

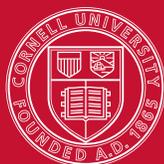


Developing Measures for Environmental Sustainability in Hotels: An Exploratory Study

Cornell Hospitality Report

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by Jie J. Zhang, Nitin Joglekar, Ph.D., and Rohit Verma, Ph.D.



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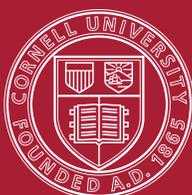
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Continued next page

EXECUTIVE SUMMARY

Hoteliers' efforts to improve the environmental sustainability of their operations would be promoted by having a consistent industry-wide measure for benchmarking current operations and tracking the effect of environmental sustainability initiatives. This type of measure can also assist external stakeholders, such as the hotel guests and regulatory entities, to gauge hotels' environmental sustainability efforts. This report presents the results of an exploratory study that develops such a measure, using resource consumption records of 984 U.S. hotels over a period of eight years. The measure is based on an analysis of resource consumption–related expenses found in these hotels' year-end operating statements, for electricity, water and sewer, maintenance other expenses, and laundry, linen, and supplies for both rooms and food and beverage services. Using a multivariate data analysis technique called exploratory factor analysis, the measure developed in the study consists of two parts: an operating factor that comprises large weights from electricity, water and sewer, and maintenance expenses, and a behavioral factor, which is largely driven by laundry, linen, and supplies for both rooms and F&B operations. In general, costs found in the operating factor are under management control, but the costs in the behavioral factor are subject to guests' activities. By normalizing the average of each of these two factors at zero, hotels that score above zero on each factor are spending more than other hotels, and those with a score below zero are more efficient than others. These factors can be compared according to various hotel characteristics, such as chain segment, the involvement of a third-party professional management company in the operating structure, location (both in terms of the degree of urbanization and climate zone), and whether the hotel offers F&B service. For instance, the above-average costs of providing F&B are clearly depicted in these measurements (as compared with limited-service operations).

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leadership, talent management and operational excellence in global firms; implementation of systems thinking and system dynamics methodology; valuation of clean energy supply chains and technologies. His studies are informed by observations from the clean energy, electronics, medical devices and software industries. His research has been accepted in *European Journal of Operational Research*, *IEEE Transactions on Engineering Management*, *Journal of Applied Probability*, *Journal of Product Innovation Management*, *Managerial & Decision Economics*, *Management Science*, *Production & Operations Management*, *Research in Engineering Design*, and *Systems Research & Behavioral Science*.



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Hoteliers around the world are improving the sustainability of their operations. Not only does this acknowledge the benefits to the planet and humanity, but the hotels also seek competitive advantage¹ and at the same time face potential government regulation. Moreover, environmental sustainability is a strategy to address rising resource scarcity and cost.² In 2005, for instance, the cost of operating a U.S. hotel grew by 6.5 percent, led by the 13.7-percent growth in utilities from 2004 to 2005.³ In 2008 utility expense growth exceeded the rate of inflation by 3.6 percent.⁴ By balancing productivity and environmental impact, environmentally sustainable operations are among the most promising measures towards cost containment for hotels.

¹ H. Houdre, "Sustainable Hospitality: Sustainable Development in the Hotel Industry," *Cornell Hospitality Industry Perspective*, Vol. 8, No. 2 (2008).

² UN Millennium Project, 2005 (www.unmillenniumproject.org/goals/index.htm). The 7th goal of Millennium Development Goals (MDG7) is "(to ensure) that the overall productivity of accumulated human and physical capital resulting from development actions more than compensates for the direct or indirect loss or degradation of the environment".

³ PKF Hospitality Research, *The 2006 Trends Report*, www.hotel-online.com/News/PR2006_2nd/May06_PKFTrends.html

⁴ PKF Hospitality Research, *The 2009 Trends Report*, www.hospitalitynet.org/news/154000320/4043007.html.

Though most hotels seek green operations, the hospitality industry still needs a reliable definition of what “green” means. Hoteliers are caught in a situation where standards are inconsistent and consumers’ views are unclear.⁵ The hospitality industry is not alone in this situation. Fifty-six percent of the nearly 2,000 executives participating in a 2010 McKinsey Global Survey, who represented a wide range of industries and regions, defined environmental sustainability in two or more ways.⁶

We wanted to devise a unified measure of green operation that would allow consumers and operators alike to have a reasonable benchmark for efficient use of resources. We ended up with two related measures, derived from the underlying common factors that drive the resource consumption in hotel operations. We applied exploratory factor analysis (EFA) to eight years of data from 984 hotel properties’ operating statements. PKF Hospitality Research provided these data without revealing the hotels’ identities, allowing us to develop a composite measure of the hotels’ resource consumption profiles.

Our twin measures have two distinct features. First, they are outcome-oriented, because they focus on the actual resource use and environmental consequences of hotel operations. This outcome focus is similar to the Portfolio Manager rating developed by Energy Star.⁷ But unlike Portfolio Manager, which is confined to energy use only, our measures cover a wider range of resources consumed in hotel operations. In addition to electricity, these measures include water and sewer expenses, maintenance expenses, and the cost of linens and supplies consumed in the rooms division and in food and beverage services. Second, these measures are parsimonious, because they gather all those expenses into two scales. While

⁵ The Center for Hospitality Research, *2009 Annual Report*.

⁶ McKinsey Global Survey results: “[How companies manage environmental sustainability](#).”

⁷ www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfolio-manager

each resource-use account can be measured individually, that is time consuming and often counterproductive for spotting trends and making plans. Moreover, due to the interconnected nature of resource consumption, actions taken to reduce consumption in one account have consequences for other areas. Thus, by condensing multiple expense items into two common factors, we have developed an efficient and effective approach to gain clarity and insight into the sustainability of hotel operations.

Specifically, we ask the following research questions related to developing measures for environmental sustainability:

- What are the underlying common factors driving the consumption of fundamental resources such as utilities and supplies in hotel operations?
- What are the relationships between these underlying factors and key dimensions of hotel characteristics, such as chain segment, operating structure, and location?
- How do these relationships change over time?

We found that hotels’ resource consumption can be expressed in two factors—which we have named the operating factor and the behavioral factor. We’ve named these factors according to our understanding of the nature of the underlying expenses. These expenses are found in five accounts that are defined in the *Uniform System of Accounts for the Lodging Industry*, as compiled by PKF Hospitality Consulting. The expenses driving the operating factor are energy, water and sewer, and maintenance other expenses (compiled from several *USALI* accounts). The behavioral factor comprises the expenses for laundry, linen, and supplies used in the rooms division and F&B services. The analysis calculates a normalized score for each hotel based on its use of the five expense items. This normalized score, in which zero is equal to the sample average, provides a scale for each individual hotel manager to determine the

property's relative position in the sample with respect to the operating or behavioral factor. Since the average of the scale is set at zero, a positive score means higher than average consumption, and a negative score indicates less than average consumption. Using this two-factor composite measure, we found correlations between hotels' resource consumption and various hotel characteristics, including market segments, operating structures, and geographic region. We also observed a discernible trend in resource use over time, as we will explain below. Our analysis supports the use of this two-factor measure to establish a baseline of environmental sustainability profiles for hotels of various characteristics. Further, by tracking the resource consumption of hotel properties, this two-factor measure can be used to identify best practices and illuminate ways to improve environmental sustainability.

In following sections, we review customer "co-consumption" in service operations, because this influences the behavioral factor, and then we examine non-labor hotel expenses that are relevant to environmental sustainability. We then describe the research methodology, sample characteristics, and the multivariate statistical method employed. In particular, we explain the rationale for selecting the two factors that we just described, based on the exploratory factor analysis; we investigate how the common underlying factors of hotel expenses relate to key dimensions of hotel characteristics; and we show how patterns in the factors vary over time. We conclude the report with a discussion of the managerial implications of these findings and future research direction.

