

Manager perceptions of big data reliability in revenue management.

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Abstract: This paper investigates the perceptions that managers have of the value and reliability of using big data to make hotel revenue management and pricing decisions. Whilst big data-driven automated revenue systems are technically capable of making pricing and inventory decisions without user input, the findings here show that the reality is that managers still interact with every stage of the revenue and pricing process from data collection to the implementation of price changes. They believe their personal insights are as valid as big data in increasing the reliability of the decision-making process. This is driven primarily by a lack of trust on the behalf of managers in the ability of the big data systems to understand and interpret local market and customer dynamics. The less a manager believes in the ability of those systems to interpret this data, the more they perceive gut-instinct to increase the reliability of their decision-making and the less they conduct an analysis of the statistical data provided by the systems. This provides a clear message that there appears to be a need for automated revenue systems to be flexible enough for managers to import the local data, information, and knowledge that they believe leads to revenue growth.

Keywords: hotels, big data, revenue management, data analytics, revenue management systems, decision-making reliability

Article Classification: Research Paper

Introduction

The hotel sector has gone through a revolution in the last two decades with increasing competition and consumer power driving extensive development in revenue management techniques (Noone, 2016; Abrate and Viglia, 2016). At the same time, major hotel companies have been shifting towards organisational models that favour management contracts and one of the things resulting from this has been money being spent on developing sophisticated revenue management systems that make their brands more appealing to potential management partners and owners, by demonstrating their ability to deliver accurate and reliable revenue decision-making that delivers profits (Mauri, 2013). Alongside these hotel specific trends has been the growth of what is termed big data, which has impacted on hotel organisations from the individual properties up to the corporate levels of global chains.

This paper reports on a three-stage qualitative study undertaken with the aim of exploring the true perceptions that managers in the hotel industry have of big data-driven revenue systems in terms of their ability to increase the reliability of decision-making. It focuses attention on the degree to which access to massive increases in the amount and complexity of data and data-driven revenue technologies are influencing how hotel managers make day-to-day price and revenue decisions in practice. There is currently little research explicitly investigating the role of big data in decision-making within the hotel industry and certainly even less focusing on decision-making at the property level. This is even though changes in ownership and management structures in the hotel sector often leave individual hotel managers ultimately responsible for the final revenue and pricing decision (Hodari and Sturman, 2014). Where research has been carried out, the emphasis has been on the impact of analytics on casino hotel operations (Garrow and Ferguson, 2008; Ferguson, 2013), electronic data exchange in hotels (Leung and Law, 2013) and data-mining (Ho Ha and Chan Park, 1998).

Within the hotel sector, big data plays a unique role in revenue management with the growth of complex, shared market and revenue metrics through third parties such as STR Global, which now provides daily, weekly, monthly and annual data for benchmarking and planning purposes. The

combination of these themes is that individual hotel or revenue managers have been faced with an explosion of revenue data points, which has grown from an afternoon ring round in the 1980s and 1990s, where hotel reception staff would be tasked with calling competitors daily to ask their occupancy levels, to revenue and pricing statistics being constantly refreshed on manager's mobile devices (Ferguson and Smith, 2014). Data is becoming the currency of revenue management in the hotel sector and due to this, questions arise as to whether the amount, variety and speed of data which managers have to deal with is actually beginning to undermine the value of data itself within the revenue management process, as data overload may cause them to switch off to the data, and also whether managers actually believe that big data alone is enough to make a reliable revenue management decision.

Literature Review: Big data – a decision-making panacea?

There is an on-going debate in the literature over the origins of the term big data and tensions often arise between old and new meanings. Early mentions of big data are often discounted by academics as not accurately reflecting the true nature of the term as it is understood in a contemporary context. Although Charles Tilly (1980), a sociologist, mentioned the big data people in a paper, Diebold (2012) dismisses this as mere creative writing that could not possibly reflect the technical complexities of big data today. It is really Douglas Laney whom the academic literature cites most frequently as the person who originated a framework to describe big data in an up-to-date way. Laney (2001) developed the three V's of big data, which included volume, variety, and velocity (Chen, Chiang and Storey, 2012; Kwon, Lee and Shin, 2014; Phillips-Wren and Hoskisson, 2015). This encapsulates the modern day understanding of big data, in the sense that it is large amounts of data, both structured and unstructured, that arrives at high-speed often in real-time. Big data is now often demonstrated to be the raw material of a more complex process including business analytics, business intelligence, and knowledge management. Indeed, previous research conducted in the hospitality sector suggests a move away from thinking of revenue management decision-making as mainly a data gathering exercise to one of data analysis and absorption into other management decision-making processes (Haynes and Egan, 2014), suggesting that big data may need to be considered as a raw material for decision-making not a complete solution.

