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Model and Application of Promtional Pricing for Hotel Rooms

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Abstract: This essay studies on the problem of pricing of hotel rooms when promoted as slack season. The promotional pricing of hotel rooms is studied taking account of their sales characteristics,discount rates,room occupancy rate, room over the determination and so on. A dynamic pricing model is thus developed to minimize the loss of profit on a restricted condition that the volume of rooms is needed to sell off. For the genetic application and particle swarm, pricing is given with optimal cost. The effect of pricing on loss of profit is analyzed through a simulation. This study aims to provide an important reference for promotional decision-making at the hotel industry.

Key words: Hotel rooms, promotion, discount rate, dynamic pricing, model, application

INTRODUCTION

One of the features of the tourism industry is a strong seasonal. Due to the restriction of the natural climatic factors in a year, some scenic spots close down in the slack season even which bringing impact on the stars hotel operation at these areas directly. Depending on the sales strategy, offering discounts, preferential prices to attract guest consumption, some hotels maintain the normal operation and the survival. The room is a major revenue source of the hotel, but in general to the economic hotel, guest room is its lifeline, it becomes more and more important (Anupindi, 1999).

The key factor which decides the hotel economic benefit will depend on whether it could make a reasonable room price. Generally in different seasons or special period of time, the demand for hotel rooms is usually huge fluctuation. Its characteristic is that its value can not be stored. General hotel must make seasonal promotion prices according to rooms' demand, so to increase sales and minimize the loss of profits on the base of ensuring the funds returned. The key factor of how to sell hotel rooms is to optimize the management of the hotel room and the effectiveness in using sales promotion method.

At present, extension study on the classical inventory models mainly focus on adding new costs or improve existing cost description ways, including inventory problem of products existing substitutable demand, optimal purchase strategy when demand level being related to the current inventory level, the optimal stock policy of centralized inventory demand strategy that time related, systems analysis of Multi-echelon inventory when demand being satisfaction whit Poisson distribution.

Based on analysis the characteristics of hotel rooms and the discount sales, this study aims to establish the model of profit loss discount in the process of implementing price promotion and according to the characteristics of nonlinear optimization models, it uses intelligent methods of optimization to solve the optimization problem and algorithm analysis of different and determine the optimal pricing of hotel rooms when discount sales.

PROBLOM DESCRIPTION

Problems hypothetical: Through the studying on discount sales process of the hotel rooms, it should make sales price the following hypotheses in order to make quantitative study being universal significance (Axsater, 1997):

- The annual interest rate is unchanged in a year and one year is 52 weeks
- The room price is adjusted weekly by hotel, the rest of the time the price is unchanged
- Fixed cost to sell rooms is the same before and after the discount, the hotel no longer orders this room after discount

Representation of symbol: The need for the establishment of mathematical model, it should obtain the following related symbols (Bassok *et al*., 1999):

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- Q_0: The number of rooms the hotel dealing with
- P_0: The rooms price in sale busy season
- L: Sale revenue difference between discounted and undiscounted when the sales amount is Q_0, just called total amount of loss
- x_t: The discount rate of a hotel room at the period of t
- a, b, d: The undetermined coefficient in the model, being constants
- r: The bank interest rate before discount
- h: The cost of reserved one week of hotel room after discounted
- s: As for to sell the treatment room and other rooms lost sales opportunities bringing about by the loss of a room;

Profit analyses of the pricing discount rooms: The discount sale is to decrease the price for sale, the operator must have to solve the of profit loss under the premise of decreasing price (Chen and Zheng, 1998). So, it makes the following analysis of profit discounted process. In the Fig. 1, the line AB represents the demand curve before discounted and the revenue reached the maximum at the point E. According to the economic theory, the point E is in the middle of line AB. When the sales revenue reaching the top, the price is P and the sales amount is Q. It shows at Fig. 1.

After discount, the price decreases to P', so the sale amount increases to Q'. If the hotel room price is P' at the beginning, the sale amount should be Q'. But now the price decreases from P to P', so to attract more potential customers by this promotion means. The customer will not buy rooms at the normal price, P, under the room price promotion; they may want to seize the opportunity to purchase this room (Guan *et al*., 2004).

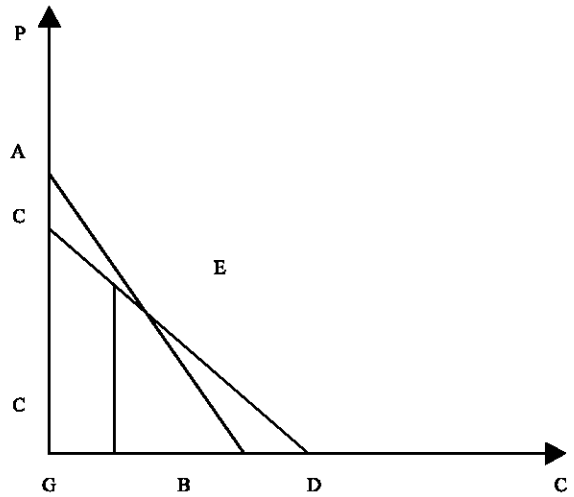

Fig. 1: Schematic of relation between price and sales volume

Supposed the amount of sales is ΔQ, so after discounted, the quantity should be Q'+ΔQ, not Q'. If the price increases, Q<l0; on the contrary, it should be ΔQ>0. it becomes the new demand line,it is line CD at Fig. 1.