The Co-consumption of Resources in Service Operations

The importance of customer participation in service processes, or customer co-production, is well established. Customers, their belongings, and the information they provide are all deemed necessary for the service process.⁸ An important corollary of the central role of customer inputs in service processes is the inverse relationship between the extent of customer contact and the system's performance.⁹ That is, from a process flow perspective, as the amount of customer inputs increases, more variability is introduced into the service process and efficiency can be lost. To control this variability, many properties have implemented such countermeasures as a limited service menu and decoupling of front- and back-office operations by shifting functions

⁸ S.E. Sampson and C. M. Froehle, "Foundations and Implications of a Proposed Unified Services Theory," *Production And Operations Management*, Vol. 15/ No. 2 (2006), pp. 329-343

⁹ R.B. Chase and D.A. Tansik, "The Customer Contact Model for Organization Design," *Management Science*, Vol. 29, No. 9 (1983), pp. 1037-1050.

that formerly were handled at the front desk (such as reservations) to automated systems.

Co-production also means co-consumption. The resource and environmental consequences of service operations are largely determined jointly by customers and servers at the point of service. Typical hotel linen re-use programs provide an example. Regardless of what the hotel does, it is still up to the guest to decide whether the towels and sheets should be changed each day. In some cases, even if the guest indicates a willingness to re-use the linens, housekeepers may change them anyway, especially if they are not certain of the guest's wishes. Thus, the hotel cannot firmly predict water, energy, and supply usage in connection with linen use. Understanding the co-consumption process can shed light on how to make consumption levels consistently more efficient.

Resources and Supplies Consumed in Hotel Operations

For this study, we examined expenses in five *USALI* accounts from the hotels' operating statements, because they have a direct impact on the hotels' environmental sustainability and they are consumed in direct connection with the hotels' primary business. These five items are electricity; water and sewer; maintenance other expense; laundry, linen, and supplies for the rooms operation; and laundry, linen, and supplies for food and beverage services. Let's briefly review these items.

Electricity. Electricity dominates hotels' energy expenses—for heating, air conditioning, and ventilation; hot water production; lighting; electrical systems (e.g., elevators); and cooking. Energy consumption accounts for between 3 percent and 6 percent of the total operating costs. As the major part of this energy is produced by gas, coal, and petroleum products, reducing the energy consumption would also contribute to decreasing greenhouse gas emissions, chiefly CO₂.

Water and sewer. Most studies indicate that hotels use between 100 and 200 gallons of fresh water per occupied guestroom per day. This averages out to about 36,500 to 73,000 gallons of water per room per year—a substantial expense, given that water charges in the United States range from two dollars to more than five dollars per 1,000 gallons. From a sustainability standpoint, water conservation is gaining in importance, as water supplies are increasingly tenuous in many locations. Although hotels cannot directly control the pricing structure for energy and water utilities, studies of historic hotel data show a direct relationship between utility costs and hotel revenues.¹⁰ Consequently, we can conclude that hotel managers indeed have influence over the utility

¹⁰ R. Mandelbaum, "Hotel Utility Costs Surge Protection Is Needed," PKF Consulting, *Hotel Online Special Report*, March 2004.

expenses, and that there exist opportunities for efficiency gains.

Maintenance other expense. Although the *USALI* does not have an account expressly called “maintenance other expense,” this term is used to collect numerous costs that are assigned to the property operations and maintenance department. These are expenses associated with the day-to-day upkeep of a hotel, but not capital expenses. From 2001 to 2005, hotel maintenance expenses grew 18.3 percent, a pace nearly 33-percent greater than that of all other hotel operating costs during this same period. As a result of these relatively strong increases, maintenance department costs as a percentage of total hotel operating expenses have averaged 6.8 percent in each of the past four years, up from the long-term average of 6.0 percent.¹¹

The “maintenance other expense” item that we used for this analysis equals about half of the total maintenance cost. Maintenance other expense covers operating supplies and tools, spare parts, landscaping, and the one-off replacement of furniture, fixtures, and furnishings. Not included are the salaries, wages, and benefits paid to property maintenance personnel, and equipment maintenance contracts.

Laundry, linen, and supplies. As we discussed above, guest behavior can influence this essential element of rooms and F&B service costs. This is true whether hotels operate their own laundry or contract for laundry services.

Analyzing Hotel Data

Our study required a representative dataset that consistently tracks operating expenses at the hotel unit level over an extended period of time. Examination of this panel dataset provides immediate insights from descriptive analysis and allows rigorous statistical analysis to make inferences about the underlying relationships. We begin by identifying systematic variations in the common factors that drive resource consumption in the five expense items, and then we investigate how these variations relate to key hotel characteristics. Longitudinal analysis will reveal any evolutionary changes in these factors.

Study Setting and Data Collection

As mentioned above, we engaged PKF Hospitality Research (PKF-HR) to provide data from a representative sample of hotels in the United States. (See the accompanying box for information on the data collection process.) Since 1936, PKF has collected unit-level year-end operating statements from thousands of hotels across the U.S. From the statements for 2001 through 2008, 200 specific revenue and expense items were extracted for 990 U.S. hotel properties and then put into a uniform format to ensure equitable benchmarking.

¹¹ PKF Hospitality Research, “Hotel Maintenance Creeps Up,” 8/2/2006, www.4hoteliers.com/4hots_nshw.php?mwi=2616.

PKF Hospitality Research and the Annual Trends® in the Hotel Industry Survey

The data for this study were supplied by PKF Hospitality Research. Each year, PKF-HR collects annual operating statements from thousands of hotels across the United States. This survey dates back to 1936, when the first *Trends® in the Hotel Business* report was published by Harris, Kerr, Forster & Company, the predecessor to Pannell Kerr Forster, and PKF.

Data Collection, Processing, and Comparability

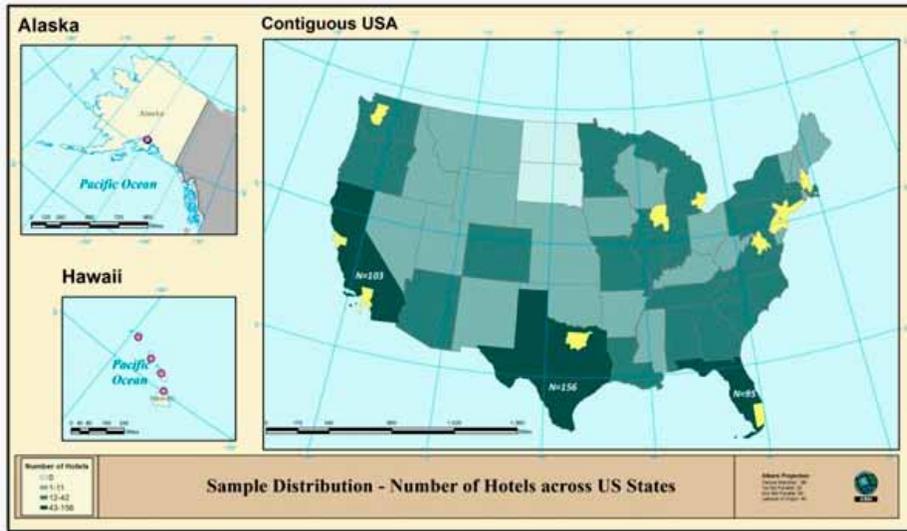
Participation in the *Trends® in the Hotel Industry* survey is voluntary and complimentary. Approximately 320 entities submitted 6,300 operating statements for the 2010 *Trends®* survey, using survey forms or simply by sending copies of their December profit and loss statements. A few companies provide large electronic data files that contain in excess of 10,000 individual revenue and expense items.

Each hotel company or property customizes their layout and accounts. Since the *Trends®* report is primarily used to benchmark unit-level financial performance to similar operations, however, the comparability of the data contained in the document is essential. To ensure comparability, PKF-HR enters all the data it receives in accordance with the classification system prescribed by the most current edition of the *Uniform System of Accounts for the Lodging Industry (USALI)*. As needed, revenue and expense items will be re-classified from their original designation. Over 200 unique revenue and expense items are captured in the *Trends®* database.

