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Research in
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Artificial intelligence in today's hotel revenue management: opportunities and risks

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ABSTRACT: The implementation of revenue management in the hospitality industry has significantly increased in the past years. It started in the rooms departments and is slowly evolving to be further used for conference and event spaces, as well as food and beverage outlets. At the same time, advancements in technology allow new products such as automated revenue management systems to develop. On one hand, the opportunities are to make use of big data and shift to a science-based revenue management. On the other hand, risks include the increased vulnerability such as through hacking or data leaks. The current debate is often dominated by the fear of possible job loss and a lack of trust in the new technology. Nonetheless, the industry is slowly shifting towards automation and will have to adapt over time.

KEYWORDS: artificial intelligence (AI), hotels, literature review, revenue management, risk and opportunities

Introduction on revenue management

Revenue management was initially invented by the airline industry about 60 years ago and has been adapted by the hospitality industry over the past several decades (Anderson & Xie, 2010). Traditionally, it was defined as selling the right product, to the right customer, at the right time, for the right price (Yeoman & McMahon-Beattie, 2017). So far, it has mainly been implemented in the rooms departments. Ten years ago, scholars predicted a renaissance of revenue management that would evolve through technology in other hotel operations as well (Cross, Higbie, & Cross, 2009). With the rapid development of new revenue management software, it is questionable to what extent the revenue department as we know it today is future proof. As technology is developing at an increasingly faster pace, it is getting easier to run complex algorithms that allow revenue management to optimise and improve. The revenue department as it is known today is undergoing major changes. Current developments in the hotel industry include the automation and centralisation of revenue management that replaces the role of on-property revenue managers (Kimes, 2011). Artificial intelligence and automation are praised as game changers in the industry. This, in turn, leaves the question: will it be possible to fully automatise and replace humans or is the future a close collaboration between both?

Opportunities of automation

Revenue management is a rather new discipline in the hospitality industry. It has already seen major changes such as the shift from an occupancy-driven to price-optimisation revenue management. So far, existing revenue management software still relies heavily on being fed with information and being maintained by humans. With the rise of artificial intelligence, and

a fast development in computer software and hardware, revenue management software is becoming more accurate, reliable, and heuristic in its decision-making. Using advanced technology, super computers, and cloud services, a shift from a rule-based revenue management to science-based revenue management is made possible. Automatic and centralised revenue management systems effectively analyse all possibilities and execute the option that is most in line with the holistic strategy of the hotel (Wang, 2012; Wang, Yoonjoung Heo, Schwartz, Legohérel, & Specklin, 2015). This can lead to an increase in efficiency levels, resulting in lower costs and a higher level of profit for the hotel.

Big data

All revenue management systems rely heavily on data and processing power. Recently, the mass media started using the term "big data", which lacks a general and uniform definition. A popular approach is the "3Vs" that describe big data as volume, variety and velocity, or the "4Vs" that further include value, showing usefulness and importance (Li, Xu, Tang, Wang, & Li, 2018). With the implementation of an automatic revenue management software, it is possible to make use of big data for forecasting and pricing. Especially both short- and long-term forecasting is of great importance for a successful business operation and a competitive advantage (Pan & Yang, 2017). Scholars argue though that internal data might not be enough anymore to have a competitive advantage, and in order to build a "data warehouse" external data needs to be acquired (Buhalis & Leung, 2018). Due to the immense volume of big data it can only be processed by non-traditional computing methods (Pan & Yang, 2017). With the modern traveller leaving digital traces before, during, and after their stay, technology allows us to create profiles that include the guest's satisfaction, preferences, geographical location, and spending habits (Pan & Yang,

2017). While most revenue management models rely mainly on historical data, big data can also take a company's external data into consideration (Buhalis & Leung, 2018). This data can, for instance, include the political environment and security of a destination (Buhalis & Leung, 2018). Social media can be a good source for hotels to get this data and be more customer-centric, and can even be seen as a new distribution channel (Noone, McGuire, & Rohlf, 2011). Through the effective use of all this data in real time, room rates or packages can be customised for each guest, individually offering the best options for both revenue maximisation and guest satisfaction (Wang et al., 2015).

Before the hospitality industry can transform and integrate fully automated revenue management systems, the general structure of the department must be changed. An ongoing trend here is centralisation (Kimes, 2011). So far, most hotels have their own revenue management department. Some hotels outsource their revenue department to cut costs. Additionally, the trend is to have a central office that is responsible for multiple properties on a corporate level. This implies that current revenue management departments are operating on the business unit level and will be relocated to the corporate level (Wit & Meyer, 2014). With smart revenue management software, it will be possible to cover more properties with one manager, which reduces costs.

Risks of automation

Critics argue that even though automatic revenue management systems are effective techniques to increase revenue streams and thus profits, they lack the ability to maintain and create human relationships (Wang, 2012). Pricing is an essential criterion for strategic customers of a hotel. Key partners therefore have contracts with hotels to guarantee them a certain corporate rate. This rate typically remains the same during the contract period regardless of the best available rates. One result from the automatising of revenue management is that the system is not able to favour loyal key account partners with fixed lower rates above higher paying one-time customers. This may lead to dissatisfaction among business partners and clients, who might then take their business elsewhere. Meanwhile, corporate rates that were only available to be booked directly through the hotel's reservations or sales department are now available online via reservation interfaces and mobile applications that are linked to revenue management systems. Key accounts are essential for a hotel during low-demand periods but are easily neglected by the automatic revenue management systems in high-demand seasons. A loss of key accounts can have significant impact on the hotel's long-term performance (Wang, 2012).

