A REVENUE OPPORTUNITY MODEL FOR AIRLINE INDUSTRIES FOR THE DEREGULATED GLOBAL MARKET

Banu Türkmen, Akif A. Bulgak, Ali Akgündüz

Department of Mechanical and Industrial Engineering, Concordia University, Montreal, Quebec, Canada

Abstract : This study analyzes yield management, that is, how to sell a finite inventory of perishable assets so as to maximize revenues. Here the assets are seats on a scheduled flight. We consider a two-class dynamic model, dealing with an opportunity to capture additional revenues by offering an upgrade to discount fare customers. We also extend the model to include overbooking and no-shows. The nature of the airline industry, especially for three decades is discussed and a brief summary of the future work is given.

Keywords: Airline Yield Management, Capacity Shifting

1. Introduction

In the market place, service/product providers often use some limited resources to satisfy different classes of demands. This practice leads to question of how to manage the selling process of limited resources to maximize the total revenue. Yield management (YM) models addressing this issue are defined as multi-class models. In the literature, the multi-class models are commonly referred to airline seat allocation models, since most of these models have been constructed for identifying effective decision rules for airlines, which routinely book multiple fare classes into a common seating pool in an aircraft. Airlines are able to change their pricing structures taking into account the fundamental differences between leisure travelers and business travelers. In general, business travelers are time sensitive and tend to make reservations closer to the departure date. On the other hand, leisure travelers are price sensitive and book well before the departure date. In order to protect seats for high-fare passengers, airlines need to limit seats availability to early booking low fare passengers. In other words, seats that are available for sale to a particular booking class are also available to bookings in any higher fare booking class, but not the reverse. This process is called nesting.

There are many researches done in seat inventory control or YM but none of them suggests a perfect modeling of revenue maximization, in terms of being realistic and at the same time being practical. There are a lot of variables to model and execution time of these models are long and they are not convenient to use in a reservation process of an airline.

2. Literature Review

In general, the previous work on airline yield management can be categorized as belonging to one of two basic model types, static or dynamic. In a static model, the booking period is to set a booking limit for every booking class at the start of the booking process. A weakness of this approach is its inability to consider the actual current booking status during the process. However it can handle large problems and can address the multiple flight-leg problems. A dynamic model sets the booking limit for each booking class according to the actual bookings throughout the entire booking process. In terms of accuracy, the dynamic models can be better than the static models. A weakness of the dynamic approach is that it is computationally intensive.

Belobaba (1987 a, b, 1989) developed an Expected Marginal Seat Revenue (EMSR) approach to find an approximation to an optimal policy for the single leg, multi-fare problem. He developed the idea of Littlewood (1972) as that was for two fare classes only. EMSR heuristic uses pair wise fare comparisons to quickly arrive at approximate booking limits. Because of its computational ease, his EMSR heuristic provides a natural alternative to the optimal policy. Weatherford, Bodily and Pfeifer (1993) examine dynamic booking limits for two classes of passengers with sell-ups and overlapping dynamic arrival rates based on Belobaba's work. Independently, McGill (1988) and Curry (1990) developed models for the case where lower classes are booked first. They use continuous demand distributions. Wollmer (1992), Brumell and McGill (1993), and Robinson (1995) investigated the single-leg problem with multiple fare classes. They showed that Belobaba's heuristic is sub optimal. They developed procedures to find the optimal booking policy under the assumption that the probability of filling the plane is known. Liang (1999) proposed a continuous-time dynamic yield management model and showed that a threshold control policy is optimal. Zhao and Zheng (1998) proved that a similar threshold control policy is optimal for a more general airline seat allocation model that allows

diversion/upgrade and no-shows. In particular, Subramanian, Stidham, and Lautenbacher (1999) present a model permitting cancellations, overbooking and discounting. They develop a discrete time, finite horizon Markov Decision Process (MDP), and solve by backward induction on the number of periods remaining before departure. Gallego (1996), Lee and Hersh (1993), Rothstein (1985) and Talluri and van Ryzin (1999) can be referred for overbooking policy and bid-price control. Lee and Hersh (1993) present a general model of booking limits for multiple fare classes and multi seat booking requests by subdividing time into sufficiently small intervals. On the other hand, van Slyke and Young (2000) study a time dependent finite horizon stochastic knapsack model. They characterize the optimal return function and the optimal acceptance strategy for this problem. For a comprehensive list of revenue management work, one can refer the survey paper of McGill and van Ryzin (1999).