From Fig. 1, to the new demand line, when realizing the sale amount maximum, it must be on the line EL, supposing it is point F. obviously, when the point E movement to point F, the sale revenue increases gradually (Hariga, 1997). It means the hotel could enhance its sales revenue by the price discount.

ESTABLISHMENTS THE MODEL AND SOLUTION

Through the anglicizing the profit, ΔQ shows the potentials buys who are attracted by the price discounted, it is related with the amount of decreased. And the amount of reduced (P_0→P_0 x)is direct proportion to ΔQ. The function relation is supposed:

$$\Delta Q = d\,(P_0\text{-}P_0x)$$

When the guest room price decreases to the first "t" weeks, the increased sales amount is:

$$\begin{aligned}&\Delta Q_t - \Delta Q_{t-1} = d_t(P_0 - P_0x_t) - d_t(P_0 - P_0x_{t-1})\\ &= d_tP_0x_{t-1} - d_tP_0x_t\end{aligned}$$

Taking the minimize the loss of profit as the objective function, dynamic pricing model is established as follows:

$$\text{Min } L = Q_0 \times P_0$$

$$\sum_{t=1}^{n}[(a_t - b_tP_0x_t + d_tP_0x_{t-1} - d_tP_0x_t)(P_0x_t - th - ts)/(1+\frac{r}{52})^t]$$

$$\text{s.t.}\sum_{t=1}^{n-1}(a_t - b_tP_0x_t + d_tP_0x_{t-1} - d_tP_0x_t) < Q_0,$$

$$\sum_{t=1}^{n}(a_t - b_tP_0x_t + d_tP_0x_{t-1} - d_tP_0x_t) \geq Q_0.$$

$$0 \leq x_t \leq 1, t = 1, 2, \cdots, n.$$

Optimal aim of pricing model can be simplified as:

$$\max f = \sum_{t=1}^{n}[a_t - b_tP_0x_t + d_tP_0x_{t-1} - d_tP_0x_t)\,(P_0x_t - th - ts)/\left(1+\frac{r}{52}\right)^t]$$

Table 1: Main parameters in the model

t	at	bt	dt
1	13.0	0.020	0.015
2	11.0	0.025	0.010
3	10.5	0.050	0.008
4	10.0	0.075	0.004

Because the model is a nonlinear state, to solve the optimization problem by using the conventional genetic algorithm and particle swarm algorithm, the design and implementation of analysis and test process and algorithm (Hwang and Hahn, 2000).

RESULTS OF SIMULATION AND ANALYSIS OF THE CASE

Case simulation: A hotel wants to sale its standard rooms in the winter, at March; the rate of standard room diminishes gradually (Wang and Guo, 2003). At this time, every day there have10 rooms not rent out. Price of standard room is 600 Yuan per day, cost per week delay is 50 Yuan per standard room, loss of a standard room per day of is 20 Yuan, the bank interest rates is 2.1% and the other parameters are at Table 1.

Comparative analysis of the algorithms: Set the parameters of genetic algorithm: Pop-size = 50, child-size = 100, crossing-over rate is Pc = 0.6, aberration rate is Pm = 0.40, Iterative algebraic is 1000. Particle swarm algorithm parameter setting: Cl = C2 = 0.2, Maximum number of iterations is 1 000.

Two algorithm could get the optimal simulation results: x1 = 0.72, x2 = 0.60, L = 3 221. But due to the influence of the initial population, it is impossible to get the optimal solution each operation (Wang and Guo, 2003). Two algorithms run 100 times, which achieved the optimal solution 52 times using genetic algorithm, but it was31 times to achieve the optimal solution by particle swarm algorithm. Although having crossover and mutation, many of the tedious steps, genetic algorithm is more complex than the particle swarm algorithm, but it could be found by statistics, the genetic algorithm is more accurate than particle swarm optimization algorithm (Wang and Wang, 2004). Since the scale of the hotel is small by the example, there is no difference between the running times of two kinds of algorithms.

CONCLUSION

According to the different characteristics sales at off-season and peak season hotel itself, there will be room unsalable phenomenon, or some rooms also faces in the next sales cycle will be eliminated possibly, at the end of peak season arriving.The need for rooms is processed by means of promotion.

Against this background study presented relational expression among hotel sales, time and price relationships and profitability analysis was studied. It constructed a mathematical model for rooms' dynamic pricing discounts and established an objective function of mathematical programming base on the discount rate variable, the hotel's total loss minimization. It designed a genetic algorithm, particle swarm algorithm program and the method was verified through practical examples and effective formulation of preferential policies. It has theoretical and applied value for the hotel to formulate preferential policy.

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