On occasion, certain expense items are excluded from the financial statement of a hotel depending on the source of the document. For example, financial statements received from management companies sometimes do not include certain ownership expenses such as property taxes or property insurance. In these circumstances, PKF-HR will estimate these costs to ensure comparability. The estimates are based on the relative movement of the same expense item in comparable hotels for which we have data in the current year.—PKF-HR

EXHIBIT 1

Geographic distribution of hotels

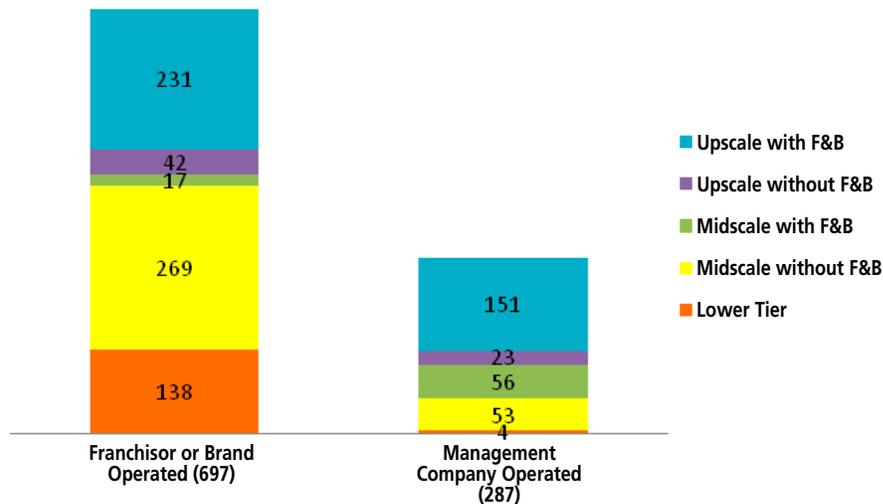


Top 10 states

| State | Number of Properties |
|-------|----------------------|
| TX | 156 |
| CA | 103 |
| FL | 95 |
| GA | 42 |
| AZ | 37 |
| TN | 34 |
| CO | 34 |
| VA | 33 |
| IL | 32 |
| WA | 31 |

EXHIBIT 2

Distribution of hotels operated by franchisor and by management company



Thus, we had a total of 7,920 observations. The 990 hotels in the dataset are located in 48 states and the District of Columbia, represent all major hotel chains, and include a variety of property type, geographic location, rate, and size. As shown in Exhibit 1, the hotels were widely distributed, and three most-represented states were Texas, California, and Florida.

Since we are interested in the relationship between the underlying common factors and location characteristics of the hotels, we supplement the hotel dataset with infor-

mation on climate from NOAA¹² and population density derived from the U.S. census.¹³

Sample Characteristics

Exhibit 2 shows the frequency distribution of the hotels in the sample. About 70 percent (697) of the hotels are franchise hotels, operated by the brand, and the remaining 287

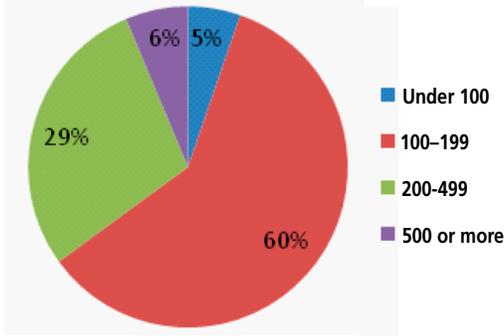
¹² National Climatic Data Center, wlf.ncdc.noaa.gov/oa/climate/climate-data.html.

¹³ www.census.gov/geo/www/gazetteer/places2k.html#zcta.

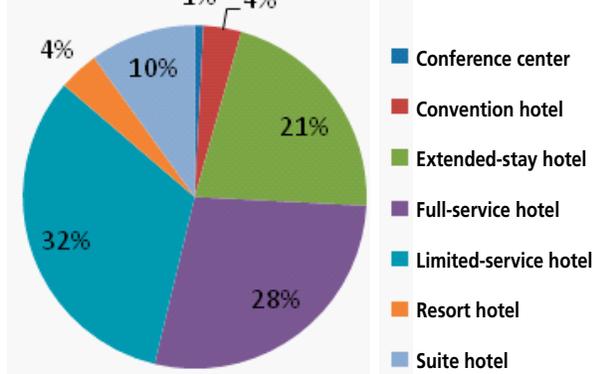
EXHIBIT 3

Hotel characteristics

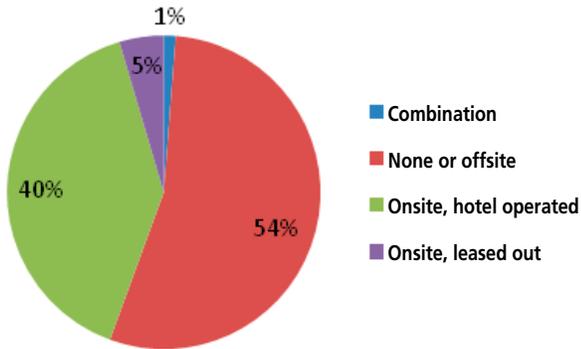
Number of rooms



Property type



F&B status

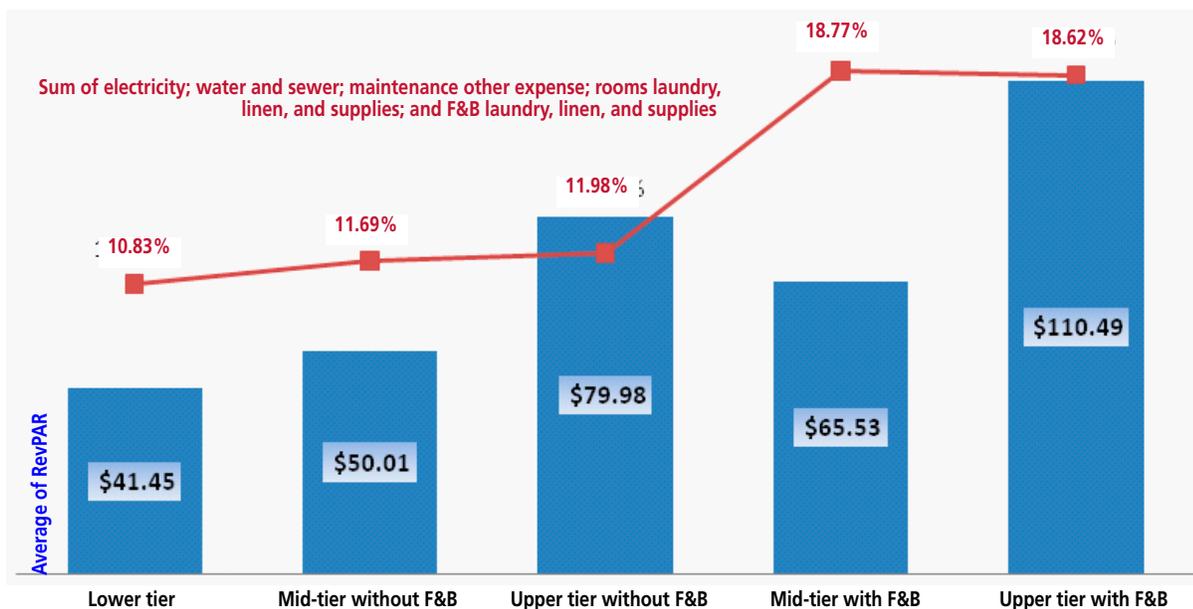


are run by third-party professional management companies. Both categories comprised chain scales from the high end to economy end of the industry, although we noted that management companies tend to operate a higher concentration of upscale and luxury hotels. We dropped the six hotels run by individual owners, because that was too small a sample.

Exhibit 3 shows the sample distribution in terms of some key hotel characteristics. The sample leans toward small hotels, with about 70 percent having less than 200 rooms. Just under half of the hotels offer onsite F&B service. The property type pie chart shows the distribution of hotels based on the level of facilities and amenities they provide. The hotel property types are described in the box overleaf.

