Using Palisade RISKOptimizer to increase yield-management effectiveness in the hotel industry

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ABSTRACT

This paper presents the use of Palisade RISKOptimizer to optimally manage inventory in situations where the unused unit instantly loses its value. The application of RISKOptimizer will help different industries maximize the mean profit for their perishable asset. This paper will discuss a technique to allocate limited resources to the right kind of customers at the right time for the right price in order to maximize total revenue or "yield" on the investments. Yield management comprises of both a business philosophy and a methodology that can be implemented in a variety of ways. The main task of RISKOptimizer is to associate the power of Palisade @Risk's Monte Carlo simulation engine with the advanced genetic algorithm of Evolver to solve optimization problems that include uncertainty. A simulation spreadsheet model from the hotel industry will be presented to demonstrate the utilization of RISKOptimer in the area of yield management.

Keywords: RISKOptimizer, Palisade Decision Suite Tools, Yield-Management, Hotel Industry, spreadsheet modeling

DEFINTION OF YIELDMANAGEMENT

In business, the term "Yield Management" is used for a number of methods, all of which have the purpose of maximizing the financial yield from a defined inventory. It is usually implemented as a model for price setting, with the goal of maximizing revenue by varying the price charged to a given customer based on the value they place on the purchase. The methods make use of dynamic pricing, forecasting, and market segmentation. Their goal is to maximize the revenue by controlling levels of inventory, and the pricing of it. This is also referred to as Revenue Management.

Yield Management uses the principle of supply and demand, with the underlying concept of selling the right product to the appropriate consumer, and at the right time. Using it, managers can systematically place customers into the appropriate "supply demand" range, with the goal of achieving the highest yield for the products. A customer who has minimal flexibility in their plans is most likely to accept a higher price for lodging. On the other hand, a customer with greater flexibility is more likely to bargain hunt, and not pay the higher price. Revenue Management involves more than the manipulation of numbers, it is a holistic approach to determining a strategy with the goal of achieving the greatest amount of revenue. It involves simulation and optimization tactics.

According to Gabor Forgacs's (2010) explanation, Yield Management encompasses product definition, competitive benchmarking, strategic pricing, demand forecasting, business mix manipulation, and distribution channel management.

BUSINESS ENVIRONMENT SUPPORTING EFFECTIVE YIELD MANAGEMENT

Effective Yield Management is a challenge since it involves customers' behavior. There are however several factors that support the ideal environment for effective Yield Management technique. These include: fixed or limited capacity, fluctuating demand, market segmentation, advance sales, perishable inventory, low marginal or variable cost and multiple pricing structure.

Fixed or Limited Capacity

In general, a hotel has a fixed inventory of rooms of each type (standard double, standard king, two king beds, view, suites, non-smoking, etc.). While they might well charge more for the larger rooms that can accommodate a family, it will depend upon what the clientele is at any given time of week (or year). Thus, the user of Yield Management methodologies needs to understand and take into consideration the demand for each of the elements in the inventory, and the values the client places on them to be able to price them optimally.

Demand Fluctuations

Years ago, many thought that one could get the best price by booking a room far in advance. Whether or not that was really true then, it most certainly is not the case today. As managers become more adept in understanding the customer's preferences, they adjust the prices accordingly. For example, it is not only location (beach or mountains) but also season (summer or winter) that influences demand in recreational areas.

City hotel managers must take it upon themselves to learn about the conventions and corporations in their area and take the time to learn about the patterns or demographics of these corporations or organizations. The same is true for major events, such as football bowl games. Hotels (many using Yield Management methods) may start with a high rate, and drop it accordingly with time, in order to assure filling the rooms as a meeting or convention approaches. However, if the reservations are ahead of forecast, the rates may go up.

Market Segmentation

Different groups of customer will have different ideas of the value of the product. Business travelers often can't book in advance, may need business services, and might well not be picking up the tab personally. Families on vacation will often need multiple beds, and retired people may put saving a few dollars over some conveniences.

The variety of specialty hotels has everything to do with the type of consumer segments the business wishes to target. Different segments have different tastes and preferences and perhaps most significantly, different price points. There are: business travelers, couples, families, backpackers and solo travelers.

