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A Study on the Influence of Boarding Methods on Airplane Boarding Time

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Abstract: Different boarding methods will have a certain impact on the boarding time, and then which may cause flight delays. In this paper, we first analyses and compares the different kinds of boarding mode both home and abroad. Then we have carried on the experimental research of boarding methods with random boarding, tail first and nose last, color boarding pass, far from the corridor first board. Through the experimental research, it was found that disorderly boarding is the best way. Through the actual investigation study, we analyse the influence of different crowd on the boarding time in current Chinese boarding condition, and find that the boarding time of the flight with more young people and less old and children is most rapidly under normal circumstances. This paper has a certain reference value for airlines to reduce boarding time and improve the service quality.
Keywords: Boarding time, Boarding methods, Airlines, Flight delay

INTRODUCTION

All along, flight delay is a worldwide difficult problem. For airlines, flight delays not only bring huge economic losses, but also seriously affect the airline's reputation and competitiveness. In addition, for the long-term development of the aviation transportation, flight delays will make civil aviation lose the advantage of convenient and efficient. The airlines have to pay for the facilities and services that the aircraft using at airport. The airport may also cause a series of losses for the aircraft's long time stop. According to statistics, at the airport, the plane dock every minute need to pay $30 [1]. So how to shorten the stop time of the plane has become a urgent research topic. Check-in procrastination can lead to the extension of boarding time, although it is not the main reason for flight delays, but there is no doubt that the shorter boarding time can save must cost for airlines.

AN INTRODUCTION TO THE CURRENT AIRPLANE BOARDING METHODS

Dr. Jason H. Steffen is an astrophysics in U.S. fermilab, who carried out the experimental test of airplane boarding methods in 2009 [2]. His boarding method was compared with the current way and found that his way was faster. Dr. Jason H. Steffen method is very organized, the passengers whose seat near the window on one side boarding first from the back-end and sit down across a seat, that is filling the row of 1, 3, 5, and so on. Then, passengers on other side boarding from the nose, and arrange as the same. Then the middle seat, still sits alternately. Again next are in the middle seat on the other side and the seat near the aisle. Finally, the passengers on even-numbered row seat boarding in turn by the same method. Alternate seating makes each passenger has enough activity space, and considering the position of each seat, avoid the trouble of constantly that the passengers on the aisle seat stand up for other passengers.

There is similar research in the domestic. In 2011, Dr. Tie-Qiao Tang studied the airplane boarding efficiency and combined Hai-Jun Huang *et al*. proposed a new aircraft boarding model with consideration of passengers' individual properties. Its basic principle is based on passenger information, the passengers who near the window or action quickly priority boarding to avoid the "seat conflict". The study found that the main factors influencing the efficiency of boarding are slow block and seat conflict, if the passengers on one side of the aisle first boarding, he needs to make way for the passengers near the window, this will cause congestion aisle. If a slow person blocking the aisle, the whole boarding efficiency will decrease. In Dr. Tie-Qiao Tang opinion, airlines should arrange the passengers by their characteristics, passengers walking fast and with light and small hand luggage should priority boarding. In the future, the computer system can determine the best seat number and boarding order according to the characteristics of the passenger, health, seat preference and the size and number of hand luggage. Dr. Tie-Qiao Tang established mathematical formula for boarding process the first time, invented the third method to arrange the boarding order according to the passengers individual characteristics. Calculation results show that, compared with the current widely used boarding method, the new method can speed up the boarding process, reduce the beyond, congestion and conflict phenomenon in the process of marching.

The comparison of current boarding methods between domestic and foreign is shown in table 1.

