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Implication of Statistical Indices in Hotel Room Revenue Analysis

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Abstract

The purpose of this paper is to introduce hotel managers and hospitality educators to room revenue analysis method that is based on statistical indices. A paper presents a theoretical example of a room pricing and shows how changes in a total room contribution margin can be attributed to one of three changes: (a) changes in contribution margins for a hotel room with a specific rate, (b) changes in proportion (composition) of different rooms sold, and (c) changes in quantity of rooms sold. Hotel managers may use this approach as a supplementary tool for already existing yield management techniques.

Keywords: Hotels, Statistical Indexes, Profitability.

Yield Management and Pricing Approaches in the Hotel Industry

Room pricing and revenue management are important matters for every hotel that wants to stay competitive and generate maximum possible profits. Hotel management faces a variety of complex issues such as providing consistent and quality service to its guests, reducing employee turnover, and generating profits. Hotels have an established track of handling room rates and reservations to maximize sales performance (Jones and Hamilton, 1992). Today, hotels offer various rates for the same room by utilizing yield management to maximize revenue for each room. The large hotel chains in general can afford spending more resources on a variety of up to date reservation and forecasting systems than small independent hotels (Ingram, 2008). Albright (2008) stated that revenue and pricing

management in the last few years became more sophisticated in the hotel industry because of wide introduction of such sales channels as for example Priceline or Expedia. In response to that hotels try to launch more and more advanced reservation systems.

Literature has proposed a variety of definitions of yield management. According to Martin (2006) a yield/revenue management is a system that attempts to understand and react accordingly to a consumer behavior in order to maximize revenues and profits. The yield management system was first introduced in the airline business in the late 1970s when competition for guests became more significant due to the deregulation of the U.S. airline industry (Kimes, 1989 and Walker, 2004). Revenue management system was later implemented to other type of business including the hotel one and became quite beneficial. Hotel management became more interested in structured systems for revenue analysis. Today hotels are among the top three major industries that utilize principles of revenue management (Chiang, Chen, and Xu 2007). The main objective of yield management is to achieve the highest possible revenue through manipulation of room rates based on guests' demand (Siguaw et al., 2001). Badinellin (2000) showed that the basic idea behind yield management is that different guests are willing to pay different rates for the same airline seat or hotel room. Jauncey et al. (1995) stated that yield management allows managers to offer a variety of rates to different customers based on anticipated demand.

According to Verginis (1999), there are two main approaches to pricing: cost-based and market-based. The cost-based pricing approach is heavily dependent on the base cost of a product. The market-cost approach focuses more on such variables as product demand and competition. In hotel-room pricing, the first cost approach would be based on the assumption that for every thousand dollars included in the cost of a room \$1.00 should be set up in profits (Schmidgall, 2002). In other words, if it cost \$150,000 to construct a room, the price for this room is supposed to be \$150 per night. The second cost approach is a bottom-up approach

based on the Hubbard formula that eight main steps that can determine the price that should be charged per hotel room (Arbel and Woods, 1991). Clearly both approaches ignore market conditions and guest needs.

Market-based approaches perhaps reflect principles of microeconomics related to supply and demand. Relihan (1989) stated that demand for hotel rooms can be influenced by raising or lowering prices for hotel rooms. Lewis and Shoemaker (1997) argued that how much money guests are willing to pay for a product should be taken into consideration when trying to determine the price of a hotel room. The clearest advantage of this approach is receiving actual feedback from customers. This approach is definitely time consuming and may be quite costly. Room price is one of the easiest variables to control for hotel managers but there is no universal approach that can be beneficial for all hotels.

