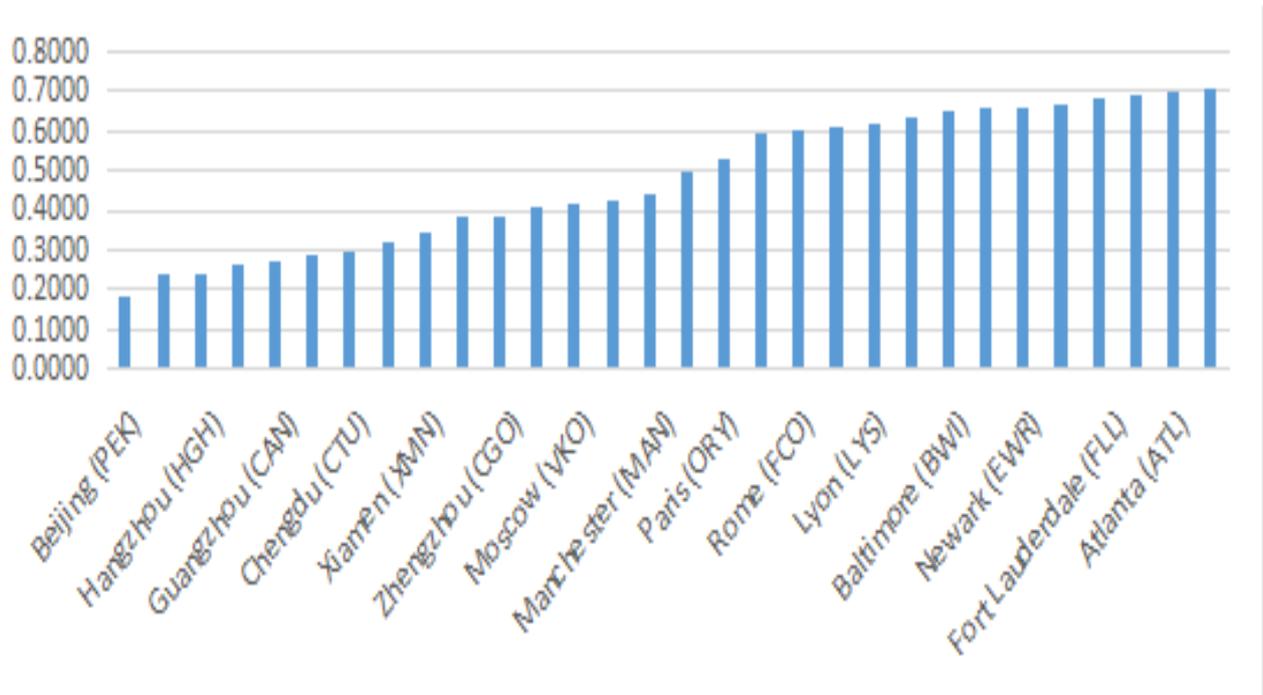


Fig. 1 The ranking of the main airport's punctuality

As the histogram shows, the last six airport belong to China which contain PEK, HGH, CAN, CTU, XMN and CGO. So we can draw a conclusion that the problem of flight delay is serious.

The following, we collect the data of VriFlight[2] about the punctuality among the main airport among the world from 2013 to 2014. The result also shows China perform badly. So we ensure China is one of the country that has the most serious problem of flight delay.

### The main reasons for the flight delay

According to the CAAC, the main reasons for the flight delay include five parts: own reason, rate of follow, the weather, military activities and the security of airport.

Through Delphi method[3], we work out the weight matrix:

$$\begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 1/2 & 1 & 2 & 3 & 4 \\ 1/3 & 1/2 & 1 & 3 & 4 \\ 1/4 & 1/3 & 1/3 & 1 & 2 \\ 1/5 & 1/4 & 1/4 & 1/2 & 1 \end{bmatrix}$$

Base on this weight matrix, we work out: RI=1.12, CR=0.0307. So we get the table of weight as following:

reason	percent
own reason	0.4126
rate of follow	0.2581
the weather	0.1838
military activities	0.0882
security of airport	0.0573

These data only reflect the frequency of each reason, we can't know when one reason happen, how long may the delay lasting. So we built some models[4] relatively and use data of some airports to predict what degree may the reason cause. The result is shown below:

Table 2 the degree of each reason

reason	time(min)
own reason	0 – ∞
rate of follow	55
the weather	60
military activities	190
security of airport	130

In summary, the frequency of occurrence of the own reason is the biggest and the degree of it's influence belongs to large span; the frequency of occurrence of the rate of follow is big and the degree of it's influence is small; the frequency of occurrence of the weather is big and the degree of it's influence is small; the frequency of occurrence of the military activities is small and the degree of it's influence is big; the frequency of occurrence of the security of airport is small and the degree of it's influence is big.