EXHIBIT 4

Energy, water, and supply expenses as a percentage of RevPAR, 2001–2008



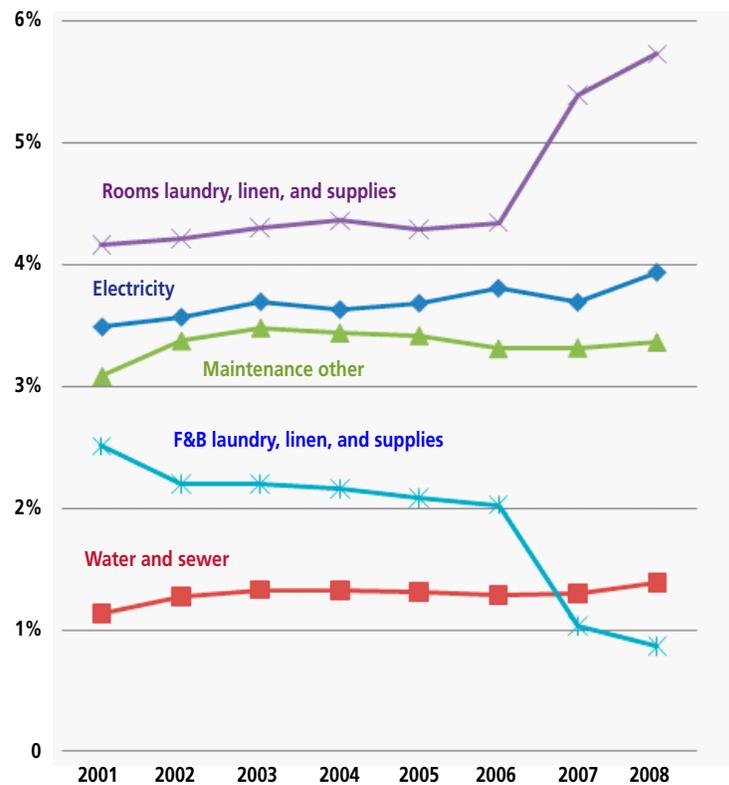
| Property type | Description |
|-----------------------|---|
| Resort Hotel | A hotel, usually in a suburban or isolated rural location, with special recreational facilities. |
| Conference Center | A lodging facility where 60 percent or more of total occupancy is generated by conferences and which offers a full-package plan including guest rooms, meals and full-service conference rooms as well as skilled staff trained to serve meeting planners and attendees. |
| Convention Hotel | A hotel which provides facilities and guest services geared to meet the needs of large group and association meetings and trade shows. Typically, these hotels have in excess of 400 guest rooms and contain substantial amounts of function and banquet space flexibility designed for use by large meeting groups. They often work in concert with other convention hotels and convention centers to provide facilities for citywide conventions and trade shows. |
| Suite Hotel | A hotel in which all rooms have "separate," but not necessarily physically divided, "sleeping and living areas." |
| Full-Service Hotel | A hotel which provides a wide variety of facilities and amenities, including food and beverage outlets, meeting rooms, and recreational activities. |
| Extended Stay Hotel | Properties oriented towards guest stays of five nights or more. Guest rooms usually contain more residential equipment and amenities than standard hotel rooms. |
| Limited-Service Hotel | A hotel which provides only some of the facilities and amenities of a full-service property. No food and beverage service for sale. |

Exhibit 4 provides an overview of the average RevPAR of the sample hotels from 2001 to 2008 (discounted to 2008 dollars), and the sum of the five expenses as a percentage of the RevPAR for the same period.¹⁴ We had to make slight adjustments in the data due to changes that began in 2007 in the *USALI* and in PKF's data. These changes affected three expense items, namely, the laundry-related services for rooms and for F&B, and maintenance other expenses. The new measures gathered certain expenses into these categories that formerly were separate. So, we made these data consistent for all years. Exhibit 4 also shows the greater expense of offering F&B services. Specifically, the chain segments without F&B spend roughly 11 to 12 percent on utilities and supplies,

¹⁴ The CPI inflation calculator uses the average Consumer Price Index for a given calendar year. <http://data.bls.gov/cgi-bin/cpicalc.pl>.

EXHIBIT 5

Energy, water, and supplies as a percentage of RevPAR, 2001-2008



while the segments with F&B incur about 50-percent more expense in those categories.

Exhibit 5 breaks down the expenses in Exhibit 4 to show the yearly trend of these expenses as percentage of RevPAR. Note that the expenses display an upward trend, except for F&B laundry, linen, and supplies. Since 2006, we see a large jump in the expenses relating to rooms laundry expenses, but it is not clear what has caused this sharp increase. Some energy costs did increase, but this may be a function of consumer behavior as well. Electricity and water expenses each experienced about 0.5-percent RevPAR increase in the eight-year period, possibly as a result of the rising utility costs. Regardless of the reason, hoteliers are under increasing pressure to contain the rising expenses from energy, water, and supplies. The combination of sharp cost increase and the industry downturn instills a sense of urgency to improve environmental sustainability of hotel operations.

Although Exhibit 5 is informative, the comparisons in five different dimensions that it presents are unwieldy, and difficult to interpret. For this reason, we applied exploratory factor analysis on these data to uncover the underlying

EXHIBIT 6

Parallel analysis graph showing two factors (1 and 2) should be retained

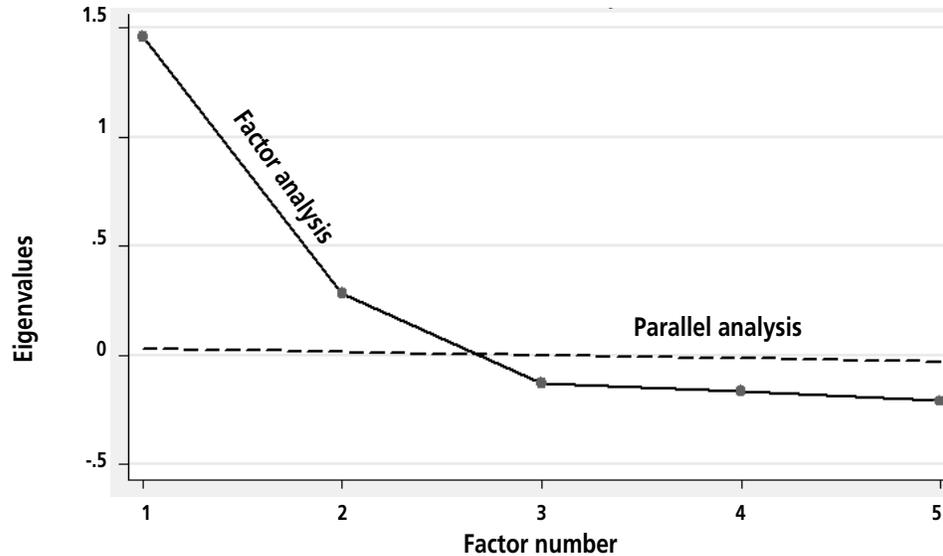


EXHIBIT 7

Factor loadings, showing variables included in each of the two factors

| Variables | Factor 1 (Behavioral) | Factor 2 (Operating) |
|---|-----------------------|----------------------|
| Electricity expense (% of RevPAR) | 0.134 | 0.586 |
| Water & Sewer expense (% of RevPAR) | -0.183 | 0.550 |
| Maintenance other expense (% of RevPAR) | 0.377 | 0.430 |
| Rooms LLS expense (% of RevPAR) | 0.571 | -0.047 |
| F&B LLS expense (% of RevPAR) | 0.597 | -0.116 |

Number of observations = 7,854. Principal factor method, oblique promax rotation (Kaiser on)

common factors and to condense the information into fewer factors for further investigation.

Exploratory Factor Analysis (EFA)

Using exploratory factor analysis we condense the information in the original group of variables (in this case, the five USALI accounts) into a manageable number of indices (known as factors) with minimum loss of information.¹⁵ EFA can be used to highlight variables that contain similar information, and also variables that contain completely independent information. Moreover, the predicted factor scores can be used in further analysis to help understand the distribution of the observations, and how much and why they differ.

¹⁵ J.F. Hair, Jr., R.E. Anderson, R.L. Tatham, and C. William, *Multivariate Data Analysis*, Fifth Edition (Upper Saddle River, NJ: Prentice-Hall, 1998).