In contrast to production companies that can adjust the number of units produced based on product demand, hotels have a relatively fixed number of rooms that can't be easily changed within a short period of time (Choi and Cho, 2000). Kotas (1986) claimed that hotels are one of those segments of the service industry that experience significant demand fluctuations that can be broken into annual, weekly, and daily. For example, hotels in Aspen, Colorado can be near, or at capacity in the winter due to its fabulous mountain skiing resorts that attract tourists from all over the world. On the other hand, Alaska's hotels may be almost sold out during the summer months because challenges of cold winter weather may not be well-taken by travelers. Weekly patterns will be more noticeable in hotels that cater to a clear market segment such as business and leisure. Business travelers will stay in hotels more during the week while leisure travelers may stay more on weekends and holidays. Daily patterns perhaps reflect that most people have a tendency to leave a hotel in the morning and come back at night.

However, in many cases managers can adjust such variables as average room rate to compensate for fluctuations (Lockwood and Jones, 1990). Griffin (1996) listed accuracy of historical usage information among several factors that are essential to the yield management process. Indeed, historical information and its proper analysis is a key reference point for future decisions. Donaghy et al. (1995) suggested that historical data must be properly analyzed in order to predict any possible fluctuations in demand and fully utilize hotel capacity and forecast future demand. In the majority of cases room rates are taken into account when a room selling price is in a process of being established.

Rate fences can be divided into three categories. The first one is a physical rate fence such as room type, room view and view location. Non physical rate fences include (a) customer characteristics, (b) transaction characteristics, and (c) consumption characteristics. Customer characteristics include employees of companies discounts, frequent customers, holders of certain memberships e.g. AAA. Transaction characteristics include restrictions on time of purchase, place of purchase, level of risk accepted, and limited availability. Time characteristic fences include day of the week, time of year and length of stay (Kimes, 2002). Despite the fact that profit from room sales is not the only source for hotel revenues it is definitely the largest one and requires specific attention. Conducting basic analysis that reveals absolute and relative differences in profit amounts among different comparison periods has become a broad practice for hotel business (Schmidgall, 2002). Jones and Hamilton (1992) indicated that despite the significant importance of technology in issues of yield management, human factors can not be underestimated. Indeed management of every company has to have a clear understanding of numerical information that can be obtained through reports in order to get a better understanding of business operations.

A proper application of statistical indexes may help management further determine how different quantitative factors such as contribution margin per room, the number of rooms

sold, and proportion of a specific selling rate can contribute to overall revenues of a hotel for a specific period of time. The results can be compared among several periods that can go in chronological order or perhaps in the case of a strong seasonality factor (which is not unusual for the hotel business) among seasons with similar demand.

Laspeyres and Paasche Statistical Indices

Binary indices such as Laspeyres and Paasche are extensively used in macro-economics analysis. Both indices primarily explain changes that occur in obtained revenue related to changes in price and changes in quantity. The Laspeyres quantity index (1) is calculated using an arithmetic weighted average of price and quantities of purchased items where price is fixed on a level of a base period. The Paasche quantity index (2) presents a price index calculated using an arithmetic weighted average of price and quantities where price is fixed on a level of a recent period:

(1)

$$I_q^L = \frac{\sum_{i=1}^n p_i^0 q_i^1}{\sum_{i=1}^n p_i^0 q_i^0}$$

(2)

$$I_q^P = \frac{\sum_{i=1}^n q_i^1 p_i^1}{\sum_{i=1}^n q_i^0 p_i^1}$$

A similar algorithm is used for the Laspeyres price index (3) and the Paasche price index (4):

(3)

$$I_p^L = \frac{\sum_{i=1}^n p_i^1 q_i^0}{\sum_{i=1}^n p_i^0 q_i^0}$$

(4)

$$I_p^P = \frac{\sum_{i=1}^n p_i^1 q_i^1}{\sum_{i=1}^n p_i^0 q_i^1}$$

A variety of economic parameters can be presented as a combination of several variables. For example, in the hotel business, the number of rooms sold can be presented as the multiplication of rooms available for sale by the occupancy percentage. The main rule that should be applied to such multiplications is that the final parameter will have a clear economic meaning. The simple multiplication of sold hotel rooms by unsold hotel rooms doesn't have significant economic meaning.