Although the automation of revenue management has the clear benefit of an increase of accuracy and speed, it is questionable whether hotels should rely solely on automation rather than employing humans (Frey & Osborne, 2017). It increases the vulnerability in cases of outages, hacking attacks, or systems failures. Hotel operation systems have been exposed to those threats, as shown in recent examples. In 2018, there was a hacking attack on Marriott International, where the data of 500 million guests was stolen (O'Flaherty, 2019), or where a former employee hacked the revenue management system to manipulate room rates and discounted them to as little as US\$12 (Mest, 2017). The more dependent hotels become on automation, the higher the risk of financial consequences when

systems fail or face problems. Research tried to define the costs from information technology (IT) incidents, starting with \$140 000 per incident for the average company, or up to a total of \$700 billion per year for North American companies alone (Oats, 2017). Furthermore, it increases the dependency on suppliers and third parties such as consultants and service providers, especially for smaller operations that do not have the expertise or capital to run complicated software and programs.

In order to make use of automated revenue systems, as much data as possible is needed. To prevent unauthorised individuals from corporate data mining, data protection policies need to be in place. It is argued that a model should be developed where the benefits for organisations and individuals are balanced (Li et al., 2018). Utilising such a model can assist organisations to determine whether it is justified to process the data or that the individual should give consent. Besides that, it clarifies the need for providing data for the individual.

The current debate

There is a big debate on automation and the fear of a potential job loss, labelled as "technological unemployment" by the economist John Maynard Keynes (McClure, 2018). This distrust significantly increased during the Great Depression, but economists became more optimistic in the following years (McClure, 2018). Recently, mistrust has grown especially since research was published that predicted 47% of jobs in the US to be affected by automation or even no longer be needed (Frey & Osborne, 2017). Other research such as a study by Gartner Research states that more than 1.8 million jobs will be lost due to technological advancement in the US, but 2.3 million new ones will be created (Arnold, 2018). According to a report by McKinsey & Company (2017) up to one fifth of the world's workforce will be replaced by robotics by 2030, especially in developed nations such as Germany or the US. This leads to fear among many and is therefore a widely discussed topic in society. Nonetheless, it can be said that automation is already well underway in most sectors, especially in highly developed industrial countries, and will continue to grow in the next few years.

The question is whether software developers, hotel managers, and employees can overcome their prejudices and together redefine what the job of a revenue manager will be in the future.

Future development

The position of the revenue manager is currently seen and executed by a human with the utilisation of hardware and software. With the current developments in this field, it is questionable how realistic this function design will be in the near future. Is the revenue manager position becoming replaced by a completely independent operating system or does human approval remain essential? (Schwartz & Cohen, 2004). So far, most revenue management systems are simple algorithms that fail to learn or show AI characteristics. Human revenue managers, in turn, can be defined as heuristic (Cetin, Demirciftci, & Bilgihan, 2016), which is the ability to learn independently from experiences through personal behaviour and the behaviour of others (Gilmore & Williams, 2013). This ability is essential to execute revenue management on a professional level and scale. Therefore, it is essential for

revenue managers to stay updated with developments in the market and invest in gaining new knowledge. In contrast to human revenue managers, moving to automated or centralised revenue management systems will increase the level of dependency on the system. Increasing the dependency level will automatically result in an increase of risk for a hotel (Wit & Meyer, 2014). This implies that hotels are then highly dependant on developers and thus suppliers of these systems. Besides that, software from third parties can be very costly. Can a hotel afford such a significant investment, and does it deliver value? Especially for hotel chains, a suggested option is to develop an artificial intelligent system in the organisation. This backward vertical integration results in a decreased level of dependency on suppliers (Wit & Meyer, 2014). However, developing software that is capable of using artificial intelligence involves a big investment. Therefore, the general feasibility is questionable. The big question is if this investment can be balanced against the expected increase in revenue.

Currently some hotels are executing revenue management at a basic level as a functional department through only looking to the rooms' revenue. It is a long way to develop the department and bring it to the business unit level (Wit & Meyer, 2014; Wang et al., 2015). Therefore, it is recommended to allow revenue managers to execute revenue management in all departments that generate revenue and grant them the required capabilities to do so (Kimes, 2011; Wang et al., 2015). Developments in revenue management technology might further stimulate a decrease in locally employed revenue managers, but increase the level of revenue management specialists on a corporate level who ensure human control in revenue management.

Conclusion

The technological developments of the last decade have had a tremendous influence on the hospitality industry, the travel behaviour of guests, and how hotels operate. After revenue management was introduced to the industry, this new form of pricing has been adapted by most hotels. While having a revenue management strategy for hotel rooms is the standard, the industry is slowly transitioning to further implement it in conference and convention spaces, as well as food and beverage outlets (Kimes, 2011; Wang et al., 2015). Automation and artificial intelligence (AI) are developing at a fast pace, offering new opportunities such as the use of big data, but this also comes with challenges such as the fear that current employees can lose their jobs. Social media offers a great source for business to connect with the guests and collect their data. This could be used for short- and long-term pricing but also as a new channel to sell rooms. While complete automation is not yet feasible, intelligent revenue management software currently supports the revenue manager in analysing and forecasting, and in strategy-oriented rational decision-making. This allows companies to centralise their revenue departments, as one manager now can oversee more than one property. Nonetheless, the dependency on this software comes with risks for the hotels that must rely on the security of the systems used, often provided by external third-party suppliers, which can be expensive. One of the biggest challenges for these systems are human relationships that are often maintained between hotels and guests over years.

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