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Hotel revenue management: Investigating the interaction of information technology and judgmental forecasting

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Hotel Revenue Management:

Investigating the Interaction of Information Technology and Judgmental Forecasting

by

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PART ONE

Introduction

Revenue management, also known as yield management, is the process of applying records of historical data and current reservations to predict future demand as accurately as possible to maximize revenue. By understanding the customer's expectation and behavior, successful revenue management can determine market segmentation using a combination of features such as price budget, distribution channels, and service level. Forecasting plays an important role in any revenue management process. Raising the accuracy of forecast could result in better staffing, purchasing decisions, as well as budgeting (Weatherford & Kimes, 2003). Early research was conducted mainly in the airline industry since American Airlines first implemented a computer reservations system (SABRE) and created significant revenue (Smith, Leimkuhler, & Darrow, 1992). The hotel industry and airline industry share some common characteristics: fixed capacity, high fixed costs, low variable costs, and perishable inventories. Therefore, forecasting methods and data collection in the airline industry can be applied to the hotel industry.

A forecasting procedure can be divided into two forms: 1) judgmental forecasting, and 2) statistical forecasting. In the form of statistical forecasting, the computer system usually functions as mechanical-support to assist users to utilize the database more effectively (Silver, 1991). In the form of judgmental forecasting, the computer system functions as decisional-support to encourage users towards more effectual decision-making.

Before the advent of Revenue Management System (RMS), a revenue manager manually developed the forecast by analyzing the historical data (e.g., lengths of stay or rate categories). The process was not sophisticated but it was time-consuming. As a result, the old-fashioned way is no longer appropriate for the current environment with such fierce competition and fast-paced marketplace. There are two main challenges in terms of not applying automation in revenue management steps. First, people require considerable time to handle large-scale data. If a hotel chain manages multiple properties, it could take years for a revenue manager to analyze the booking patterns from the past records on various dimensions. Second, people are not capable of doing calculations as quickly as RMS. For example, a hotel with 2,000 rooms requires forecasting and revising forecasted numbers multiple times a day and then updates the rates in every distribution channel. It is impossible for people to keep pace with the RMS.

Information technology is the key in the development of RMS. With the currently evolving technologies, computers are capable of doing sophisticated calculations to arrive at a precise forecast. Most vendors claim that the system will produce significant increase in revenue; for instance, JDA Software Group, Inc. assisted Continental Airlines Cargo to boost a 2.5% increase in bottom-line revenue and 10% increase in forecasting accuracy in 2009 (JDA Software Group, Inc., 2010). In addition, the hotel's price becomes more transparent due to ubiquitous Internet access. Some hotels adjust the rates based on advanced revenue management intelligence, utilizing the real-time information to monitor competitors' rates and their own demand levels.

It is noteworthy that RMS interacts with the revenue management team in the way that the computers do the complex calculation and the managers make evaluative judgment. Most studies of hotel revenue management were conducted to make improvements on forecasting models or make comparisons between different methods of forecasting to obtain the most accurate estimate, whereas the influential factors such as human judgment and RMS itself were rarely discussed (Armstrong, 2006; Chiang, Chen, & Xu, 2007; Weatherford & Kimes, 2003).

Purpose Statement

Traditionally, forecasting has included human judgment and/ or guessing. The process has often been described as "guesstimation." For instance, people are easily affected by user interface issue or rewarding policies during this process. The purpose of the study is to study and understand how revenue managers and other decision makers "make noise" during forecasting, especially when utilizing the advanced RMS, and to offer constructive suggestions to overcome the issues related to human judgment. In other words, the main objective of this study is to analyze the known influential factors for the interaction of revenue managers' judgment and RMS tools by reviewing existing literature and making suggestions to improve forecasting in the hotel industry.

Objectives.

Given the stated purpose, the research objectives can be summarized as below. First, this proposed study intends to develop a guideline of best practices for revenue management professionals (e.g., hotel revenue managers and RMS designers) to further understand the possibly suspected elements, such as interface issue or perception of users. According to Schwartz and Cohen's study (2004), "the nature of the user interface affected the way the revenue managers adjusted in the computers' forecasts, even though the managers were all given the same predictions regardless of the interface" (p. 85). In addition, this study will identify literature that provides supporting evidence for judgmental forecasting and how to improve decision making during revenue management process. In the end, this study could potentially contribute to existing hospitality research literature on this topic because very little has been published. The information collected in this study will provide revenue management professionals with practical knowledge they need to minimize judgmental biases, the negative effect caused by biases, and inaccuracy on the quality of allocation decisions or on the hotel's profit margin.

Justification

An ever-increasing number of studies have shown that human judgment is necessary in the forecasting process although the computer is capable of producing sophisticated forecasts. According to an extensive study of judgmental forecasting, the role of human judgment has been changed from a warning against accuracy to a required element contributing to the most precise forecasts (Lawrence, Goodwin, O'Connor, & Önkal, 2006). In addition, business practitioners have agreed to the academic studies that the accurate forecasts can-not be generated without human judgment. For instance, Nike announced that they suffered from a major inventory write-off due to the inaccurate forecasts generated from the $400 million experimental forecasting software. Another example is Goodyear, which installed a demand forecasting system in 2000; this system failed to improve inventory control (Worthen, 2003). The poor outcomes were both due to lack of human judgment input.

