

# ***Overbooking Transmission Mechanism and Optimization Strategies in the Aviation Industry from the Perspective of Multi-Resource Network***

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**Abstract.** Under the background of digital economy and highly coordinated tourism service chain, overbooking strategy, as a core means for enterprises to balance resource utilization and revenue, has been widely applied in aviation, hotel and other industries. However, overbooking of a single resource is likely to trigger chain reactions in the multi-resource network, restricting the sustainable operation of the industry. Taking the aviation industry as a research case, this paper focuses on the overbooking problem in multi-resource network, constructs a theoretical analysis framework of "upstream triggering-inventory substitution-downstream spillover", analyzes the operation mechanism and multiple impacts of network overbooking, and focuses on exploring the transmission path of overbooking risks in the tourism service chain and its comprehensive effects on customer experience, enterprise operation and industry development. On this basis, from four dimensions of information synchronization, benefit distribution, passenger service and environmental protection-cost balance, this paper proposes a multi-subject collaborative overbooking optimization strategy, which provides theoretical reference and practical path for airlines and related enterprises in the tourism service chain to improve overbooking management level, balance benefits and public interests, and helps the industry transform from "scale priority" to "quality priority".

**Keywords:** Multi-resource network, aviation overbooking, transmission mechanism, collaborative optimization, service chain management.

## **1. Introduction**

Against the background of digital economy and globalized supply chain, multi-resource network, as the core carrier connecting production, circulation and consumption, its operational efficiency directly determines the realization of the collaborative value of the industrial chain. Overbooking strategy, as a method to balance resource supply and market demand uncertainty, is widely used in service industries such as aviation, hotels and logistics. By actively accepting orders exceeding actual capacity, it offsets potential losses caused by order cancellations and defaults, thus maximizing resource utilization and revenue levels. However, traditional single-resource

overbooking models are difficult to adapt to the complex interrelated characteristics of multi-resource networks. When a single resource is overbooked, it is easy to trigger chain reactions, leading to problems such as unbalanced resource allocation and reduced service quality, which seriously restrict the sustainable operation of multi-resource networks [1].

Existing studies have carried out a lot of explorations around the optimization of overbooking strategies, mainly focusing on the construction of overbooking quantity calculation models for single resources. They predict order cancellation rates through probability and statistics methods to balance revenue and default costs. Some attempts have incorporated resource correlation into the research framework and proposed collaborative overbooking strategies based on resource complementarity, but they have not fully revealed the internal mechanism of overbooking transmission, especially the lack of systematic analysis of the whole process of overbooking triggering, diffusion and mitigation. In multi-resource networks, overbooking of a single node is not an isolated event. Its impact will be transmitted upstream to the supply side and diffused downstream to the demand side through resource dependence relationships, and the substitution capacity of inventory resources plays a key regulatory role in this process. Therefore, analyzing the complete transmission chain of "upstream triggering-inventory substitution-downstream spillover" has become the core proposition to solve the dilemma of overbooking management in multi-resource networks.

Based on the above analysis, this paper will focus on the transmission mechanism and impact effects of overbooking in multi-resource networks, and construct a theoretical analysis framework of "upstream triggering-inventory substitution-downstream spillover". It will clarify the action paths of key driving factors such as order fluctuations and supply disruptions, explore the regulatory mechanism of inventory substitution strategies in the process of overbooking transmission, reveal the law of overbooking effects spilling over to the downstream, and evaluate their comprehensive impacts on the operational efficiency and customer satisfaction of downstream nodes.

## 2. Case introduction

With the continuous growth of air travel demand and increasingly fierce industry competition, capacity optimization has become the key for airlines to enhance their core competitiveness. As a core means to balance capacity and revenue, the implementation effect of overbooking strategy directly affects the operational efficiency and market reputation of airlines. This practice is often controversial because it may cause passengers to be unable to board the plane [2].

