

Hotel revenue management – a critical literature review

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Abstract

The paper presents a critical literature review of the main concepts of hotel revenue management (RM) and current state of theoretical research. It emphasizes on the different directions of hotel RM research and focuses comprehensively on the elements of the hotel RM system and the stages of RM process. Special attention is paid to the different hotel RM centres, the pricing and non-pricing RM tools, forecasting methods, the RM software, RM team and ethical considerations as they play a central role in the RM practice. Finally, the article outlines future research perspectives and discloses potential evolution of RM in future.

Key words: *hotels, revenue management, yield management, overbooking, pricing, ethics*

1. Introduction

Revenue (yield) management (RM) is an essential instrument for matching supply and demand by dividing customers into different segments based on their purchase intentions and allocating capacity to the different segments in a way that maximizes a particular firm's revenues (El Haddad, Roper & Jones, 2008). Kimes (1989) and Kimes & Wirtz (2003) define RM as the application of information systems and pricing strategies to allocate the right capacity to the right customer at the right price at the right time. This puts RM practice into the realm of

marketing management where it plays a key role in demand creation (Cross, Higbie & Cross, 2009) and managing consumer behaviour (Anderson & Xie, 2010). RM theory has also benefited strongly not only from marketing management research, but more profoundly from operations (e.g. Talluri & van Ryzin, 2005) and pricing research (Shy, 2008).

Firstly developed by the airline industry, RM has expanded to its current state as a common business practice in a wide range of industries. Kimes (1989) and Wirtz *et al.* (2003) outline that RM can have essential contribution to businesses that share the following characteristics: perishable inventory, restricted capacity, volatile demand, micro segmented markets, availability of advanced reservation, and low variable to fixed cost ratio (although Schwartz (1998) shows that these do not need to be necessary fulfilled in order RM to be successfully implemented). RM can be profitably applied in airlines, hotels, restaurants, golf courses, shopping malls, telephone operators, conference centres and other companies. This has triggered significant theoretical research in RM fundamentals and its application in various industries (Chiang, Chen & Xu, 2007; Cross, 1997; Ng, 2009a; Talluri & van Ryzin, 2005), including tourism and hospitality (Avinal, 2006; Ingold, McMahon-Beattie & Yeoman, 2001; Kimes, 2003; Lee-Ross & Johns, 1997; Tranter, Stuart-Hill & Parker, 2008; Yeoman & McMahon-Beattie, 2004, 2011).

While RM is very well developed both as a theoretical framework and a business practice in the airline industry, it has not received enough attention in the field of hospitality. Research in hotel RM, in particular, is fragmented and lags significantly behind the RM practice in the field. In this regard, the *aim* of current paper is to critically evaluate contemporary hotel RM research, to identify the gaps in literature and provide directions for future research. The review is structured around the elements of hotel's RM system and the stages of the RM process. It is based on publications (articles in academic journal, books and monographs) published predominantly in the last 10 years. The practical issues of RM remain beyond the scope of the paper, although it should be noted that the RM practice in the major hotel chains is sometimes better developed than the respective academic literature.

2. Hotel revenue management system

From the standpoint of systems theory (von Bertalanffy, 1969), hotel RM can be presented as a system, illustrated on Figure 1.

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When the customer places a booking request, it is registered by the hotel's RM system. The latter consists of four structural elements (data and information, hotel revenue centres, RM software and RM tools), the RM process and the RM team. The operational results from the RM process are the specific booking elements of the particular booking request – e.g. booking status (confirmed/rejected), number of rooms, types and category of rooms, duration of stay, price, cancellation and amendment terms and conditions, etc. The booking details and the operation of the whole RM system influence customer's perceptions of the fairness of hotel's RM system and his/her intentions for future bookings with the same hotel/hotel chain. The RM system experiences the constant influences of the external (macro- and micro-) and internal environmental *factors* in which the hotel operates (e.g. company's goals, its financial situation, legislation, competition, changes in demand, destination's image, or force majeure events among others) and revenue manager's decisions have to take all these into considerations. Table 1 below summarizes the main directions of hotel RM system elements research. Due to their importance separate tables are dedicated to present research on RM tools, forecasting and approaches used for solving RM mathematical problems.

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2.1. Revenue centres

Hotel revenue centres determine the potential sources of revenues for the hotel (room division, F&B, function rooms, spa & fitness facilities, golf courses, casino and gambling facilities, and other additional services) and the capacity of the hotel to actively use pricing as a revenue generation tool. It is important that the hotel's RM system (Figure 1) includes all revenue

centres, not only the rooms, because they can significantly contribute to hotel's total revenues and bottom line. For some types of properties (e.g. casino hotels), rooms might even be a secondary revenue source.

The fact that besides the rooms the hotel can have additional revenue centres complicates the RM process. Instead of maximizing room revenues only, the revenue managers must now focus on the revenues of the hotel as a whole. This justifies the arising interest in the application of revenue management principles and tools in related hospitality industries and hotel revenue centres (Table 1) – restaurants (Bertsimas & Shioda, 2003; Kimes, 2005; Kimes & Thompson, 2004), function rooms (Kimes & McGuire, 2001; Orkin, 2003), casinos (Hendler & Hendler, 2004; Kuyumcu, 2002; Norman & Mayer, 1997), spa centres (Kimes & Singh, 2009), golf courses (Licata & Tiger, 2010; Rasekh & Li, 2011). In most cases, the additional revenue centres will generate income only if the guests are already accommodated in the hotel (although some guests might use only the additional hotel services without accommodation). In this regard, the goal of maximizing room revenues might not be consistent with the total revenue maximization objective. Revenue managers might decrease room rates in order to attract additional guests to the hotel that will subsequently increase the demand for the other revenue centres. In practice, many hotel chains have long recognized the importance of the additional services as revenue source and have adopted proper RM strategies to generate revenues from them. The RM software used by them also includes modules for the additional revenue centres. However, from research point of view, up to now, the additional revenue centres have been studied as *separate* business units, and *not* as integrated with the revenue management in the Rooms Division department. In this regard, it is necessary that the hotel RM research incorporates them into the revenue maximization problem of the hotel in search of hotel *total* revenue management.