To achieve the goal of obtaining accurate forecasts, implementing effective RMS is as essential as the role of human judgment. Each increment of progress in information technology forms an opportunity for more comprehensive reservations control and greater integration with other important planning functions (McGill & Van Ryzin, 1999). In the present, fully functioned RMS is capable of performing pricing, inventory control, and distribution channel management. Nevertheless, it is complicated to measure the result by separating the effort between RMS and revenue management team. A study of US Airways evaluated the revenue management analysts' contribution to a RMS and showed that the revenue was improved up to 3% with analysts' effort (Zeni, 2003). Skugge (2004) pointed out some companies were more successful with revenue management than others because they hired more talented revenue managers and placed more emphasis on revenue management education and training program. Therefore, understanding the association between the human judgment and the RMS is a prominent step to raise the accuracy of forecasting.

Constraints

The objective of this study is to analyze the available influential factors for the interaction of revenue managers' judgment and RMS tools by reviewing existing literature and making suggestions to improve forecasting in the hotel industry. It is essential to understand that the majority of study regarding specific judgmental biases caused by information technology is from global businesses (e.g., supply chain corporations, marketing consulting firms, or the financial industry). Forecasting tasks may be influenced by the nature of the product and service or by market conditions (Smith & Mentzer, 2010). For instance, financial forecasting may emphasize collecting data concerning the timing and chance of signing a big contract; retail forecasting may stress gathering more detailed demand data and analyzing the demand change because of promotions or competitors' action. The information gathered and discussed in this study will be modified to the hotel industry's condition. A limited amount of research examines the relationship between revenue managers' judgment and the role of RMS; however, the perspectives or findings from other industries may provide some stimulants to boost novel ideas in the hotel industry.

In addition, the variable selection is arbitrary since the interaction of revenue manager's judgment and RMS is not the only element that affects the accuracy of forecasting, as shown in Table 1. Other influential factors including the external environment (e.g., the economy, social trend, or competitors' action) should be taken into consideration. These variables may change the goal of forecasting, as well as alter the definition of accurate forecasts. For instance, the Internet has gradually become a convenient and efficient tool to disseminate information to potential customers and to record reservations. More and more people have changed booking behavior from through a telesales agent or travel agent to directly online booking (O'Connor & Frew, 2002). The hotel industry must enhance the reservation system and rearrange or train staff accordingly to keep forecasting efficient.

Table 1

Influential Factors of Accurate Forecasting

Internal Factors	External Factors
RMS	Economy
Human judgment	Social trend
Model selection	Competitors' action
Forecasting method	Political regulations
Data collection	
Nature of the experiment	
Goal of forecasting	

Glossary

Judgmental forecasting: Judgmental forecasting usually involves combining forecasts with human opinions or adjustments (Armstrong, 2001).

Statistical forecasting: Statistical forecasting concentrates on using the past to predict the future by identifying trends, patterns and business drives within the data to develop a forecast (Statistical Forecasting, 2006).

RMS (Revenue Management System): Revenue Management Systems in the hotel industry are automated revenue and booking systems that calculate room rates through managing current bookings and historic demand to achieve maximum revenue (JAZD Markets, Inc., 2010).

PART TWO

Introduction

As mentioned in the previous section, the cooperation of RMS and human judgment leads to efficient and effective forecasting and further increase of hotel' revenue. Studies have shown that the most accurate forecasts are developed by combining judgment with statistical methods (Goodwin, 2002; Lawrence, Goodwin, O'Connor, & Önkal, 2006; Schwartz & Cohen, 2004).

The role of human judgment is indispensable in the entire revenue management process no matter how advanced or multi-functioned task RMS could perform. As illustrated in Figure 1, "human judgment is intervened when data and models are selected, models are fitted, forecasts are evaluated and adjusted, and final decisions on rates and allocation are made" (Schwartz & Cohen, 2004, p. 86).

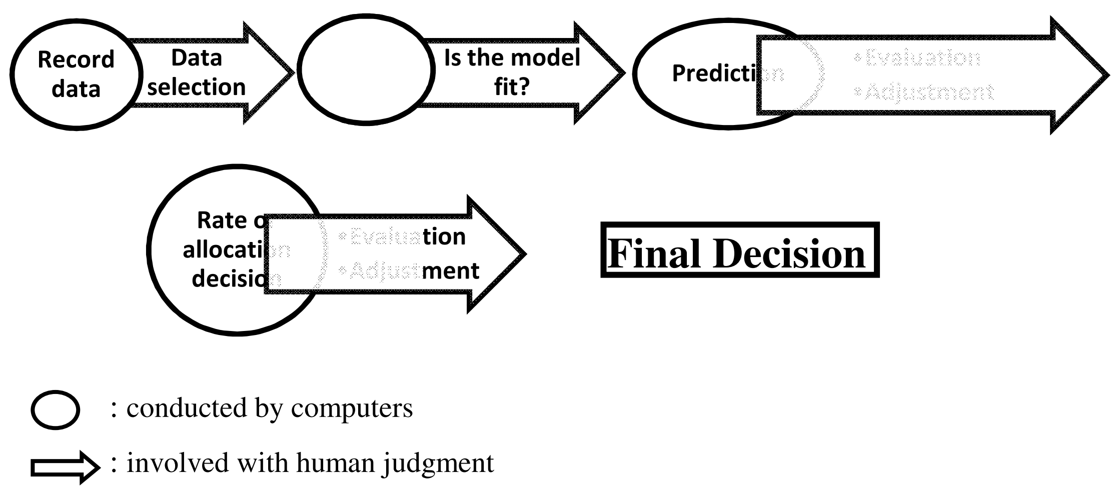

Figure 1. Revenue management process. Adapted from "Hotel revenue management forecasting: Evidence of expert-judgment bias," by Z. Schwartz, and E. Cohen, 2004, *Cornell Hotel and Restaurant Administration Quarterly*, *45*(1), p. 86.