Two Factors in the Environmental Sustainability Profile

Our EFA analysis covered eight years of data for the 984 hotels (less the six owner-operated properties) for a total of 7,872 observations. We ended up with two overriding factors, as we explain next.

As we said, the goal of factor analysis is to identify a small, manageable set of explanatory factors, as determined by the analysis. The results of this analysis are shown in the parallel analysis graph in Exhibit 6, which shows that two factors should be retained. The first two factors in the graph maximize the explained variability in the original variables with the least number of factors. The relevance of each variable in the two factors is shown in the pattern matrix in Exhibit 7. As you see, factor 1 is mostly defined by

EXHIBIT 8

Environmental sustainability factor scores and chain segment

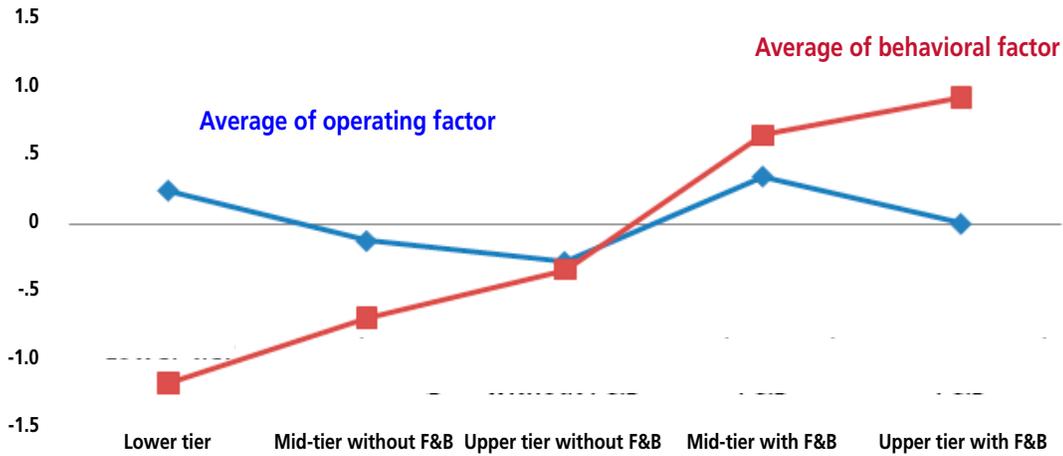
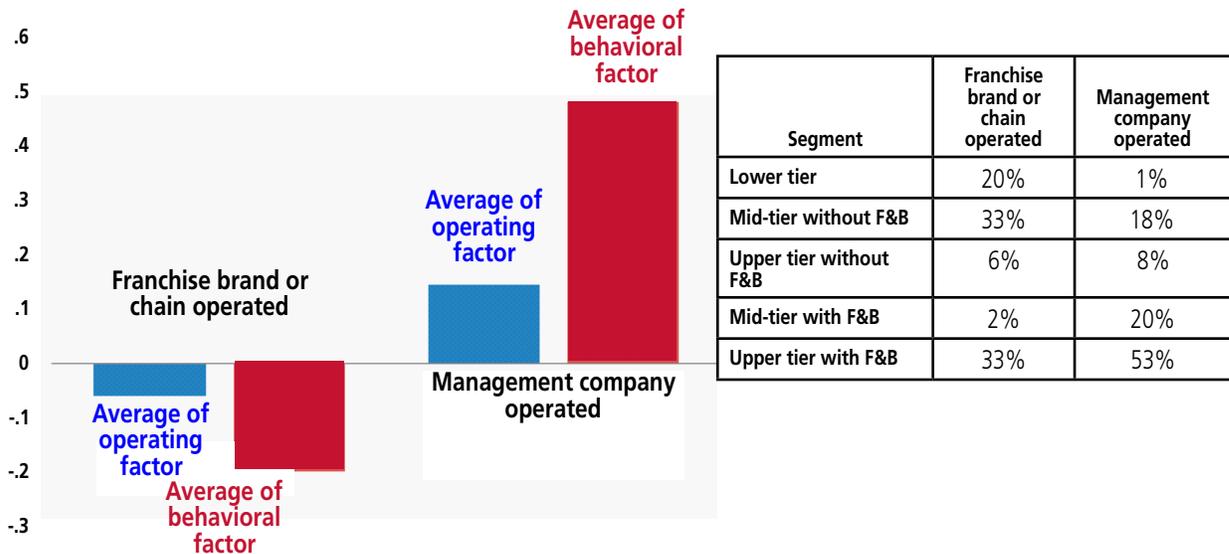


EXHIBIT 9

Environmental sustainability factor scores and management structure



| Segment | Franchise brand or chain operated | Management company operated |
|------------------------|-----------------------------------|-----------------------------|
| Lower tier | 20% | 1% |
| Mid-tier without F&B | 33% | 18% |
| Upper tier without F&B | 6% | 8% |
| Mid-tier with F&B | 2% | 20% |
| Upper tier with F&B | 33% | 53% |

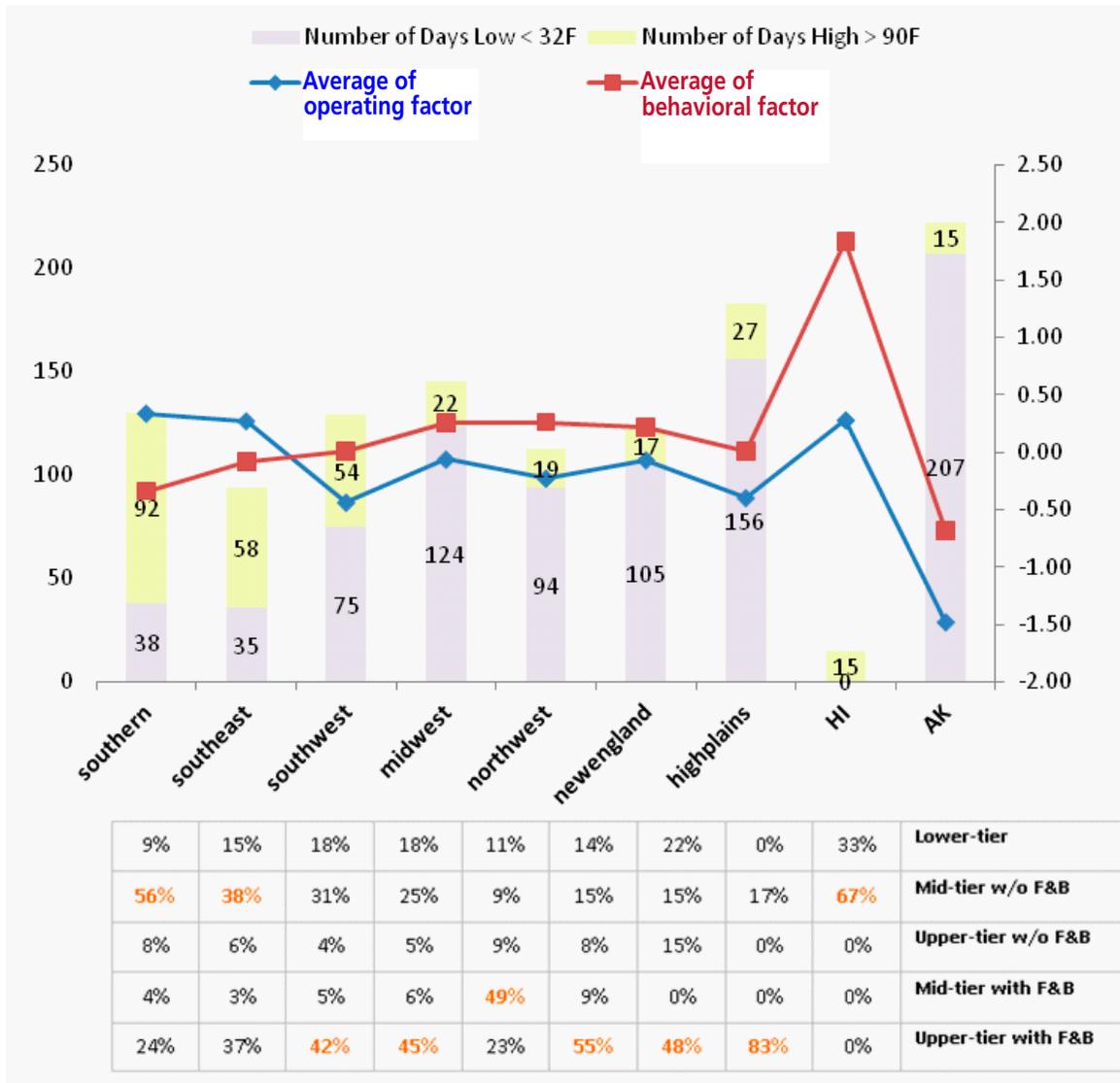
the laundry-related items, and factor 2 primarily comprises electricity, water and sewer, and maintenance expenses.