Table1: Comparison of current boarding methods between China and foreign

Airlines	Current boarding methods
The United States	Improvement of random boarding method
The British	Self-service check-in
Japan	Using NFC terminal "JAL touch&go" Boarding services
China international airlines	Web check-in and send electronic boarding pass by SMS
China southern airlines	Using QR code boarding pass and boarding by class
China eastern airlines	Self-service check-in in "The fingertips of china eastern airlines"

In America, frequent travelers and business class passengers priority boarding and separated according to the seat number in cabin, facilitate the passengers to find their own seat quickly, which belong to the improvement of random boarding. The fifth terminal of Britain's Heathrow using self-service check-in. In Japan, most airlines using NFC terminal "JAL Touch & Go" boarding services. The airplane boarding methods in China are also very diverse, take the China Eastern airlines for example, passengers only need to add "China Eastern airlines" public account of the WeChat, the check-in process can be easily dealt with. Through WeChat, mobile phones, China Eastern's official website or airport self-service equipment, passengers can complete boarding formalities one day in advance, including choose their favorite seat and favorite meals, which greatly improve the efficiency of passengers boarding, effectively improve the utilization rate of the airplane and saving the cost of airlines. Both the web check-in of China international airlines and using QR code boarding pass in China southern airlines are to facilitate the passengers boarding and shorten the boarding time. In conclusion, through the introduction and comparison of the boarding methods, the airlines using many methods to shorten the passengers boarding time, improve the utilization rate of the airplane, thus saving the cost of airlines.

EXPERIMENTAL STUDY ON AIRPLANE BOARDING METHODS

Random Boarding

Random refers to the state of chaos without rules. Random boarding refers to the boarding method without any rules [4]. Passengers boarding the airplane in order of arrival, first come first boarding, then last boarding, the queuing is more casual, and there is no seat number restrictions. This boarding method is widely used in airlines at present [5], which as shown in figure 1.

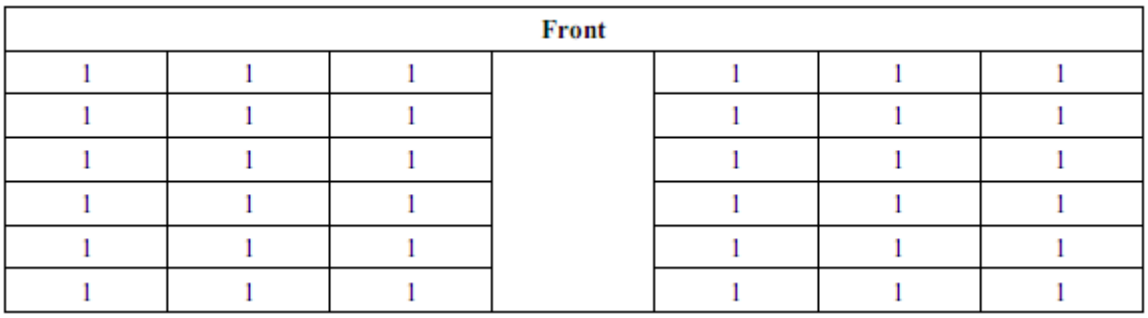

Fig-1: Boarding order of random boarding

Tail First and Nose Last

"Tail first and nose last" means the passengers in the back of the cabin boarding first, after that the passengers in front of the cabin. This method can empty the corridor and prevent the aisles crowded [6]. For small and medium-sized passenger aircraft, in order to reduce to the passengers make way for subsequent arrival passengers, priority boarding are the passengers near the window, after that the passengers in the middle seat, then the passengers near the aisle. As shown in figure 2, six seats in each row is the common aircraft economy layout, the top of the figure refers to the nose of the airplane, the bottom of the figure is the tail, boarding gate at the side of the nose, the order of boarding is 1.2.3…respectively.

Front						
13	14	15		15	14	13
10	11	12		12	11	10
7	8	9		9	8	7
4	5	6		6	5	4
1	2	3		3	2	1

Fig-2: Boarding order of tail first and nose last

Color Boarding Pass

Passengers were divided into three groups according to their seats location. Then their boarding pass was marked such as red, yellow and green. The passengers holding red boarding pass are in the back of the cabin, they will boarding first, then the passengers holding green boarding pass will sit in front of the cabin, at last the passengers holding yellow boarding pass will be arranged in the middle of the cabin. As shown in figure 3, 1 represents red, 2 represents yellow and 3 represents green.