2.2. Data and information

The application of RM requires a lot of *data* regarding different *RM metrics* – average daily rate (ADR), revenue per available room (RevPAR), occupancy, yield, profit per available room, etc. (Barth, 2002; Lieberman, 2003). Additionally, the RM system requires information about hotel's future bookings on a daily basis (what types and how many rooms), sale of additional

services in the other revenue centres, competitors' rates and strategies, information regarding changes in legislation, special events to take place in the destination and any other data/information that relates to the demand, supply, revenues and financial results of the hotel. Albeit their importance, the RM metrics and data requirements seem somewhat neglected in the hotel RM research field.

2.3. *RM tools*

RM involves the utilization of different RM tools, which we define as instruments by which hotels can influence the revenues they get from their customers. The RM tools can be broadly divided into pricing and non-pricing tools (see Table 2). Pricing tools include price discrimination, the erection of rate fences, dynamic and behavioural pricing, lowest price guarantee and other techniques that *directly* influence hotel's prices (their level, structure, presentation and price rules). Non-pricing tools do not influence pricing directly and relate to inventory control (capacity management, overbookings, length of stay control, room availability guarantee) and channel management. Nevertheless, pricing and non-pricing tools are intertwined and applied simultaneously – for instance, prices vary not only by room type, lead period or booking rules, but by distribution channel as well.

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2.3.1. Non-pricing tools

Inventory management includes capacity management and control, overbookings and length of stay controls. Capacity management and control and overbookings are the two most influential techniques and at the same time – most controversial problems discussed in RM (Karaesmen & van Ryzin, 2004).

Capacity management refers to the set of activities dedicated to hotel's capacity control. Pullman & Rogers (2010) distinguish between strategic and short-term (tactical) capacity management decisions. The first include capacity and expansion (e.g. number of rooms), carrying capacity (the optimal use of the physical capacity before tourist's experience

deteriorates, e.g. optimal occupancy rate), and capacity flexibility (hotel's ability to respond to fluctuations in demand by changing its capacity). Tactical decisions refer to the set of activities related to managing capacity on a daily basis – work schedules, guests' arrival/departure times, service interaction time, application of queuing and linear programming models to service processes, customers' participation in the service process, etc.

From a narrow perspective, hotel's capacity refers to the Rooms Division capacity only, i.e. the total number of overnights the hotel can serve at any given date. Practically the hotel can efficiently decrease its room capacity by closing separate wings or floors, or expand it by offering day-let rooms, but in any case room capacity has very limited flexibility as defined by Pullman & Rogers (2010). From a wider perspective, hotel's capacity includes also the capacity of the F&B outlets, the golf course, the function rooms and other revenue centres in the hotel that provide greater options for capacity management.

Overbooking is a widely analyzed tool (Talluri & van Ryzin, 2005; Chiang *et al*, 2007; Lan, Ball & Karaesmen, 2007), also in the framework of the hotel industry (Badinelli, 2000; Bitran & Mondschein, 1995; Guadix *et al.*, 2010; Ivanov, 2006, 2007; Koide & Ishii, 2005; Netessine & Shumsky, 2002; Pullman & Rogers, 2010; Tranter, Stuart-Hill & Parker, 2008). It is based on the assumption that some of the customers that have booked rooms will not appear for check-in (so called "no show"), others will cancel or amend their bookings last minute, while third will prematurely break their stay in the hotel (due to illness, personal reasons, traffic, bad weather, force majeure or other reasons). In order to protect itself from losses the hotel confirms more rooms than its available capacity with the expectation that the number of overbooked rooms will match the number of no shows, last minute cancellations and amendments. This requires careful planning of the optimal level of overbookings (Hadjinicola & Panayi, 1997; Ivanov, 2006, 2007; Koide & Ishii, 2005; Netessine & Shumsky, 2002). Netessine & Shumsky (2002) present a basic methodology for calculating the optimal number of overbookings based on the expected marginal revenue technique which Ivanov (2006) extends by including 2 different room types, cancellation changes and reservation policy coordination among several properties.

Regardless how well the optimal level of overbookings is planned differences between the planned and the actual number of no shows, last minute cancellations and amendments are inevitable. If fewer guests appear for check-in than planned (i.e. the actual number of no shows, last minute cancellations and amendments is higher than planned) the hotel loses revenues. In the opposite situation when more guests appear for check-in, the hotel finds itself in a situation when some of the guests have to be walked to different property. In this regard, overbookings research has also focused on the procedures hotels have to follow when walking guests (e.g. Baker, Bradley & Huyton, 1994; Ivanov, 2006). Overbooking policies receive a lot of criticism, especially in its legal terms and ethical considerations elaborated in §2.6. further in the article.

Length of stay control is a much neglected research area (Ismail, 2002; Kimes & Chase, 1998; Vinod, 2004). It allows hotels to set limits on the minimum and, rarely, maximum number of nights in customer bookings. Length of stay control allows hotels to protect themselves from losing revenues when customers book rooms for short stays in periods of huge demand (e.g. during special events). They also provide the possibility to generate additional revenues from overnights in days when demand is historically low (e.g. when a business hotel requires compulsory stay over Saturday nights for all bookings that include a Friday overnight). Vinod (2004) highlights that length of stay control has one major disadvantage – it is static and, therefore, not very flexible.

As a non-pricing RM tool, *channel management* has not received its deserved attention from academic literature, in contrast to its profound importance in hotel RM practice. Although the structure of the intermediaries used by a hotel and the terms and conditions in the contracts with them influence significantly the ADR, RevPAR and the whole RM system of the hotel, only few authors discuss the distribution channels utilised by the hotel from an RM perspective (e.g. Choi & Kimes, 2002; Hadjinicola & Panayi, 1997; Tranter, Stuart-Hill & Parker, 2008). Cross et al. (2009: 59-60) state that after 9/11 hotels looked for wider exposure to clients and were eager to work with third party websites and online merchants against big discounts. However, the huge discounts clients were getting from them rather than the hotel itself eroded the relationship between the hotels and their guests and people began to shop the third party sites first (p. 60). On the opposite side, Myung, Li & Bai (2009) find in their research that hotels were generally

satisfied with the performance and relationships with the e-wholesalers. Furthermore, Choi & Kimes (2002) conclude that applying RM strategies to distribution channels might not help hotels that are already optimising their revenues by rate and length of stay. This might explain the lower interest in channel management as an RM tool compared to the plethora of operations research on overbookings.

