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Optimizing Revenues in the Hospitality and Retail Industries: Comparing and Contrasting Different Industry Problems and How SAS® Analytics Is Used to Solve Them

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ABSTRACT

With the acquisition of IDeaS by SAS® in 2008, SAS now offers advanced revenue optimization solutions for both the retail (SAS® Revenue Optimization Suite) and hospitality industries. This paper will explore the similarities and differences in the business problems and the solutions. Specifically, we will explore how different ownership and management structures impact the solutions, how different industries approach the problem of market segmentation to maximize profitability, and how SAS uses analytics to solve these very complex estimation and optimization problems. Finally, we will explore how pricing in these industries is changing, and how SAS is using the knowledge gained in solving these different problems to keep up with those changes.

INTRODUCTION

Joe is a merchant at a large department store with locations in major malls across the US. Joe is responsible for women's dresses. He selects vendor partners, merchandise to buy, and sets prices for the merchandise in order to reach his margin goals for each season. These items are purchased from the manufacturer six to nine months in advance of each selling season. Every season Joe works with his vendors to select a new set of dresses for the upcoming season that meets the style and price requirements of his target market, making sure to provide a selection of both styles and prices to cross all of the different types of customers that the store serves. The merchandise is initially offered at full price, and is subsequently marked down, with the goal to sell as many over the entire selling period as possible without having any left over going into the next season.

Jane is a revenue manager for a city center hotel with 700 rooms. She is responsible for setting room rates for all room types as well as managing the distribution channel strategy. As an example of a typical decision for her, Memorial Day weekend is usually a busy weekend at Jane's hotel. The majority of guests will want to arrive on Friday and check out on Monday for a three night stay, so she needs to make sure that she's restricting the sales of rooms for a one night only stay Saturday night, so as to maximize revenue over the entire weekend. Thursday night and Monday night of that weekend are not quite as busy, so if possible, she'd like to set her pricing controls for the entire period to attract business to these slower nights around the weekend without sacrificing revenue over the weekend. Leisure guests will be the largest group in the hotel since it's a holiday weekend, but she'll need to balance demand from her leisure, group, and business guests so that she's not serving one segment at the expense of more valuable demand from another segment.

While on the surface, these might seem like very different industries with very different business problems, at their core, these two problems share similar characteristics. Both Joe and Jane are tasked with:

Maximizing revenue from limited inventory over a fixed time horizon by selling to customers with different needs.

In this paper, we will explore the similarities and differences between these two problems that belong to a special class of pricing problems classified as Revenue Management.

INTRODUCTION TO REVENUE MANAGEMENT

Businesses that can apply revenue management share the following list of common characteristics (Kimes 1989; Kimes and Chase 1998).

1. Fixed and limited capacity – this means that there is a limited amount of product available for sale

2. Perishable inventory – due to a fixed time horizon for sale, unused product cannot be resold
3. Segmentable customers – groups of customers who place different value on the product
4. High fixed costs but relatively low variable costs
5. Time variable demand patterns, with the ability to forecast these patterns

These businesses must maximize the revenue from their limited capacity, which will be unsellable after the time horizon expires. They have a segmentable customer base, some that are willing to pay a premium to access the inventory when they want it, and others who are more price-sensitive and will accept a restriction on how or when the product is purchased in exchange for a discount. The core product has different demand at different times. Due to the relatively low cost of sales, deep discounts can be used to drive demand without sacrificing profitability. The goal is to use variable pricing strategies to sell the limited capacity to the customers who are willing to pay the most money for that capacity (**Error! Reference source not found.**).