The key issue made clear in the literature is that data and knowledge are not the same things. Having access to huge quantities of big data does not make managers instantly knowledgeable, informed decision-makers (Lewis, 2006; Liberatore and Luo, 2010; Biran, Zack and Briotta, 2013). Data must be correctly interpreted and converted into knowledge and as data becomes increasingly unstructured including data sources such as user-generated, social media content this challenge will only intensify. The fragmentation and variety of data hotel managers must sift through from competitor data to financial accounting data also adds complexity. Therefore, to increase the strategic value of data, academics maintain that managers must ask the right questions to source data that will support accurate decision-making (Liberatore and Luo, 2010; Biran, Zack and Briotta, 2013). A structured approach to data collection is needed to enable managers to demonstrate the reliability of their decision-making to a wide range of stakeholders, crucially important where multiple parties are involved in a management contract or franchise (Melissen, van Ginneken and Wood, 2016; Hodari, Turner and Sturman, 2017), including asset managers (Singh *et al.*, 2012).

Even when managers successfully manage to convert data into knowledge, if they keep that knowledge to themselves then it will be of little use in the decision-making process, which is why data requires coordination and integration (Connell and Voola, 2007; Hayne, Troup and McComb, 2011). The key reason for this is that all employees and managers should be working towards one version of the truth (Liberatore and Luo, 2012). If everyone is looking at different data sets this is

hard to achieve. There are two keys to achieving this. Firstly, researchers agree that all employees are walking data generators collecting daily data on things such as customer feedback (McAfee and Brynjolfsson, 2012). In particular, hotel managers gather data from customers and staff about the local market as they carry out their daily duties, sometimes even subconsciously and therefore become valuable stores of data themselves. Therefore, this data needs to be extracted and stored centrally so that the entire business can benefit. This is a challenge and often there are multiple reasons why employees may wish to withhold data either intentionally or unintendedly. Secondly, silo-busting refers to sharing different pots of data across departments or functional areas, so all employers and managers can access it. Zeng and Lusch (2013) go as far to say that this requires a culture change in businesses and that we shouldn't view the collection and analysis of data as transactions but rather a complex ecosystem of interconnecting data sets, which hints at the need for technology to manage big data, for instance Leung and Law (2013) researched integration of hotel systems such as property management systems with data generated through third-party sites and agents and termed this electronic data interchange.

Alongside and partly driven by the big data revolution, increasing competition and the rise of the management contract model, the hotel sector has also witnessed major developments in revenue management system technologies (Erdem and Jiang, 2016). Kimes (2017) also identified information technology and data analytics as the top two drivers of change in revenue management and 35 percent of the 381 respondents in her survey answered that hotel revenue management would be "automated with analytics" within the next five years (Kimes, 2017, p.4). Revenue management systems, like revenue management itself, have their origins in the airline industry from the late 1960s when the SABRE system was developed by American Airlines (Wang *et al*, 2015). Initially, these systems would have analysed only a small amount of data such as historical and future reservations, booking patterns per market segment and over-booking levels (Cross, Higbie and Cross, 2009). Wang *et al* (2015) now define current revenue management systems as two embedded strategic information systems covering a reactive loop with highly detailed data for tactics, and a slower loop with aggregated information for developing strategy. Increasing volumes and complexities of data have driven developments in technology and required systems to become increasingly sophisticated.

Hallin and Marnburg (2008) highlight the statistical intricacy of revenue management systems by describing the models used, including regression, time series and moving average and Cetin, Demirciftci and Bilighan (2016) add in optimization algorithms and data mining techniques. Earls (2017) also argues that due to the increasing complexity of the distribution market, revenue management systems must now carefully incorporate distribution and online marketing elements into the revenue management decision-making process. This is reflected in the way the revenue management literature has evolved in two directions. Revenue management research has emerged towards one of two directions in terms of data processing and analysis. The first focuses on an optimization model approach utilizing real statistical data to identify the optimal revenue management decision (El Gayar, 2011; Padhi and Aggarwal, 2011; Aziz *et al*, 2011; Koushik, Higbie and Eister, 2012). The second emerging approach again utilises real statistical data but identifies the increasing subtle complexities in the real-life practice of revenue management. These approaches then adopt a more holistic examination of the revenue management process by considering both the technical and social elements of effective revenue management decision-making (Bodea, Ferguson, and Garrow, 2009; Queenan, Ferguson and Stratman, 2011; Earls, 2017).