Advance Sales Reservation

Reservations made in advance and variable demands allude to a distribution of demand of consumption, so that there are variations in prices to manage, and segmental markets ensure that the firm is able to discriminate on prices. Demand also varies with the season. A luxurious hotel in the Florida in the winter will have a very different demand than a hotel in Canada in the winter. A ski resort in Utah will have a different demand in the winter than the summer season. Each hotel must identify its main season, off season and shoulder seasons.

Hotels commonly develop rate structures that are tailored to their expected demand pattern, and extend a year or more out. This is used to work with market segments such as the tour industry or convention event planners. Here a company will book a block of rooms well in advance and at a contract price. In this case, for the hotel to maximize its revenue, the algorithm must be able to allocate the inventory of rooms to the clients who will accept the highest prices.

Perishable Inventory

If a hotel room is not sold on any given night, then it has effectively "perished" for that night. This means that the hotel business has a limited window over which the product can be sold. This is common in many industries (e.g., airline seats, concert seats, sports events). Many hotels will offer a discount if an advanced reservation is paid at the time it is made, and is non-refundable. They will also commit inventory to services such as Expedia, for "special discounts" as the reservation date approaches the current date.

Low Marginal Costs

For a hotel, the marginal cost of cleaning and expendables for a room that is used, compared to one that is not sold is small when compared to the marginal cost of having built it. Thus the variable cost to the hotel need only be exceeded by a reasonable amount, if it is necessary to

discount it, for the hotel to be better off selling it. This of course does not take into account the intangible impact of undermining the price structure.

Multiple Pricing Structures

According to hotel's quality and service, room prices change or the hotel can offer different prices for different customers and groups for yield management. Each hotel will establish its own "standard room rate". Room rates are usually determined at the time of registration. This means that the room rates are standard prices for the customers unless the customer has a special status with the hotel.

Group rates depend on a number of variables, including the season of the year, the number of room nights wanted (based on group size and duration), other revenue (food and beverage, function room rentals, golf, spa, etc.), and the group's history. Group bookings demand special attention and are usually handled by the Sales Manager. In places like Las Vegas, one will find room rates that vary greatly depending on the number of conventions, whether it is a weekend or week night or what shows happen to be playing.

It is important to have an understanding as to how a client will perceive the variable rate policy to aid hotel management in using the revenue maximizing tools, while maintaining client satisfaction.

OTHER CONSIDERATIONS (VARIABLES) IMPACTING YIELD MANAGEMENT

There are other considerations or variables that impact Yield Management. These include purchases at various time, overbooking, cancellation, discount allocations, group reservations, packaging, extending the length of stay, and customer loyalty practices.

Purchases at Various Times

Hotel room demand varies significantly during an ordinary week and by season. Hotels serving business clients are more in demand during the weekdays, and less so on the weekend. Hotels in Hawaii or on the Florida Coast are busier in the winter, but less so in the summer. This leads to the need for on and off peak rates to manage demand and maximize profit with a fixed quantity of available rooms.

Overbooking

Overbooking is a common practice with hotel that want to maximize revenue. Hotels managers assume that someone will cancel at the last minute and the hotel will be filled. Some hotels have a 24 hour cancellation policy. Cancellation Policy Hotels have a variety of options, from no charge for a cancelled reservation, or charging the full amount if not canceled more than 24 hours before, to a week or more before in the case of very high on peak times. This is to minimize the chance of rooms being unused (or perishing) for no shows, and provides the revenue as if the client had actually arrived.

Discount Allocation

This is a practice of offering a reduced rate to different groups of people. Discount rates are often offered to senior citizens, government officials or to members of a certain group, such as an AAA auto club. They are also sometimes offered to large corporations which have a large number of employees traveling, to encourage them to have "brand loyalty".

Packaging

This is the practice of including items or services in addition to the room and treating it as a total package – all for one price. For example, the price may include breakfast, a car rental or a round of golf. These packages may appeal to clients in search of "deals". It provides the opportunity to hide, or mask, the actual cost of elements, while increasing revenue.

