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Study on the Model of Hotel Rooms Overbooking

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Abstract: With an increasing of hotel rooms spoiling caused by a variety of reasons, implementation of hotel rooms overbooking has become an inevitable option, the overbooking would also lead to many conflicts. This paper established the expected revenue model of overbooking by the distribution of customer arrival rate, got the optimal quantity of overbooking, found an equilibrium point that can not only make full use of rooms and reduce the loss of room rental which makes the expected revenue the biggest. This study simplified the model according to the actual situation of the hotel, carried on the case analysis at last. The method is convenient and feasible and has some reference significance for the implementation and management of the hotel overbooking.

Key words: Revenue management, arrival rate, overbooking

INTRODUCTION

Overbooking refers to the customer to accept the reservation number exceeds the maximum allowable hotel rooms. If the customer actually needs is more than the maximum allowable number of hotel accommodation, would bring the overbooking. Overbooking technology has been proved at home and abroad that can bring good economic benefits, but in recent years, the hotel in the process of using overbooking technology faced some confusion, such as hotels in the implementation of overbooking often faced a dilemma, on the one hand, the product has timeliness, if the spoiling hotel rooms can't be sold in the day, its value will lost forever, so the overbooking benefit is obvious to the hotel; on the other hand, the phenomenon intensified that overbooking lead to some customers with orders but cannot live because of the hotel is fully booked, this phenomenon will make the hotel's reputation suffered damage and cause legal disputes, it is also the reason why many hotels reluctant to implement overbooking. However, with the rapid development of tourism electronic commerce, network volume of hotel guest room booking has increased dramatically, as well as the uncertainty of online booking, they all have brought the increase of spoiling of hotel t rooms. In addition, with the increasing number of major events, such as the Olympic Games, the World EXPO and the Asian Games, the hotel will early booking the rooms in a long period of time, the extension of scheduled periods will inevitably leads to the customer not occupancy rate increase. Spoiling of the hotel rooms, therefore, is not only inevitable but also appear the trend of increase, reduce the room waste, increase the hotel revenue, provide rooms to those customers who have real demand, implement rooms overbooking become an inevitable choice for the hotels.

RELATED THEORIES RESEARCH OF HOTEL ROOM OVERBOOKING

In the research of revenue management techniques, overbooking problem has the longest history and the most thorough, since the heat is not decreased.

In the hotel industry, Beckmann (1958) original modeling with the distribution of passenger number, put forward an approximate optimal overbooking condition, the goal is to minimize the seat spoiling cost and overbooking cost. In the 1970s, the study of overbooking extended to the hotel industry. Rothstein (1974) did some earlier work to find the similarities of hotel reservation management and hotel reservation management problems, put forward the markov chain decision model through their comparison. Ladany (1976) put forward a dynamic decision model to the hotels that have single room and double room. Liberman and Yechiali (1978) put forward another dynamic decision-making model; this model can cancel the previous booking or add special price reservation. Schwartz and Hiemstra (1997) used the curve fitting method for the hotel room's reservation, through fitting the hotel booking curve in the past to improve the precision of the hotel reservation. Koide and Ishii (2005) proposed a discount pricing model to cancel the

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reservation and overbooking. In general, foreign research about hotel rooms overbooking is through the establishment of various models; improve the utility of guest room stock to increase the hotel revenue.

Domestic, Wu and Liang (1995) earlier analyzed the best order overbooking quantity of hotel rooms and given a simple example. Yu (1996) using the central limit theorem of inference, put forward a mathematical model of overbooking hotel room control to improve the hotel's occupancy. Li and Wang (2006) established the profit model of overbooking hotel cycle of a day and by using the binomial distribution to solve the model. In addition, the domestic has appeared a few Thurber paper involved in hotel overbooking, the research contents include hotel revenue optimization (Koide and Ishii, 2005), Hotel room allocation (Li, 2006) and hotel room overbooking. Overall, the study of the relevant domestic hotel overbooking started relatively late, the production is less, most are the introduce of research results and simple application abroad, the research content is more fragmented, but more and more researchers had joined in this area.

Hotel rooms overbooking are evolved from airlines overbooking; there are both connection and difference between them. But to some extent, hotel rooms overbooking is more complex than airlines overbooking, mainly reflected in the hotel rooms overbooking customers more variety than airlines overbooking; the basic material of hotel rooms overbooking is more complex than airlines overbooking.

Data statistics show that in our country the proportion of No. Show is estimated to be 5~15%, to compensate for the loss of revenue caused by availability; some domestic hotel companies had taken overbooking model of sales. In practice, most hotel companies still rely on the experience of the staff to determine the number of overbooking; this will cause a lot of uncertainty. In this study, on the basis of previous studies, according to the arrival rate of customer to construct the overbooking model and simplified the model according to the actual need.