The development of revenue management systems which can potentially interpret a volume of data greater than the average human could lead to the question of whether these systems can reach

levels of reliability that effectively eliminate human decision-making or whether intuition still needs to play a part. However, it has been noted that in practice people perceive the world differently and that personality type may influence the level to which managers process the data (Bevilacqua et al, 2014). This raises the importance of investigating the detail of how humans process complex data in practice. Major hotel companies make large claims over the abilities of their revenue systems, although clearly there is a certain amount of rhetoric being used here to attract prospective management contractors and franchisees, for instance, IHG (2017) claim their price optimization tool, Perform increases revenue per available room (RevPAR) by 4.3 percent on average. Carlson Rezidor Hotel Group (CRHG) also maintain their system, SNAP (Stay Night Automated Pricing) increased revenues by four million dollars in its first two years of adoption, despite the development taking six years (Pekgün *et al.*, 2013), which also serves to highlight the levels of time and investment needed to develop revenue management systems. However, Savino and Batbaatar (2015, p.399) suggest that this could simply be due to the size of the organisations as they support the idea that IT systems play a more important role in larger enterprises where it is “necessary to manage a larger quantity and variety of data”. Some academics would also argue that relying on big data in decision-making removes ambiguity and leads to more accurate decision-making (Davenport and Harris, 2007; Liberatore and Luo, 2012) and these systems are arguably fed with Big Data. There is also a suggestion that revenue management systems, by dealing with day-to-day revenue tactics, may “free revenue managers to think strategically” (Cross, Higbie, and Cross, 2009, p.64). Pekgün *et al.* (2013) again offer the example of CRHG’s system that was designed specifically to minimize user effort as the system reviews the data, such as transactions, inventory and competitor rates to make the pricing decision which is then reviewed by the user rather than the user reviewing that same raw data and then making the decision.

Nevertheless, the issue comes when managers may not have the requisite statistical skills to decide when to over-ride the system and when to trust it. Kimes (2017) highlights information technology was also rated within the top five challenges facing hotel revenue managers. The survey also highlights that since the same survey was conducted in 2010 the use of analytical models for pricing has increased but is not commonplace. This suggests a gap between where technology may be going in the future and where it is now, especially in terms of automation and skills. Pekgün *et al.* (2013, p.33) agrees that the SNAP system, whilst aiding the development of useful consistencies in pricing methodology across a large hotel estate, is not fully utilised as some managers are reluctant to rely on the system by “letting SNAP send the rate recommendations directly to the reservations system without user review”. Hotels also need to have a positive culture towards technology to incorporate revenue management systems successfully (Kiron and Shockley, 2011; McAfree and Brynjolfsson, 2012). However, Cetin, Demirciftci and Bilighan (2016, p. 133) argue for the need for human input in revenue systems by stating that “this software still needs constant attention and are far from resolving problems on auto-pilot...RM cannot be run only by the systems and it demands well-trained, skilled and competent staff”. Wang *et al.* (2015, p. 805) agree, arguing that the “RM analyst has to compensate for the system limits”. In addition, data is constantly being updated and changing (Laney, 2001), so there is a great deal of time required to ensure that the data used and inputted into systems is current and relevant. The concern is that many revenue systems mainly operate on historical data and cannot anticipate market changes such as the pricing strategies of new competitors or the current pricing of substitutes such as Airbnb. Managers and employees also need the time and flexibility to react to changes in demand that may affect the decision-making process, for example, the recent crashes of British Airways systems would have caused unforeseen increases in demand for airport hotels and the automated systems may not have been able to predict and react to this in time. In addition, data management and analysis are complex techniques requiring

advanced analytics in an industry suffering from a skills shortage and one traditionally slow to adopt new technologies, which some believe may mean it could miss out on the full benefits on big data-driven technologies (Leung and Law, 2013).

Methodology

A qualitative approach was used in this research to engage managers working in hotels who make the pricing and revenue decisions and to explore the realities of the perceptions that these managers had of the value and reliability of using big data to make hotel revenue management and pricing decisions. Due to the research aiming to uncover managers perceptions of big data it was felt that qualitative rather than quantitative methods would elicit a more in-depth and honest response. A three-stage iterative thematic analysis technique based on the approaches of (Braun and Clarke, 2006; Nowell et al, 2017) and using different research instruments to collect and analyse qualitative data at each stage was used to develop an explanatory framework, illustrated below. The approach of Savino, Macchi and Mazza (2015) was also broadly adopted, using the modelling and testing techniques in their methodological design within the industrial context.