While human judgment has been considered to provide significant strengths to forecasting accuracy, it is inclined to bias depending on various reasons. For instance, people may be inclined to support the results they want due to the intention of themselves involved in developing the forecasts. Judgment is also affected when people do not have the same level skill, such as a well-trained person versus an under-trained person. RMS is another possible reason to promote an inadequate response while people produce forecasts.

The following related literature review is divided into four sections. The first section presents the role and validity of judgmental forecasting and follows with the comparison of judgmental forecasting and statistical forecasting. The third section examines the influences of expertise on judgmental forecasting. The last section reviews specific examples of how evolving information technology influences judgmental forecasting.

Literature Review

The role and validity of judgmental forecasting.

Human judgment used to be considered as the enemy of fidelity to the academic researchers. Based on psychological studies, human judgment has been proved to be inclined to bias in certain situations. For instance, in the belief-bias effect, people are inclined to endorse invalid arguments if the outcome favors their prior belief (Evans, Barston, & Pollard, 1983); in the illusory-bias effect, people are inclined to see patterns in data that supports theories they hold, even when such connections or associations do not exist statistically (Champan & Champan, 1971).

In early forecasting research, Hogarth and Makridakis (1981) questioned the abilities of human judgment and concluded that statistical forecasts outperformed judgmental forecasts after reviewing 175 papers. Specifically, human judgment was described with biases and errors due to the illusion of control, inability to seek possible disconfirming evidence, and overconfidence in decision-making outcome. However, Bunn and Wright (1991) identified that the recorded biases were from undergraduate students' answers to simple written tests completed in the psychological laboratory. Moreover, most of the tests were related to judgment in general knowledge instead of judgment in forecasting. It is very important to delve into the psychological study on the quality of judgment before making generalization in the forecasting literature. In fact, Fischhoff (1988) has stated that all serious forecasts require some exercise of judgment, such as model selection, initial parameter setting, and evaluation of research outcomes. The emphasis of ongoing research is to identify when people should intervene and how to structure the process of the interaction.

The practitioners, on the other hand, always have faith in managerial judgment in forecasting. In a survey study, 500 of the world's largest companies showed that the overwhelming majority of corporate managers pointed out severe constraints in using solely statistical techniques (Klein & Linneman, 1984). Sanders and Manrodt (2003) performed a large survey of 240 US companies. They found that 11% of these companies reported using forecasting software; 60% of the companies who did use forecasting software revealed that they routinely adjusted the forecasts according to their judgment. Thus, understanding how to use judgment appropriately is a prominent task. In the recent survey of 124 financial and economic forecasters conducted in Turkey, 95% of the respondents believed that routinely revisions often resulted in more accurate and persuasive predictions (Gönül, Önkal, & Goodwin, 2009). The investigation demonstrated that forecasts were frequently adjusted when they lacked a justifiable explanation, when the forecasters considered they could improve the result by integrating their knowledge, or when the forecasters perceived a need to take responsibility for the forecast.

These surveys of usage not only help the academic researchers clarify the role of judgment in decision-making procedures, but also affirm the validity of judgment in business practices.

In sales forecasting study, judgment is defined as either a sales force composite or jury of executive opinion (Dalrymple, 1987). Fildes and Goodwin (2007) conducted a survey of 120 forecasters from a variety of industries; 35.4% of respondents indicated that judgment was very important in comparison with statistical methods. This was possibly due to the fact that forecasters had experience in the process or associated product knowledge (e.g., promotional and advertising activity, price change, and health of the market) with the process. On average, 69.3% of respondents estimated that the forecasting accuracy increased more than 5% after judgmental adjustments. To further assess the effect of judgmental adjustments, the researchers gathered more than 60,000 forecast data and found that the judgmental adjustments raised accuracy (Fildes, Goodwin, Lawrence, & Nikolopoulos, 2009).

As with survey and sales forecasting research, macroeconomic forecasts tend to favor judgmental intervention. Turner (1990) examined the impact of judgmental adjustments in the major UK macroeconomic forecasts and found that these adjustments had a significant effect on the forecasts. For instance, the residual adjustment on the 1988 forecast of consumer expenditure growth was modified from a model-based +3% to an adjusted -2% due to the change in the savings ratio in the late 1980s. This change was credited with the skill of the forecaster instead of the quality of the model. Similarly, Fildes and Stekler (2002) summarized the results of macro economic forecasting review and concluded that the necessity of human intervention is not controversial.

The comparison of judgmental forecasting and statistical forecasting.

In forecasting practices, the forecasters usually have additional information that is not contained in the statistical model. The information is made up of the following: knowledge of the time period, knowledge of the nature of the time series, and knowledge of other factors influencing the time series (Lawrence, Edmunson, & O'Connor, 1985). In this section, the study reviews forecasting literature under the constraint that judgmental forecasters have no expertise in the area. While both methods are limited to the historical data only, it is fair to make a comparison of effectiveness between two methods.

The first large-scale comparison of the accuracy of judgmental forecasting and statistical forecasting using real economic series data was conducted by Lawrence et al. (1985). Their research followed the former "Makridakis" 111 real series forecasting competition, using different forms of presentation: graphical method and table method. The forecasters were divided into the researchers themselves and the 202 mainly undergraduate students. The research concluded that "it had demonstrated judgmental forecasting to be at least as accurate as statistical forecasting, while in a number of subgroups of the time series a judgmental forecasting was the most accurate" (Lawrence et al., 1985, p. 34). Furthermore, the error measurement of judgmental forecasting was less correlated with statistical forecasting than statistical forecasting were correlated with each other, which suggested an accurate forecasting was the combination of judgmental forecasting and statistical models. Later, Lawrence et al. (1986) applied the same data set from previous research and examined the effect on accuracy, which could be increased from combining judgmental forecasts, either with other judgmental or with statistical forecasts. The outcome offered further support to the former speculation.