However none of the researches mentioned above deals with the case of stochastic capacity in the future. All of them assume the capacity available is deterministic while the demand is uncertain. Wang and Regan (2002) propose a solution for the continuous stochastic dynamic yield management problem in which fight capacities are subject to change and suggest aircraft assignments accordingly. The problem is divided into two periods. The result from the second stage is used to derive the salvage function for the first period for determination of the optimal policy. They also claim that though only the simple case of changing capacity is considered, the method developed can be extended to a more general case where the capacity can be changed at multiple times and to multiple levels. Pak, Dekker and Kindervater (2003) show how to incorporate the shifting capacity opportunity into a dynamic, network-base revenue management model. They use convertible seats for shifting class capacities. A row of these seats can be converted from economy class to business class seats and vice versa. When a row is converted from business to economy class, the number of seats in the row is increased and the width of each seat is decreased. It can be analyzed under dynamic capacity management.

3. Model Description And Objective Of The Study

There has been an increasing demand for additional revenue opportunities of airlines in this highly competitive industry. Overbooking is the practice of ticketing seats beyond the capacity of an aircraft to minimize the revenue lost caused by no-shows and to capture the additional revenue from the additional customers. However, when airlines sell more than available seats, there is always a possibility of denied boarding representing a cost figure. Airlines are usually divided into groups called cabins depending on the types of aircraft. Each cabin has different capacities and each seat in a cabin associated with different marginal revenues. In practice it is quite likely for the demand of economy cabin to exceed the cabin capacity in certain flights. For the same flight forecasted demand for the business cabin may be less than its capacity. When lower fare class tickets are oversold and at the same time marginal expected revenue of selling one more higher class ticket is less than marginal expected revenue of selling one more low fare class ticket, it is sensible to give higher class seats to lower class passengers by asking some additional value than their ticket price. If a passenger accepts this offer and gives extra money to pass higher-class seat, airline gets additional revenue and also gets rid of some denied boarding costs. In this study, a theoretical reasoning is searched for this practical issue. A dynamic mathematical model is developed to seek a revenue opportunity of this case. The dynamic multi-class model of Zhao (1999) is modified to capture additional revenue from discount fare customers who accepts the upgrading offer. This model assumes that demands for both classes arrive concurrently according to independent, non-homogenous Poisson processes. It is formulated as an optimal stopping problem to determine when to close lower fare class. This dynamic model is closely related with the static model proposed by Littlewood (1972), which is also known as protection level policy. The dynamic seat allocation model is extended to incorporate overbooking later. In our model, there are different types of customers. Full fare customers, discount fare customers, customers that have already discount fare but also accept the offer of upgrade. One can consider those customers and discount fare customers as one type for simplicity. Arrival process of customers is Poisson and independent of each other. Also it is assumed that once closed, the discount fare is not allowed to reopen. In this work we demonstrate the booking process in three different scenarios. First, a general model in which no upgrading option is offered to economy cabin customers is given. Next we modified this model to incorporate upgrading option with an additional fare. Finally we included no-shows and overbooking possibilities to the model to capture the extra revenue.

4. Future Extensions And Conclusion

The model is highly depend on the probability function of acceptance of offer (u(t)). So, further analysis can be done for the cases in which *u(t)* is decreasing or increasing or constant. And efficiency of model is assessed according to different results obtained from different cases.

In practice airlines tend to upgrade passengers from coach class to business class when coach capacity is less than demand and business capacity is higher than demand. We observe similar practices in other industries such as car rental companies, cruise lines and hotels. To the best of our knowledge, our model is the first formulize this business practice to capture this opportunistic revenue. Most desirable objectives for the airline industry would be to ensure greater stability in the marketplace and to improve profitability of industry.

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