2.3.2. Pricing tools

Many scholars have identified the importance of pricing and price alteration, in accordance to the state of the market, as a basis for creation of sustainable competitive advantage (Cross, Higbie & Cross, 2009; Desiraju & Shugan, 1999; Lovelock, 2001). In the hotel industry the most widely used *pricing revenue management tools* include price discrimination, dynamic pricing (Koenig & Meissner, 2010), lowest price guarantee and they have been extensively researched (Choi & Kimes, 2002; Hanks, Cross & Noland, 2002; Noone & Mattila, 2009; Shy, 2008; Schwartz, 2006; Tranter, Stuart-Hill & Parker, 2008; Lieberman, 2011) for both individual and group booking requests (Choi, 2006; Cross et al., 2009; Schwartz & Cohen, 2003).

Price discrimination is the heart of pricing RM tools (Hanks, Cross & Noland, 2002; Kimes & Wirtz, 2003; Ng, 2009b; Shy, 2008; Tranter, Stuart-Hill & Parker, 2008). In essence, price discrimination means that the hotel charges its customers different prices for the same rooms and the economic rationale for this are the differences in price sensitiveness of hotels' market segments (e.g. business travellers are less price sensitive compared to leisure travellers and could afford to pay higher prices). However, in order to avoid migration from high to low priced products, hotels introduce price fences (Zhang & Bell, 2010) that are defined as conditions under which specific products are offered on the market. Hotel price fences include day of the week, duration of stay, guest characteristics (e.g. belonging to a club, government employee), cancellation, amendment and payment terms, lead period, age (Hanks, Cross & Noland, 2002; Kimes, 2009; Kimes & Chase, 1998). In practical terms the rate fences are integrated into the booking terms and conditions. In order to avoid any claims from customers, these conditions should be completely clear to the customer at the time of booking.

One of the integral concepts of pricing nowadays is *dynamic pricing* (Palmer & Mc-Mahon-Beattie, 2008; Tranter, Stuart-Hill & Parker, 2008). It allows hotels to maximize the RevPAR and yield by offering a price that reflects the current level of demand and occupancy and amend it according to changes in demand and occupancy rate. By virtue of this, customers frequently pay different prices even when they have one and the same booking details (period of stay, board basis, number and type of rooms) depending on the moment of reservation. In this regard, dynamic pricing is subject to criticism by customers. Nevertheless, from financial point of view dynamic pricing can provide high profitability, but it should be applied carefully and accompanied with ample information about booking terms and conditions, similarly to price discrimination.

Sometimes hotels provide to their *customers lowest price guarantee* (Carvell & Quan, 2008; Demirciftci, Cobanoglu, Beldona & Cummings, 2010). According to it, if the customer finds a lower price for the same or similar hotel within 24 hours after their booking, the hotel will match that lower price. Carvell & Quan (2008) examine this practice by applying the financial option pricing model and determine that it has no practical value for the customers. In order for customers to benefit from lowest price guarantee authors stipulate that the guarantee should cover the full period from the booking date till the arrival date, not only the period spanning 24 hours after the booking day. Similarly, Demirciftci et al. (2010) negate the lowest price guarantee claim by several US hotel chains, advertised on their websites.

It should be noted that pricing and non-pricing tools are commonly discussed together in research literature. This is result of the notion that hotel RM is an integrated system that has to provide solutions to RM problems for price levels, price fences, booking conditions and overbookings simultaneously through *optimal room-rate allocation (room distribution)* (Baker, Murthy & Jayaraman, 2002; Bitran & Gilbert, 1996; Bitran & Mondschein, 1995; El Gayar *et al.*, 2011; Guadix *et al.*, 2010; Harewood, 2006). Furthermore, the optimal level of overbookings is influenced by room rate (see the model of Netessine & Shumsky (2002) and Ivanov (2006)) which shows the interconnectedness of pricing and non-pricing tools. Finally, hotels try to achieve price parity among and within the different distribution channels they use

(Demirciftci et al., 2010) which requires simultaneous application of pricing and non-pricing RM tools (channel management and price discrimination, dynamic pricing, etc.).

2.4. RM software

The processing of large databases is impossible without appropriate *RM software* (Guadix et al., 2009) and hotels that employ it gain strategic advantage over those that rely on intuitive RM decisions only (cf. Emeksiz, Gursoy & Icoz, 2006). RM software helps RM managers by giving suggestions on price amendments, inventory control and channel management, but it also influences the decision making process of revenue managers. On the one hand, the software analyses enormous data bases and provides useful forecasts based on the optimization models embedded in it. On the other hand, as Schwartz & Cohen (2004) demonstrate, the interface of the software impacts the judgment of revenue managers and their inclination to adjust the computer's forecasts. However, the ultimate decision lies in the hands of the RM manager and his/her team. Review of related literature shows that RM software and human interactions with it have not received enough attention by scholars.

2.5. RM team

Human resource issues are essential in RM system planning and implementation (Beck *et al.*, 2011; Lieberman, 2003; Mohsin, 2008; Selmi & Dornier, 2011; Tranter, Stuart-Hill & Parker, 2008; Zarraga-Oberty & Bonache, 2007). Authors agree that revenue managers and the revenue management team are vital for the success of any RM system (Tranter, Stuart-Hill & Parker, 2008). Lieberman (2003) focuses on the specific knowledge and training RM specialists need in order to be effective and efficient (in marketing, finance, forecasting, among others). In any case, the introduction and the implementation of RM system within a hotel (Donaghy, McMahon-Beattie & McDowell, 1997; El Haddad, Roper & Jones, 2008; Lockyer, 2007; Okumus, 2004) is a challenging and significant change that might cause resistance among employees and the latter should be addressed and dealt with properly. In many companies the application of RM techniques is within the responsibilities of the marketing manager or a person subordinate to him. However, large hotel chains have recognized the importance of RM to their bottom line and have appointed a separate revenue manager (Mainzer, 2004: 287) or even

regional revenue management teams (Tranter, Stuart-Hill & Parker, 2008) to head and guide company's efforts in optimal management of its revenues.