Thus, we have reduced the five resource consumption variables to two factors. Because the laundry and linen-related expenses load heavily on Factor 1, we posit that Factor 1 captures the influence of guest behavior on resource consumption, as it relates to linen use. We therefore named Factor 1 the “behavioral factor.” In contrast to linen use, we consider utility and maintenance expenses (now part of Factor 2) to be largely at the discretion of hotel operators. Because factor 2 is related to the operating characteristics of

the hotels, we call it the “operating factor.” The factor analysis generates scores for each hotel on each of the two factors, expressed as numerical values that indicate a hotel’s relative standing.¹⁶

¹⁶ The Bartlett estimation method, a weighted least square method, is chosen to estimate the factor scores in our study. See: A. Beauducet, “How to Describe the Difference between Factors and Corresponding Factor-Score Estimates, Methodology,” *European Journal of Research Methods for the Behavioral and Social Sciences*, Vol. 1, No. 4 (2005); and R.J. Ambrosino, “A Comparison of Four Methods for Estimating Common Factor Scores,” presented at Northeastern Educational Research Assoc., 1973.

Environmental sustainability factor scores for U.S. climate zones



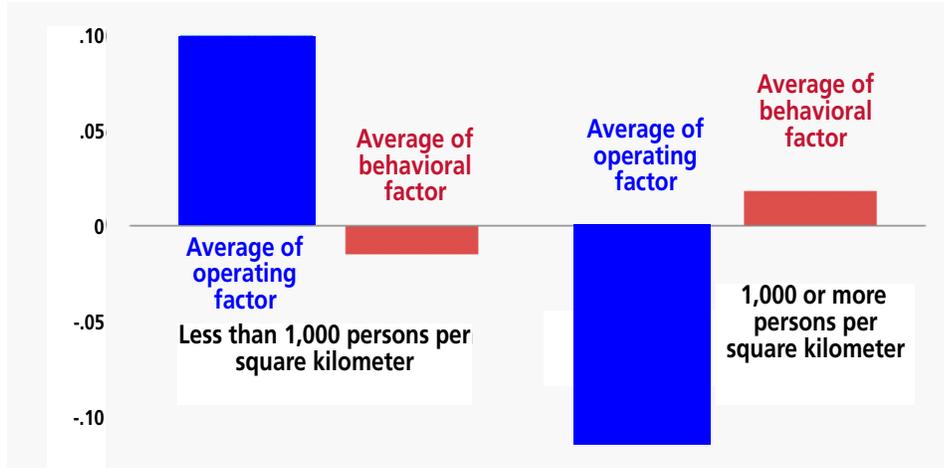
Relationship between the Factor Scores and Various Hotel Characteristics

In this section we give examples of the type of analysis you can perform using the two factors. We analyze the relationship between the factor scores and key hotel characteristics, including the targeted chain segment, the management structure (franchise- or chain-operated vs. third-party management firm), and location-related characteristics such as climate and extent of urbanization. All values refer to the eight-year average.

Relationship between the Factors and Hotel Chain Segment

The behavioral factor line in Exhibit 8 captures the significantly higher cost of F&B in full-service hotels (the rightmost two red data points vs. the other three). Further, Exhibit 8 shows that both factors contribute to the cost increase depicted in Exhibit 4 (from 12% to nearly 19%), but in varying patterns. The increase in the behavioral factor from lower-tier to upper-tier hotels (red line) is largely consistent with the logical observation that those hotels provide

Environmental sustainability factor scores by degree of urbanization



Sample distribution

| Chain scale | Low urbanization | High urbanization |
|------------------------|------------------|-------------------|
| Lower tier | 15% | 16% |
| Mid-tier without F&B | 40% | 24% |
| Upper tier without F&B | 0 | 5% |
| Mid-tier with F&B | 8% | 7% |
| Upper tier with F&B | 31% | 48% |

more facilities and amenities and thus incur higher costs. The operating factor, on the other hand, first decreases while moving upward among the chain scale segments, then escalates when F&B service is offered, but eases between mid-tier and upscale hotels. Within the same level, for example, the mid-tier without F&B vs. mid-tier with F&B, the operating factor increase is moderate. We observe a similar type of increase when comparing upper tier without F&B to upper tier with F&B.

Relationship between the Factors and Management Structure

Exhibit 9 shows that hotels under management contract incur higher resource expenses for both environmental sustainability factors. It is possible that the higher concentration of upscale hotels in the management-contract group (61%) contributes to its higher expenses. In addition, about 73 percent of the hotels in the management company category offer F&B service.

Relationship between the Two Factors and Location

Not surprisingly, location plays an important role in resource consumption, varying by climate and by time, as

a destination experiences increasing heat waves (or snow storms) and water-use restrictions. The relationship between the two factors and climate is shown in Exhibit 10. As shown in the exhibit, hotels in different climate regions have markedly different resource use patterns, not all of which can be strictly related to high (or low) temperatures. Other variables, such as clusters of high-end (or low-end) hotels, seem to influence the regions' scores on the two factors, as might the hotels' efforts to conserve resources.

Variations in urbanization (as determined by population density) also influence resource pricing and consumption patterns (see Exhibit 11). In general, the operating factor driven resource consumption is lower in the urban areas, while the behavior-driven resources expenses are lower in the non-urban areas.

Longitudinal Analysis with Hotel Characteristics

We mentioned above that we observed changes over time in the two sustainability factors, depending on a hotel's chain scale segment and whether the hotel is operated by the franchisor or under a management company. This is an example of another type of analysis that you can perform with these two indexes.