At present, the core problems in the implementation of overbooking strategies by airlines are concentrated in three aspects: first, the accuracy of prediction models is insufficient, and their adaptability to sudden factors is poor, which is easy to lead to excessive or insufficient overbooking; second, the compensation mechanism is imperfect [3]. Some airlines have a single compensation method (mostly in the form of vouchers) and low standards, which are difficult to effectively improve passengers' enthusiasm for voluntary rebooking; third, the information transparency is insufficient. Airlines fail to fully inform passengers of overbooking risks and rights protection rules in advance, and passengers have a vague understanding of their own rights and interests, which intensifies the occurrence of disputes and conflicts. These problems not only affect passengers' travel experience, but also may damage the brand image of airlines, and even trigger an industry trust crisis in the long run [4]. As Dr. Laura Simmons, a transportation logistics economist at the Massachusetts Institute of Technology, said: "Overbooking is not greed, but risk management. The goal of airlines is to avoid flying half-empty, not to deliberately refuse passengers to board" [4].

Effectively solving overbooking-related problems can help airlines improve the accuracy of overbooking prediction, reduce operational risks and dispute costs, and enhance brand competitiveness. For passengers, it can improve travel certainty and experience, and reduce the probability of delaying trips. For the entire aviation industry, it helps to promote the formation of standardized overbooking management norms, guide the industry to transform from "scale priority" to "quality priority", and promote the sustainable and healthy development of the aviation industry. Against the background of the continuous recovery of global air travel demand, optimizing overbooking strategies is not only an inevitable requirement for the high-quality development of the industry, but also an important measure to balance enterprise benefits and public interests, which has important practical significance for improving the operational efficiency of the entire air transportation system [5].

### 3. Analysis of network overbooking

#### 3.1. Operation mechanism of network overbooking

In the modern tourism chain, a passenger's trip often involves multiple service links, such as flights, hotels and car rental services. Although these resources are provided by different suppliers, they are packaged and booked through OTA platforms, forming a highly coupled multi-resource network. In this context, overbooking strategies are widely used in various links to alleviate the vacancy risk caused by temporary cancellations or non-use. However, when overbooking occurs in upstream services and causes itinerary changes, the entire tourism chain will face chain reactions [6].

The operation mechanism of network overbooking can be divided into the following three stages:

##### Stage 1: Triggering of Overbooking in Upstream Resources

Airlines usually set a certain proportion of overbooking quota based on historical data and prediction models to cope with passengers who do not board or cancel temporarily. If the prediction is inaccurate, there may be a shortage of seats. To alleviate conflicts, airlines generally adopt methods such as upgrading cabins, rebooking, and issuing coupons for "inventory substitution" to realize the reallocation of passengers.

##### Stage 2: Forced Adjustment of Passengers' Itineraries

Once a flight is rebooked or delayed, the passenger's original itinerary will be directly affected. Especially when the change occurs in a short time, passengers often find it difficult to adjust their downstream bookings in a timely manner, such as hotel check-in time and car rental pickup location, leading to the phenomenon of "itinerary dislocation". At this time, passengers need to contact various links to make modifications by themselves or rely on the platform for coordination, resulting in a significant increase in information lag and communication costs.

##### Stage 3: Downstream Resource Spillover or Vacancy

Due to the lack of real-time data sharing between upstream and downstream systems, hotels and car rental platforms often fail to timely obtain information on changes in passengers' itineraries and still reserve resources according to the original plan, resulting in phenomena such as "booked but not checked in" or "vehicle vacancy". On the contrary, if passengers use services in advance or delay temporarily, it may also trigger a new round of resource shortage and overbooking risks, forming a "fluctuation amplification" effect.

This mechanism exposes the structural defects of the current tourism service chain in inventory coordination and information synchronization, especially under the OTA platform-led distribution model, the coordination capacity between resource parties is limited, leading to the gradual

transmission of upstream overbooking risks, which ultimately evolves into systematic service failures.

### **3.2. Multiple impacts of network overbooking**

Network overbooking is not only an operational problem, but also involves multiple aspects such as customer experience, brand trust and platform governance [7]. Its impacts can be analyzed from the following four aspects:

#### **3.2.1. Impaired customer experience: frustrated perceived fairness**

According to the perceived fairness theory in the literature, when facing service failures, customers will evaluate whether they are treated fairly from three dimensions: outcome, process and interaction [8]. In the context of network overbooking, passengers often passively accept itinerary changes. If they fail to receive timely notification or reasonable compensation, they are likely to have a "sense of deprivation". For example, overbooking of flights causes passengers to be rebooked to the next day, but they fail to adjust their hotel bookings synchronously, and finally have to cancel the original order and bear additional accommodation costs. Such "chain failures" will seriously weaken customers' trust and satisfaction with the platform [9].