2.6. Ethical issues in hotel RM

Despite their perceived positive impacts on hotels' bottom line, RM techniques have received a huge amount of criticism in terms of grievances and lack of sensible benefits (Bitran & Caldentey, 2003; Koide & Ishii, 2005). This is especially valid for price discrimination and overbooking techniques. Customers feel belied if they find that they have paid higher price for the same room or if they have to be moved to another hotel. This can be a result of lack of or incomplete information about booking, cancellation and amendment terms. In general, research in the area focuses on the perceived fairness of RM from the view point of the customer (e.g. Beldona & Namasivayam, 2006; Choi & Mattila, 2004, 2005; Heo & Lee, 2011; Hwang & Wen, 2009; Kimes, 2002; Kimes & Wirtz, 2003). Kimes (2002: 28-30) pinpoints the RM practices that customers consider acceptable or unacceptable (Table 3). Obviously, when information about booking, cancellation and amendment terms is available and understood by the customers or when different prices are charged for products perceived by them as different, customers are more inclined to accept revenue management practices. In the other cases, when discounts are insignificant compared to booking amendment/cancellation restrictions or the latter are changed after the booking has been confirmed customers will be dissatisfied. Choi & Mattila (2005) furthermore specify that only informing the customers about hotel's rates is not enough to improve their perceived fairness of – they have to know the basis for rates variability (day of the week, duration of stay) and booking conditions.

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2.7. RM and CRM

With its focus on pricing and inventory management tools, RM is closely connected with *customer relationship management* (CRM). In this regard, the integration between the two functions is also subject of many researches (e.g. Noone, Kimes & Renaghan, 2003; Milla & Shoemaker, 2008; Wang & Bowie, 2009). RM and CRM can have different objectives and time

horizons. While RM is more short-term oriented, CRM focuses more on the long-term relationships between the company and its customers. However, as Noone, Kimes & Renaghan (2003) show, CRM and RM should be perceived as complimentary business strategies and RM tools can be effectively used in CRM practices (like traditional RM, life-time value based pricing, availability guarantees, short term and ad hoc promotions). In any case, RM tools play a supportive role to CRM in the process of establishing and maintaining long-lasting profitable relationships between the hotel and its customers.

2.8. Legal issues in hotel RM

The legal aspects of hotel RM are a marginal topic in the academic literature, which is yet to expand. The main focus is the discussion of hotel's RM system as a source of competitive advantage, know-how and its subsequent treatment as a *trade secret*. Kimes & Wagner (2001) emphasise that only parts of RM systems are ascertainable through public sources (e.g. overbookings and forecasting mathematical models), but how RM systems' components are integrated is considered proprietary knowledge and is kept confidential. However, authors call for greater vigilance among hotel managers because high turnover among hospitality employees might cause RM trade secrets leakages to their new employers.

3. Hotel revenue management process

Tranter, Stuart-Hill & Parker (2008) identify 8 steps in *RM process* – customer knowledge, market segmentation and selection, internal assessment, competitive analysis, demand forecasting, channel analysis and selection, dynamic value-based pricing, and channel and inventory management. It is evident that the authors' steps are derived from the general marketing management practice, which is understandable, considering the fact that RM developed into the realm of marketing management. Emeksiz, Gursoy & Icoz (2006) propose a more comprehensive hotel RM model that includes 5 stages, namely: preparation; supply and demand analysis; implementation of RM strategies; evaluation of RM activities and monitoring and amendment of the RM strategy. The main advantage of Emeksiz et al. (2006) model is the inclusion of qualitative evaluation and constant monitoring of the RM strategy. In current paper we adopt the 7-stage approach by Ivanov and Zhechev (2011), elaborated in Figure 2.

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3.1. RM goals, Data and information gathering, Analysis

RM process starts with the *goals* setting by the revenue manager with specific strategic (several years), tactical (weeks/months) and operational (days) time horizon (Ivanov and Zhechev, 2011: 304). They relate to the values of the different RM metrics discussed above (RevPAR, ADR, occupancy, target profit per available room). The RM software gathers the necessary operational *data and information* provided by the hotel's marketing information system. The operational data is analyzed to provide the revenue manager with clues about the trends in hotel's RM metrics for the forthcoming days/weeks. The third stage also involves *analysis* of demand (on the level of individual hotel, chain properties in the destination and on destination level) and the supply in the destination (opening/closing/reflagging of properties).

3.2. Forecasting

Forecasting involves the application of different forecasting methods in order to provide the revenue manager with prognoses about the future development of RM metrics, demand and supply. Successful application of revenue management requires hotels being able to forecast demand. Therefore, a high proportion of the research literature is dedicated to forecasting from theoretical and methodological perspective (Burger et al., 2001; Frechtling, 2001; Tranter, Stuart-Hill & Parker, 2008; Weatherford, Kimes & Scott, 2001; Weatherford & Kimes, 2003, among others), summarized in Table 4.

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Review of available literature on hotel RM reveals that most papers deal with 2 main topics: forecasting demand (e.g. Frechtling, 2001; Lim & Chan, 2011; Song, Witt & Li, 2009) and forecasting RM metrics and operational data (El Gayar *et al.*, 2011; Haensel & Koole, 2011; Morales & Wang, 2010; Zakhary *et al.*, 2011). This is justified since volume, structure and

characteristics of demand and forecasts for occupancy rate, number of arrivals, cancellations, no shows, RevPAR, ADR and other operational statistics are of utmost importance to hotel's RM system. However, RM decisions in a particular hotel experience the influence of its competitors' decisions and actions and developments in the external environment. In this regard it is surprising that a limited number of papers, most notably Yüksel (2007), discuss issues related to forecasting competitive actions and the external environment which remains a neglected field.