Change in environmental sustainability factor scores over time by segment

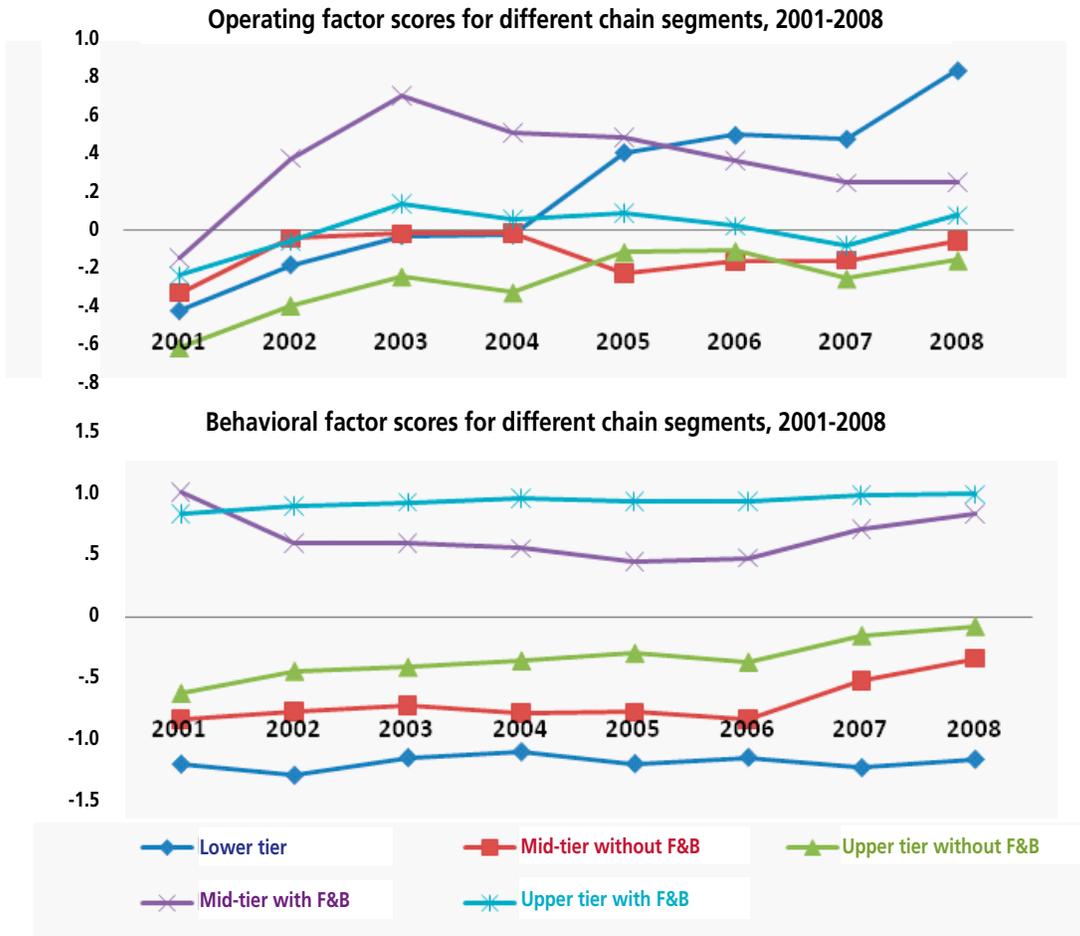


Exhibit 12 (next page) examines the change in the two factors between 2001 and 2008 for the chain scale segments. Across most segments, expenses constituting the operating factor more or less followed the overall economic cycle. The exception is the lower-tier properties (dark blue line), which saw considerable increase across the years. The patterns for mid-tier with F&B, upper-tier with F&B, and upper-tier without F&B are consistent with each other, and the upper-tier hotels without F&B used the least operating-factor-driven resources.

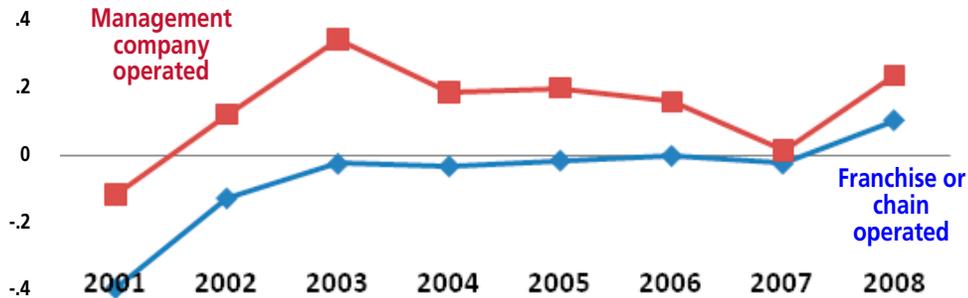
For expenses in the behavioral factor, once again the chain segments that offer F&B services consistently use more resources than do the other segments. The overall pattern displays a slow but steady upward trend, especially for the hotels targeting the middle section of the market.

Relationship between the Two Factors and Management Structure

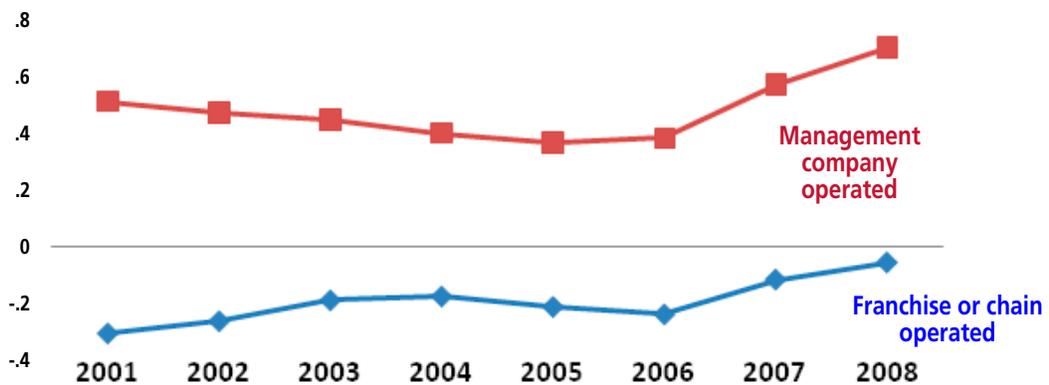
Comparing the franchise- or chain-operated hotels with those operated by third-party management companies (Exhibit 13, overleaf), we note that expenses driven by these two factors display different patterns. Again, the operating-factor-driven expenses appear to follow the overall economic cycle, while the behavioral-driven factors have remained flat or slightly downward from 2001 to 2006, but increased in 2007 and 2008. Overall, hotels operated by management companies had higher scores on both environmental sustainability factors, meaning that they consumed relatively more resources. The operating-factor gap between the two hotel types has shrunk over the years, while the behavioral factor gap has been stable.

Change in environmental sustainability factor scores over time by management structure

Operating factor scores for different management structures, 2001-2008



Behavioral factor scores for different management structures, 2001-2008



The Value of This Measure

Let's review our main purpose, which was to develop a consistent and quantitative measure for environmental sustainability in the hotel industry. Although each hotel is in a slightly different situation, an objective industry standard would be useful to help managers and customers make informed decisions about resource use. This exploratory study is the first attempt at developing such an environmental sustainability index along multiple resource dimensions for operating units representative of the whole industry.

Not only can such a measure be used to establish the baseline for the current state of hotels' environmental sustainability, but it also allows hotels or chains to benchmark performance. More important, these measures can be used to gauge the effectiveness of various operational improvements and innovations aiming at increasing environmental sustainability, and to monitor the progress on environmental sustainability. This measure can be further developed into an evidence-based analytical tool to aid hotel manager in set-

ting quantitative, realistic resource consumption goals based the hotel's specific operating environment, and charting its own standing in environmental sustainability relative to its competitors.

Reviewing our findings. We did, in fact, identify two principal factors that can be used to gauge the utility and supply expenses in hotel operations. The operating factor, as we termed it, is found to have large weights from costs assigned to accounts that seem largely at the discretion of hotel management, in terms of electricity, water and sewer, and maintenance other expense compared to RevPAR. By contrast, what we termed the behavioral factor is connected to laundry, linen, and supplies in both rooms and F&B services, which relate more heavily to guest activity.

Systematic variations in environmental sustainability factor scores relate to key dimensions of hotel characteristics. In particular, as the chain scale of a hotel goes up, the behavioral factor scores increase. The operating factor also increases moderately when moving upmarket (say, from

mid-tier without F&B to upper-tier without F&B, or from mid-tier with F&B to upper-tier with F&B). So, offering F&B service not only increases the expenses in the behavioral factor (compared to those without), but adds operating-factor-related expenses, too. This suggests that environmental sustainability should be managed with an awareness of the effects of total resource consumption, or, in this instance, both factor indexes.

The interaction of factors is demonstrated by a consumption reduction project implemented by the Willard InterContinental Hotel, in Washington, D.C.¹⁷ In 2007, the Willard set quantitative goals to reduce consumption of electricity, natural gas, and water. However, changes in the operation deflected that goal, and actual consumption exceeded the targets by at least 10 percent. In addition to a 5-percent business increase in that year, the hotel also opened a new restaurant. Further efforts resulted in reduced resource use, but this experience confirms that the effect of offering F&B service goes farther than expected in terms of resource consumption. When managers set consumption reduction goals, they should take the spillover expenses related to F&B into consideration.