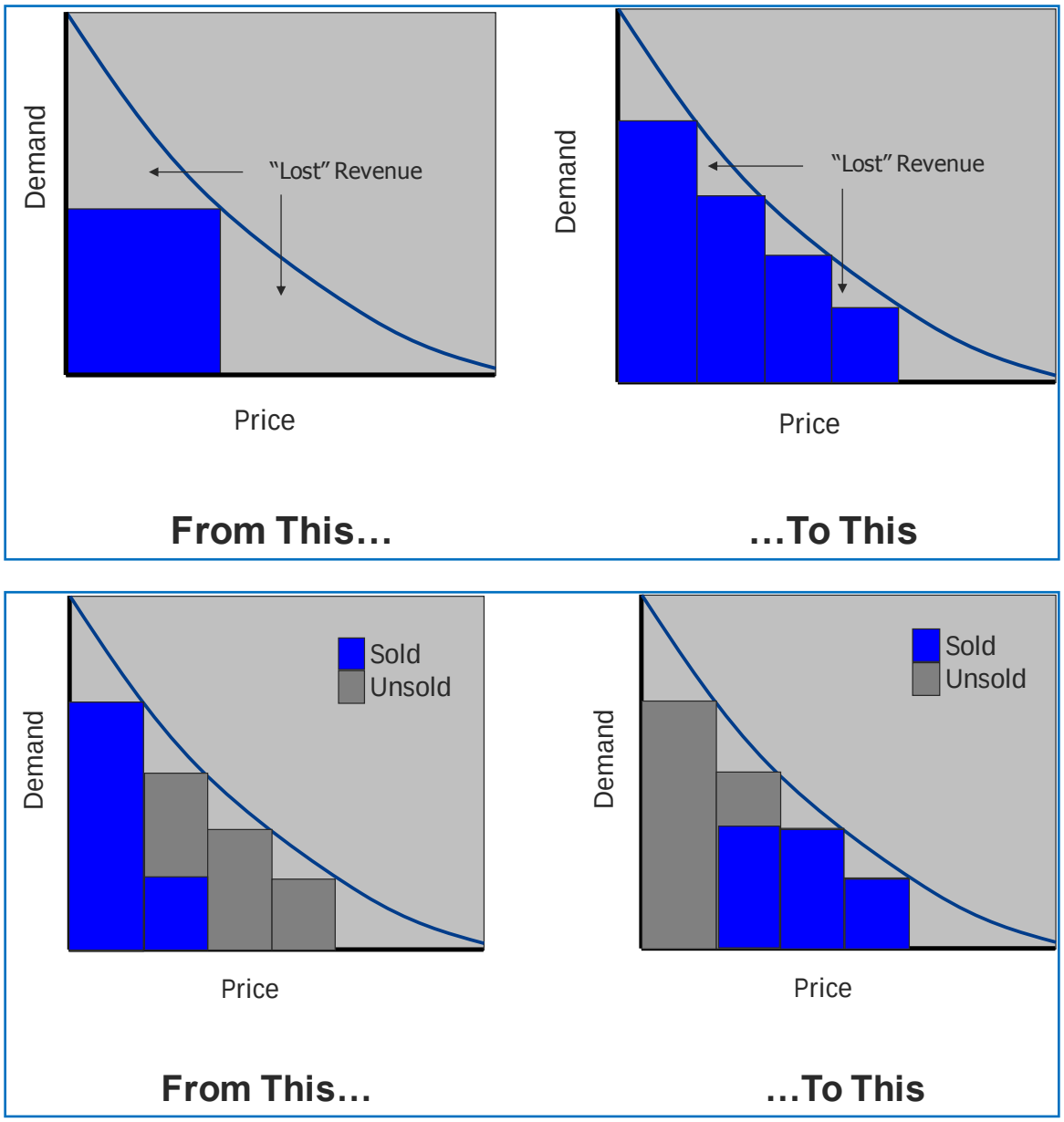

Figure 1: Goals of a Revenue Management Program

Revenue Management was introduced as a science following the introduction of deeply discounted fares into the airline industry after the deregulation of that industry in the United States in 1978. The challenge for the industry was knowing when to offer these discounts and to whom, so as to not displace more valuable demand. While firms can implement manual revenue management controls such as not offering discounts during busy periods, successful implementation of revenue management requires information technology for data management and analytics.

Revenue management programs involve the introduction of variable pricing to increase the amount of revenue that can be generated from the existing capacity. Along with variable pricing strategies, firms must also introduce appropriate purchase restrictions to ensure that discounts are not available to customers who would have paid full price. For example, advanced purchase restrictions, such as offering reduced-price hotel rooms with a 14-day advance purchase, attract the price-sensitive leisure customer, but are not attractive to the last minute business traveler. A discounted airline ticket with a connection is another way of ensuring that customers who are willing to pay for convenience pay a higher price. Offering pricing that is specific to certain channels, and therefore not broadcast to the entire customer base, is another way to make sure that discounts are not available to higher valued segments.

Figure 2: Revenue Management Cycle

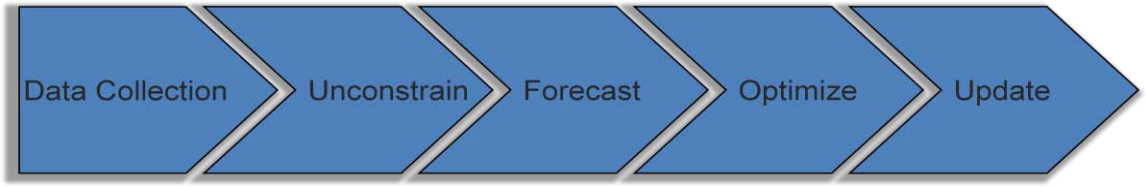

Figure 3: Revenue Management Cycle

The revenue management analytics cycle has five steps (Figure 2). Demand data is collected from the selling systems. Actual sales are tracked in these systems until the point at which the product is sold out. However, these systems do not reliably capture unrealized demand, customers who were turned away because the product was not available, or customers who turned down the product because it was too expensive. In order to maximize revenue, total demand (both realized and unrealized) must be known so that the optimal mix can be derived. Unconstraining algorithms, which mathematically predict total demand are used to derive the actual historical demand if unlimited quantities of the product were available and at all levels of price sensitivity. **Error! Reference source not found.** demonstrates what unconstrained demand might look like in a hotel context.