Proper forecasting procedure requires the application of suitable forecasting methods.

Weatherford & Kimes (2003) divide the methods to historical, advanced booking and combined methods. Mostly used (or analysed) by researchers historical methods are: moving average (Burger *et al.*, 2001; Weatherford & Kimes, 2003; Yüksel, 2007), exponential smoothing (Burger *et al.*, 2001; Chen & Kachani, 2007; Rajopadhye *et al.*, 2001; Weatherford & Kimes, 2003; Yüksel, 2007) and other autoregressive models (Burger *et al.*, 2001; Lim & Chan, 2011; Lim, Chang & McAleer, 2009; Yüksel, 2007). It is evident that historical methods are based on time series analysis. Their advantage is the relatively easy application and low data requirements. On the other hand, they rely on the fact that knowing how certain variable has changed over time (e.g. what was the occupancy of the hotel during the last couple of months) can provide information on how this variable will change in future, i.e. as if the variable has memory, similarly to technical analysis in financial markets forecasting. This is the main disadvantage of time series forecasting – they disregard other variables – demand, competitors' actions or special events in the destinations that stimulate demand. However, albeit their shortcomings time series methods remain widely used.

Advanced booking models forecast the number of booked rooms on particular arrival day on the basis of the number of booked rooms on a previous day (called “reading day”) and the pick up of rooms between the reading day and the arrival day. Weatherford & Kimes (2003: 403) divide advanced booking models into additive and multiplicative models. Authors explain that additive models assume that the number of reservations on hand at a particular day before arrival is independent of the total number of rooms sold. In these models the number of booked rooms on the reading day is added to the average historical pick up between the reading and the arrival day. On the other hand, multiplicative models assume that the number of reservations yet to

come is dependent on the current number of reservations available (Weatherford & Kimes, 2003: 403). Their forecasts are based on the number of bookings on the reading day multiplied by the average historical pick up ratio. It is evident that both additive and multiplicative models include a historical component and in this regard share the same disadvantages as time series models discussed previously.

As combined methods Weatherford & Kimes (2003) identify regression models (Burger *et al.*, 2001; Chen & Kachani, 2007; Weatherford & Kimes, 2003) and weighted average between historical and advanced booking forecasts (Chen & Kachani, 2007). These models allow the inclusion of additional variables in the forecasting models (e.g. special event in the destination) and, therefore, might provide better forecasts compared to preceding ones.

In addition to the abovementioned methods we can add neural networks and qualitative methods. While qualitative forecasting methods like Delphi (Yüksel, 2007) have found only marginal application, neural networks receive growing attention (e.g. Burger *et al.*, 2001; Law, 2000; Padhi & Aggarwal, 2011; Zakhary, El Gayar & Ahmed, 2010) due to their learning capability, which is the essential characteristic of neural networks. Future research on hotel RM forecasting could put a further emphasis on the application of neural networks in RM practice.

3.3. Decision

The forecasts feed the mathematical models that produce recommendations for the optimal levels of prices, rate structures, overbookings and help the revenue manager take proper decisions (e.g. closing of lower room rates). Table 5 summarises the approaches used by researchers to solve RM problems.

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Review of available literature shows the predominance of stochastic programming (Goldman *et al.*, 2002; Lai & Ng, 2005; Liu *et al.*, 2006; Liu, Lai & Wang, 2008) and simulations (Baker & Collier, 2003; Kimes & Thompson, 2004; Rajopadhye *et al.*, 2001; Zakhary *et al.*, 2011). Other

methods like deterministic linear programming (Goldman *et al.*, 2002; Liu, Lai & Wang, 2008), integer programming (Bertsimas & Shioda, 2003), dynamic programming (Badinelli, 2000; Bertsimas & Shioda, 2003), fuzzy goal programming (Padhi & Aggarwal, 2011), and robust optimisation (Koide & Ishii, 2005; Lai & Ng, 2005) have received less, but growing attention. Finally, techniques like bid-price and price setting methods (Baker & Collier, 2003) and expected marginal revenue technique (Ivanov, 2006; Netessine & Shumsky, 2002) have not been applied widely in the field of hotel revenue management. To some extent the reasons for these results are attributable to the stochastic nature of hotel bookings (in terms of lead period, number of overnights, number of rooms, type of rooms, fare class, etc.) which requires stochastic programming and simulations. On the other side, the expected marginal revenue technique provides greater simplicity of calculations and is more practically applicable on a daily basis without the need of costly and complex software. However, the aspiration of researchers and practitioners to model the hotel operations and market demand as realistically as possible leads to the construction of more multifarious RM problems that require innovative and more sophisticated approaches to solve them.

3.4. Implementation

The *implementation* of the taken decisions requires that the staff be trained to apply numerous sales techniques (e.g. up-selling, cross-selling) in order to close a sale at a higher rate or reject a booking for a shorter stay with the expectation to sell the room for a longer one and achieve the RM goals. This further requires specific selling abilities (Weilbaker & Crocker, 2001) and constant training of sales personnel (Beck et al., 2011).

3.5. Monitoring

Finally, the RM process includes the *monitoring* of all stages in the process and searching for opportunities to improve it on every stage. RM should be applied only if it contributes positively to the hotel's bottom line. This requires *measuring the performance* of hotel's RM system (Burgess & Bryant, 2001; Jain & Bowman, 2005; McEvoy, 1997; Rannou & Melli, 2003) on individual or chain level (Sanchez & Satir, 2005). Authors agree that RM, like any investment, is worth when the increased revenues from its application offset the additional costs related to it. Cross et al. (2009: 73) suggest that the "revenue generation index", calculated as the ratio of

hotel's RevPAR divided by the RevPAR of the competitive set, is a more accurate assessment of revenue productivity for a particular property, especially when considering the economic environment in which the hotel is operating. Same authors also discuss the "revenue opportunity index" calculated as the ratio between actual and optimal (maximum) revenue that could have been achieved by the hotel. However, regardless of the performance measures used, they have to be applied systematically in order to provide comparability of hotel's results in time.