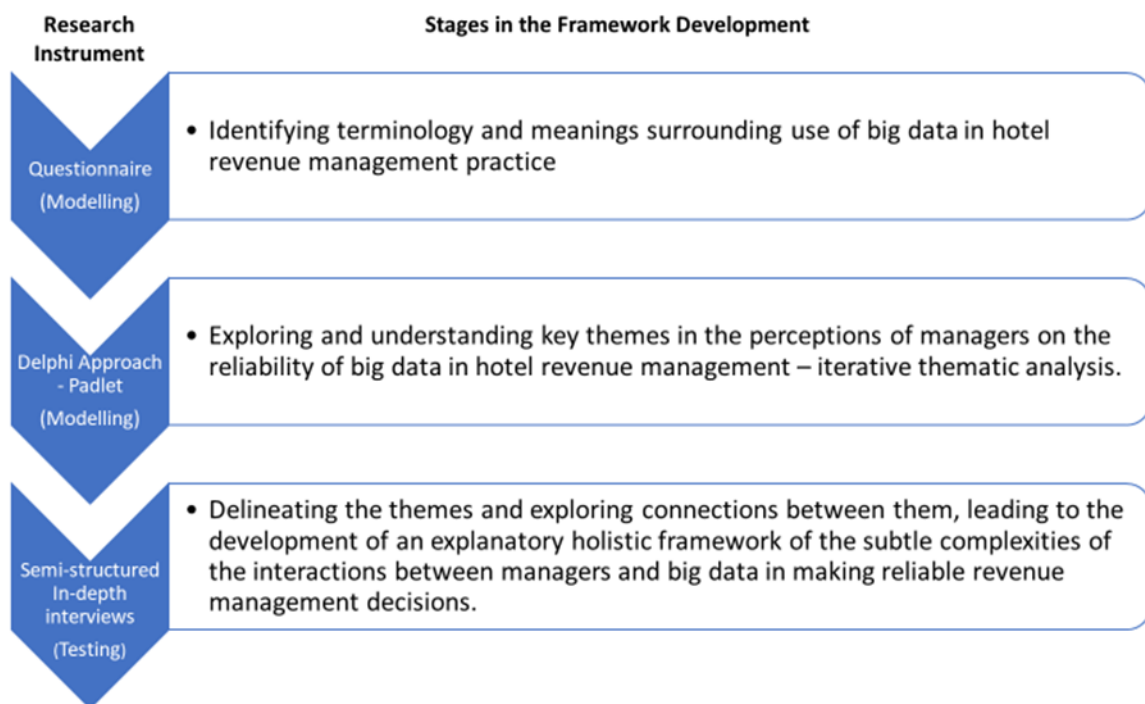


Figure 1: Methodological Development of the Framework

The first stage was a questionnaire which aimed to identify the terminology and meanings attached to big data by managers to guide the later stages of the research and to ensure the questions set were closer to the common understanding of the managers rather than relying solely on terminology used in the academic literature. Within qualitative methods, this increases the validity through content validity and pre-testing of themes (Savino and Batbaatar, 2015) although in their research statistical approaches to data analysis were used. To do this, key open questions were asked. The first one being "How would you define big data?" and the second, "What is the most common form of big data you handle each day?". The questionnaire was generated in Survey Monkey and distributed to a series of members-only LinkedIn groups via the discussion section. Background on the questionnaire was provided along with a link to the anonymous questionnaire. The LinkedIn groups selected were Hospitality Analytics, Hospitality Sales, Revenue and Customer Service, Hotel

Industry Professionals Worldwide, the HBAA and Revenue Management Professionals, Travelclick – Hotel Revenue Management, Hotel Technologies and Software and Hotels Magazine – Hotel Industry Decision Group and Travel Analytics Professionals as this gave access to managers who would be making revenue management decisions and have access to revenue big data. The use of LinkedIn was also chosen as it was felt that the medium would increase participation and a usable response rate of 72 percent was achieved. Thacker and Dayton (2008) confirm the idea that utilising social media channels for research could lead to better participation than traditional methods as respondents are used to creating content and responding through these mediums.

A Delphi approach was selected for the second stage, using Padlet online pin-board software, which can be used as an innovative, engaging method for designing a questionnaire. Padlet allows the research to post questions and send a link for comment by respondents. The Delphi approach was adopted at the mid-point of the thematic analysis due to the importance of first getting the real terminology used in the industrial context. Although Veal (2006) suggested that the Delphi approach had been previously underutilised in leisure and tourism research, both Robson (2002) and Donohoe and Needham (2009) are confident of its use in utilising a group of experts to clarify and refine a research question. The virtual pin-board also facilitates the collection of data at a distance in a time efficient manner and allows engagement with respondents in real-time, increasing participant engagement. Two hotels were involved in this study with a minimum of five rounds of Delphi, with a round taking place each week. The hotels were selected as they were part of a chain operating as management contracts and held formal weekly meetings to review the performance of the hotel using a wide variety of data. The General Manager was sent a brief of the research project and the initial question for the first round via a link to Padlet. Each relevant manager, who was pre-screened to check involvement in revenue management decision-making, was then expected to complete an entry in response to this question on Padlet. The guideline was a minimum of one sentence per respondent and that it should take no more than five minutes per manager per week and it was suggested that this was completed at the weekly operations meeting to encourage participation. Feedback time was also kept to a minimum as it was deemed important to get an instinctive reaction from respondents as an honest response is so crucial in guiding exploratory research in its early stages, in line with the Delphi approach (Linstone and Turoff, 1975). Subsequent questions were sent through each week and these questions emerged from the responses of the participants. The questions were designed to explore employees and managers reaction to the data they had available to them, what data they focused on and how that data was used in price and revenue decision-making.