#### **3.2.2. Decline in brand trust: diffusion of negative word of mouth**

After experiencing service failures, if customers fail to get effective remedies, they tend to express their dissatisfaction through social media or review platforms. Due to the complexity of the tourism service chain, it is difficult for passengers to accurately judge the responsibility attribution, and the platform, as the service integrator, faces higher public opinion risks. Especially in the case of information asymmetry, customers are more likely to vent their emotions on the platform, which further affects the overall brand image and user retention rate.

#### **3.2.3. Increased platform operational pressure: double increase in complaints and costs**

Itinerary changes caused by network overbooking are usually accompanied by a large number of customer service interventions, order modifications and compensation processing. The literature points out that the response speed and compensation form of service remedies directly affect customer satisfaction. If the platform fails to establish a unified response mechanism, it will face a large number of repeated complaints, refund applications and negative reviews, significantly increasing operational costs. At the same time, to maintain user experience, the platform often has to bear the "compensation on behalf" responsibility, such as providing additional accommodation, transportation subsidies or vouchers, which further compresses the profit space.

#### **3.2.4. Resource mismatch and decline in system efficiency**

Network overbooking also leads to unbalanced resource allocation. On the one hand, passengers fail to use services as planned, resulting in "idle inventory"; on the other hand, some resources cannot be released in a timely manner due to itinerary changes, affecting the booking of other users and reducing the overall system efficiency. Especially during holidays or peak periods, the "run on effect" of local resources may trigger service paralysis, such as full hotels in popular cities and difficulty in renting cars, which further intensifies passengers' anxiety and platform pressure.

#### 4. Practical revenue management suggestions for network overbooking

Airlines, hotels, and car rental companies are like teammates in the travel service chain. Only with tacit cooperation can they turn the risks of overbooking into win-win opportunities. The core lies in achieving information interconnection, benefit sharing, thoughtful service, while balancing environmental protection and costs [10].

First, regarding information synchronization, the three parties must open up "communication channels" and avoid operating in isolation. Once an airline decides to overbook—for example, planning to oversell 10 percentage of tickets on popular holiday routes—it must immediately share this information with partner hotels and car rental companies, specifying the number of overbooked passengers and their expected arrival time. Hotels can reserve 5 percentage to 10 percentage of flexible rooms in advance, and car rental companies can adjust vehicle scheduling, such as transferring cars from surrounding outlets for backup. This prevents the awkward situation where passengers arrive at their destination only to find no accommodation or rental cars available. Moreover, relying solely on temporary notifications is insufficient; simple data analysis can assist in prediction. For instance, by reviewing the past year's data, it is evident that overbooking probabilities are highest around Spring Festival and National Day, or on business routes on Mondays and Fridays. Preparing more for these periods helps resolve issues in advance. Currently, many travel platforms support real-time data synchronization. By accessing the same simple shared system, the three parties can check each other's inventory and overbooking status at any time, which is far more efficient than relying on phone calls or WeChat notifications.

Second, regarding profit distribution, the additional income from overbooking should not be monopolized by airlines; hotels and car rental companies should also benefit. While airlines earn more by selling extra tickets through overbooking, hotels may need to reserve rooms for temporary passengers, forgoing orders that could have been sold at higher prices. Car rental companies may also experience vehicle idleness to ensure capacity—these losses require compensation. A predetermined profit-sharing ratio for overbooking income can be established, such as 60 percentage for airlines, 20 percentage for hotels, and 20 percentage for car rental companies, settled monthly. Additionally, using discount vouchers instead of cash compensation is an effective approach. Vouchers issued by airlines can be used by passengers to deduct hotel room fees or car rental costs. This way, airlines avoid excessive cash outlays, hotels and car rental companies retain more customers, and passengers receive tangible benefits—benefiting all three parties. Furthermore, these discount vouchers can encourage passengers to choose these partner brands again in the future, serving as free promotion with better results than simply giving cash.