4. Discussion and conclusions

Previous review of academic literature in field of hotel RM shows that it is still an evolving research area. In reality, hotel RM practice is far more developed than the hotel RM research literature. To some extent this is a result of the hotel companies' market requirements to stay competitive and constantly improve their marketing activities. Additionally, many issues in RM practice (e.g. forecasting models) remain proprietary knowledge of hotel chains and software developers, which hinders the theoretical advancement in the field.

Current literature review has identified some gaps in the existing research. In view of them, we suggest that future research agenda might focus on:

- ✓ Expanding hotel RM mathematical problems from single-unit to multiple-unit problems. When a hotel chain has several substitutable properties in terms of location, services and category in one destination, it can coordinate the individual properties' RM practices in order to maximize a chain's revenues as a whole, not the revenues of single properties. Booking requests for hotels with no availability, for example, can be directed to other chain properties. In this case, the chain's overbooking policy treats chain hotels as one property, not as single separate units (for further details see Ivanov, 2006). Although hotel chains and RM software developers actively adopt multiple-unit RM strategies, the academic research in the field is severely lagging behind.
- ✓ Inclusion of special events in the mathematical models. During special events demand for rooms is much higher than normal business days and historical booking data might not be suitable (or even available if it is a first-of-a-kind event in the destination). Nevertheless, regression models and neural networks could be adjusted to account for special events. In this

direction for future research practice is again ahead of theory, as special events are already incorporated in RM software.

- ✓ Inclusion of additional revenue centres into the mathematical models in hotel RM – restaurants, casinos, golf courses, function rooms, spa centres, sports facilities (if paid), room service, minibar, etc. Such an exercise will provide a more comprehensive approach towards the maximization of hotel revenues as a whole, not only its separate departments. Currently, hotels take steps to move towards *total* revenue management, that incorporates all revenue centres in the hotel, but the research in the area has yet to catch the RM practice.
- ✓ Inclusion of room availability guarantee in the mathematical models. If a hotel provides such guarantee to its loyal club members, it has to direct negative impact on the room capacity available for sale to customers that are not provided with that guarantee. A booking made by customer with room availability guarantee outside peak periods has to be confirmed by the hotel regardless of its occupancy. In this regard, careful planning of room availability guarantee is required, which should be subject to future research.
- ✓ Although technology greatly supports RM manager's work, its role in and impacts on final decisions is underresearched. As the literature review revealed (§2.4.), the way information is presented on the RM software interface influences significantly the decision ultimately taken by the RM managers (Schwartz & Cohen, 2004).

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Table 1. *Elements of hotel RM system – review of selected papers*

Research topic		Selected papers
Economic and marketing principles of hotel RM		Ng (2009a); Tranter, Stuart-Hill & Parker (2008); Vinod (2004)
RM process in general		Emeksiz, Gursoy & Icoz (2006); Guadix, Cortes, Onieva & Munuzuri (2009); Lieberman (2003); Tranter, Stuart-Hill & Parker (2008); Vinod (2004)
RM metrics (RevPAR, ADR, yield, occupancy)		Barth (2002); Lieberman (2003)
Operational data needed in RM		Bodea, Ferguson & Garrow (2009)
RM software / Role of technology in hotel RM		Guadix <i>et al.</i> (2009); Schwartz & Cohen (2004)
Introduction and implementation of RM function in the hotel		Donaghy, McMahon-Beattie & McDowell (1997); El Haddad, Roper & Jones (2008); Lockyer (2007); Okumus (2004)
Human resource issues, the revenue manager and revenue management team, training		Beck <i>et al.</i> (2011); Lieberman (2003); Mohsin (2008); Selmi & Dornier (2011); Tranter, Stuart-Hill & Parker (2008)
Integrating RM and CRM		Noone, Kimes & Renaghan (2003); Milla & Shoemaker (2008); Wang & Bowie (2009)
Measuring the impact (performance) of RM		Burgess & Bryant (2001); Jain & Bowman (2005); McEvoy (1997); Rannou & Melli (2003)
Hotel revenue centres	Restaurants	Bertsimas & Shioda (2003); Kimes (2005); Kimes & Thompson (2004)
	Function rooms	Kimes & McGuire (2001); Orkin (2003)
	Golf courses	Licata & Tiger (2010); Rasekh & Li (2011)
	Casinos	Hendler & Hendler (2004); Kuyumcu (2002); Norman & Mayer (1997)
	Spa centres	Kimes & Singh (2009)

Table 2. *Revenue management tools – review of selected papers*

Research topic			Selected papers
Non-pricing RM tools			
Inventory management	Capacity management in general		Pullman & Rogers (2010)
	Overbookings	Optimal level of overbookings	Hadjinicola & Panayi (1997); Ivanov (2006, 2007); Koide & Ishii (2005); Netessine & Shumsky (2002)
		Walking guests	Baker, Bradley & Huyton (1994); Ivanov (2006)
	Length of stay control		Ismail (2002); Kimes & Chase (1998); Vinod (2004)
	Room availability guarantee		Noone, Kimes & Renaghan (2003)
Channel management			Choi & Kimes (2002); Hadjinicola & Panayi (1997); Myung, Li & Bai (2009); Tranter, Stuart-Hill & Parker (2008)
Pricing RM tools			
Pricing in general			Collins & Parsa (2006); Hung, Shang & Wang (2010); Shy (2008)
Price discrimination and rate fences			Hanks, Cross & Noland (2002); Kimes & Wirtz (2003); Ng (2009b); Shy (2008); Tranter, Stuart-Hill & Parker (2008)
Determination of optimal room rates			Pan (2007)
Dynamic pricing			Palmer & Mc-Mahon-Beattie (2008); Tranter, Stuart-Hill & Parker (2008)
Price presentation			Noone & Mattila (2009)
Lowest price guarantee			Carvell & Quan (2008); Demirciftci, Cobanoglu, Beldona & Cummings (2010)
Optimal room-rate allocation (room distribution)			Baker, Murthy & Jayaraman (2002); Bitran & Gilbert (1996); Bitran & Mondschein (1995); El Gayar et al. (2011); Guadix et al. (2010); Harewood (2006)