The themes emerging from the Padlet questionnaire data were then used to structure the final stage of the research which was twelve in-depth, semi-structured interviews, approximately one hour long, with hotel managers and area/cluster revenue managers to further explore the emerging themes of the two earlier stages of the research. Gathering more detailed data from hotel managers as well as revenue managers allowed comparisons to be made between the perceptions of generalists and specialists, to avoid any bias. At each stage data analysis was carried out during each stage of data collection, using thematic analysis techniques informed by the approaches of Braun and Clarke (2006) and Nowell *et al* (2017). Key emerging themes were identified across the data as it was collected. Braun and Clarke (2006) describe this process as identifying, analysing, organizing, describing themes found within a data set to answer research questions. This allowed the themes to be refined over-time, reach saturation and form a clear visual framework to show what was occurring. The final stage is the testing of the concepts ensuring the reliability and validity of those concepts through theoretical saturation (Strauss and Corbin, 1998), where through continuous analysis no new themes are identified and also ensuring the credibility and confirmability of the

research by checking that the themes identified did originate from the research data (Guba and Lincoln, 1989).

Research Findings

The following key themes, graphically represented below in figure 2, emerged from the data collection and analysis process outlined in the section above. Through a further iterative analysis where the relationships between the themes were considered a framework to explain the findings of the research was developed which can be seen in figure 3.

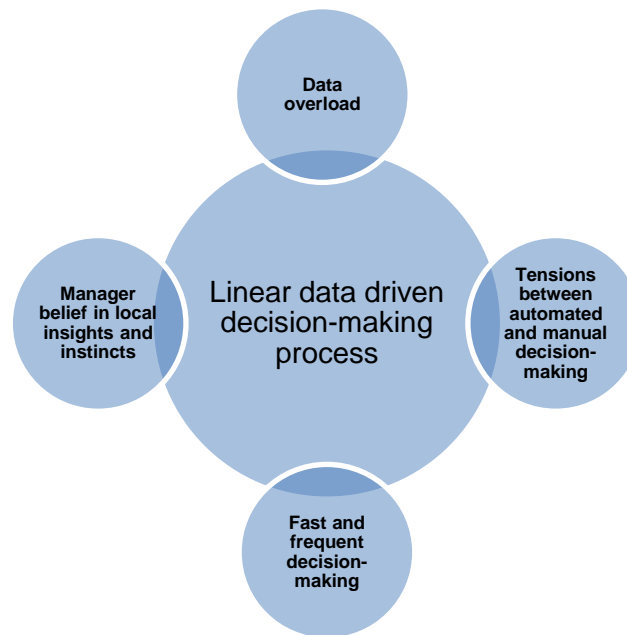


Figure 2: Key themes from the research data

Perhaps, unsurprisingly from the early stages of the research, it was apparent that the first key challenge of applying big data to revenue management was the speed and volume of data reaching managers. From the initial responses of managers, it was clear that they recognised big data as a raw material and that its value could only be unlocked through analysis, but that they felt "overwhelmed" by the process and that at the hotel level the high volumes of revenue management related data could hamper the analytics process. These challenges are perhaps exacerbated in hospitality where complex management structures, such as franchises and management contracts, increase the number of data flows and the variability of data which is provided by multiple stakeholders often with different agendas. The major issue appears to be that there is too much data and not enough time to interpret it at a hotel property level, where operational pressures are high. Information overload in-turn causes a silo-effect, the very thing it is advised to avoid in the big data literature. This research showed that managers knew they had too little time to utilise the data available to them and consequently reverted to focusing just on the data that they perceived would help them achieve success in their specific role or to meet their short and long-term targets. A manager who is targeted on the performance of their hotel against its competitor set will likely place the primary focus on the STR produced competitor set data. A sales manager who is targeted on the number of bed nights achieved per month becomes only interested in occupancy data and consumer feedback rather than considering revenue per available room or average room rate.

As the research progressed a deeper focus was placed on data-driven revenue management systems and not just big data in isolation, to see how managers perceived big data when they were needed

to be less heavily involved in big data analysis itself, as this could be done by the system and therefore perhaps less influenced by information overload. It became clear through the analysis of the research data that there were clear steps in the process of using data in revenue management including data collection, presentation and delivery, analysis and interpretation and ultimately actions or implementation of decisions. In automated revenue systems, these stages would be carried without human user input and prior to hotels having revenue systems they would have been carried out manually. It is perceived by managers to increase the reliability of revenue decision-making rather than relying on big data alone, where big data is in turn perceived to not be able to reflect the intricacies of guests, local competitors, and markets. Managers appear to use the revenue systems as a guide to their decision-making and they favour user input at all stages of the core processes of data-driven revenue decision-making from data collection to putting revenue decisions into action. Even where this may mean collecting and interpreting more of the data themselves, they still preferred to do this.