Statistical indices can be modified and applied to analysis in many sectors of business. For example, if a car dealership has an increase in dollar sales from period one to period two, this sort of analysis will help to determine why the increase occurred based on which quantitative factor has changed. It may look like the increase in sales is a good thing but it may be caused only by the factor that individuals have purchased more expensive vehicles, but the actual number of cars sold has significantly dropped from period one to period two. In this case, the marketing department should try to find the reasons why the dealership has a drop in the number of cars sold.

Those indices are also beneficial for comparing price and quantity data on national consumption from one year to another. The fact that not all prices on goods increase or

decrease proportionally and some goods have a much higher impact on the changing of overall expenditures (e.g. pencils versus cars), the quantity (weight) of each item sold should be taken into account.

Utilization of Indices for Hotel Revenue Analysis

Indices with structures similar to those of Laspeyres and Paasche can be developed for hotel business analysis and include such variables as contribution margin per sold room and number of rooms sold. Multiplication of contribution margin (CM) per hotel room and the number of rooms sold (Q) shows the total contribution margin that a room with this particular rate “delivers” within a certain period of time. A summation of total contribution margins for rooms with different rates determines the total contribution margin that hotel rooms deliver toward sale profits. Absolute and relative increases in overall hotel rooms contribution margin can be seen as positive trends because they directly contribute to increases of profits. However, a comparison of total room contribution margins between two or more periods does not provide detailed information about which quantitative variables contributed to this overall change and to what extent.

The absolute increase in total room contribution margin can be presented as a result of three individual changes: changes in contribution margins for a hotel room with a specific rate, changes in proportion (composition) of different rooms sold, and changes in quantity of rooms sold or as $\Delta CMQ = \Delta CMQ (CM_j) + \Delta CMQ (d_j) + \Delta CMQ (Q_j)$, where:

CM = contribution margin per individual room sold,

d = proportion (composition) of an individual room sold in a total number of rooms sold

Q = number of sold rooms, and

J = number of rooms of different types.

In hotel businesses, the number of rooms sold and the proportion of specific types of rooms sold may vary significantly from one period to another. It is almost impossible to achieve a situation when in two different months a hotel is selling exactly the same number of rooms and generate exactly the same amount of sales revenues from its transactions. Changes in the contribution margin for a hotel room may occur because of a difference in selling price or the direct (variable) cost of a room. Despite the fact that variable costs per hotel room do not often have significant changes, selling price per room and implication of a variety of discounts can be quite a common development.

In order to determine which quantitative factors (i.e. changes in room contribution margin, changes in proportion of rooms with different rates sold, and changes in quantity of room sold) have caused a change in the total contribution margin, only similar rooms that have the same given discount from period one to period two should be compared. An example in Table 1 and 2 demonstrates how an analysis can be conducted between two periods for a hotel that has only four different discounts.

Table 1

Information on hotel rooms with four different rates period one

Room	CM ₀	Q ₀	CM ₀ * Q ₀	d ₀
Types	contribution margin (\$)	Number of rooms sold sold	Total contribution margin per room (\$)	Proportion of sold rooms in overall room sales (%)
#1	128.5	1250	160,625	0.26315789
#2	117.4	1380	162,012	0.29052632
#3	146.5	1170	171,405	0.24631579
#4	93.2	950	88,540	0.2
Total		4750	582,582	

Table 2

Information on hotel rooms with four different rates period two

Room	CM ₀	Q ₁	CM ₁ * Q ₁	d ₁
Types	contribution margin (\$)	# sold	Total contribution margin per room (\$)	Proportion of a sold rooms in overall rooms sales (%)
#1	156.1	1220	190,442	0.25284974
#2	123.5	1160	143,260	0.24041451
#3	132.7	1340	177,818	0.27772021
#4	97.8	1105	108,069	0.22901554
Total		4825	619,589	