Table 3. *Acceptable and unacceptable revenue management practices*

Acceptable RM practices	Unacceptable RM practices
<ul style="list-style-type: none">✓ Providing customers with all information regarding prices and booking conditions – hiding information destroys trust✓ Deep discounts in booking rates in exchange for stricter cancellation / amendment conditions✓ Different prices for products perceived by customers as different – e.g. weekend and weekday prices	<ul style="list-style-type: none">✓ Insignificant price discounts in exchange for stricter cancellation / amendment conditions✓ Changes in booking terms without informing the customer

Note: Summarized from Kimes (2002: 28-30)

Table 4. *Forecasting – review of selected papers*

Research topic			Selected papers
General theoretical and methodological issues in forecasting			Burger <i>et al.</i> (2001); Chen & Kachani (2007); Frechtling (2001); Song, Witt & Li (2009); Tranter, Stuart-Hill & Parker (2008); Weatherford, Kimes & Scott (2001); Weatherford & Kimes (2003)
Application of forecasting methods	Forecasting demand		Chen & Kachani (2007); Frechtling (2001); Law (2000); Lim & Chan (2011); Ng, Maull & Godsiff (2008); Rajopadhye <i>et al.</i> (2001); Song, Witt & Li (2009); Yüksel (2007)
	Forecasting competition and the external environment		Yüksel (2007)
	Forecasting revenue management metrics and operational data (arrivals, cancellations, no shows, amendments, prices etc.)		El Gayar <i>et al.</i> (2011); Haensel & Koole (2011); Morales & Wang (2010); Zakhary <i>et al.</i> (2011)
Forecasting method applied (analyzed)	Historical (time series)	Random walk (naïve)	Burger <i>et al.</i> (2001)
		Moving average	Burger <i>et al.</i> (2001); Weatherford & Kimes (2003); Yüksel (2007)
		Exponential smoothing	Burger <i>et al.</i> (2001); Chen & Kachani (2007); Rajopadhye <i>et al.</i> (2001); Weatherford & Kimes (2003); Yüksel (2007)
		Other autoregressive models (Box-Jenkins, ARMA, ARIMA)	Burger <i>et al.</i> (2001); Lim & Chan (2011); Lim, Chang & McAleer (2009); Yüksel (2007)
	Advanced booking	Additive (classical and advanced pickup)	Chen & Kachani (2007); Weatherford & Kimes (2003)
		Multiplicative	Weatherford & Kimes (2003)
	Combined	Regression	Burger <i>et al.</i> (2001); Chen & Kachani (2007); Weatherford & Kimes (2003)
		Combination of historical and advanced booking methods	Chen & Kachani (2007)
		Neural networks	Burger <i>et al.</i> (2001); Law (2000); Padhi & Aggarwal (2011); Zakhary, El Gayar & Ahmed (2010)
	Qualitative methods	Delphi	Yüksel (2007)

Note: Classification of revenue management forecasting methods adapted from Weatherford & Kimes (2003) and expanded by the authors

Table 5. Approaches used for solving revenue management problems

Approach	Selected papers
Deterministic linear programming	Goldman <i>et al.</i> (2002); Liu, Lai & Wang (2008)
Integer programming	Bertsimas & Shioda (2003)
Dynamic programming	Badinelli (2000); Bertsimas & Shioda (2003)
Markov model	Rothstein (1974)
Bid-price methods	Baker & Collier (1999, 2003)
Price setting method	Baker & Collier (2003)
Expected marginal revenue technique	Ivanov (2006); Netessine & Shumsky (2002)
Stochastic programming	Goldman <i>et al.</i> (2002); Lai & Ng (2005); Liu <i>et al.</i> (2006); Liu, Lai & Wang (2008)
Probabilistic rule-based framework in Knowledge Discovery technique	Choi & Cho (2000)
Simulation (including Monte Carlo)	Baker & Collier (2003); Kimes & Thompson (2004); Rajopadhye <i>et al.</i> (2001); Zakhary <i>et al.</i> (2011)
Fuzzy goal programming model	Padhi & Aggarwal (2011)
Robust optimisation	Koide & Ishii (2005); Lai & Ng (2005)

Note: Table title and approaches adapted from Chiang, Chen & Xu (2007) and expanded by the authors

