Taxi Driver Decision Model Based on Modified Time Series

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Abstract: This paper mainly analyzes and studies the influencing mechanism of factors related to taxi driver decision-making, comprehensively considers the change law of airport passenger numbers and the benefits of taxi drivers, establishes a taxi driver selection decision model under multiple schemes, and gives the driver Selection strategy. First, use *ARIMA* time series depicts the regularity of the number of passengers in each period of the day under normal circumstances, and takes into account the effect of seasonal deviation rates and holiday deviation rates on passenger traffic, and the revised *ARIMA* time series. Second, according to *FIFO* principle to *logistic* function simulates the relationship between the number of taxis queued and the number of passengers, and then uses the average passenger boarding time and the number of queues to characterize the taxi waiting time model. Finally, according to the self-interest principle A、B time cost, no-load costs, and potential passenger benefits of the plan driver. The time cost of A and the solution B no-load costs consumed by the scheme and the potential passenger revenue lost, ultimately result in the driver's decision.

1. Introduction

The growth of GDP and residents' consumption level has stimulated the rise in demand for air passenger transport. And with the increasing popularity of aircraft travel modes, airports have huge throughput, which has caused the airport's capacity supply capacity to be incompatible with throughput. Taxi is a kind of vehicle with better flexibility. Taxi drivers who deliver passengers to the airport will face two options: a solution is to go to the storage pool and wait for passengers. The main consumption of taxi drivers is in the queue. The time cost incurred during the waiting time.The cost of waiting time depends on the number of passengers and the number of taxis waiting in line.The solution b is to give up waiting and return to the city to pick up passengers directly. The driver of the plan will pay no-load fees and potential loss of passenger revenue.

2. Analysis of Influencing Factors

The taxi driver can observe the number of vehicles in the "storage pool" and the number of flights arriving at a certain period of time, and make decisions based on personal experience judgment. Among them, the personal experience judgment value is affected by seasonality and the number of flights arriving at a certain period of time. It is related to the number of passengers. Passengers who choose to take a taxi line up in the "riding area" in order, and the management staff releases the taxis into the "riding area" in batches, and arranges a certain number of passengers to board. This article uses known flight information to calculate the number of passengers $y(t)$:

$$y(t) = Q_h \times Q_z \times \rho$$

The symbol is defined as: number of flights arriving at the port Q_h Number of flight seats Q_z, Full capacity ρ.

As the passenger flow fluctuates steadily throughout the day, we consider using *ARIMA* the model predicts passenger flow, $U(t)$ the following autoregressive model pairs can be established y_t Make predictions:

$$y(t) = C + c_1 y_{t-1} + c_2 y_{t-2} + \varepsilon_t$$

Among them, c_1, c_2 Is the parameter to be determined, ε_t Is a random perturbation term.

The number of passengers at the airport not only changes with the time of day, but also needs to consider the effects of seasonality and holidays. Therefore, we have revised the above passenger flow model from both the seasonal and holiday aspects.

(1) Seasonal deviation rate ω_i

Air passenger flow is divided into high season and low season, summer and early spring are high season, and there will be more passenger traffic. In addition, August each year is the month with the highest passenger traffic in the year. Therefore, we define the following seasonal deviation rate:

$$\omega_i = \frac{y_i - \overline{y}}{y_i}$$

Among them, $\overline{y} = \sum y_i / 12$ Means the average passenger flow in months, y_i Represents the monthly passenger flow of a flight.

(2) Holiday deviation rate σ_i

During the holidays, when the strength of the willingness to travel and visit relatives increases, the contribution of holidays to the growth of passenger traffic cannot be ignored. Moreover, the contribution of holidays to passenger traffic is significantly greater than the contribution of seasonality to passenger traffic. Therefore, we define the following holidays Deviation rate:

$$\sigma_i = x_i \frac{e^{\lambda_i}}{2}, \quad \lambda_i = \frac{y_i' - \overline{y}'}{y_i'}$$

Among them, $\overline{y}' = \sum y_t / 3$ Indicates the average passenger flow during non-holiday periods, y_t Represents the daily passenger flow in general. In summary, based on the actual situation, the airport throughput model is:

$$y(t) = \left(1 + \omega_i + x_i \frac{e^{\lambda_i}}{2}\right)\left(C + c_1 y_{t-1} + c_2 y_{t-2} + \varepsilon_t\right)$$

When the passengers arrive at the airport, the main means of transportation to the city center are taxis and buses. During the bus operation period (the middle part of the timeline), passengers can choose to take a bus in order to save the cost of the bus; buses during the outage period (both ends of the timeline), passengers have to choose a taxi due to safety considerations. Therefore, we take the U Type curve to simulate the change in the ratio of passengers' choice of taxis over time:

$$U(t) = \frac{1}{2}\left(\cos\frac{\pi}{12}t + 1\right)$$

At this point, the number of passengers choosing a taxi is:

$$y_t = U(t) \times Q_h \times Q_z \times \rho$$

After analyzing the number of taxis that arrive at the airport and choose to queue in various time periods: it is found that when the passenger base of the airport is small but the marginal growth rate is large, the number of taxis in the queue also rises from a smaller value in a faster trend; the airport passenger traffic is on average When in the neighborhood, the number of queuing taxis rapidly increases; the passenger flow at the airport continues to increase, to a certain extent, the number of queuing taxis will tend to a stable value, due to the capacity limitation of the storage pool and the fear of taxi drivers, so even No matter how many passengers are waiting to take a taxi at the airport, the number of taxis to choose from is also a constant.