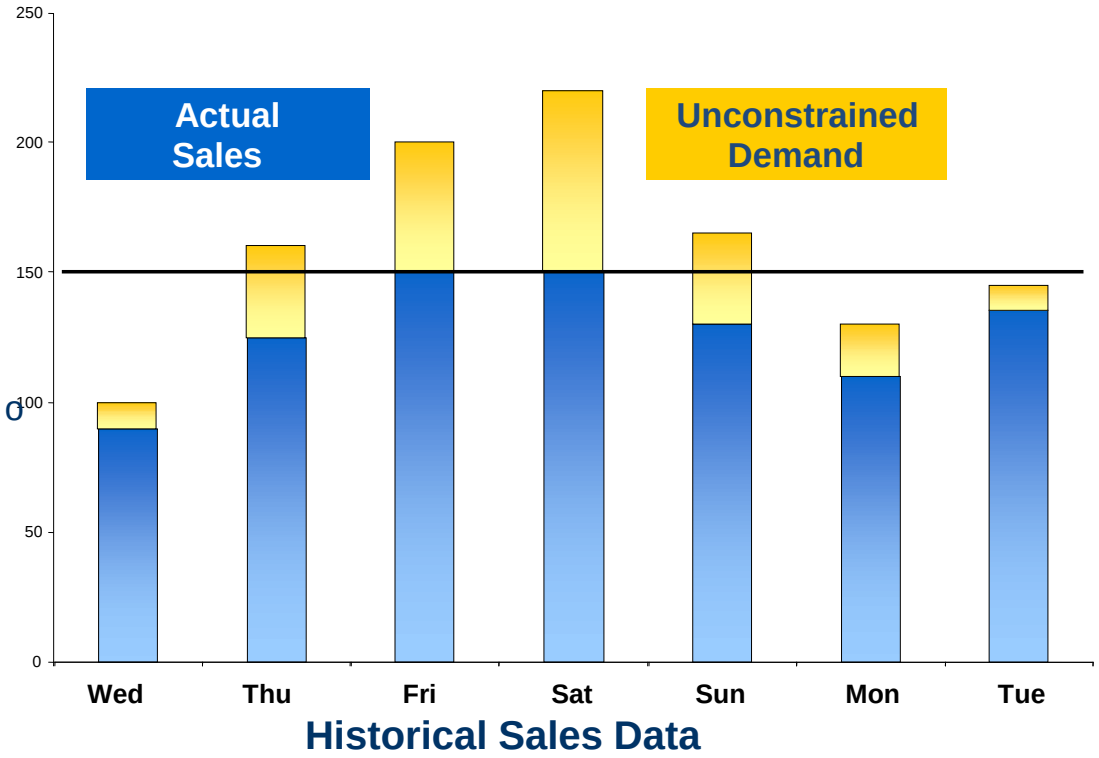

Figure 4: Unconstrained Demand Example

Once historical unconstrained demand is derived, a forecast of expected unconstrained demand is generated. This forecast is fed into an optimization algorithm that calculates the optimal mix of demand to accept and recommends a pricing strategy that will capture that demand mix. The final step in the cycle is to update the selling systems with the pricing and availability recommendations that were generated by the optimization algorithm. Then the cycle begins again, with the selling system transferring data to the revenue management system.

The application of revenue management involves large amounts of data, complex analytics, and the ability to integrate with disparate operating systems both to collect the necessary data and to push out the appropriate recommendations. Advances in revenue management are driven as much by advances in technology and increased processing power as they are by innovative mathematics.

APPLICATION OF REVENUE MANAGEMENT: COMPARING HOSPITALITY AND FASHION RETAIL

The success of revenue management in the travel industry created interest in other industries that meet the necessary conditions described above. Each new industry that approaches this specialized pricing problem can use the basic theory as well as some techniques from previous applications, but must adjust the algorithms to match the unique characteristics of their business problem. To illustrate this, we will explore the similarities and differences between the hospitality and fashion retail problems, and discuss how SAS was able to help each industry to tailor the revenue management solutions to meet their unique needs (Table 1). We will start by showing how each industry meets the necessary conditions described above, and how these conditions impact the analytics used to solve the problems. Then we will cover the similarities and differences in the revenue maximization problem.