Front						
3	3	3		3	3	3
3	3	3		3	3	3
2	2	2		2	2	2
2	2	2		2	2	2
1	1	1		1	1	1
1	1	1		1	1	1

Fig-3: Boarding order of color boarding pass

Passengers Far From Aisle Boarding First

The position far from the aisle on the airplane is the seat of near the window, in order to reduce to the passengers make way for subsequent arrival passengers, the passengers near the window will priority boarding, after that the passengers in middle seat followed, then the passengers near the aisle. As shown in figure 4.

Front						
1	2	3		3	2	1
1	2	3		3	2	1
1	2	3		3	2	1
1	2	3		3	2	1
1	2	3		3	2	1
1	2	3		3	2	1

Fig-4: Boarding order of passengers far from aisle boarding first

Parity - Window or Aisle - Front or Behind Method

This is Dr. Jason H. Steffen's method, the passengers who near window priority boarding, then the middle passengers and passengers near the aisle [2]. Then from the last row, in accordance with whether the passenger seat is odd or even, passengers with odd seats are given priority boarding. At last, according to the passenger seat is in front of the cabin or behind, the passengers with seats in back priority boarding. As shown in figure 5.

Front						
12	24	36		33	21	9
6	18	30		27	15	3
11	23	35		32	20	8
5	17	29		26	14	2
10	22	34		31	19	7
4	16	28		25	13	1

Fig-5: Boarding order of parity - window or aisle - front or behind method

The Selection of Best Method

To find the best solution, Dr. Jason H. Steffen carried out the experimental test of each boarding methods, 72 passengers boarding in accordance with the real boarding environment. Cabin seats are Six columns but narrowed to twelve rows. Each boarding method was tested one by one, and the time spent from the beginning of boarding to the last passenger sitting on the seat was recorded. The result is as follows, in table 2.

Table 2: Time required for each method

Method	Steffen method	Passengers far from aisle boarding first	Random boarding	Tail first and nose last	Color boarding pass
Time	3′36″	4′13″	4′44″	6′11″	6′54″
Ranking	1	2	3	4	5

We can see that the time of tail first and nose last method for boarding is longer than random boarding. Storing luggage is the main reason of "tail first and nose last" method needing more time. It is common that two passengers boarding in the same row store their luggage at the same time, this process requires a lot of time, and the aisles are also easily blocked by the passengers, the same row and the rear passengers will be blocked in the aisle, and was affect the speed into their seats. Dr. Jason H. Steffen's method need the shortest time, and is the most effective plan. This is because when two passengers get into the aircraft immediately before and after, because the principle of parity, the two are always separated by a row, stowage of luggage will cross staggered, this will not cause aisle congestion, boarding time also the shortest. "Parity - window or aisle - front or behind method" makes the boarding time greatly reduced, but not much used. Because of its obvious shortcomings, the boarding pass has every passenger's number, this method needs the passengers must be in accordance with the number of boarding. But in fact, It is very difficult to let each passenger waiting consciously for boarding in a row to follow this rule. Everyone wants to board the airplane early. Not everyone will follow the rules consciously. When the rules are not observed, boarding time will be seriously slowed down. Therefore, from a human point of view, the "random boarding" method should be the fastest.

INFLUENCE OF DIFFERENT GROUPS OF PEOPLE ON THE BOARDING TIME IN CHINA'S CURRENT BOARDING STATUS

In this paper, we carry on the experimental research on the influence of different groups of people on the boarding time in China's current boarding status. Between January 1, 2016 to May 10, 2016, a total of 18 sorties were carried out from Qingdao to Urumqi, with an average passenger capacity of 125 in economy class, of which 13 persons were under 12 years old, 83 persons were between 12 to 60 years old, 29 persons over 60 years old, as shown in table 3.

Table 3: The statistics of all ages with an average passenger capacity in economy class of Qingdao to Urumqi flight

Age	Under 12	12 to 60	Above 60
Number	13	83	29

During the flight mission, the difference of boarding time between passengers of different ages was calculated from the time of boarding the passengers until the last passenger was seated, as shown in table 4. As a result of the study, each time a passenger boarding order was obtained from the crew chief to get the information of age and sex of the passengers, and the impact of different groups on boarding time was distinguished by age and sex.