We also used the lens of sustainability factors to compare hotels operated by the franchise brand or chain and those operated under management contract with a third-party management company. The hotels run by management companies scored higher in both factors (using relatively more resources) than those run under franchise or by chain operators. One possible explanation appears to rest on the composition of chain segments in each group. The franchise group leans toward lower-end hotels and others without F&B, which generally have behavioral factor scores near or below the average. This is in contrast to hotels run by management companies, which tend to have much higher behavioral factor scores. We think that more rigorous statistical analysis is needed to separate the effects of chain segment and operating structure.

Climate conditions and urbanization influence a hotel's operating factor and its behavioral factor. Needless to say, climate zones with more severe weather conditions tax both the operating and behavioral factor in terms of resource consumption. Exceptionally hot weather appears to exert a bigger influence on resource expenses than does extremely cold weather. We also observed that hotels in some regions, such as the southwest and high plains, consume relatively less resources in spite of climate conditions, which may be an indication of their leadership in sustainability. The degree of urbanization affects the two factors in opposite ways. The behavioral factor is higher in the more urbanized areas,

likely related to the higher proportion of high-end hotels in the market, but the operating factor is lower in the more urbanized areas, suggesting more efficient operations.

The two environmental sustainability factors have evolved over time. In recent years, the upper-tier hotels have lowered their operating factor, while the lower tier hotels have seen a sharp increase in their operating factor scores. This coincides with the shift toward sustainability in the hospitality industry beginning about 2005.¹⁸ It also suggests that the high-end service offerings may have more room for service differentiation through green innovations. That said, we also note that the gap between the operating factor scores for the two types of hotel has reduced over the years, undoubtedly due to innovations throughout the industry.

What It Means for Managers

Managers can use the environmental sustainability factors we developed to gauge their sustainability efforts over time and to compare their operations with other hotels. Based on the year-end operating statements at the hotel property level, this measure is not only objective and verifiable, but consistent across hotel properties.

The general manager can first establish a baseline of the hotel's sustainability profile using the most recent financial statement. This profile can then be updated quarterly to capture both systematic and random variations in environmental sustainability. Second, based on the quantitative snapshots, the impact of current green practices can be measured and the practices improved. Third, for future projects, the cost-benefit analysis can be founded on verified data and expressed in solid terms. During implementation, the actual effect can be tracked and quantified, leading to a better understanding of the distinctive characteristics of the hotel and its guests.

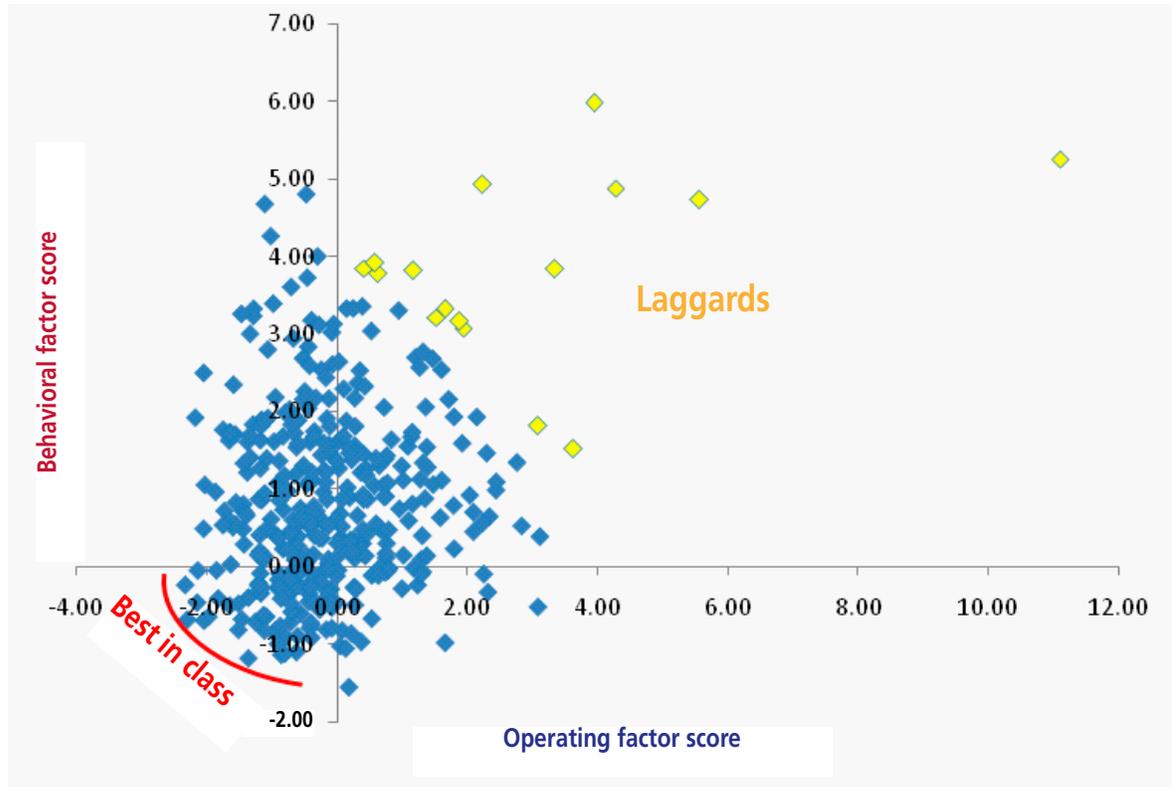
Hotel brand owners can also take advantage of these factors to better manage their hotel portfolio—in particular by supplementing profitability-based evaluation of hotels and managers with the environmental sustainability profile.

That profile not only can assist with performance evaluation, but it also can help disseminate best practices. Take the example found in Exhibit 14 (on the next page), which depicts the estimated environmental sustainability factor scores for the hotel units in the upper-tier with F&B segment. Each dot in the graph (blue or yellow) represents a hotel's eight-year average of the operating factor (on the vertical axis) and the behavioral factor (on the horizontal axis). Since the environmental sustainability factors measure resource consumption, hotels in the lower left quadrant consume relatively fewer resources. The red curve located at the lower left boundary traces the hotels that consume the least

¹⁷ H. Houdré, "Sustainable Hospitality: Sustainable Development in the Hotel Industry," *Cornell Hospitality Industry Perspectives*, No. 2 (2008).

¹⁸ Cornell University Center for Hospitality Research, *Sustainability Roundtable discussion*, October 2009.

Environmental sustainability profile for 389 upper tier hotels with F&B, 2001-08 average



resources as a percentage of RevPAR, which are the “best in class” for resource efficiency. These hotels can serve as centers of excellence and share innovations in environmental sustainability.

On the other hand, hotels in the far upper right (represented by the yellow dots in the graph) are in need of help with regard to sustainability. With such high resource consumption, even if current profitability looks good, they face increased risk from fluctuations in resource prices and shifts in consumer preferences.

Looking Ahead

The “best in class” performance illustrated in Exhibit 15 can be formally studied using a process known as stochastic frontier analysis (SFA),¹⁹ which uses the actual performance

¹⁹ Stochastic Frontier Analysis is a method of economic modeling. It has its starting point in the stochastic production frontier models simultaneously introduced by: D.J. Aigner, C.A.K. Lovell, and P. Schmidt, “Formulation and Estimation of Stochastic Frontier Production Functions,” *Journal of Econometrics*, Vol. 6 (1977), pp. 21–37; and W. Meeusen and J. Van den Broeck, “Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error,” *International Economic Review*, Vol. 18, No. 2 (1977), pp. 435–444.

of the most efficient hotels as the “frontier” against which other hotels are compared, in terms of the amount of output for a particular set of inputs. A follow-up study is underway to link the environmental sustainability factors with hotels’ operating performance using the SFA method. The intuitive conclusions obtained through the exploratory work in this report can be rigorously tested within the frontier framework, allowing estimates of the effect size of key hotel characteristics and external forces.

Further, the SFA panel analysis model²⁰ can estimate the efficiency change over time, from which we can map the performance frontiers of the hotel properties as they develop over time, while identifying the contributing elements in the process. The goal in all of this is to assist hotels in finding ways to continually enhance the sustainability of their operations. ■

²⁰ George Battese Tim J. and Coelli, “A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data,” *Empirical Economics*, Vol. 20 (1995), pp. 325–332.

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