On the contrary, Sanders (1992) evaluated the performance of judgmental and statistical forecasts and the judgmental adjustments of statistical forecasts, using artificial time series data. The forecasts were produced by 38 undergraduate students. The research outcomes showed that judgmental forecasts performed worse and resulted in more biases than statistical forecasts overall. Nevertheless, Lawrence et al. (2006) explained that the statistical forecasts, based on assumption of a stable generating function, should outperform judgmental forecasts with artificial series data.

Human ability to foresee change and instability is beneficial to develop forecasts. However, the accuracy of judgment could be influenced by the characteristics of data, the attributes of task, and the source of data. Therefore, academic researchers obtained relatively opposite results when comparing judgmental forecasting with statistical forecasting. First, people produced more accurate forecasts while the series data was shown in the graphic form than in the table form because humans were skilled in "eyeball" processing (Lawrence et al., 1985; Lawrence & Makridakis, 1989). In addition, the judgmental adjustments improved the accuracy of forecasts when people dealt with low noise series data (Andreassen & Kraus, 1990; Sanders, 1992). People were regarded as confused in processing complex data to detect the trend. Second, the task differences can either assist or hinder the use of judgment as well as affect the ability of people to learn skills. For instance, Lawrence and O'Connor (1996) concluded that humans performed better than the model-of-man in the time series forecasting research because humans could use contextual information properly. Stewart, Roebber, and Bosart (1997) presented the similar results; they found that "task predictability was an excellent indicator of forecast accuracy" (p. 205). Thus, understanding the attributes of task is significant before evaluating accuracy of human judgment. Finally, judgmental adjustments may be impacted by the data source from a human expert or a statistical method. A recently published research examined the extent to which people changed their original forecasts due to advice among these two sources, using undergraduate students (Önkal, Goodwin, Thomson, Gönül, & Pollock, 2009). When receiving advice from a single source, the participants tended to believe the advice from a human expert rather than from a statistical method and adjusted the forecasts toward the advised value. When receiving multiple sources, the participants still put more emphasis on the advice from a human expert. In all cases, the accuracy of adjusted forecasts was raised given the advice value was correct.

The influence of expertise on judgmental forecasting.

An expert is defined as a person who is trained to be capable of making objective judgment and possesses additional information that can be useful in either explaining the historical record or in predicting the future (Lawrence et al., 2006). Sometimes the impact of this information can be minor; at other times it can be quite essential to cause major influences on forecasting.

While experts make forecasts in the field of their expertise and the decision-making process has formal structure with support of hard data, the results of judgmental forecasts are usually accurate. In financial earnings forecast literature, Brown (1996) provided the investment community with specifically convincing reasons to stress the importance of analysts' judgmental forecasts. First, the predicted numbers developed by analysts were proper benchmarks for evaluation purposes. In addition, the forecasts produced by analysts considerably outperformed those made by naïve or complex time series models. Finally, the average forecast errors made by analysts' neither increased nor tended towards optimism over time. Lawrence et al. (2006) have analyzed that there are two underlying reasons for the greater accuracy of judgmental forecasting.

First, experts have additional information, which may explain a significant part of the non-modeled component of the variance. Also, experts are able to obtain more timely information.

Another research study showed that judgmental adjustments to the former forecasts led to positive influences on the market (Ivkovic & Jegadeesh, 2004). Furthermore, Asquith, Mikhai, and Au (2005) found significant information content in the professional released forecasts. Goodwin (2005) reviewed nine published papers and concluded that judgment was especially helpful to improve forecasting when pinpointing a one-time event or when experts had great knowledge regarding a trend or product that could not be explained by the model. This theory could be applied to the hotel industry as a revenue manager's responsibility is to supervise the whole forecasting process. An experienced revenue manager should pay attention to identifying an irregular occurrence (e.g., promotion or terrorist attack) that might influence hotel occupancy rate. In addition, the revenue manager should pay attention to future changes either in internal or external operating environment and adjust suitable data parameter or model selection accordingly.

Contrary to the above research, experts' opinion may be biased and fail to give accurate forecasts in some situations. In a sales forecasting study, the result presented that judgmental forecasts were less accurate than a simple, un-seasonally adjusted, naïve forecasts (Lawrence, O'Connor, & Edmunson, 2000). This result was probably due to the fact that forecast accuracy was not the ultimate goal in the company forecasting process. The analysts might alter the setting of the forecast to achieve the particular objective or satisfaction of customer demand. Moreover, the accuracy of forecasts might be compromised because of budget or incentive in individual department. In hotel practice, the judgmental forecasts made by revenue managers were impacted by the way revenue managers perceived forecasting system (Schwartz & Cohen, 2004). They adjusted more to the previous forecasts when they considered the forecasting system was not reliable, and vice versa.

Weather forecasting may be a perfect example of relatively effective exercise of judgment in comparison with statistical forecasting since the forecasters held a considerable amount of information available, obtained detailed feedback, and experienced a variety of meteorological situations (Bunn & Wright, 1991). Nevertheless, the Inter-governmental Panel on Climate Change (IPCC) Report about global warming was found with error and violation of forecasting principle due to experts' prediction (Green & Armstrong, 2007). The forecasts were more of the scientists' opinions converted into mathematics and blurred by complicated writing but less a result of scientific procedures. Unaided expert judgment results in poor forecasts because experts transform only their own perceived information into models and produce forecasts correspondingly.