Table 1: Comparing Hospitality and Retail

Category	Hospitality	Fashion Retail
Fixed and limited inventory	Fixed number of hotel rooms of different types that must be sold by the night of arrival.	Fixed number of items that are ordered in advance, and must be sold by the end of the buying season.
Perishable product sold over a fixed time horizon	Booking window, reservations made throughout the period before day of arrival, and "sale" is made on the day of arrival.	Fashion season, divided into "discount periods". Inventory is sold throughout the season.
Segmentable customers	Leisure versus business versus groups.	Fashion forward versus discount seeking.
High fixed costs and low variable costs	Cost of operating the property compared to the cost of accommodating one additional guest (cleaning room, commission on sale if necessary, small additional utility costs, and so on).	Initial cost associated with ordering and distributing the product, plus cost to operate the brick and mortar outlets are high compared to variable costs of individual sales. Some variable cost associated with making a price change.
Time variable demand	Peak periods, like during the week for business hotels versus off peak periods like summer time at Caribbean resorts.	Product becomes less desirable to the customer throughout the selling season. Demand is intense at the beginning of the selling season with a long tail. Significant changes from season to season due to product and portfolio changes.
Revenue	Sales of hotel rooms of different over different lengths of stay, which can be packaged with other services both within property and externally.	Sales of fashion items (for example, women's and men's apparel) of different styles, colors and sizes.
Decision support solution	IDeaS V5i™ Revenue Optimization	SAS® Markdown Optimization

FIXED AND LIMITED INVENTORY

A hotel has a fixed number of rooms to sell each night, and is unable to adjust that fixed number according to demand. These rooms vary by type: doubles versus kings, suites, and views and each of these types might have a different value to the customer. While the hotel might not be able to charge more for a standard king room versus a double, they can certainly charge more for a view or a suite. The revenue management system needs to consider demand for each room type and the value that customers place on these room types in order to price them appropriately.

In the hospitality revenue optimization problem, the inventory constraint results in a shadow price that represents the value of one additional room. This shadow price, or bid price, is then used as a hurdle rate for pricing. Many selling systems use this hurdle rate to open and close available rates. If an available rate plan is higher than the hurdle rate, then it is available for sale. This is a relatively simplistic characterization of the pricing solution for hotels. In reality, hotels offer a variety of different rates to different segments of guests, and the bid price is only one element of the decision. Constraints on what data formats the selling systems can accept also impact the type of control that the IDeaS system is able to send. The IDeaS V5i solution provides a control similar to the bid price control (and several other controls, depending on the selling systems) to ensure that all streams of business are offered the rate that maximizes overall revenue.

In the fashion retail industry, product orders are placed six to nine months in advance of the selling season and the company cannot order more if demand exceeds supply. While the retailer might always offer women's dresses or men's shirts, each year new fashion trends mean that styles and colors change enough that fashion retailers sell a "new" set of products every selling season. New product forecasting is challenging because forecasting methods generally rely on historical data. SAS® Markdown Optimization solves this problem for fashion retailers by recognizing those patterns in demand that are consistent across similar products and different stores.

TIME PERISHABLE INVENTORY

If a hotel room is not sold by the night of arrival, then that room for that night will not be able to be sold. Similarly, the fashion retailer has a limited amount of time to sell the inventory of fashion items. These items are desirable to customers only while the product is "in style" and "in season," and fashion retailers want to keep their stores "fresh." A store full of out of date merchandise will eventually lead customers to stop coming to the store. This means that in both industries, the business has a fixed time horizon over which the product can be sold. After that time horizon expires, the business loses the opportunity to sell that product.

The fixed time horizon for hotels is the "booking horizon," the time during which hotel rooms are sold via reservations before the day of arrival (first day of the booking). Traditionally, guests have been able to cancel an advanced reservation without penalty, and even no show on the day of arrival without being charged. These conditions are changing, with many hotels offering a discount in exchange for a non-refundable advanced purchase or charging if the reservation is not canceled within a certain time frame before arrival.

Without significant penalties for cancellation and no shows, hotels must account for the likelihood that a guest will cancel the reservation before the night of the stay or not show up for their reserved room. On a sold out night with advanced reservations, cancellations and no shows would mean empty, non-revenue producing rooms that would otherwise have been sold. To account for this, hotels set overbooking policies, taking extra reservations in anticipation of cancellations and no shows. IDeaS V5i bases overbooking levels on the classic newsperson problem, where the cost of the empty room is balanced against the cost of not satisfying demand. The solution can also take into account the amount of risk the hotel is willing to take on (how many guests they are willing to "walk," accommodate at a nearby property, per a set number of arrivals). The results of these overbooking techniques are then folded into the optimization algorithms. Essentially, the available capacity at the hotel is increased by the overbooking recommendation, so the hotel "oversells" rooms up to the day of arrival.

As the hotel fills through advanced bookings, the remaining available rooms become more valuable, and prices increase. If the hotel does not fill as expected, then discounts might be offered to hedge against unsold inventory. This means that for the hotel industry, prices can rise and fall throughout the booking window, although, generally, prices increase.

Unlike the hotel industry, retailers do not generally sell products "in advance" – and so retailers do not need to deal with the overbooking problem. However, retailers have a different problem – how to deal with unused inventory. In hospitality, unused product (empty rooms) essentially disappears after the day of arrival. In retail, the fashion item is a physical product that must be dealt with.

Retailers have used a variety of methods for disposing of unused product. For fashion merchandise in particular, the generally most cost effective way to deal with this is to simply sell it out – discounting the item until all inventory is gone, and effectively treating these discounts as the "cost to move" the product. The timing and nature of such "markdowns" is a crucial decision, as unlike the hotel room, whose price can be increased if it is discounted too far, the price on a retail item cannot be increased.