### Secondary Fuzzy Evaluation Model

**Set up the system of evaluation.** When the delay occur, how to manage the problem to make the loss to the lowest is the vital thing. If we can predict the risk of the airport, it's true that the loss can be limited well. For we can take some efficient measures to deal with the matter when the risk is high. So the Secondary Fuzzy Evaluation Model is made to predict the risk of a airport. The aim is to help the airport working normally and predict some problems that may happen through the current data. It can monitor the situation of the airport and improve the plan to decrease the possible of delay. After we invested large data companies, supporting the indexes of prediction and adopting the evaluation system to build the model. Lastly, providing some measures to improve the situation. We have know that the main reasons for the flight delay include own reason, rate of follow, the weather, military activities and the security of airport.

So we set the collection of factors:

- $$u = \{u_1, u_2, u_3, u_4, u_5\}$$
- $u_1$  stands for own reason;
  - $u_2$  stands for rate of follow;
  - $u_3$  stands for the weather;
  - $u_4$  stands for military activities;
  - $u_5$  stands for the security of airport.

The collection of risk's degree:

- $$v = \{v_1, v_2, v_3, v_4\}$$
- $v_1$  stands for no risk;
  - $v_2$  stands for low risk;
  - $v_3$  stands for medium risk;
  - $v_4$  stands for high risk.

From the above we can work out the weight of each factor:

$$A = [0.41 \quad 0.26 \quad 0.18 \quad 0.09 \quad 0.06]$$

We work out the fuzzy matrix by analyzing varieties of data among the airports. Using the formula:

$$B_k = A_k \circ R_k = \vee(a_{ij} \wedge r_{ij}) = (b_{11}, b_{12}, \dots, b_{1n}) \quad (1)$$

And work out the evaluation matrix:

$$B = A \circ R = A \circ [B_1, B_2, B_3, B_4, B_5]^T = (b_1, b_2, b_3, b_4, b_5) \quad (2)$$

**Result to deal with.** We can acquire the result basing on the maximum membership principle[5]. Firstly, a variety of information about the airport is needed. Then, put the experiment data into

formula to work out the evaluation matrix. Eventually, work out the risk of the airport basing on the maximum membership principle.

Some works have been done to verify the accuracy of the evaluation system[6]. Although this model simplify some factors and quantitative some parameters ideally. But the result of test shows that this model do provide many advantage. A problem is still remaining that a part of data is hard to monitor. So some efficient work are need to do to deal with this problem.

## Summary

Stated thus, China is one of the country that has the most serious problem of flight delay and flight delay caused serious losses hundreds of millions of time. More research is needed to deal with the problem relatively. The vital index to measure the situation of a airport is punctuality. So it's the starting point of the research. From the basis we have referrer to, We made some effort to find the main reasons for the delay and quantitative them reasonable. Then we district the weight among these factor as the weight matrix. Finally, we create the evaluation system to help the airport to monitor the various index so that they can adjust duly when the risk is high.

The advantage of the model lie in the accuracy and convenience. We can predict the risk of the airport exactly and the loss can be limited well for we can take some efficient measures to deal with the matter when the risk is high. And we can adopt these system anytime as long as we can measure the parameters all the time.

The disadvantage we also have mention above. It's hard and complex to quantitative all factors reasonable. And the biggest question is that a part of airport's data is hard to monitor and we hope we can find some efficient methods in the future.

It is obvious that our work can be more in-depth and our model can be improved more practical. And the problem of the flight delay in China is still remanding long time to solve. We hope it works or it can provide a new ideal to deal with this problem.

## References

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