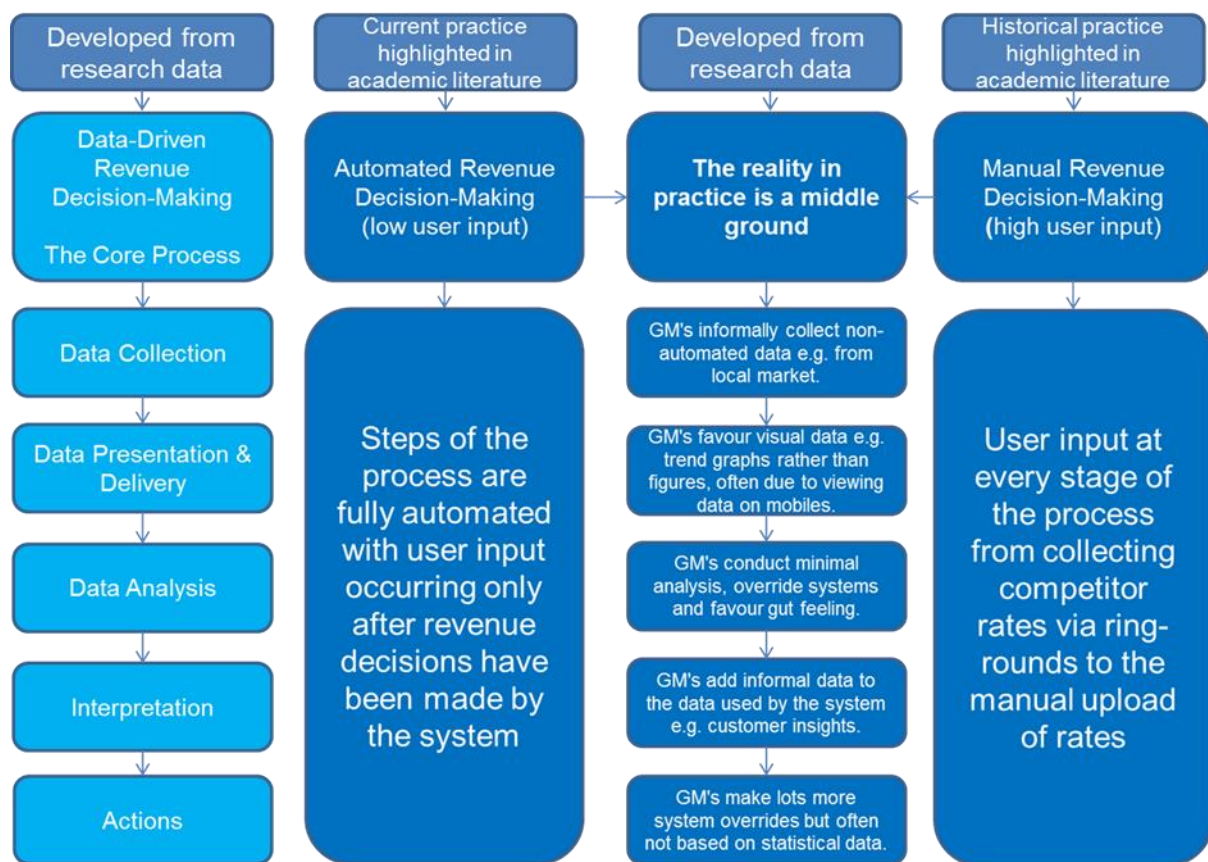


Figure 3 – The realities of data-driven revenue management processes – a framework

In the first stage of the process which is data collection managers appeared to feel they had different and perhaps better insight into different types of data that the system was not interpreting, in particular customer information and local market dynamics. Several managers commented that they would only use the system as a guide and that it failed to have a full understanding of the business. Their perception was that their skill lay in interpreting the local market and this was needed in addition to the big data generated by the automated systems to increase the reliability of the decision-making process. One stated that "there is only so much a system can tell you if it can't feel and see, you know. It obviously understands numbers but doesn't understand anything else...it doesn't understand the market" and another confirmed, "the system will not predict what you're actually dealing with...the business that's coming through". There were

two concrete examples given of this at work within hotels and where two different automated systems from two different brands were considered to be misunderstanding the market dynamics and customer behaviours.

One manager commented the system would sometimes mix up the relative strengths of the hotels performance against the market, for example he said that if there was a big group in the hotel which makes the hotel generally busy but the city was generally quiet it might suggest a rate increase that couldn't be sustained for the remaining inventory and in that case, he would suggest to the revenue manager to override it. Another manager remarked that the automated system on the day the interview was conducted was suggesting a rate of £85 room only, for a key business night, but that the hotel was selling at a high booking pace at £154 room only for the same night. The manager believed that the system was not considering the attractiveness of the brand reward scheme which many of the regular business guests wished to benefit from even if they could pay less elsewhere. The manager commented that some guests paid for Christmas or the annual holiday out of their brand loyalty points. They said that the system was unable to take this into account, so it needed to be over-ruled on some key business nights. Here the system seems not to be able to differentiate between customers and consumers. It presumes the corporate booker has the power and is price-sensitive when in fact it is the guest, the business traveller who has more power in the booking decision and is not price-sensitive but brand loyal.