Markdowns are more effective than other disposal methods (such as sending unsold inventory to an outlet store) because of the following:

- Alternate methods are much more expensive – such as the cost of creating and maintaining the outlet store.

- Virtually all alternates require moving the product – which itself introduces costs through "product loss" such as damaged or stolen merchandise.
- While markdowns do require labor – in particular the labor required to place the new price on the merchandise – this same labor cost exists in virtually all other alternatives (for example, the product will be marked down at the outlet as well).
- Markdowns also draw a certain customer segment to the store – and give the retailer the opportunity to then sell additional merchandise to that customer.

In order to solve the problem of what products to mark down, where, by how much, and when, retailers use the SAS Markdown Optimization solution.

CUSTOMERS WITH DIFFERENT NEEDS

In the hotel industry, certain guests are willing to pay a premium for the room to be available to them at a specific time, whereas others will accept purchase restrictions in exchange for a discount. Business travelers have different needs than leisure travelers, including products (Internet, workspace in the room) and price sensitivity. Groups expect a discount for volume of bookings and require other services like meeting space or food and beverage.

Similarly, fashion forward customers are willing to pay a premium to be the first to wear the new item or to wear it while it's still "in season." Price sensitive fashion customers will wait for the product to be discounted and are willing to NOT be the first to wear it.

In order to determine the most effective markdown strategy, SAS Markdown Optimization must measure the price sensitivity of their customer segments. Traditionally, hospitality revenue management solutions have not been required to measure price sensitivity, instead relying on their ability to independently forecast the demand for customers with different values, and then optimizing the inventory allocation to market segments (that is, how much product to sell to which customer segment) against a fixed set of pre-determined prices. However, as will be discussed in more detail later, changing business practices in the hospitality industry are requiring revenue management solutions to measure price sensitivity.

HIGH FIXED AND LOW VARIABLE COSTS

Compared to the cost of building the hotel, paying for electricity and water, paying the staff, and the furniture, fixture, and equipment, the marginal cost of selling one more hotel room is negligible. The variable costs include cleaning the room, any sales commissions, and a small amount for utilities or toiletries in the room. These low variable costs mean that any revenue generated by selling one more unit of inventory (the room) can be used to offset fixed costs. As a result, hotel managers can feel comfortable discounting the product to drive more sales and improve profitability.

The fashion retailer outlays cash before the beginning of the selling season to cover the cost of obtaining the fashion item from a vendor. They also have fixed costs associated with the outlets in which the items are sold, like utilities, labor costs, and the cost of holding the inventory. Compared to these high fixed costs, the marginal cost of selling one additional unit of inventory, one item, is negligible. Therefore, the retailer can also discount the product and use any revenue to offset the fixed costs and improve profitability.

This important characteristic is the genesis for the name "revenue management." The theory of revenue management is based on the concept that where variable costs are low, any increases in top line revenue will essentially drop right to the bottom line. Sales of exactly the same product introduce the same set of variable costs, and the condition for revenue management holds. However, when the product is sold through more or less expensive channels, packaged with other goods and services with different cost structures, or sold through a promotion, the cost structure associated with the product changes. If the sales under these conditions are maximized together, then the variable cost condition does not necessarily hold. It is no longer an "apples to apples" comparison. For this reason, managers using revenue management practices and/or solutions cannot always ignore costs, and should periodically review variable costs to ensure that assumptions hold. Optimization algorithms can account for costs, if necessary, such as optimizing on profits instead of top-line revenue, which equalizes the elements. To date, most revenue optimization solutions have not needed to take this step.

In the hospitality industry, the hotelier can discount the room at any point and at any level up to the cost to sell the room, without penalty. The variable cost associated with a fashion item not only includes the cost of the item, but also a penalty associated with any discounts on selling the item. The retailer always carries inventory and this inventory is typically valued at its original selling price. When inventory is marked down, it is "devalued." Retailers have to budget for markdowns and must be careful how many markdowns they take per period since this charge can impact their balance sheet.

There is also a labor cost associated with executing a price change in the retail industry. Prices are generally marked on each item. This means that when prices are changed, the retailer must "touch" every remaining inventory item to change the price, and at times, move the inventory to a different area of the store to make room for full priced items or to simply organize merchandise in the most effective manner for selling. Signage might also be changed to help customers understand the nature and level of the discount. Retailers plan and budget for the labor associated with price changes. While these costs can be low when spread over the entire inventory, store costs can increase if price changes are not carefully managed and controlled. The SAS® Markdown Optimization solution is structured to work within these operating constraints.