As learned from studies discussed, a professional's judgment may be affected by work experience, available information, and related knowledge within the area as well as by motive, belief, and forecasting system. Some factors could help experts produce more accurate forecasts, whereas other factors could prevent experts from making appropriate adjustments.

There are mainly three possible factors worthy of discussion. First, motivation is always the reason for bias in managerial judgment. Lawrence et al. (2006) argued that "self-serving bias in the forecasts may be a powerful determinant of comparative forecast accuracy advantage in the cases of sales forecasting" (p. 501). Management might be influenced due to the company's reward structure; therefore, they exert control over forecast numbers to meet or satisfy the forecasting target. As a result, management receives the bonus while the accuracy of forecasts is sacrificed. Second, there are certain biases even a well-trained and experienced person easily tends toward: overconfidence or overreaction (Eroglu & Croxton, 2010). For instance, a revenue manager might have confidence in a large convention group booking because the client has kept a long-term relationship with the hotel. Thus, a revenue manager altered forecasts predominantly in the upward direction or the magnitude of alteration was too large while he/ she should be conservative to a future event. Finally, the role of forecasting support system is another cause to invoke bias. Research evidence suggested that inflexible interfaces and poor graphics were damaged to managerial judgment (Fildes et al., 2009). If some features of the system promoted judgmental bias in itself, the system might make experts difficult to apply their experience or knowledge appropriately to adjust the forecasts to the right direction.

In hotel practice, Schwartz and Cohen (2004) presented that revenue managers' judgment was indeed influenced by different interface design of RMS, which were computer speed and the existence of an interactive chart. Today's intelligent RMS provides more decisional guidance than traditional meta-support system; thus, it is important to understand whether these input mechanisms influence the essence of forecasters' judgmental inputs (Silver, 1991). The major issue in current research is the extent to which revenue managers should interfere in a certain situation and an evaluation of RMS design, which may cause biases against human judgment.

How evolving technology influences judgmental forecasting.

This section uses specific examples in business practice to consider how forecasting system affects an expert's judgment and examines the characteristics of the system. Fildes, Goodwin, and Lawrence (2006) demonstrated that the forecasting system should achieve two main purposes: (1) to strengthen the forecaster's skill by understanding when judgmental intervention is proper and (2) to enable the forecaster to provide precise judgmental adjustments when such adjustments are proper.

Early research has presented that the forecasting system is one of the elements that influence an expert's judgment and further impact the forecasting performance. Fildes and Hastings (1994) mentioned what characteristics a perfect forecasting system should focus on and connected this discussion with organizational factors in market forecasting. Davis and Mentzer (2007) regarded information technology as part of an information logistics component in their sales forecasting management framework. Smith and Mentzer (2010) conducted a survey research from 216 senior forecasters to examine the association between particular features of the forecasting system and the forecaster's perception of system quality and access. The result presented the positive relationship and presumed that the effectiveness of a forecasting system depended on the evaluation of the forecasters, especially when the forecasters thought if the system provided the right data, the required techniques and the easy access to data and techniques or not. If the forecaster figured that the forecasting system did not function well due to above shortcomings, the accuracy of forecasts would be impacted.

Despite the fact that much literature exploring the features of forecasting system is focused on supply chain corporations, the main function of RMS in the hotel is similar to that of forecasting system in supply chain corporations. The main functions are as follow: (1) a database recording the time series historical items (e.g., price and occupancy rates) and special events (e.g., sales promotions and holidays); (2) a set of statistical forecasting methods such as exponential smoothing; (3) functions that allow the adjustments of expert's judgment and record these adjustments for error comparison (Fildes et al., 2006). Ideally, the forecasters should adjust the computer-generated forecasts to overcome irregular occurrence, such as sales promotions, market condition, or economy. However, much evidence showed that the forecasters were inclined to bias and the exercise of judgment was far from ideal as a result of forecasting system.

Fildes et al. (2006) summarized early research and concluded that the effective information guidance provided by the system was to enable the forecasters to become involved in the forecasting process, asking them to provide feedback or extra explanation to the adjustments. For instance, Lim and O'Connor (1995) found that forecasters consistently depended on their own judgment regardless of the pop-up window that contained the following warning: "Please be aware that you are 18.1% less accurate than the statistical forecast provided to you" (p. 156). To the contrary, Goodwin (2000) found that forecasters made relatively fewer unnecessary adjustments when they had to specify the rationale. Moreover, the adjustments were more helpful to the accuracy of forecasting. The different outcomes were due to the extent to forecaster engagement.

In the hotel practice, given the experiment settings, it was assumed that revenue managers' judgment was swayed by the presentation of user interface (Schwartz & Cohen, 2004). For instance, the computer's processing speed could be an implicated signal to revenue managers due to lack of other information. People might interpret a fast and modern computer as a sign of reliability so people reasonably made minor adjustments to forecasts with increased belief in the computer forecasts. Second, the slower computer with pop-up window showing the progress report might result in smaller adjustments since people thought that they were involved in the process and understood each step of processing. Finally, the charting tool might also affect human judgment. When asked to identify trends or assess forecasts depending on historical numbers and occupancy patterns, people were more skilled at interpreting graphical information than numerical information.