Extending the Length of Stay

Inevitably, there are times that a guest wants to extend their stay. This presents a problem if the hotel is fully booked for the entire time the guest wants. Imagine that the guest arrives for one night on a Tuesday, and then requests staying until Friday morning. The hotel however is fully booked on Thursday. Management has to balance the probable demand for the room on Wednesday, with the risk of not being able to honor a possible good customer's reservation on Thursday. While it is an advanced and complicated method for decision making, it can significantly contribute to total revenue.

EXAMPLE OF USING RISKOPTIMIZERIN THE HOTEL INDUSTRY

RISKOptimizer will be used as a tool to perform yield management in the hotel industry. The main task of RISKOptimizer is to combine the advanced genetic algorithm of Evolver with the power of Palisade @Risk's Monte Carlo simulation engine to solve optimization problems that involve uncertainty. It finds the best solutions for problems that include optimizations under uncertainty while incorporating for random uncontrolled factors. The following numerical example illustrates the use of RiskOptimizer in performing yield management in the hotel industry.

Sleep Tite Hotel has 200 rooms; 120 rooms are standard size, 60 rooms are deluxe size and 20 rooms are corporate suites. Sleep Tite has two sets of pricing, the discount rate and the full price rate. The discount rate is $85 for the standard, $110 for the deluxe and $175 for the corporate suite. The full price rate is $125 for the standard, $175 for the deluxe and $225 for the corporate suite. Sleep Tite manager must determine how many rooms to reserve for the discounted rate and how many rooms to offer at the full price rate. The manager cannot book too many rooms because the hotel incurs overbooking costs for each person who shows up with reservation and cannot find a room. The overbooking costs are $200 for the standard, $250 for the deluxe and $300 for the corporate suite. Sleep Tite incurs a variable costs of $30 for the standard, $35 for the deluxe and $50 for the corporate suite. From past history Sleep Tite believes that the demand is different among the three room sizes. Table 1 (Appendix) presents the historical demand for Sleep Tite.

Sleep Tite estimates that fifty percent of the customers who cannot reserve a discount room will book a room at a full price rate. Sleep Tite has a twenty four hour advance cancellation policy. Records show that on average 95% of holders of reserved rooms show up on time. The

hotel manager must address several issues. How many rooms should be reserved at a discount rate? How many rooms should be reserved at full price rate? How many total reservations should Sleep Tite take before cutting off rooms offering?

THE OPTIMIZATION MODEL DEVELOPMENT USING SPREADSHEETS

Sleep Tite manager needs to develop a spreadsheet optimization model to solve for the limit on the number of discounted rate rooms and the limit on the number of full rate rooms to offer for the available three room sizes. Since the nature of the demand for the three room sizes is uncertain, Sleep Tite manager will use software that deals with simulations and optimization under uncertainty. Sleep Tite manager decided to use RiskOptimizer from Palisade Decision Suite tool as a mechanism to solve for the number of offered rooms.

Any optimization model has three requirements. An optimization model seeks to maximize or minimize some quantity (usually profit or cost). In the case of Sleep Tite, the objective function is to maximize the expected value of the contribution margin. Second, there must be alternative courses of actions to choose from. In the operation management literature, they are called the decision variables. They were also known as adjustable cells in spreadsheet modeling. Sleep Tite has two sets of adjustable cells. The first set is the limit on the number of discount rate rooms to offer for the standard, deluxe and corporate suites. The second set of adjustable cells is the limit on the full price rate rooms to offer for the standard, deluxe and corporate suites. The sum of these two adjustable cells for each room size is the total number of rooms to offer before cutting off the reservations. The third requirement is the list of constraints or restrictions that limit the degree to which the model can pursue the objective function. Sleep Tite needs to make sure that the total number of rooms to offer is greater than or equal the number of discounted fare rooms (or else the value of full price rate rooms will be negative). Also the values on all adjustable cells need to be positive integers. Figure 1 (Appendix) Exhibits the spreadsheet model solution for Sleep Tite.