The second stage of the process is data presentation and delivery and here managers were seen to scan visual representatives of the data rather than the absolute figures, for example several managers commented that they only "sense-checked" the data and preferred to look at the trend graphs in the STR competitor reports rather than the detailed figures. Looking purely at trends may mean decisions are made without utilising all the available data and only based on one dynamic of the revenue situation of a hotel. This is perhaps exacerbated by the increased use of mobile technologies in revenue management that have allowed managers to make pricing decisions outside of the business context. The use of mobile technologies, often off property, results in managers not basing their decisions on a full dataset but on snippets of information which may potentially undermine their price strategies in the longer term. It was also felt this showed the managers to perceive the detail of big data to be less relevant and only the top-line figures were used to combine with their local knowledge. One manager described deleting detailed revenue reports from his inbox without reading them because they knew that it would not tell them anything else that they felt did not already know and would not, therefore, add value to the decision-making process.

In terms of data analysis and interpretation as seen above managers are not fully processing all the data available to them and potentially still mistrust the automated systems and feel the need for gut feeling and intuition to still play a part in revenue management decision-making, as well as risk-taking and creativity. Managers seemed to believe automation removed flexibility and managed out risk, even though the academic literature suggested that automated systems would free managers for more strategic thinking. When hotel pricing, especially in competitive markets, is so changeable and reactive, managers perceived and valued flexibility as helping increase the quality of the decisions through making them more instinctive and responsive to change in the local market but also believed their local knowledge was a check and balance to the decisions made by automated systems to ensure prices were not changed too frequently on system autopilot. Managers seemed concerned that rate integrity and stability was important for the customer experience. This is perhaps also because all the general managers interviewed perceived that they had the power to make the ultimate decision on price and therefore hadn't yet relinquished control over the day-to-day, tactical revenue decisions. Managers seem to view revenue management as an art as much as a

science and that automated technologies may not reflect that. One manager for a large brand commented, "sometimes I guess it is more of the human element rather than just a kind of analytics and facts and figures and black and white...it's just a guide tool, it's not...you know...we have to follow that to the letter" and another remarked, "revenue is not black and white and sometimes we have to take risks".

Crucially a common issue seems to be one of the managers perceiving themselves to have a greater degree of judgment over that of the automated system. One manager expressed this directly stating, "you still trust yourself more than the system...it is a natural process...you just do it, don't you?". Another agreed, "you can feed all that data in but sometimes it's you know...it's a gut feeling...I think you should have a better feel for your business...that you should be able to go no...it needs to be this...not just the computer does it". However, there may be some suggestion that revenue managers, who are more statistically driven are happier to trust the systems rather than general managers who seem to be more instinctive. When hotel managers and revenue managers need to agree on prices together this could cause an interesting tension between the two parties and debates between the hotel and off-site revenue could serve to slow down rather than speed up the process as both parties focus on different sets of data. One General Manager commented on the different viewpoints of general managers and central revenue team using the automated systems, "for me, it's gut feeling...for them its spreadsheets". The danger here is, of course, that vital data that would, in fact, support both those roles are ignored and that revenue management gets broken down into its component parts rather than being viewed as an organisation wide strategic decision. Revenue managers, especially those working at specialist revenue hubs away from properties appear to be viewed as more statistically and technologically driven and may be happier to trust in systems as they are more aware of the working behind the algorithms than general managers.

Finally, the last step in the process is action, where again the use of mobile and tablet technologies is increasing the number of revenue actions and price changes that are made but with that remains the lack of detailed analysis prior to the decisions being implemented. One deputy general manager commented of herself and the General Manager that, "we've both had our system put onto our I-pads, so we can sit at home at night and check rates". Another said, "it's like if I'm abroad...I can actually manage the hotel". Taking decisions using mobile technology, at home and out of context may mean that not all the data is utilised fully and only a quick scan of the data is conducted. It may be based on visual scanning of trends rather than analysis of the more detailed statistics available. It seems almost that with more data and the ability to change prices more quickly and easily there has become actually less accurate decision-making in revenue management in hotels even if it is more frequent.

Perceptions of the reliability of big data-driven revenue management decision-making – implications for managers and academics

What the findings of this research allow is a unique insight into the realities of the perceptions and use of big data-driven revenue management decision-making within hotels. Whilst the academic literature has shown to place its faith in the increasing automation of revenue management decision-making using big data and analytics which should require no user input (Wang *et al*, 2015; Kimes, 2017), this research has placed this under question. Based upon a fresh understanding of the perceptions hotel general managers have of big data this research shows that despite the increase in automated systems and the rise of the revenue specialist, the hotel general manager is often still the key decision-maker when it comes to pricing and revenue decisions and therefore their perception of the reliability and quality of big data are profoundly influencing its use at the hotel level. Their

involvement was potentially also increased by the use of mobile technologies facilitating their easy contribution to the revenue and pricing decisions when working remotely.