TIME VARIABLE DEMAND

In the hotel industry, demand for hotel rooms varies from day to day, season to season, and year to year. For example, hotels that serve mainly business travelers might be busier during the week and resort hotels in the Caribbean are less popular during summer months. Time variable demand means that in order to maximize revenue, hotels need to keep prices high during peak periods but offer discounts to stimulate demand during off peak periods – varying price to manage the amount of demand relative to a fixed supply. Demand forecasts help these industries to understand the nature of the time variable demand and optimization will recommend pricing strategies to maximize revenue through peak and off peak periods. For example, IDeaS V5i provides demand forecasting by market segment, which becomes the input to the optimization algorithm that ultimately recommends the pricing strategy.

The fashion retail industry's demand for seasonal products varies according to the season. For example, winter coats might be in high demand in November, but customers are less interested in purchasing winter coats, particularly at full price, in April. The demand for fashion items follows a typical lifecycle curve; it is more intense at the beginning of the season and tapers out with a long tail. This means that the timing of discounts is very important. The markdown strategy must take into account how early in the season to take a markdown to generate enough demand to sell through the inventory. If the markdown is too early, then customers who would have paid more will get a discount, and the product will sell out in advance of the end of season. If it is too late, then sufficient demand might not exist to generate the required lift, and more severe markdowns will be required – introducing price-change costs as well as further markdown charges. In order to account for this effect, SAS® Markdown Optimization must deal with markdowns as a multi-period problem in which the output is a schedule of prices through all the periods of the selling season. The problem typically has several constraints, amongst which is that the price must never *increase* in subsequent periods. This problem must be calculated with enough advanced notice to execute the price change, as the execution of price changes in stores takes time. For large retailers, it can take up to a week to plan and execute a price change.

MAXIMIZE REVENUE

The location where prices are managed influences the design of the solution. In the hospitality industry, pricing decisions are made and executed locally, at the individual hotel level. A property-level revenue manager is responsible for completing the analysis and implementing pricing recommendations, sometimes with the support of regional or corporate revenue managers. In the retail industry, pricing decisions are made "above-store" and are executed at the store level. The implication of the location of decision making influences the solution design. The IDeaS V5i Revenue Optimization solution is designed to be an end-to-end solution accessible at the property to many different levels of users. Therefore, this solution is delivered as software as a service so it does not require extensive IT support at the local level. Because it is accessed by such a broad range of users, the solution uses a robust graphical user interface and limits the ability of the user to change the models or select alternate techniques. In contrast, fashion retail pricing is decided centrally and broadcast to the stores. This means that the software only

needs to be installed in one location, and is accessed by a limited number of end users. SAS Markdown Optimization was originally designed as a client/server solution, and allows more flexibility for the users to influence the analytics.

At a basic level, the hospitality industry maximizes revenue through the sale of hotel rooms, and fashion retailers do so through the sale of fashion items. There are variations in how the sale is executed that have analytic implications, such as pre-set rate plans, packaging, the network effect of length of stay, and transparent pricing.

Rate Plans Versus Discount Levels

Due to advanced bookings, the hospitality industry has traditionally pre-set a schedule of rates that are offered or not depending on demand forecasts. These rate plans are developed up to a year or more in advance of when they will be offered. In fact, some segments, such as groups and tours, book a year or more in advance and base their decisions on the rates the hotel is able to offer. Because the industry is working with a pre-determined set of rates, the revenue maximization problem is one of optimizing the allocation of inventory to guests who are willing to pay the highest price. The optimization algorithm selects the appropriate rate from the available rate plans that should be offered. The industry has traditionally set rate plans based on a percentage increase from the year before, or a dollar difference from their closest competitor. IDeaS has developed a rate optimization algorithm that uses price sensitivity and market pressures to calculate an optimal set of rate plans and to make the selection of rate plans more intelligent.

While retailers do not make multiple prices available, they do generally have rules regarding the types of prices or discounts that can be offered. For example, the preponderance of $.99 endings is not by chance. Retailers feel that this ending is preferable to endings like $0.32 or $0.68, which might seem “arbitrary” to the customer. Similarly, for purposes of in-store merchandising/presentation, retailers prefer to use a pre-defined set of discounts – say 20%, 40%, and 60%, so that merchandise can be placed together and attention-grabbing signage placed to induce purchase. These rules are incorporated into the SAS® Markdown Optimization solution.

Packaging

In hospitality, the basic product, the hotel room, can be bundled with other products and services such as breakfast, rental car, spa treatment, or theater tickets. These packaged products can offer attractive options for customers who are looking for deals. They can also result in incremental revenue to the property by offering services that the guest might not have thought to purchase on their own. They can also help the firm maintain price integrity. Since items are not priced individually, packages hide the degree to which each element has been discounted off of the normal price. However, packages offer pricing challenges in that they should be priced according to demand for each product so as not to displace higher paying customers. Many hospitality companies are restricted in their ability to sell packages by legacy selling systems that require these packages to be predetermined and pre-priced and the only option is to offer them or not. This keeps hotels from offering dynamically priced packages where the prices are determined according to demand, or where the customer can select package elements.

The retail industry does not typically package or bundle clothing items, with the exception of coordinates, suits, and promotional pricing, in which each element could be sold separately or together with different pricing. While the absence of packages or bundles simplifies the pricing problem, it reduces the opportunities that the industry has to maximize revenue by offering a variety of products with differential, bundled pricing.