The following steps are used in developing the spreadsheet optimization model for Sleep Tite:

In cells B4, C4, and D4 enter the number of rooms available for Sleep Tite for the standard, deluxe and corporate suites respectively. In cell E4 enter the sum of B4:D4. In cell F8:K13 enter the historical demands for the three room sizes and their associated probabilities. In cells B6:D6 enter the discounted price rate, in cells B7:D7 enter the full price rate, in cells B8:D8 enter the overbooking cost, and in cells B9:D9 enter the variable cost for the standard, deluxe, and corporate suite respectively. In cell B11 enter the percentage of people who get shut out of a discount rate will pay full rate. In cell B15 enter the average of all room reserved who will show up for their reservation on time. In cells B17:D17 enter trial values for the limit on rooms with discount rates (first set of adjustable cells). In cells B18:D18 enter trial values for the limit on rooms with full price rates (second set of adjustable cells). In cells B19:D19 compute the maximum number of reservations that will be taken with the formulas B17+ B18, C17+C18, and D17+D18. In cell B21, the total demand for the standard room size is generated with the formula RiskDiscrete(F8:F13,G8:G13), in cell C21, the total demand for the deluxe room size is generated with the formula RiskDiscrete(H8:H13,I8:I13), and in cell D21, the total demand for the corporate suite is generated with the formula RiskDiscrete(J8:J13,K8:K13).

Everybody who wants to reserve a room will reserve a discounted rate room if it is available. Therefore, the number of discount rates room sold is computed in cells B23:D23 with

the formulas minimum of discounted room reserved and total coming as follows: Min(B17,B21), Min(C17,C21), and Min(D17,D21) Everyone who wanted to reserve a room and could not reserve a discount rate room is a candidate to reserve a full rate room. In cells B24:D24, the full price rate candidates are computed using the following formulas: Max (B21-B23, 0), Max (C21-C23, 0), and Max (D21-D23, 0).

In cells B25:D25, the fact that an average of fifty percent of all people who get shut out of a discount rate will still reserve at full rate will be used. Therefore, the number of people who are willing to pay full rate are computed with the following formulas: =IF(B24=0,0,RiskBinomial(B24,$B$11)), =IF(C24=0,0,RiskBinomial(C24,$B$11)), and =IF(D24=0,0,RiskBinomial(D24,$B$11)). In cells B27: D27, the number of full rate rooms reserved (sold) are computed by the minimum number of full rate rooms available and the number of people willing to pay the full rate. Using the following formula: Min (B18, B25), Min (C18, C25), and Min (C18, C25). In cells B29:D29, the fact that an average of 95% of all the people who had a reservation will show up on time will be used. Therefore, the total number of people showing up will be 95% of the sum of the number sold at discount rate plus the number sold at full rate. To compute the total number showing up, the following formula is used: =RiskBinomial(B23+B27,$B$15), =RiskBinomial(C23+C27,$B$15), and =RiskBinomial(D23+D27,$B$15). In cells B31: D31, the revenues from discounted rate are computed using the following formulas: B23.B6, C23*C6, and D23*D6. In cells B32: D32, the revenues from full rate are computed using the following formulas: B27*B7, C27*C7, and D27*D7. In cells B33:D33 the total revenues are computed by taking the sum of revenues generated from discounted rate and revenues generated by full rates using the following formulas: B31+B32, C31+C32, and D31+D32. In Cells B36:D36, the overbooking cost is generated using the following logic: If the total number of people showing up is greater than the number of rooms available, then Sleep Tite will incur an overbooking cost of the difference. Therefore, The following formulas are used: =IF(B29>B4,(B29-B4)*B8,0), =IF(C29>C4,(C29-C4)*C8,0), and =IF(D29>D4,(D29-D4)*D8,0). In cells B37:D37, the variable costs are generated using the following formulas: Minimum of total number showing up and the number of rooms available multiplied by the variable cost as follows: =MIN (B29, B4)*B9, =MIN (C29, C4)*C9, and MIN (D29, D4)*D9. In cells B38: D38, The total cost is calculated by taking the sum of overbooking cost and variable cost as follows: B36+B37, C36+C37, and D36 +D37. In cell B40:D40, the contribution margin is calculated for the three room sizes as follows: B33-B38, C33-C38, and D33-D38. In cell E40, the contribution margin for all the rooms is calculated by taking the sum of (B40:D40). Please Note that this is the cell that represents the objective function of the optimization model. RiskOptimizer will be used to maximize the expected value of cell E40 as shown in Figure 2 (Appendix).