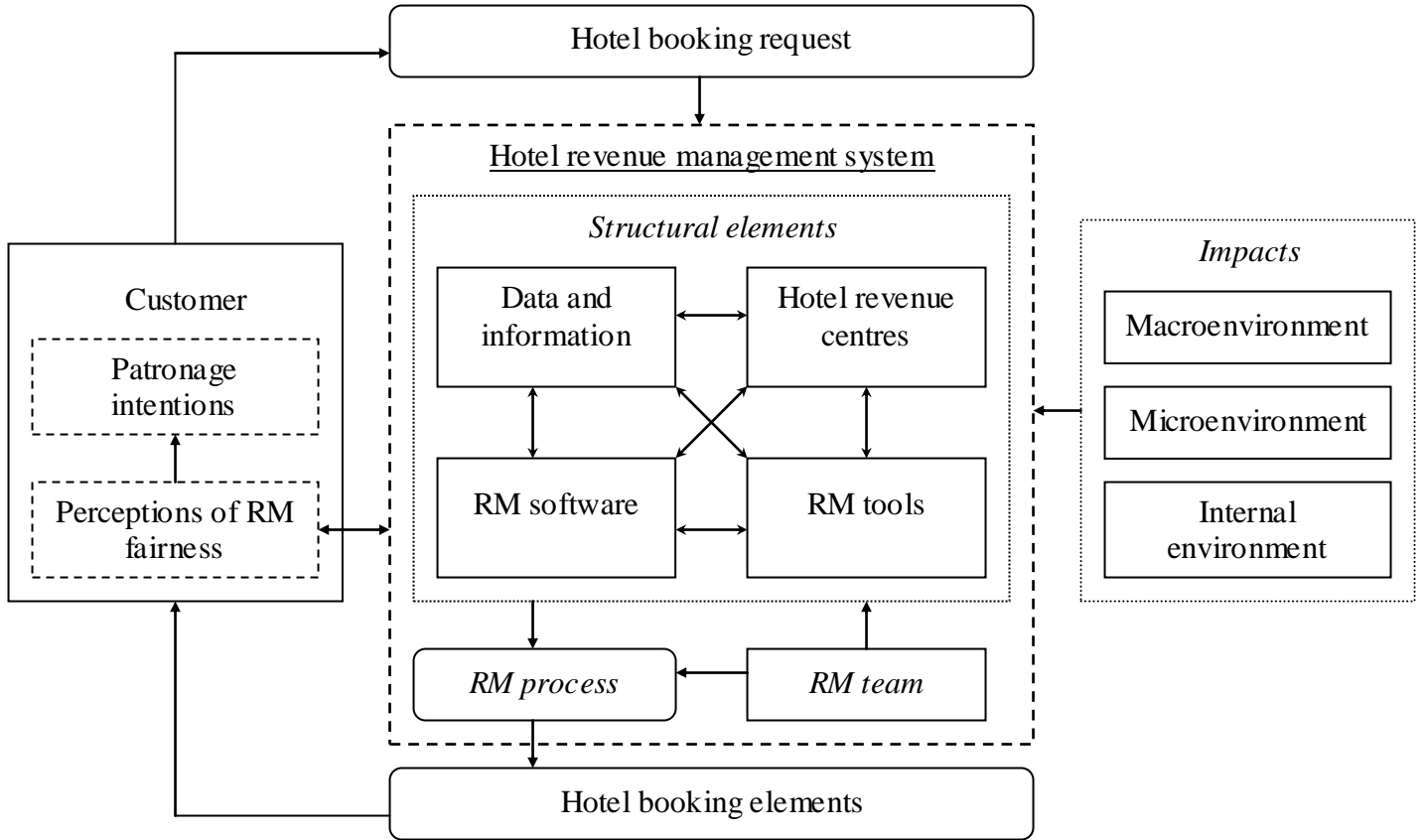


Figure 1. *Hotel revenue management system* (adapted and expanded from Ivanov & Zhechev, 2011)

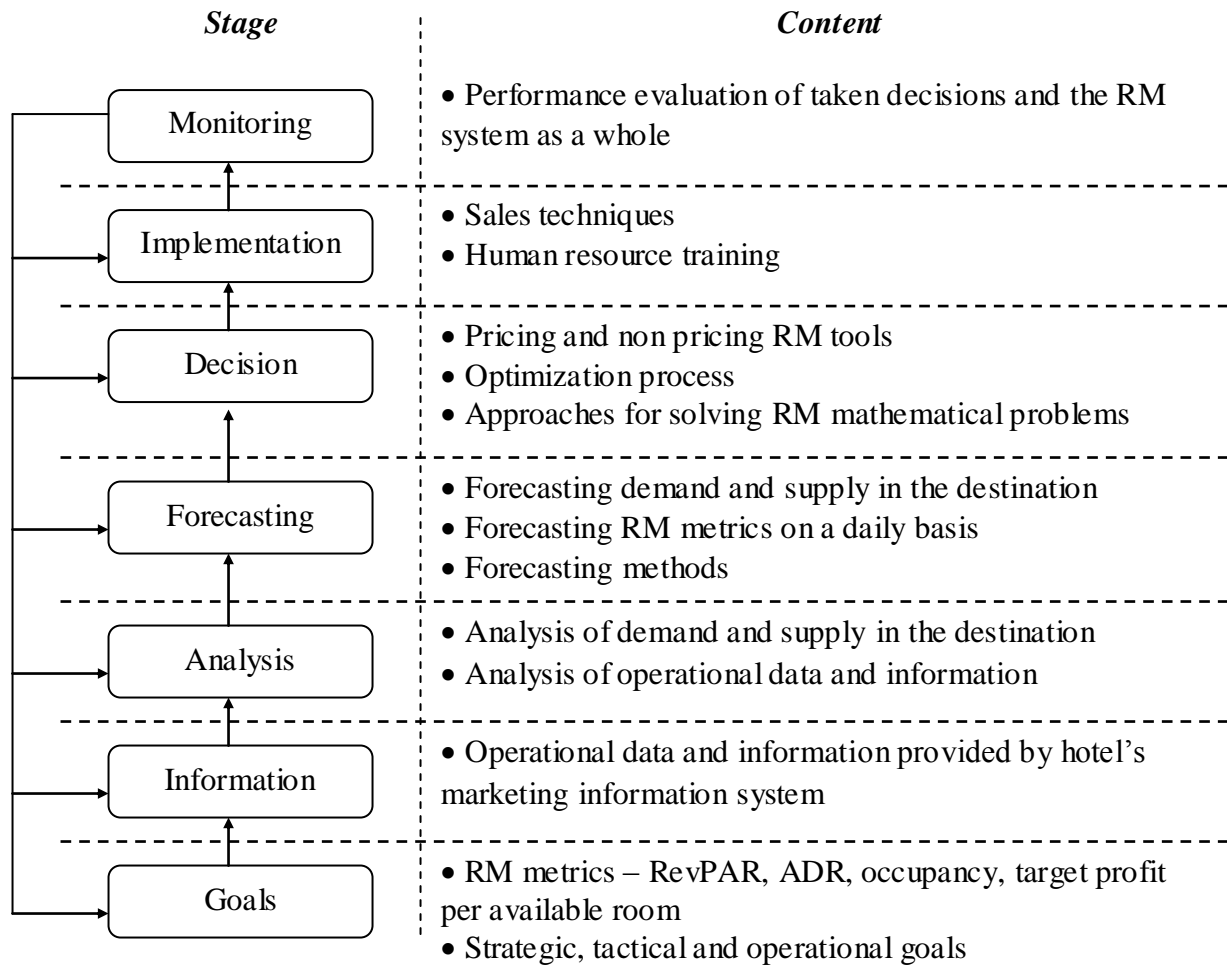


Figure 2. *Hotel revenue management process* (adapted from Ivanov & Zhechev, 2011)