In a sales forecasting research, the result of an online survey of forecasting executives from 480 corporations presented evidence that a lack of familiarity by forecasters with the systems caused “black box” forecasting (McCarthy, Davis, Golicic, & Mentzer, 2006). For instance, the forecasters did not know the methodology because the system automatically selected and fitted the forecasting model; therefore, they suggested that the system was correct and reliable. This “black box” forecasting resulted in overconfidence in statistical forecasting and misinterpretation of forecasting systems. Kusters, McCullough, and Bell (2006) also suggested that the forecasting system should provide detailed description about the default assumptions and calculations to make the forecaster easier to assess the outcomes.

Recently, Asimakopoulos, Fildes, and Dix (2009) examined the influences of six different interface designs of sales forecasting system on 60 university students. The experiment emphasized analyzing forecasters’ difficulties in effectively visualizing a forecasting system when proceeding forecasting duty, such as providing justification to the adjusted forecasts based on available product knowledge and market conditions. Four major points will be discussed. First, forecasters figured that the pop-up window including relevant knowledge (e.g., possible price changes) might be helpful to make decisions when interacting with the system. In addition, most forecasters mentioned the need to maintain a record of the forecasting process for effective evaluations. Third, forecasters felt frustrated if the system could not provide easy navigation (e.g., next/previous buttons and/or sidebars) between the different forecasting duties and preview of product knowledge. Finally, forecasters expected a handy tool (e.g., the notepad), which allowed them to compare and communicate associations between activities and products. While it was difficult to receive feedback from professional forecasters, management school students could be perceived as potential forecasting analysts and could make contributions as well.

Conclusion for Part Two

The literature has shown that the most effective forecast is created by the mix of experts' judgment and appropriate statistical model embedded in the forecasting support system. Studies have shown that human judgment is considered beneficial to forecasting because of work experience and related product or market knowledge. The comparative accuracy between judgmental forecasting and statistical forecasting was usually confused because human judgment could be affected by the features of the data, the nature of the task, and the source of the data. As academic researchers assumed that a well-trained person could make objective judgment and produce more accurate forecasts, they found that an expert was still inclined to bias due to motivation, self-confidence, and forecasting support system.

The features of a forecasting support system have been gradually investigated since people are heavily dependent on the system to perform forecasting tasks. Davis (2010), CTO of Choice Hotels, believes that the integration of Property Management System (PMS), Central Reservation System (CRS), Customer Relationship Management (CRM), and RMS will be the trend in the future and further contribute to a hotel's success. Conophy (2010), CTO of InterContinental Hotels Group, also revealed that "the technology around revenue management is getting more and more sophisticated" (Future of technology, para. 1). Hotels used to be able to emphasize room rates and adjust for seasonality; however, it has become more significant to observe the competitors' action from different channels nowadays.

As a result, it is important for academic researchers and practitioners to realize the features of the system and apply the system to elicit proper human judgment and thus improve the accuracy of forecasting. Tory and Staub-French (2008) suggested that the target of system visualization was to support forecasters to obtain insight into the historical data and to communicate the information with others over a period of time. Therefore, this study intends to understand which characteristics of the system will be valuable for sophisticated and long-term data analysis. To fill the gap between the knowledge of how the system should be designed to assist forecasters and the understanding of how people interact with the system to make fair judgment, it is probable to obtain some guidance from the literature to improve the design of the forecasting system. Although many of the instances cited in the literature were from corporations beyond the scope of the hotel industry, the hoteliers and RMS designers should be capable of taking advantage of these findings and adapting them to the application of RMS.

PART THREE

Introduction

Forecasting is a driving force behind productive business planning as well as a critical issue that contributes to success of a company, especially during an economic recession. Decisions regarding staffing, purchasing, financial budgeting, and other resources allocation all rely on accurate forecasts; otherwise, the company's performance will be impacted. At this time, it is significantly important for multi-national hotel chains to achieve effective management if they could take forecasting performance into account. RMS is one of the factors that influences on forecasting accuracy due to interaction with people. State-of-the-art RMS can perform last-minute room rate adjustments, estimate demand and supply, produce an optimal rate based on competitor's pricing perfectly, and function 24 hours a day. However, a skilled forecaster is still the centerpiece of the whole revenue management process (Mourier, 2010). Mourier, CEO and founder of RevPar Guru, suggested that the best approach to carry out revenue management is to put emphasis on the use of RMS to enhance revenue managers' proficiency, instead of forcing them to keep up with currently never-ending data processing, computations, and pricing updates. Therefore, hoteliers should make good use of RMS and stress the training program of RMS so that a talented revenue manager can spend more time on analyzing information for future planning to lead to a more profitable hotel operation.

Academic researchers have recognized the important role of human judgment in forecasting practices (Fildes & Goodwin, 2007; Fildes, Goodwin, Lawrence, & Nikolopoulos, 2009; Gönül, Önkal, & Goodwin, 2009). It is difficult to measure the relative effectiveness between judgmental forecasting and statistical forecasting because of the nature of people (Lawrence, Edmunson, & O'Connor, 1986; Lawrence, Goodwin, O'Connor, & Önkal, 2006;

Sanders, 1992). Sometimes people are good at anticipating change and identifying irregularity, whereas sometimes they are affected by the information they observe (Lawrence & Makridakis, 1989; Önkal, Goodwin, Thomson, Gönül, & Pollock, 2009; Stewart, Roebber, & Bosart, 1997). Moreover, even a skilled and experienced person is inclined to bias when receiving various stimuli, such as motivation, self-trust, and forecasting support system (Eroglu & Croxton, 2010; Fildes et al., 2009; Lawrence et al., 2006). More and more researchers have noticed the need to examine the design of a forecasting support system that influences forecasters' judgment to improve the quality of forecasts (Fildes, Goodwin, & Lawrence, 2006; Smith & Mentzer, 2010). As plenty of hotel companies, such as Accor Hotels, Carlson, and Trump Hotel Collection, have implemented the use of RMS (EasyRMS, 2010), future in-depth research must be done to understand how RMS could elicit appropriate judgment calls and to evaluate whether the current commercial RMS could offer required facilities to support forecasters.