RISKOPTIMIZER SIMULAION RESULTS DISCUSSION

Figure 3 (Appendix) exhibits the simulation results for RiskOptimizer. The spreadsheet optimization model was developed to solve for the limit on the number of rooms to be reserved at a discount rate, the number of rooms to be reserved at a full price rate, and the limit on the total reservations that should be taken before cutting off rooms offering. The model ran 1779 valid simulations, each one has 1000 iterations. RiskOptimizer recommends that Sleep Tite limit the discount rate to 0 for the standard rooms, 2 for the deluxe rooms and 5 for the corporate suite rooms. It also recommends limiting the full price rate to 128 for the standard rooms, 67 for the

deluxe rooms, and 20 for the corporate suite rooms. At most 128 rooms' reservations for the standard, 69 rooms for the deluxe, and 25 rooms for the corporate suites should be taken. From Table 2 we see that RiskOptimzer finds the maximum expected contribution margin to be $20,890.

The advantage of this spreadsheet model is that all the formulas were referred to cell references. None of these cell formulae used any hard coded numbers in them. Therefore, if the historical demand changes in upcoming years, the only task required by Sleep Tite manager is to modify the old historical demand, update for the new one, and rerun the model. The model also took into consideration other input such as the prices for the discounted rate, the full price rates, overbooking costs, and variable costs. Any future changes for any of these numbers can be regularly updated to rerun the simulation model in order to get the most current results. The model is also largely affected by two important inputs. It is first affected by the percentage of people who get shut off at a discounted rate who are willing to pay the full price rate. We used fifty percent in the model. If this percent changes in the future, the manager only needs to update it into the spreadsheet and rerun the model. The other important input cell that affects the solution is the show up rate for people who already reserved a room. The model used ninety-five percent in the solution. If any other future percent occurs, one only needs to update the model and rerun for more accurate results.

Three basic alternative solutions can be addressed for companies that expect uncertainties in their historical demand. First, mangers can use their best judgments and guesses for uncertain demand and move forward with some deterministic models like linear programming. Second, a mathematical model can be developed to incorporate uncertainty. The disadvantage of this alternative is that it theses analytical models can be very complicated and difficult for many mangers to understand. The third approach to face the uncertainty in the historical demand is to develop an Excel spreadsheet simulation model. The advantage of this approach is that it is relatively easy to construct regardless of the complexity of the problem.

CONCLUSION

Yield Management is not a simple strategy. It involves simulation and optimization tactics. The spreadsheet model in this paper provides managers with a template to use in order to maximize the expected contribution margin in the hotel industry. Managers can also make changes to the model as the changes occur. The most advantageous feature is that it does not require managers to have mathematical skills to apply this strategy..

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APPENDIX

Table 1: Sleep Tite Historical Demand

		Sleep Tite Historical Demand			
Standard		Deluxe		Corporate Suite	
Demand	Probability	Demand	Probability	Demand	Probability
160	0.08	70	0.08	20	0.05
200	0.17	90	0.2	30	0.15
220	0.35	100	0.25	40	0.15
230	0.25	120	0.35	50	0.2
240	0.1	130	0.07	60	0.35
250	0.05	140	0.05	70	0.1