The absolute increase in total room contribution margin between periods 1 and 2 can be calculated as $CM_1Q_1 - CM_0Q_0 = \$619,589 - \$582,582 = \$37,007$. Relative increase in total hotel room contribution margin between periods 1 and 2 can be calculated as $(CM_1Q_1 - CM_0Q_0) / CM_0Q_0 = (\$619,589 - \$582,582) / \$582,582 = 0.0635$. For differentiation purposes, according to international statistical abbreviation, variables that relate to base periods are superscripted with “0” and variables that relate to the recent period are superscripted with “1”

In order to determine how each of the above-listed quantitative factors has influenced an overall change in room contribution margin, the influence of two variables should be temporarily excluded from analysis while an influence of the third variable is estimated. Such an approach will help to determine the “pure” influence of this particular variable. The impact of contribution margin per individual hotel room should be calculated while the number of items sold for a particular period such as changes in quantity of rooms sold (Q) and changes in proportion of rooms with different rates sold (d) should remain constant as in the base period. A variable such as contribution margin that does not clearly reflect the number of rooms sold should be fixed on a recent period level (Efimova, Petrova, & Rumyantsev, 2000). The following calculations in equations 5 – 7 estimate the extent to which each factor contributed to a change of overall room contribution margin.

Due to changes in contribution margin per individual room, the absolute change in overall contribution margin equals \$27,339

$$\Delta CMQ(CM_j) = \left(\sum_{j=1}^k CM_j^1 d_j^1 - \sum_{j=1}^k CM_j^0 d_j^1 \right) \sum_{j=1}^0 q_j^1 = \quad (5)$$

$$\{[(156.1 * 0.2529) + (123.5 * 0.2404) + (132.7 * 0.2777) + (97.8 * 0.2290)] -$$

$$(128.5 * 0.2529) + (117.4 * 0.2404) + (146.5 * 0.2777) * (93.2 * 0.2290)\} * 4825$$

$$(128.41223 - 122.74611) * 4825 = 27,339$$

Due to changes in the proportion of items sold, the absolute change in overall room contribution margin equals \$469.3368

$$CMQ(d_j) = \left(\sum_{j=1}^k CM_j^0 d_j^1 - \sum_{j=1}^k CM_j^0 d_j^0 \right) \sum_{j=1}^k q_j^1 = \quad (6)$$

$$\begin{aligned} & \{[(156.1 * 0.2529) + (123.5 * 0.2404) + (132.7 * 0.2777) + (97.8 * 0.2290)] - \\ & - [(128.5 * 0.2632) + (117.4 * 0.2905) + (146.5 * 0.2463) + (93.2 * 0.2)]\} * 4825 = \\ & = (122.74611 - 122.6488) * 4825 = \$469.3368 \end{aligned}$$

Due to changes in the quantity of items sold, the absolute change in overall room contribution margin equals \$44,378.99

$$\square CMQ(Q_j) = \left(\sum_{j=1}^k q_j^1 - \sum_{j=1}^k q_j^0 \right) \sum_{j=1}^k CM_j^o d_j^o = \quad (7)$$

$$\begin{aligned} & (4825 - 4750) * [(128.5 * 0.2632) + (117.4 * 0.2905) + (146.5 * 0.2463) + (93.2 * 0.2)] \\ & = \$9,198.6637 \end{aligned}$$

Because of changes in the quantitative variables (contribution margin per room sold, proportion of rooms sold, and quantity) the overall change in rooms contribution margin equals \$37,007 (\$27,339 + \$469.3368 + \$9,198.6637)

This amount should be equal to the absolute increase obtained as a difference between the overall room contribution margins of the two periods that was determined earlier.

However, in many cases, insignificant variation may occur because of numerical rounding when for example it is chosen to keep only two digits after decimal.

In certain cases, a positive increase in the total room contribution margin may occur when only one of the three variables has a positive change although the rest of the variables have a negative change. For cases in which the absolute amount is larger for a variable with positive change than for variables with negative change, the overall change will be positive. Conversely, for cases in which the absolute amount is larger for a variable with negative change than for variables with positive change, the overall change will be negative.