Academic researchers and practitioners have agreed that the combination of professional judgment and the statistical model embedded in the system can result in a more effective forecast than either one alone. This study draws on the forecasting and technological system literature to consider how the bias might be caused and how to improve the system. Although the literature provides many practices from a variety of fields, the hotel professionals could refer to or modify the finding as Fildes et al. (2006) suggested and could adapt the concepts to the use of specific RMS design. The most important intent is for revenue management professionals to realize that they must use RMS correctly and invest in RMS for a rewarding performance. This section will provide a guideline for revenue management professionals to understand the ideal characteristics of RMS.

Results

Based on the extension and replication of concepts of Silver (1991) and Fildes et al. (2006), a well-designed RMS should incorporate some characteristics, which are listed below, to support revenue managers' judgment:

- The RMS will be acceptable to forecasters, whether to revenue managers or analysts. Forecasters' perception of RMS will have an effect on forecasters' decision making in addition to the quality of forecasts.
- The RMS will be simple to operate. RMS will allow a comparison of different statistical forecasts or make forecasters easily identify extreme forecasts errors with obvious visual interface design.
- The RMS will offer flexible choices of appropriate facilities and methods. Forecasters feel more responsible and obligated to forecasting performance when they participate in the process of forecasting.
- The RMS will provide guidance to encourage forecasters to adopt appropriate strategies. Clear guidance with transparent methodology and accuracy measurement reduces confusion and misunderstanding.
- The RMS will support the proper mix of judgment and statistical forecasts. Intelligent RMS provides appropriate statistical forecasts and makes the judgmental adjustments more demanding.

The result of this proposed study uses research evidence to demonstrate that various designs or components of the forecasting system lead to judgmental bias in different areas of business practices. Unlike research conducted in much other forecasting literature, this study emphasizes the role of RMS and how to use it to promote appropriate judgment. As a result, this study provides a guideline for assessing alternative interface designs and the support system's model components. For instance, a revenue manager is able to evaluate RMS capabilities (e.g., useful database, effective statistical methods, and comparative error measurements) to determine if this system could be helpful to develop improved forecasts. Regarding ease of use, different windows presenting the contrast between system-generated forecasts and judgmental forecasts, highlight function, and notepad tool provided by RMS are considered beneficial to record as well as explain judgmental adjustments. Moreover, flexible RMS enables revenue managers to feel involved in the interaction with the system and makes them reflect on their current point of view. Intelligent RMS enhances the quality of forecasts by providing revenue managers with more detailed guidance and feedback on their adjustments; as a result, the RMS reduces the bias due to misinterpretation of the system. In the end, integrating of the above characteristics should contribute to a well-designed RMS that assists revenue managers with appropriate judgment to develop accurate forecasts.

Conclusion

Recently, Casino Enterprise Management (CEM) magazine granted the 2010 Hospitality Operations Technology (HOT) Award to The Rainmaker Group, a world leader in RMS for the hospitality industry ("Rainmaker's revolution," 2010). The Rainmaker Group creates the only RMS that considers Total Customer Value when deciding optimal availability situations. Total Customer Value represents hotel revenues and potential revenues from gaming, spa, food and beverage, as well as other prominent profit centers. This advanced system also includes factors that may change future demand from local influences (e.g., holidays and city-wide events) to arrive at optimal room rates for customer segmentation.

To highlight the association between literature review and research results, Table 2 offers an overview of research on the features of the forecasting support system.

Table 2

Research on the Features of the Forecasting Support System

Reference	Major Theme of Study	Identified System Issue	Linking to Research Result
Fildes & Hastings (1994)	Forecasting support system and organizational factors in market forecasting	Accuracy v.s. bias and quality of information	RMS will support the proper mix of judgment and statistical forecasting.
Lim & O'Connor (1995)	Judgmental adjustments of initial forecasts	The degree of users' proactive or passive involvement with the system	RMS will offer flexible choices of appropriate facilities and methods.
Goodwin (2000)	Improving the voluntary integration of statistical forecasts and judgment	The extent of users' engagement	RMS will offer flexible choices of appropriate facilities and methods.
Schwartz & Cohen (2004)	RMS and its effectiveness	Design of user interface	RMS will be acceptable to forecasters.
Fildes, Goodwin, & Lawrence (2006)	The design features of forecasting support systems and their effectiveness	The extent of users' engagement	RMS will offer flexible choices of appropriate facilities and methods.
Kusters, McCullough, & Bell (2006)	Forecasting software	Methodology	RMS will provide guidance to encourage forecasters towards appropriate strategies.
McCarthy, Davis, Golicic, & Mentzer (2006)	The evolution of sales forecasting management	"Black box" forecasting	RMS will provide guidance to encourage forecasters towards appropriate strategies.
Davis & Mentzer (2007)	Organizational factors in sales forecasting management	Information processing	RMS will be acceptable to forecasters.

Reference	Major Theme of Study	Identified System Issue	Linking to Research Result
Asimakopoulos, Fildes, & Dix (2009)	Various interface design of sales forecasting system	Interface design	RMS will be simple to operate.
Smith & Mentzer (2010)	The influence of individuals, systems and procedures on forecast performance	Features and users' perception of system quality and access	RMS will be acceptable to forecasters.