Network Effect

In a similar vein, maximizing revenue in the hospitality industry is also complicated by the issue of selling multiple nights stays (known as “length of stay”). Guests who wish to stay for multiple nights are technically buying a different “product” than guests who wish to stay for only one night. However, the sale of these single versus multiple night stays are linked. The sale of one product (a single night stay) could potentially block the subsequent sale of an alternate product (a two night stay). For example, the hotel might have one room available on a Saturday night and a combination demand from guests who want to stay two nights arriving Friday and one night arriving Saturday, but no guests who want to arrive Friday and stay one night. If the hotel were to sell the room to a guest who was willing only to stay Saturday night, then they would not be able to sell this room on Friday to guests wishing to stay for two nights. In fact, with many rooms likely to go empty on Friday, the hotel would be better off selling a room only to guests wishing to stay two nights, even if they had to offer a discount off of the peak Saturday night rate to do so (two nights at $150 generate more revenue over all than one night at $250) (**Error! Reference source not found.**).

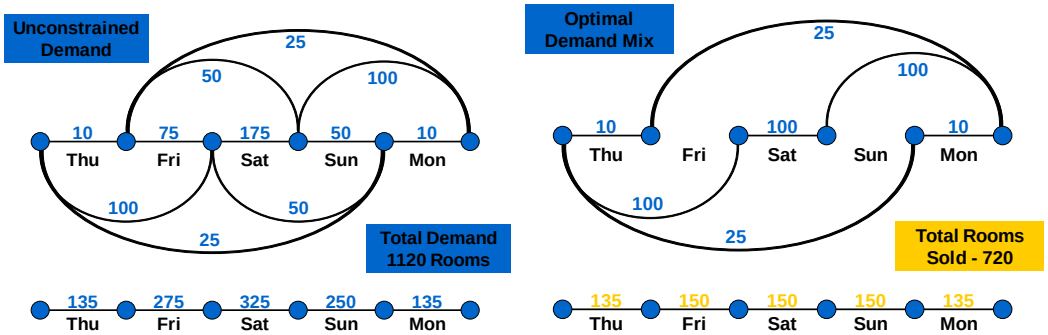

Figure 5: Example of Network Problem in Hospitality

In order to support this decision, revenue management forecasts must be performed at a very detailed level, down to the specific market segment, length of stay, and room type. Most hospitality organizations forecast lengths of stay from 1 night to 8+ nights and can have 10+ room types and 20+ market segments. The forecasting window is usually a year. This results in the revenue management solution being required to perform over 584,000 forecasts nightly. Further, some of the market segment, room type, and length of stay combinations might have very low demand – one or two rooms every once in a while, making accurate forecasts a challenge. Sparse forecasting techniques, as well as aggregation and disaggregation methods can be used to handle this problem. The bottom line: when multi-night stays become commonplace, the objective function of the optimization algorithm for hospitality must account for the network effect of multiple night lengths of stay.

Fashion retailers might face a similar challenge. There might be bundles of products, such as ”coordinates,” that can be sold together or separately. However, selling the individual components is much less valuable to the retailer than selling the package, and individual components can lose their value to the customer. For example, suit coats without matching pants or skirts are not as valuable to customers and must be deeply discounted if they are to be sold without the rest of the suit. While the sale might not be completely blocked, the item must be discounted so deeply that it is much less valuable to the firm, and in the extreme case, even sold at a loss.

Transparent Pricing

The recent transition to heavy use of Internet bookings has posed particular challenges for the hospitality industry. Instead of having to call many hotels in a market, the consumer is now able to easily see all offered hotel prices and products within a market and across channels. This transparency has increased competitive pressures on price and has limited the flexibility of hotels to offer a variety of prices through different selling channels. Due to pressure from consumers who were frustrated at having to search multiple Web sites to find the best deal, hotels have been forced into “Best Available Rate” guarantees. They promise their consumers that the lowest available rate will always be offered on their Web site. Once hotels made this promise, on line travel agents (like Expedia, Orbitz, and Travelocity) started building “rate parity” into their contracts with hotel companies. For example, hotels guarantee that they offer the best available rate through their own Web site, but their contract with Expedia requires that that exact rate, the lowest available, also be offered on Expedia even though the cost to sell the room through that channel is much higher than through the hotel Web site. There are penalties both actual and in good will if the hotel violates this guarantee. This presents an analytic challenge, to forecast the “right” best available rate, and also a logistical challenge to ensure that the “right” rate is communicated to all possible selling channels. Pricing solutions for hospitality must also take into account competitive information, as this will be fully transparent to the customer at the time of the buying decision. Pricing transparency has increased competitive pricing visibility for hospitality and resulted in a new set of algorithms, choice modeling, that take customer shopping behavior into account in the pricing decision.