Figure 1: The Spreadsheet Model

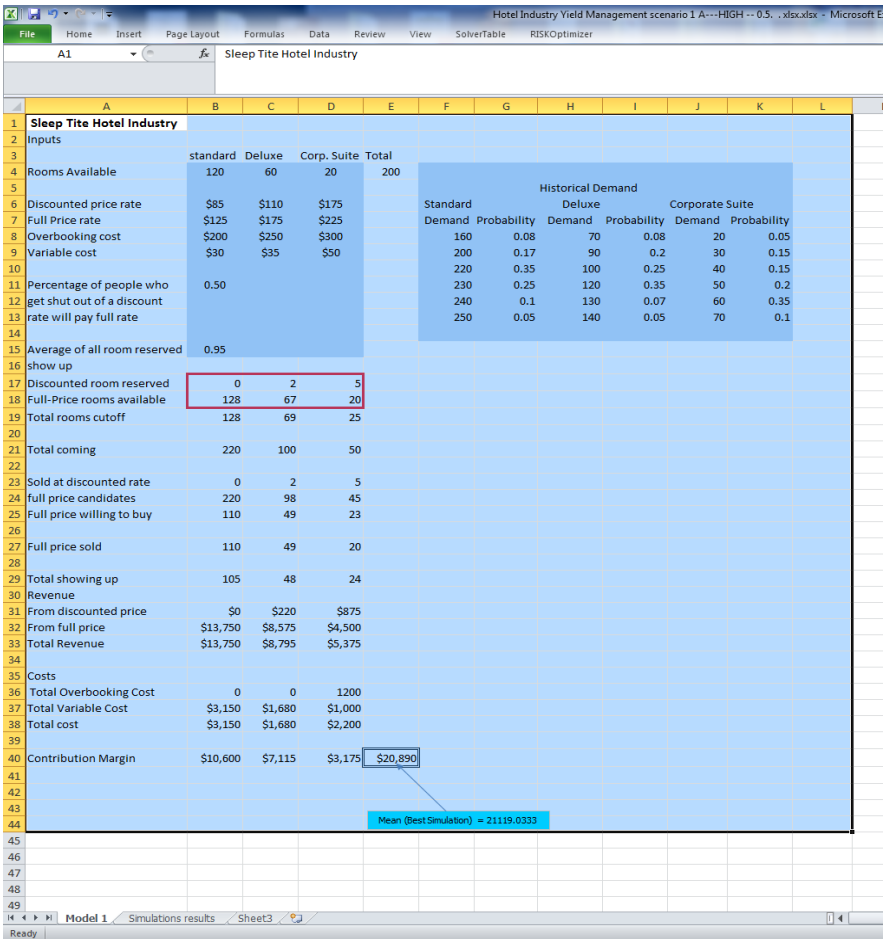


Figure 2: RiskOptimizer -Model Parameters

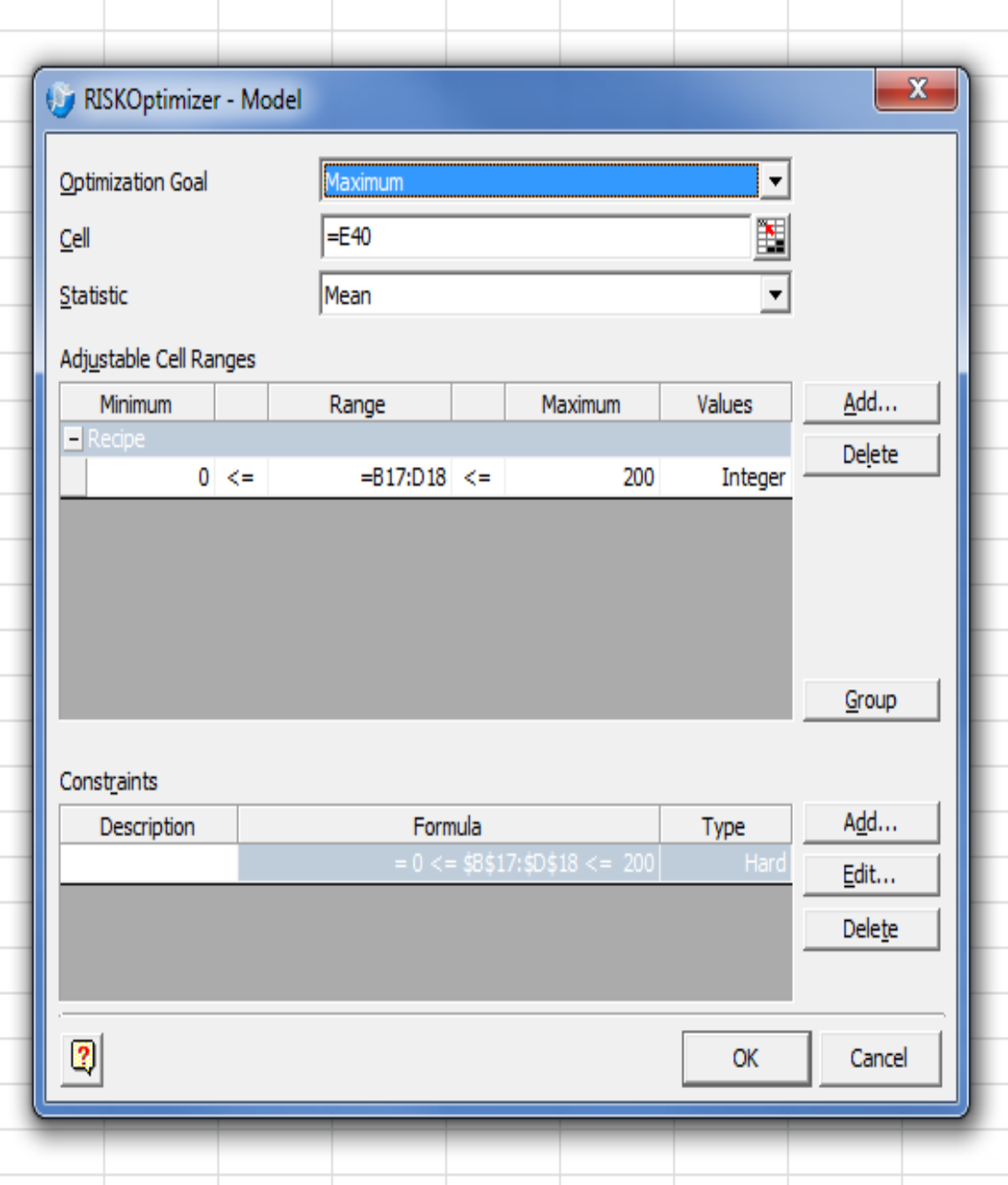
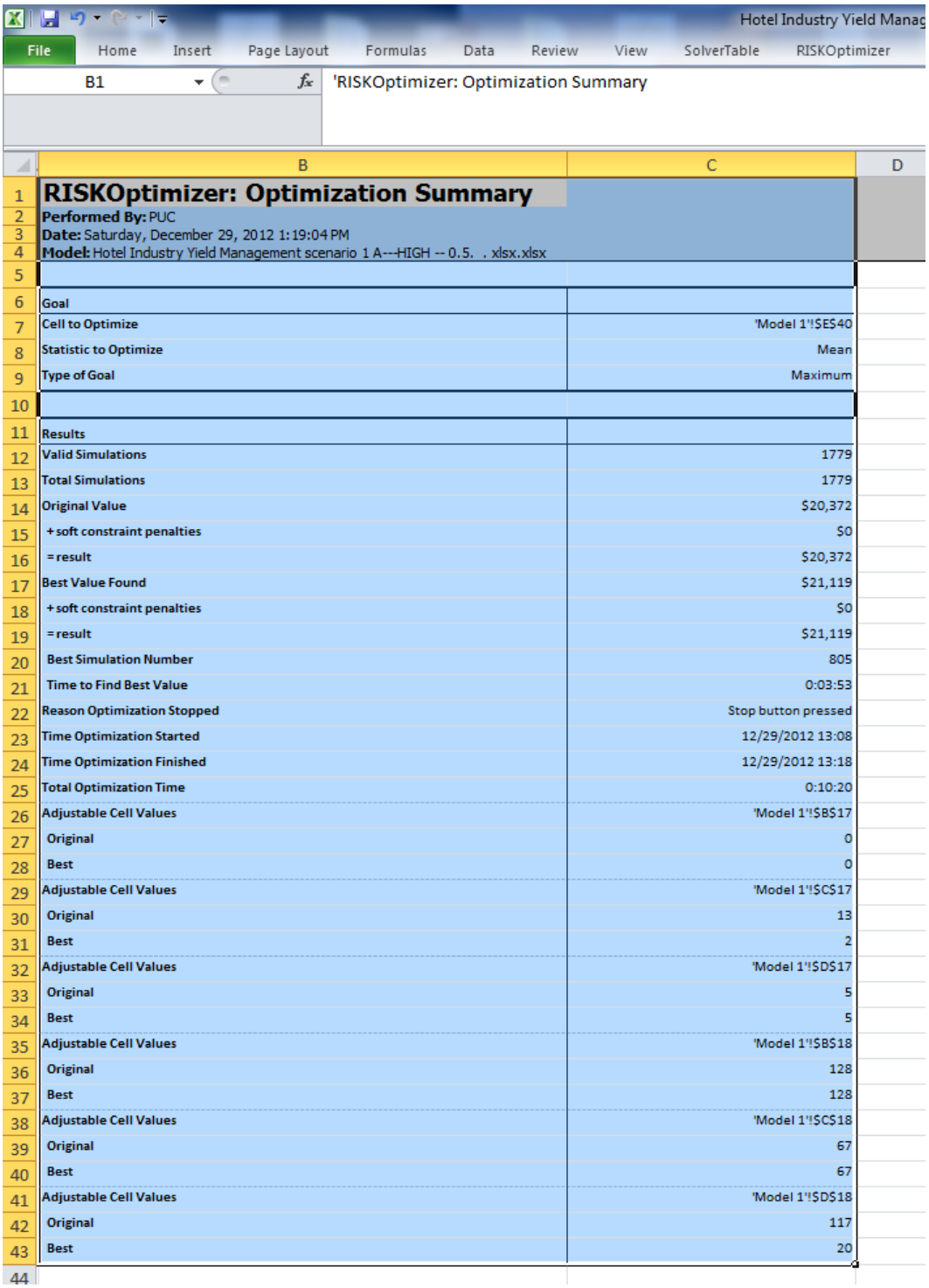