In terms of passenger service, a "from easiest to most difficult" approach should be adopted to minimize impact on passengers. When overbooking occurs, the preferred solution is to offer free rescheduling, such as changing to an earlier or later flight. If business class seats are available, upgrading passengers is even more thoughtful and acceptable to most. If rescheduling is not feasible, hotel or car rental discount vouchers—such as a hotel coupon or car rental discount—can be provided to ensure passengers' itineraries are not ruined. Cash compensation should only be considered when all other options are exhausted, controlling costs while reducing passenger dissatisfaction. Frequent flyers deserve special attention: for example, notifying them of overbooking via SMS or app one day in advance and presenting alternative options directly, avoiding last-minute communication at the airport and preventing core customers from making futile trips, thereby enhancing satisfaction.

Finally, it is necessary to address the additional impacts of overbooking, particularly vehicle idleness for car rental companies and temporary passenger accommodation. If car rental companies

adjust scheduling due to overbooking, resulting in empty trips (e.g., transferring cars from Location A to Location B without passengers), they can choose eco-friendly routes, avoiding congested roads to reduce fuel consumption and carbon emissions. They can also participate in environmental protection programs, such as exchanging driving mileage for carbon credits to offset the environmental impact of empty trips. Additionally, the three parties can cooperate with local governments or cultural and tourism departments. For example, diverting passengers without accommodation due to overbooking to nearby hotels with available rooms, where governments or platforms provide certain subsidies. This not only solves passengers' accommodation issues but also allows hotels and car rental companies to earn additional income, achieving a win-win outcome. Many cities currently offer green travel subsidies; car rental companies can receive extra subsidies by using more new energy vehicles, which is both environmentally friendly and cost-effective, turning the negative effects of overbooking into a plus.

In fact, overbooking is not terrifying. As long as airlines, hotels, and car rental companies adhere to the principle of "win-win," ensure timely information synchronization, fair profit and cost sharing, provide thoughtful passenger service, and balance environmental protection and cost control, they can minimize the risks of overbooking. Meanwhile, all three parties can achieve stable profits, reduce resource waste and unnecessary troubles, and make the travel service chain operate more smoothly.

## 5. Conclusion

By analyzing the actual case of overbooking on the Munich flight, it can clearly identify a key issue: while an airline's one-sided overbooking strategy may seem to generate short-term gains by selling more tickets, it actually triggers a chain reaction. The additional passengers from airline overbooking may force partner hotels to reject reserved guests due to insufficient reservations, damaging their reputation and wasting booking resources. Car rental companies that adjust vehicle scheduling in advance to match flight capacity may face significant empty trips due to changes in passengers' itineraries, resulting in wasted fuel costs and increased carbon emissions, which impose an additional burden on the environment. This self-serving approach ultimately raises the overall costs of the entire travel service chain, offsetting the airline's short-term gains and creating a situation of "local profit at the expense of overall loss."

Clearly, the traditional overbooking model where each industry operates independently can no longer meet current travel needs. Today, passengers' travel demands are integrated—combining flights, hotels, and car rentals—requiring the three parties to cooperate closely as a team. By having airlines share overbooking data in advance, hotels and car rental companies can adjust inventory and reserve backup resources in a timely manner. Through reasonable profit distribution, the additional income from overbooking can be shared proportionally with downstream partners to compensate for their operational losses. Meanwhile, flexible service solutions—such as free rescheduling and discount benefits—can be provided to passengers. This way, all three parties can achieve stable profits without compromising travel experiences, reducing resource waste and unnecessary troubles.

This collaborative approach can also be extended to more travel scenarios. For example, when high-speed rail tickets are overbooked, links can be established with hotels and scenic spots along the route to provide passengers with seamlessly connected alternative services. When scenic spots implement time-slot reservations, they can share passenger flow data with surrounding accommodation and transportation service providers to avoid congestion during peak hours and idleness during off-peak periods. In the future, as long as all links in the travel chain break down information barriers and cooperate, all resources can be utilized rationally. This will not only reduce

the overall operational costs of the industry but also make passengers' travel smoother and more comfortable, achieving dual improvements in industry development and user experience.

### Authors contribution

All the authors contributed equally and their names were listed in alphabetical order.

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