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ORIGINAL RESEARCH ARTICLE

Determinants of revenue management framework as enablers for cloud & e-commerce hospitality management

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ABSTRACT

The digital landscape's impact on hospitality, driven by new online practices, has heightened the importance of loyalty programs. This essay explores the fusion of e-commerce with hotel management, utilizing cloud-based practices to handle electronic commerce data. Through a review of existing literature and on-site observations, it uncovers evolving managerial techniques and data warehousing for predictive modeling. The manuscript investigates how Revenue Management Artificial Intelligence (RM AI) influences Hospitality Supply Chain Management (SCM) sustainability. Findings reveal a positive impact on sustainability but stress the need for customized AI solutions for each hotel.

Keywords: e-commerce; cloud management; hotel management; revenue management; supply chain management

1. Introduction

1.1. Relevance

Revenue Management (RM) has become one significant sustainability contribution to hotels and other players in the Tourism & Hospitality Industry[1–5].

However, RM presents network problems concerning new forms of distribution channels[6–8], changing management practices, and consumer behavior, as well as informatic constraints, namely Deterministic Linear Programming (DLP) and Dynamic Programming (DP), two characteristics still limited by the Machine Learning implications[9].

Concerning the decision-making process, the algorithms used might also lack variables to indicate the path to follow, as the mathematical and autonomy problem solvers are already well developed[10,11], as emphasized by the rise of Artificial Intelligence (AI), and its connection between the decision-maker and the machine[12].

The usage of digital and technological solutions, like big data, the Internet of Things (IoT's), Machine Learning (ML), cloud computing, smart sensors, connectivity, Machine to Machine (M2M), acts as enablers to the rise and development of diversified online sustainable concepts that allow the analysis of e-commerce complexity (such as interoperability, decentralization, virtualization, modularity, real-time capability, and service orientation), aiming for a multilevel Adaptive and Integrated Sustainable Supply Chain Management (AISSCM)[4,13], through this, we may, therefore, endorse the concept of innovative productions and intelligent

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services.

Recent theories emphasize the need to follow Online Delivery Providers (ODP's), which could also be known as Online Travel Agents (OTA's), that represent a growing hospitality sector in terms of data collection and reporting of correspondent analytics, to act in a new challenging period, but a few studies identify the drivers behind the adoption of this new technology[14].

1.2. Context

Research question

The growing significance of big data and the integration of specific hotel software and systems are recognized as key facilitators of autonomous management[15–18]. These advancements harness artificial intelligence to provide valuable insights for decision-making[1,12,13,19,20].

However, various theories emphasize that while machine learning is invaluable for evaluation, it may not be equally efficient for direct decision-making and operational development[21–24].

To address these dynamics, this article's central inquiry is to comprehensively assess how Revenue Management Artificial Intelligence (RM AI) influences the sustainability of Hospitality Supply Chain Management (SCM). Additionally, it delves into a related sub-question: how do these factors contribute to enhanced sustainability for hotels? Which underscores the importance of online pricing and channel management in the hospitality industry[4].

By exploring these questions, this article seeks to clarify the underlying motivations and problem background that drive the investigation into the role of RM AI in the sustainability of hospitality SCM.

2. Literature review

2.1. Hotels' revenue management practices

Hotels' Revenue Management (HRM) practices are derivative of airlines' yield management in the hotel industry[4,5,25–27].

Applying the variables associated with maximizing hotels' revenue due to its services' limited capacity and basing its demand-based pricing strategy to control for optimal inventory levels and to forecast real-time demand, considering it a form of analyzing this industry' supply chain[28–34].

Through the study of Kimes[34], we can visualize that RM is being considered as a tool for strategic alignment for the hospitality industry—see **Figure 1** below.