The practicability of the guideline could be examined regarding whether it suggests some characteristics as similar as the real-world RMS. According to The Rainmaker Group (2010), the revolution system provides users with "visibility into the components of their property's forecasts so that they can understand how the system arrived at its results" ("Features and Benefits," para. 2). This feature is related to what the guideline suggests: clear guidance with transparent methodology reduces misunderstanding. Other features, such as "demand and booking patterns can be easily compared to last year or last week" or "it is easy to use with color-coded data visualization screens" both correspond to the guideline's advice that RMS will be simple to operate. RMS providers have been upgrading from a traditional revenue management model to a revenue optimization algorithm that includes channel, pricing, and inventory control functions with demand forecasting, customer analysis, and the ability to manage multiple sources of revenue (Albright, 2008).

The findings of this study have significant practical implications for hotel revenue managers and RMS designers. Hotel revenue managers require more guidance from RMS because of the competitive and fast-paced organizational environment. In other words, hotel revenue managers need more guidance from RMS to make appropriate decisions to assume uncertainty and risk of daily occupancy rate. According to Silver (1991), "the need for guidance is to help choose among competing solution techniques or among alternative methods of processing information” (p. 109) while a system serves high-level operators, such as hotel revenue managers. Therefore, when a hotel revenue manager considers implementing a new RMS, it is beneficial to apply this guideline to measure its effectiveness and whether it is able to elicit proper judgmental response. Furthermore, a revenue manager could use the guideline to examine the existing RMS to figure out which element causes the judgmental bias. RMS designers also benefit from the guideline to understand which features are regarded important and required and which features are regarded harmful and damaged to forecasting task. As a result, RMS designers could reconsider the content of the system and utilize these features to create a niche market.

Recommendations for Future Research

The proposed study provides an initial and basic guideline of RMS design in the hotel industry. Two recommendations for future research might be beneficial to further understand the association between the role of RMS and human judgment. First, an extensive survey investigation based on questions of task-technology fit model (Smith & Mentzer, 2010) could be distributed to revenue managers in the hotel industry to help sustain the proposed guideline. The quantitative method offers hard data to demonstrate the influence of revenue managers, RMS, and revenue management procedures on forecast effectiveness. See Appendix A for recommended survey questions.

The second recommendation for research is to carry out an experiment to explore visual effect on RMS. Studies could delve further into the technical aspect of RMS design (e.g., user-friendliness, easiness of navigation, impact of design, and content on visual literacy) to understand consequential responses to each forecaster. Such in-depth research will help to verify the relationship between the specific design of RMS and forecasting performance and will probably reveal influential factors beyond the known features. This is a relatively fresh area and could be an opportunity to give a systematical analysis of effective interface design, thus creating an optimal RMS.

APPENDIX A

Recommended Survey Questions

Construct	Questions
Procedure quality (the degree to which the procedures guiding the forecasting process are perceived to assist in the creation of demand forecasts.)	Our forecasting procedures. . . . . . support forecast development very effectively. . . . provide clear directions to guide forecast development. . . . are exactly what are needed to create accurate forecasts. . . . ensure the right methods (techniques) are used to forecast.
Procedure access (the degree to which the procedures guiding forecast creation are perceived to be available to assist in the creation of demand forecasts.)	Our forecasting procedures. . . . . . are documented. . . . ensure that forecasts are created in a timely manner. . . . are readily available to help guide forecast development. . . . are easy to follow. . . . are always up-to-date.
RMS (the extent that RMS technologies correspond to those of an idealized forecasting support system.)	Our RMS. . . . . . uses a number of statistical methods (techniques) for forecasting. . . . can display forecasts in different measurement units that might be needed by forecasters (e.g. units of alternative room type, dollars, etc). . . . can display forecasts at different levels of categories that might be needed by forecasters (occupancy rate by day of the week, room rate, room type, segments of guests, etc). . . . gives us the ability to manage products on means of distinguishing product importance (profitability of different room types). . . . can capture forecast adjustments made by each forecaster.
RMS quality (the degree to which information in the RMS assists individuals in performing their forecasting related tasks.)	Our RMS. . . . . . contains data at the right level(s) of detail to support forecasting. . . . contains the right statistical methods (techniques) needed to create forecasts. . . . contains data that is not accurate enough to create effective forecasts. . . . contains all the data needed to create accurate forecasts.
RMS access (the degree to which information in RMS is available to assist individuals in performing their forecasting tasks.)	Our RMS. . . . . . is easily accessible to forecasters. . . . makes it easy to get access to demand and forecast data. . . . makes it easy to access the forecasting methods (techniques) needed to develop forecasts. . . . is always “up” and available when forecasters need it.

Construct	Questions
Forecast performance (the extent to which demand forecasts match the actual demand for a product or service over a stated time horizon. . .A seven point scale with the following ranges was used to capture performance: <70%, 70%–74%, 75%–79%, 80%–84%, 85%–90%, 90%–94%, 95%–100%.)	Indicate the accurate degree of forecasts, based on a monthly time horizon.

Respondents were asked to choose a level of agreement or disagreement with the questions based on a scale ranging from 1 (strongly disagree) to 7 (strongly agree). Adapted from "Forecasting task-technology fit: The influence of individuals, systems and procedures on forecast performance," by C.D. Smith, and J.T. Mentzer, 2010, *International Journal of Forecasting, 26*(1), p. 158.

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