We take this change *logistic* Model to simulate: definition Q_c for a variable that reflects the number of taxis waiting in line $y(t)$ the corresponding number of queuing taxis is $Q_c(y(t))$ the maximum value that can be reached by queuing taxis is $Q_{c-\max}$ the area growth rate is $r\left(1-Q_c(y(t))/Q_{c-\max}\right)$ the minimum threshold for the number of queuing taxis $Q_c(y(t_0))=Q_0$. It can be established that the number of queuing taxis increases with the number of passengers choosing taxis. *logistic* model:

$$\begin{cases} \dfrac{dQ_c}{dy(t)} = r\left(1-\dfrac{Q_c}{Q_{c-\max}}\right)Q_c \\ Q_c(y(t_0)) = Q_0 \end{cases}$$

Solving this differential equation gives:

$$Q_c(y(t)) = \frac{Q_{c-\max}}{1+\left(\dfrac{Q_{c-\max}}{Q_0}-1\right)e^{-r(y(t)-y(t_0))}}$$

3. Driver Decision Model

Drivers prefer choice based on self-interest A, B The solution with the smallest loss or the largest gain in the medium. A Time cost of solution calculation and B the no-load cost calculated by the scheme is compared with the potential passenger income, and the driver's choice decision result is predicted.

3.1 Quantitative characterization A Cost of time in scenarios

Assuming driver chooses A Plan, go to the storage pool and wait in line, according to *FIFO* in principle, the time to enter and carry passengers. The time cost is defined as the net income obtained by the driver to use the waiting time to return to the urban area.

The waiting time in line is less than the driving time from the flight to the city center, but the driver does not arrive in the city center after waiting time, so only the two cases of receiving passengers on the way and not receiving passengers are considered; in contrast, the driver driving to the city center The waiting time is not exhausted, so the driver can use the remaining waiting time to carry passengers in the city center in addition to the above two cases.

Based on the above analysis, it is established as follows A Solution time cost segmentation model:

$$C_A = \begin{cases} \left| P_1\left(\dfrac{r}{2}-c\right)Tv + P_2(-c)Tv \right| , & Tv \le d_{ij} \\ \left| P_1\left(\dfrac{r}{2}-c\right)d_{ij} + P_2(-c)d_{ij} + P_3(r-c)(Tv-d_{ij}) \right| , & Tv > d_{ij} \end{cases}$$

Among them, P_1 Indicates the probability of getting a guest on a taxi, P_2 Indicates the probability that the taxi will not be loaded with guests during the entire journey, and $P_1+P_2=1$ the probability of passenger success is determined in accordance with the key minority rule, which is defined as: In any group of things, the most important is only a small part of it, about 20%, the rest of the 80% Although it is the majority, it is indeed secondary, which is also called the law of 28. A the key to program satisfaction is: the size of the net income value obtained by giving up the successful passenger, that is, A the time cost of the plan. Based on this, it is considered that the passenger success event has a significant impact. P_1=0.2, P_2=0.8.

3.2 Quantitative characterization *B* No-load costs and potential passenger benefits in the plan

Assuming that the taxi driver chooses to wait in the airport storage pool, he will definitely be able to receive passengers. No-load expenses are defined as the fuel and depreciation costs that the driver consumes to go to the city center. The potential passenger income is defined as the driver giving up the airport waiting for passengers to lose net income.

The waiting time of the storage pool is greater than or equal to the driving time of the driver from the airport to the city center. After waiting time, the taxis of different choices have different conditions in the same situation. A The driver of the plan continues to wait in the storage pool and chooses B the guests of the plan have already arrived in the city center and successfully carried the passengers; in contrast, after waiting time, A the driver of the plan has received the guest, choose B the driver of the scheme continued to drive without load.

Based on the above analysis, it is established as follows B planned no-load cost and potential passenger income segmentation model:

$$C_B = \begin{cases} cd_{ij} \quad , \quad T \geq \dfrac{d_{ij}}{v} \\ r\left(d_{ij} - Tv\right) + cd_{ij} \quad , \quad T < \dfrac{d_{ij}}{v} \end{cases}$$

Because drivers only pursue maximizing their own interests or minimizing loss costs, that is, driver choice A, B The most self-interesting solution in China. Based on A Solution time cost and B considering the no-load cost of the scheme and the potential passenger income, a taxi driver decision model is established as follows:

$$X_i = \begin{cases} A \quad , \quad C_A/C_B \leq 1 \\ B \quad , \quad C_A/C_B > 1 \end{cases}$$

If $C_A/C_B \leq 1$, which is A the time cost of the solution is less than or equal to B The no-load cost and potential passenger income of the plan, the driver chooses A Plan. If $C_A/C_B > 1$, which is A the time cost of the solution is greater than B the no-load cost and potential passenger income of the plan, the driver chooses B Program.

4. Conclusion

In this paper, a relevant model is established for the decision problem of airport taxis. Using the retarded growth model, the time cost and B the no-load costs and potential passenger-carrying benefits in the scheme are quantitatively characterized, and the time cost to be paid by the driver is discussed based on the waiting time and the driving time from the airport to the city center to establish the final taxi driver decision model. In addition, this article provides Time series predictions with seasonal and special dates also have strong practical significance for the prediction of cyclical errors.

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