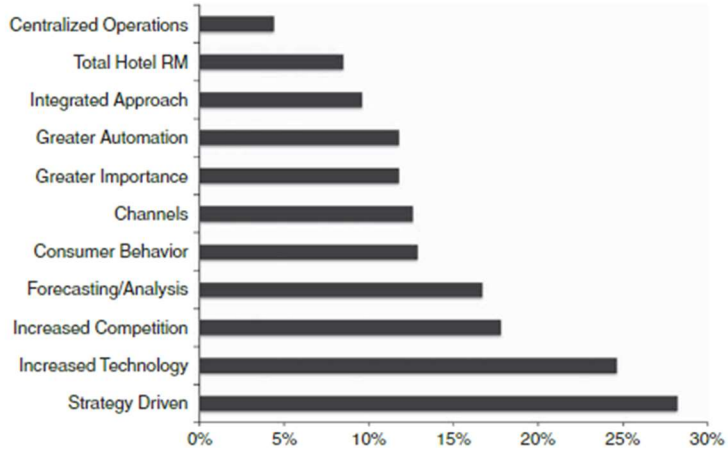

Figure 1. What will RM look like five years from now?

It is, through this research, clear that RM acts as a primary investment in hotels, restaurants, and the main hotel outlets, nowadays in terms of strategic alignment and especially if we aggregate it with systems integrations[4,24], the technological usage for qualified Revenue Managers (RMr) with analytical skills for the tangible attributes: 1) consumer behavior; 2) competition; 3) internet; 4) market; 5) economy; and 6) technology[34,35], in which, until the moment of analysis, the RMr would rely on these topics of analysis to forecast future income.

Nowadays, the insight is to use big data and AI to use present information to develop the activity shortly[33,35–37].

Accordingly, there is a need to compete over value rather than room rates, which is called strategic revenue management[26], states that the differences found in the impacts of Total Revenue Per Available Room (TRevPAR) can be explained by hotels' characteristics, management practices, and location[38].

Besides the technology usage and the analytical know-how of RMr, there is also the need to understand what Key Performance Indicators (KPIs) to analyze, somehow as described, with topics to explore over RM, such as 1) pricing strategy; 2) demand and forecasting model of analysis and implementation; 3) business analysis; 4) performance analysis and evaluation; 5) inventory optimization; 6) booking controls; and 7) OTA's management[39,40].

RM, when well applied to hotel strategy, consists of developing a value stream mapping model that drives the corresponding dynamics above, the RMr knowledge + the topics to be analyzed by the professional user[41].

Price is still a variable that has a negative impact on hotels' demand[42], and that is why[2,38], hoteliers should be focused on value propositions and then pricing strategy, changing the mindset of pricing against competition only.

Connecting all literature[4], Tactical Revenue Management emphasizes the operational focus on the RM perspective, rather than a strategic initiative that should be part of the business strategy.

2.2. Hotels' e-commerce & cloud practices

The rise of online hospitality bookings, whether at restaurants, hotels, or similar, has proven that e-commerce practices are, nowadays, fundamental for the growth and sustainability of a hospitality business[41], specifically if we focus on demand curves and price elasticity.

Connecting the hotels' operations with data warehouses that would read, store, and provide analytics for e-commerce purposes, therefore named Supply Chain Information (SCI), is positively related to supply chain management performance and potentially to firm sustainability from the B2B perspective (supplier) and further in the chain from the B2C perspective (guest)[33].

Entities should look for internal solutions that centralize data rather than decentralize information about the logistics stages of the SCM[43], where cloud management is implemented to bring awareness to every department and bring information together; however, information may need to be the right fit for the institution[44].

The emerging trends brought by the IoT's brought several variables to be considered in revenue management strategy and e-commerce management, in the sense that there was a need to understand the length of time slot, decision time slot, the sets of mobile IoT devices, and even the wireless communication systems that would communicate and receive the correspondent communications[45].

We may understand the gaps in e-commerce and cloud management practices, as there have been several failures among several online platforms[24], on which, for practical example, OTA's were the actors considered

to identify the gaps via real-world data as cloud providers[46].