Although this research does confirm the key characteristics highlighted in the academic literature that big data should be characterised as large volume, variable and arriving with high velocity (Chen, Chian and Storey, 2012; Kwon, Lee and Shin, 2014; Phillips-Wren and Hoskisson, 2015) the very nature of its size is found to be the driving force behind hotel general manager's questioning its reliability if used as the sole means of revenue management decision-making. One of the key issues emerging is that big data is "big" and potentially macro in nature and this is one of the key reasons hotel managers feel the need to keep individual control over the input of localized, unique data. Hotel managers perceive big data as only covering broad trends rather than being sensitive to the intricacies of the local market which they see as so vital in making a reliable decision. This is interesting given the academic literature introduced earlier in this paper highlighted the complexities and statistical intricacy of revenue management systems (Cetin, Demirciftci and Bilighan, 2016; Earls, 2017), which hotel managers do not seem to recognise.

What we are actually seeing with the introduction of automated revenue management systems is the opposite of what Pekgün *et al.* (2013) said would occur in terms of a reduction in user involvement. In practice, this has not happened and what we actually see is the user, in other words, the hotel manager, becoming more involved not just in reviewing the big data but adding more information into the decision-making process on the local market. Whilst the literature suggests automated revenue management systems are capable of making pricing and revenue decisions without human input and that revenue management no longer need rely on manual methods this research found that in reality at hotel property level, practices sit in the middle ground between the revenue management approaches of the past (Haynes, 2016), such as manual ring-rounds to collect competitor availability and average rates and fully automated revenue systems with low user input. Information overload was considered a common challenge in the literature, for example, Cetin, Demirciftci and Bilighan, (2016) but actually, it might not be the overload that stops managers from fully utilising big data but the strength of their belief in the importance of the local knowledge that they actually hold. This extends the point made by Haynes and Egan (2014) that big data should be seen as a raw material for decision-making, not a complete solution and this research has shown that balancing big data with local data means a more reliable decision as perceived by hotel managers.

However, the continuing reliance on local data inputted by hotel managers outside of the automated revenue systems raises questions for the future viability of these systems and actually whether the hotel general manager could be a barrier to better implementation of big data-driven systems. Currently, there seem to be both human and technological barriers to increasing the reliability of big data in automated revenue management decision-making. Connell and Voola (2007) and Hayne, Troup, and McComb (2011) had argued that big data required coordination and integration but actually what this research has shown is the need for big data covering broad trends and driven by analytics to be integrated with other forms of local level data not just with more big data. This fits with the development of complex ecosystems of interconnecting data sets that Zeng and Lusch (2013) talked about. Within the academic literature, discussions should perhaps focus less on data analytics but on how automated revenue systems can be widened out to incorporate a larger range of different local, qualitative inputs of data by hotel general managers to match with approaches to revenue management highlighted in the literature that stress both technical and social elements of revenue decision-making (Bodea, Ferguson, and Garrow, 2009; Queenan, Ferguson and Stratman, 2011; Earls, 2017). However, this research proves there is a balance needed.

Hotel managers should not discount the value of big data or ignore, as was seen to happen on occasion, and the industry needs to consider increasing the understanding of algorithms and data-mining techniques to all managers, not just revenue specialists, to change their perceptions around big data and encourage them to use it for deeper analysis rather than only using it for surface-level analysis. Hotel managers see big data as passive and local data as pro-active. This confirms the thoughts of (Lewis, 2006; Liberatore and Luo, 2010; Biran, Zack, and Briotta, 2013) that large volumes of big data do not instantly make managers knowledgeable and informed decision-makers but crucially helps to explain why this is in the hotel context. Hotel managers are involved in the collection of local data and therefore trust in the information arising from this type of data because they know its origins whereas for big data they lack understanding in how it is collected and analysed, building a perception of distrust in its reliability.

Conclusion

This research has made clear that in the hotel sector, the amount of data involved in revenue management continues to grow and that global hotel chains have turned to automated revenue management systems to attempt to divert pressure away from managers, increase decision-making accuracy and aid the multiple tactical price and revenue decisions they would otherwise have to make manually on a daily if not hourly basis. Unexpectedly, even for managers working in global chains, normally brand, process and technology driven, they seemed wary of turning their backs on their local market knowledge, customer insights and the intuition that develops from this, perhaps because this is where they believed their personal skills to lie and they understood how the data was collected. Managers perceived that their personal insights were as valid as the big data in increasing the reliability of the revenue management decision-making process. Whilst these systems use sophisticated data analytics to arrive at prices, hotel general managers still prefer to remain in control of tactical pricing and are happy to override automated systems as they feel they have better access to more relevant data, in particular, on guests and the local market dynamics. The key finding of this research seems to be that we must ensure big data automated revenue systems are made flexible enough to allow managers to import local data into the system, in combination with big data, so that the managers perception of the reliability of the systems and the big data is increased and they become more widely utilised.

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