MODEL BUILDING

The more the number of guest rooms overbooking, the smaller the possibility of rooms available, but has been refused, the greater the likelihood of check-in to compensate for the losses caused by the increase. The smaller number of overbooking, the possibility of being rejected at the smaller, but the greater the likelihood of a vacancy, thereby causing loss to the vacancy, the relationship between them as showed in Fig. 1.

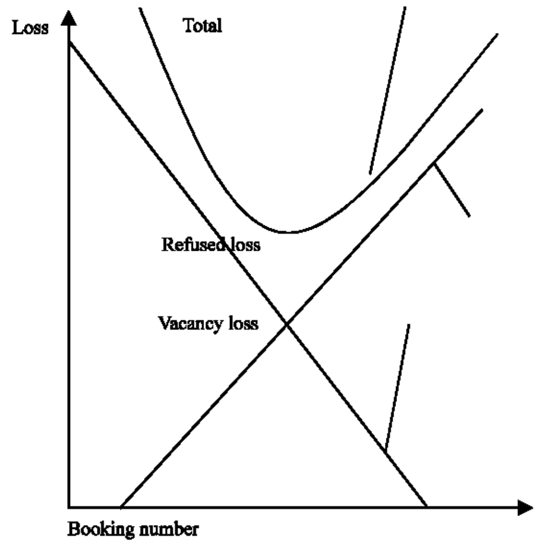

Fig. 1: Total loss, refused to stay in loss and vacancy loss diagram

Symbolic Description:

- **m:** Hotel every night 12 o 'clock to store the number of check-in, the decision variables
- **c:** Hotel real number of rooms, constant
- **p:** Room price, it is assumed that there is only one chamber, constant
- **b:** Loss to the hotel company of refusing a passenger check-in, constant
- **r:** Customer arrival rate, r = shows/m, shows on behalf of the hotel every night 12 o 'clock to store the number of check-in, random variables
- **f(r):** Customer arrival rate r of the probability density function
- **k:** Total operating costs of the hotel, constant
- **π:** Hotel's total income every day

Establishment of model

Revenue:

$$p = \min(mr, c) - b\max(mr, c) + bc - k$$

Expected revenue:

$$E\pi = p\left[m\int_0^{\frac{c}{m}} rf(r)\,dr + c\int_{\frac{c}{m}}^1 f(r)\,dr\right] - b\left[c\int_0^{\frac{c}{m}} f(r)\,dr + m\int_{\frac{c}{m}}^1 rf(r)\,dr\right] + bc - k$$

Model solution:

$$\frac{\partial E\pi}{\partial m} = p\left[\int_0^{\frac{c}{m}} rf(r)dr + m\left(-\frac{c}{m}f\left(\frac{c}{m}\right)\frac{c}{m^2}\right) + c\left(f\left(\frac{c}{m}\right)\frac{c}{m^2}\right)\right]$$

$$-b\left[c\left(-f(\tfrac{c}{m})\tfrac{c}{m^2}\right)+\int_{\frac{c}{m}}^{1} rf(r)dr + m\left(\tfrac{c}{m}f\left(\tfrac{c}{m}\right)\tfrac{c}{m^2}\right)\right]$$

Let:

$$\frac{\partial E\pi}{\partial m}=0$$

then:

$$p\int_0^{\frac{c}{m}} rf(r)dr = b\int_{\frac{c}{m}}^{1} rf(r)dr \tag{1}$$

Let:

$$\tfrac{c}{m}=x\in[0,1]$$

then 1 into:

$$p\int_0^{x} rf(r)dr = b\int_{x}^{1} rf(r)dr \tag{2}$$

In fact, for the solution of the equation is actually a point: x = c/m,such that $pR_1 = bR_2$, R1 and R2 represent the black vertical lines area covered under the left and right sides of the curve, as showed in Fig. 2. If P increases, to maintain the equality $pR_1 = bR_2$ holds, then R1 will become smaller, that is to say x to the left, X smaller mean m becomes larger, so the conclusion is that the room prices increase, the predetermined number is also increased. If B increases, to maintain the equality $pR_1 = bR_2$ holds, then R2 will become smaller, that is to say x to the right, X means that M is smaller, so the conclusion is that the compensation costs increase, the predetermined number is reduced.