Analysis of Relative Changes in Overall Hotel Room Contribution Margin

Analysis of relative changes describes the extent to which the quantity of rooms sold and the average contribution margin per hotel room affect overall change in room contribution between the two compared periods. The relationship between the quantity of rooms sold and the average contribution margin per room can be presented as a multiplication that equals total room contribution margin. Based on the information presented in Table 1, relative changes due to changes in quantity and average contribution margin can be presented as follows:

$$\Delta TCM(Q) = [(Q_1 - Q_0) / Q_0] * 100\% = [(4825-4750)/4750] * 100\% = 1.58\%$$

$$\Delta TCM (ACM) = \Delta TCM - \Delta TCM(Q) = 6.35\% - 1.58\% = 4.77\%$$

* Where TCM-Total Contribution Margin and ACM-Average Contribution Margin

In an overall change on a total room contribution of 6.35%, the increase in quantity was responsible for 1.58% of this change, and the increase in average contribution margin was responsible for 4.77% of this increase.

The percentage share of quantity and average contribution margin increase in the overall contribution margin increase can be determined as:

For average contribution margin: $[(I_v - I_{ACM}) / I_v] * 100\% = (6.35 - 4.77) / 6.35 * 100\% = 24.88\%$ or simply as $1.58\% / 6.35\% = 24.88\%$. For quantity: $[(I_v - I_q) / I_v] * 100\% = [(6.35 - 1.58) / 6.35] * 100\% = 75.12\%$ or simply as $4.77\% / 6.35\% = 75.12\%$. This sort of analysis presents in percentages the impact of each factor in the overall changes of room contribution margin. The sum of these impacts should equal 100% or will be very close to 100% because of rounding.

Discussion and Conclusions

As in many commercial operations, the main focus of the hotel business is maximizing profitability. Hotel room sales are not the only source of revenue but in many hotels it is the most significant one. Analysis of hotel revenue and profitability may be calculated in many different ways. The purpose of these analyses is to provide hotel management with relevant information on the extent to which quantitative variables such as changes in individual room contribution margins, changes in proportion (composition) of different rooms sold, and changes in quantity of rooms sold affect overall contribution margin from room sales. This approach becomes effective if changes in all three factors take place among comparison periods. If for example, the contribution margin for a hotel room stays the same, there will be no changes in influence of the contribution margin per room item on the total room contribution margin. Managers should also be aware that this analysis is only effective when a comparison is done among exactly the same number of different room rates among different periods. Seasonality is a strong factor in the hotel business and during the high season, different selling strategies and discounts can be applied.

Despite the fact that hotel management can notice positive absolute and relative growth in room contribution margin over several periods, such growth may not necessarily be achieved by growth in all three of the above-listed quantitative variables. Hotels may have significant positive increases in contribution margins of individual room items that positively influence overall hotel contribution but decreases in sales of favorable items that have a negative effect on overall hotel contribution margin. A comparison among more than two periods provides a more detailed picture of how those factors change among different periods. It also gives direction for further investigation and further analysis. This approach can also use room selling price instead of contribution margin for a hotel room.

This paper presents a hypothetical example of a hotel that has only four different room rates. Management may choose not to include every existing room rate in analysis. If

management reveals that there are room discounts that have a negative absolute amount of change due to change in one of three factors, those discounts will require additional attention. It will become an indication that their performance decreases from one period to another due to high variable costs, inappropriately assigned prices, a variety of advertising/promotion techniques and other factors.

The advantage of this technique is that it can be applied relatively easily by the use of basic spreadsheet programs such as Microsoft Excel, Access, and Apple Works that can quickly conduct all necessary calculations. In addition, this approach utilizes quantitative information that management most likely already has: such as contribution margin per hotel room, quantity of rooms sold, and proportion of each room sold.

Obtaining hotel sales data will help to determine changes in which one of the three variables (contribution margin per individual hotel room, proportion of rooms sold, and quantity) has the largest impact on overall contribution of rooms sold. A significant extension to this study would be a determination of how those changes differ for different types of hotels and what types of discounts have more effect on overall contribution margin change.

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