RM interconnects the variables above (data, supply chain information, strategy, IoT's, e-commerce, cloud management), and for its reference, not only on hotel rooms but hotel restaurants, bars, and other wellness outlets, according to customers' perceived fairness over services' value and the reference pricing on the market competition in the corresponding segment[4].

Through the theory, it is especially relevant to mention the impact of e-commerce on hotels, as stated in the appointed study, it directly affects production, by considering the relationship that is created between the guest and the hotel[47,48].

Through the OTA's, it is possible to better understand the value of this statement for the hotel industry, as it is easier to understand some RM KPI's, such as market penetration index, guest loyalty, guest pickup, guest retention, and consequently, revenue per guest and new guest, even more on new units, approaching the market, whereas they might evaluate the impacts and effects of their strategy on the clients' segment followed[47,48].

By following the essay, we realize that other variables to bear in mind are the business structure that each unit has or needs to get to implement these digital tools and the firm size, which is important to evaluate the number of people that will be associated with possible mutations in management systems and how the cultural environment and human resources are inertia to changes[47,48].

2.3. Literature and research values from review findings

It is also important to mention that, looking back on supply chain management, by gathering reservations and working with a longer booking window, the hotels are better prepared to decrease their price cost with higher negotiation power with their suppliers and increase the quality of their stock management and product perishability.

Also, it is important to keep in mind that nowadays, OTA's should not be considered by hotels and hoteliers as only a path to get clients through rooms. In cases where there is the intention to do cross-selling for F&B and other outlets, there is a need to emphasize what can be called "hotel cross-activity".

Representing a hotel that may use e-commerce like "Uber Eats" for distribution, "The Fork" for reservations, and "TripAdvisor" and/or "Zomato" for reviews, it can be associated with the general brand image and the overall hotel image by the restaurants' service and food quality (or other attributes of the corresponding outlet).

It may get the client to intend to spend a night at the hotel or use other of the outlets, as, for instance, it might be a tool for the hotel to have more walk-in guests at the less used outlets, e.g., potentiate wellness center sales on extra hours, meaning that through e-commerce and the "democratization" of online purchases, the hotel may understand that there is a need to extend the working time or even change the normal schedule to give a proper value and utilization to the outlet[39].

It is also worth mentioning that this e-commerce is less effective on micro and small enterprises due to the constraints often found, which in hospitality might also be an opportunity, as if this implies a major help on purchases and stock management prior to the transformation and production, on smaller units it is even more relevant to help the cost management associated with it, but will, at the same time, due to the impact on guest satisfaction, increase the hotels' image online[47–50].

Especially online, in e-commerce management strategy, location is a critical variable to mention and emphasize for the guests' experience[38,51–54].

However, the cloud management connected to e-commerce allows both parties to have updated information about the business in a way that the guest knows upon the reservation period the number of available rooms and the corresponding typology. At the same time, the management can track the guest behavior on the reservation website to personalize the promotions to apply to the directed segment, in a way that, e.g., the hotel may promote a double bedroom and not a twin room to implement an upscale sales technique instead of promoting the hotel as an all, thriving for higher occupancy on one specific typology.

It is very important to mention the clarification from Huang et al.'s study[45], which states that task scheduling should, on its basis of formulation, IP address problems and constraints, but also the understanding of the mechanisms that influence the ranking, such as utility, conversion rate, clickthrough rate, prices, customer rating, and the Travelocity algorithms[42].

3. Methodology

3.1. Investigation procedure

The following article relies on a research question that connects the RM theories and new management applications using Big Data and Artificial Intelligence. To do so, there was a systematic literature review and an article's qualitative analysis on published papers, searching over the keywords utilized for the literature revision and the corresponding authors and works retrieved from the Boolean research, as described upfront.

Besides this, there was an approach to hotels' managers, revenue management systems developers, and a multi-unit short-term rental, management company, to contrast the presented literature facing the actual environment of e-commerce applications and cloud management practices, providing both an explanatory and exploratory study.