Suppose that rf (r) in the original function f (x), there are (2) type available:

$$p[F(x)-F(0)] = b[F(1)-F(x)]$$

$$F(x)=\frac{pF(0)+bF(1)}{p+b},\ \frac{c}{m}=x=F^{-}\left(\frac{pF(0)+bF(1)}{p+b}\right)$$

$$m=\frac{c}{\sqrt{\dfrac{pr_1^2+br_2^2}{p+b}}}$$

The result is the same with the result of Heng Hongjun's paper "restaurant seat ultra quantity for sure". The arrival rate and the customer arrival rate in this paper is the same, in his article, consideration is the increasing number of M booking a impact on earnings but this is the direct use of the customer arrival rate to calculate the revenue, simple and clear, easy to understand (Li, 2007).

Model simplification: In real life, due to various reasons, the hotel customer arrival rate of R probability distribution function f(R) is very difficult to accurately estimate, Therefore, in order to make the model can play a better role in the actual hotel overbooking management, this paper use the customer arrival rate expectations Er instead of r, Er can be obtained by the large amount of historical data statistics, the error due to general point estimation can not indicate the estimation, so the Er here in the interval estimation, set a certain degree of confidence, confidence interval $[r_1, r_2]$, assuming Er in $[r_1, r_2]$ follows a uniform distribution, that is to say, if R in $[r_1, r_2]$ follows a uniform distribution, there are:

$$F(r)=\frac{1}{r^2-r^1}$$

$$p\int_{r_1}^{\frac{c}{m}} r\tfrac{1}{r_2-r_1}dr = b\int_{\frac{c}{m}}^{r_2} r\tfrac{1}{r_2-r_1}dr$$

Simplified:

$$p\int_{r_1}^{\frac{c}{m}} rdr = b\int_{\frac{c}{m}}^{r_2} rdr$$

If:

$$h(p,b)=\frac{pr_1^{\ 2}+br_2^{\ 2}}{p+b}\ ,$$

$$h_p'(p,b)=\frac{r_1(p+b)-r_1p-r_2b}{(p+b)^2}=\tfrac{(r_1-r_2)b}{(p+b)^2}\langle 0$$

If:

$$h_b'(p,b)=\frac{r_2(p+b)-r_2b-r_1p}{(p+b)^2}=\tfrac{(r_2-r_1)p}{(p+b)^2}\rangle 0$$

Visible, h (p, 6) is a decreasing function of p, is an increasing function of b, then m is the increasing function of p is a decreasing function of b. This is consistent with the actual operation of the hotel company, the room price is higher, the more the better rooms overbooking, compensation costs are higher, then overbooking rooms that less is better.

CASE ANALYSES

This study takes a hotel as an example, room number c = 157, room price p = 1500, refused to check in compensation costs b = 500. According to the historical data, the arrival rate of customers expectations Er interval estimate, setting the reliability =0.05, confidence interval [0.85, 0.9], then:

$$f(r)=\tfrac{1}{r_2-r_1}=\frac{1}{0.9\text{-}0.85}=20$$

According to the Eq. 4 have:

$$m = \frac{c}{\sqrt{\frac{pr_1^2 + br_2^2}{p+b}}} = \frac{157}{\sqrt{\frac{1500 \times 0.85^2 + 500 \times 0.9^2}{1500+500}}} \approx 180$$

Therefore, the best room sales number is 182, number of rooms overbooking is m-c = 25.

The following discussion of two cases:

- Refused registration fee b = 500 invariant, enhance the guest room price p = 2000

$$m = \frac{c}{\sqrt{\frac{pr_1^2 + br_2^2}{p+b}}} = \frac{157}{\sqrt{\frac{2000 \times 0.85^2 + 500 \times 0.9^2}{2000+500}}} \approx 182.5$$

- Room price p = 1500 invariant, improve refused registration fee to b = 800

$$m = \frac{c}{\sqrt{\frac{pr_1^2 + br_2^2}{p+b}}} = \frac{157}{\sqrt{\frac{1500 \times 0.85^2 + 800 \times 0.9^2}{1500+500}}} \approx 181$$

It can be seen from the above analysis that the number of rooms overbooking is not sensitive to the room price, but to refuse registration compensation costs is relatively sensitive, hotel should fully consider the impact of refuse admission to the hotel to bring the cost of compensation in sales policy (Hersh and Brosh, 1980).

CONCLUSION

This study uses the customer arrival distribution given rate room overbooking model, proved theoretically the relationship between rooms overbooking quantity and room price and compensation cost. In order to facilitate the implementation of the hotel company overbooking management, gave a simplified model. Through the case analysis, found that the number of rooms overbooking is not sensitive to room prices and relatively sensitive to refuse to register for the compensation cost.

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