Table 4 the sorties and boarding time of all age groups in Qingdao to Urumqi flights.

Table 4: The sorties and average boarding time of all age groups in Qingdao to Urumqi flights

Groups	Sorties	Boarding time
More adults, fewer children and older	10	10′24″
More children, fewer adults and older	3	12′20″
More older, fewer children and adults	5	11′32″

We can get the following results.

Flights of More Adults, Fewer Children and Older

In such flights, the general boarding time is relatively fast, because adults are relatively quick and easy to accept new things, even their first boarding. The average boarding time is 10 minutes and 24 seconds. For example, a group of adult boarding tours, the speed exceptionally fast. The airplane ride nearly one-third of adults, perhaps because of college students and they are more quality under the leadership of their teachers, they boarding orderly, the process is not too much congestion to making this boarding very smooth, the boarding time is only 9 minutes and 45 seconds. But sometimes there are exceptions, this is a passenger random boarding with mostly young couples, the boarding speed is significantly slowed down. If a girl with her boyfriend together, the girl will always show a weak side, so that her boyfriend performance of the strong point and give more performance opportunities to him. The boys are also trying to take care of girls. In the release of luggage, the boy always put both their own and the girl's luggage and also to help the girl take off her jacket, etc., excessive concern led to the slow boarding, the boarding time is 11 minutes and 26 seconds.

Flights of More Children, Fewer Adults and Older

The boarding time of such flights is usually relatively slow, because the children are naughty, frolic and they have enough curiosity for new things. Some infants cannot control their own behavior, and sometimes physiological incontinence, their parents need to help them go to the bathroom. Serious traffic congestion will be caused by their behavior and will cause the boarding time delay. The average boarding time for flights of more children with fewer adults and older is 12 minutes and 20 seconds. For example, in a flight, a class that all composed of primary school students. Their teachers are young and lack of experience, so the organizational capacity is not enough, even not enough management. Children's slapstick caused aisle congestion and lead to the disordered environment of the airplane. As a result, the boarding speed is very slow, and finally even as long as 13 minutes and 20 seconds.

Flights of More Older, Fewer Children and Adults

Under normal circumstances, boarding time of such flight is relatively slow. Because the elderly are slow and most of them needed care. However, some older self-esteem is relatively strong and unwilling to be taken care, his slow action caused the crowd slow, then delayed boarding time. The average boarding time is 11 minutes and 32 seconds. However, there are special cases, such as a tour group composed of the elderly, they orderly and without trouble to others as far as possible. They comply with the order and boarding in order. Everyone can handle their own things properly, and their baggage is relatively small, the process of putting luggage is also more rapid. As a result, the boarding took only 10 minutes and 25 seconds.

Brief Summary

Therefore, we can get the following conclusions. We usually think that the flights with more older and children will take longer boarding time, but this is not correct. Boarding time is not entirely dependent on the number of elderly and children. When there are many older people, if they are more orderly and follow the rules, the boarding time will accelerate, the same applies to children. Young people usually boarding fast, but when there are many young couples, the boarding time will slow down. Nevertheless, under normal circumstances, boarding time of the flights with more young people, fewer older and children is short.

CONCLUSION

In order to board passengers as soon as possible, the airlines take a variety of boarding methods. Among them, the methods of random boarding and tail first and nose last are very popular, and at the same time, a variety of electronic check-in program is implemented in the major airlines. According to the experimental study, Dr Jason H. Steffen's method is the fastest, but due to the complexity of the airlines and boarding passengers, and passengers may not in accordance with the requirements of boarding, so there is no practical application value of this method and few airlines adopt. At present, most airlines adopt disorder boarding. According to the actual investigation, when adopt random boarding, the boarding time has no direct relationship with the age, more older do not mean more time, which is related to the composition of the elderly crowd. But in general, more adults, fewer children and older will take less time.

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