Though increased competition and price visibility from the internet certainly has impacted certain retail markets considerably (e.g., book stores), fashion retail outlets still maintain some flexibility to offer different types and levels of discounts in different outlets, since customers do not generally wander from store to store to find the “best” price. However, consistent pricing across stores is an expectation that most customers hold and is especially important if advertising is to be effective and efficient. Most fashion retailers feel that commonality across stores is very important

at initial price and also during early season promotional periods, but are willing to forego this requirement as inventories deplete toward the end of the selling season and cross-store shopping becomes difficult. In order to support differential pricing across outlets, however, store operations must have clear policies regarding store transfers, and so on, to ensure a consistent and pleasant customer experience.

RELATED PROBLEMS

Both hospitality and retail face challenges that are similar in nature (and in some cases directly related) to revenue management. Solutions have been developed to address these business problems. In this section we will briefly describe these problems and the related solutions.

HOSPITALITY

Groups

Many hospitality companies rely on bookings from groups to fill their hotel rooms. Groups tend to book farther in advance than transient guests. They are frequently offered discounts in exchange for volume, but they bring other revenue streams such as meeting room rentals and food and beverage spend. Accounting for groups adds a significant challenge to the hospitality revenue management problem. Group demand is "lumpier" than transient demand and presents significant forecasting challenges. Further, because of the advanced nature, group planners are usually not sure of the exact size of the group, so the initial group room block might not represent the number of rooms that the group will eventually require. Hotels generally require guarantees to protect inventory for groups, but must predict how much demand from each group will materialize so that they do not end up with empty rooms. Pricing for groups is also challenging, because it must account for any displaced revenue from other streams of business. This tends to increase as the size of the group increases, as well as the expected volume discount. The IDeaS V5i solution uses a special set of forecasting and optimization algorithms to solve this problem. The solution also includes a displacement analysis, so managers can understand the impact of accepting the group on transient revenue.

Ancillary Spend and the Casino Problem

Many hotels, particularly resort hotels, have significant ancillary revenue streams from other revenue generating outlets like spas, restaurants and golf. The right mix of demand will spread spend across the property, so these companies want to ensure that they are accepting guests that will maximize revenue across the property rather than strictly hotel room revenue. Therefore, forecasting algorithms should forecast the expected ancillary spend by market segment, and this value should be folded into the optimization algorithm. As discussed earlier, these different revenue streams have different cost structures, and therefore, different profitability. Therefore, when ancillary revenue is considered, it must be the *profit* from these streams so as not to skew the decision to favor less profitable segments.

The casino resort problem is a good example of accounting for the total value of the customer in the hotel room pricing decision. In this industry, spend on the casino floor is often the primary and most profitable revenue stream on the estate. Since patrons are more likely to play where they stay, the hotel rooms are used as resources to maximize revenue from the casino. Casino patrons frequently receive complimentary or heavily discounted rooms based on their value to the casino. Rather than forecasting and optimizing hotel room revenue, the gaming value of each customer segment is calculated, and systems forecast demand by gaming segment. This customer value is fed into the optimization algorithm. The resulting hurdle rate represents the gaming value associated with the room, and patrons are granted discounts and comped rooms according to their value compared with the hurdle rate. This method ensures that the most valuable customers have priority access to the limited number of hotel rooms. This method works well for casino properties where guests identify themselves in advance, and their value is known. It becomes trickier in a resort environment when rates must be published and the majority of guests do not have a known value.

FASHION RETAIL

Size optimization

Demand for items by size can vary by region or even store to store. Therefore, offering the exact same distribution of sizes to each store in a retail chain frequently results in excess inventory by size in some stores and shortages in others. Further complicating this issue is that items come in packs according to sizes and colors. SAS® Size Profiling helps retailers to understand the distribution of demand by size for different types of merchandise (men's, women's, teen's, shoes, and so on), while the SAS® Size Optimization solution determines correct distribution of packs to order from vendors and how to distribute packs to stores in order to best meet demand while minimizing extra inventory and pack handling costs.

Space Optimization

An interesting element of the retail problem is the intersection between revenue generated by a product, the space available display the product for sale, and the location of that space relative to other merchandise. Giving more space to one category of products means less space for another category. Similarly, certain categories of merchandise sell better when they are near each other – but not every product can be "right next to" all the others. Space optimization requires understanding the impacts of these trade-offs on revenue and profitability.

CONCLUSION

While seemingly very different business problems, both the hospitality and retail pricing problems meet the necessary conditions required to apply revenue management: fixed and limited capacity, time perishable inventory, segmentable customers, high fixed and low variable costs, and time-variable demand patterns. These two industries can maximize revenue by applying revenue management theory, but unique operating characteristics of each industry require adjustments to the algorithms used to solve the problem. In both cases, algorithms recommend pricing strategies that can be used to maximize revenue from the fixed and limited capacity. Any firm that wishes to apply revenue management techniques should first evaluate whether they meet the necessary conditions and then evaluate their unique operating characteristics to determine how the algorithms need to be adjusted.

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