3.2. Literature selection

To proceed with the bibliometric analysis, the research has relied on the keywords of this article: "Cloud Management" + "Revenue Management" + "Hotel Management" + "E-commerce", searching index on Web of Science, Google Scholar, Scopus, Emerald, Springer, Taylor and Francis, Sage, IEEE, Inderscience, Informs, and others with fewer publications found, among which, the relevance of the search is implied by the mutation over the Boolean research, whereas the keywords above were changed as if considering keywords by themselves or the word used in work titles.

There were found 9088 papers, from books, book chapters, articles, reviews, and others, using the keywords in the title search and as keywords and reversing them among each search, as seen in **Table 1** below.

Table 1. Plan and search for keywords and titles.

Filter	Google Scholar	Scopus	WoS	Total
Cloud management [title], E-commerce	519	32		551
Cloud management [title], E-commerce; Hotel Management	24	0		24
Cloud management [title], E-commerce; Revenue Management	386	1		387
Cloud management [title], E-commerce; Revenue Management; Hotel Management	22	0		22
Cloud management [title], Hotel management	131	2		133
Cloud Management [title], Hotel Management; Revenue Management		1		1
Cloud management [title], Revenue Management	738	58		796

Table 2. (*Continued*).

Filter	Google Scholar	Scopus	WoS	Total
Cloud management [title], Revenue Management; Hotel Management	35			35
E-commerce [title], Cloud management	980	72		1052
E-commerce [title], Cloud management; Hotel Management	418	0		418
E-commerce [title], Cloud management; Revenue Management	980	3		983
E-commerce [title], Hotel Management	987	15		1002
E-commerce [title], Revenue Management	410	60		470
E-commerce [title], Revenue Management; Hotel Management	210	0		210
E-commerce [title], Revenue Management; Hotel Management; Cloud management	401	0		401
Revenue Management [title], Cloud management	159	14	2	175
Revenue Management [title], Cloud management; E-commerce		0		0
Revenue Management [title], Cloud management; Hotel Management	88	0		88
Revenue Management [title], E-commerce	389	16	4	409
Revenue Management [title], E-commerce; Cloud management	48			48
Revenue Management [title], E-commerce; Cloud management; Hotel Management	37	0		37
Revenue Management [title], E-commerce; Hotel Management	295	0		295
Revenue Management [title], Hotel Management	910	200		1110
Revenue Management; Hotel Management; Cloud management; E-commerce	440	1		441
Total	8607	475	6	9088

Source: Microsoft Excel.

Also removed all files (as seen in **Figure 2** below), where DOI has not been found, and divided the literature by type, whereas articles remained with 2071 works, including books, conference papers, book chapters, erratum, reviews, and articles.

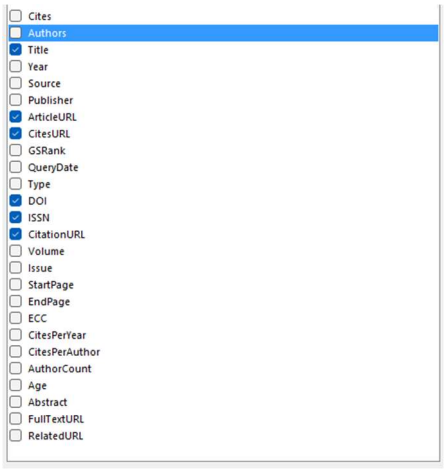

Figure 2. Filters chosen to remove duplicates.

Source: Microsoft Excel.

When filtered by, just articles, in the last five years, it has brought only 643 articles to review, providing the emerging relevance of the subject. If we evaluate from the last ten years or last five years, we found an average of >128 articles published per year, as seen below in **Table 2**.

Table 3. Bibliometrics of the articles published on these subjects.