Figure 3: RiskOptimzer-Optimization Summary



Hotel Industry Yield Manag

File | Home | Insert | Page Layout | Formulas | Data | Review | View | SolverTable | RISKOptimizer

B1 'RISKOptimizer: Optimization Summary

	B	C	D
1	**RISKOptimizer: Optimization Summary**		
2	**Performed By:** PUC		
3	**Date:** Saturday, December 29, 2012 1:19:04 PM		
4	**Model:** Hotel Industry Yield Management scenario 1 A---HIGH -- 0.5. . xlsx.xlsx		
5			
6	Goal		
7	Cell to Optimize	'Model 1'!$E$40	
8	Statistic to Optimize	Mean	
9	Type of Goal	Maximum	
10			
11	Results		
12	Valid Simulations	1779	
13	Total Simulations	1779	
14	Original Value	$20,372	
15	+ soft constraint penalties	$0	
16	= result	$20,372	
17	Best Value Found	$21,119	
18	+ soft constraint penalties	$0	
19	= result	$21,119	
20	Best Simulation Number	805	
21	Time to Find Best Value	0:03:53	
22	Reason Optimization Stopped	Stop button pressed	
23	Time Optimization Started	12/29/2012 13:08	
24	Time Optimization Finished	12/29/2012 13:18	
25	Total Optimization Time	0:10:20	
26	Adjustable Cell Values	'Model 1'!$B$17	
27	Original	0	
28	Best	0	
29	Adjustable Cell Values	'Model 1'!$C$17	
30	Original	13	
31	Best	2	
32	Adjustable Cell Values	'Model 1'!$D$17	
33	Original	5	
34	Best	5	
35	Adjustable Cell Values	'Model 1'!$B$18	
36	Original	128	
37	Best	128	
38	Adjustable Cell Values	'Model 1'!$C$18	
39	Original	67	
40	Best	67	
41	Adjustable Cell Values	'Model 1'!$D$18	
42	Original	117	
43	Best	20	
44			