Rótulos de Linha	Contagem de Year
2018	101
2019	133
2020	133
2021	206
2022	70
Total Geral	643

Source: Microsoft Excel.

After the filters were already established, the next step was to understand the number of citations per article to focus on the most important ones. Through the mean of the last five years (Avr. 11,01), we placed the final filter of only retaining articles with 11+ citations, which led to 117 articles to review. Although the selection was already made at this stage, only 100 of the 117 articles were found. After using VOS Viewer to correlate the keywords used in each essay to review, it was clear that there is no relationship between revenue management and cloud computing or e-commerce. The theory must therefore be connected and explicit, as shown in **Figure 3** below.

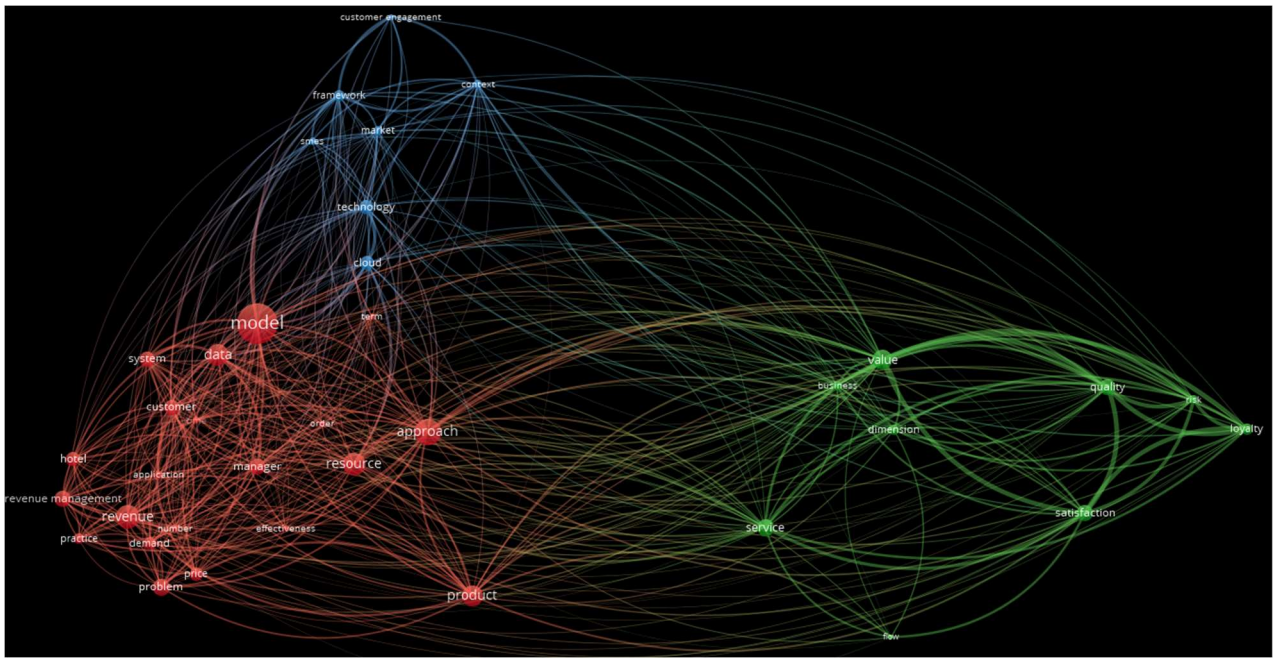

Figure 3. Network visualization of the total keywords used on the articles to review.
Source: VOS viewer.

Through the image above, it is possible to understand the connections between the researched keywords, the ones with a higher connection and those with a lower connection. It is noticed that relations are there to be connected, although they are fragmented, meaning that there are not any studies relatable among the keywords. By using a funnel technique, we have focused on the connections from RM to others rather than Back-to-Back relations. We proceeded to understand the ones that are directly related to "Revenue Management", as shown in **Figure 4** below.

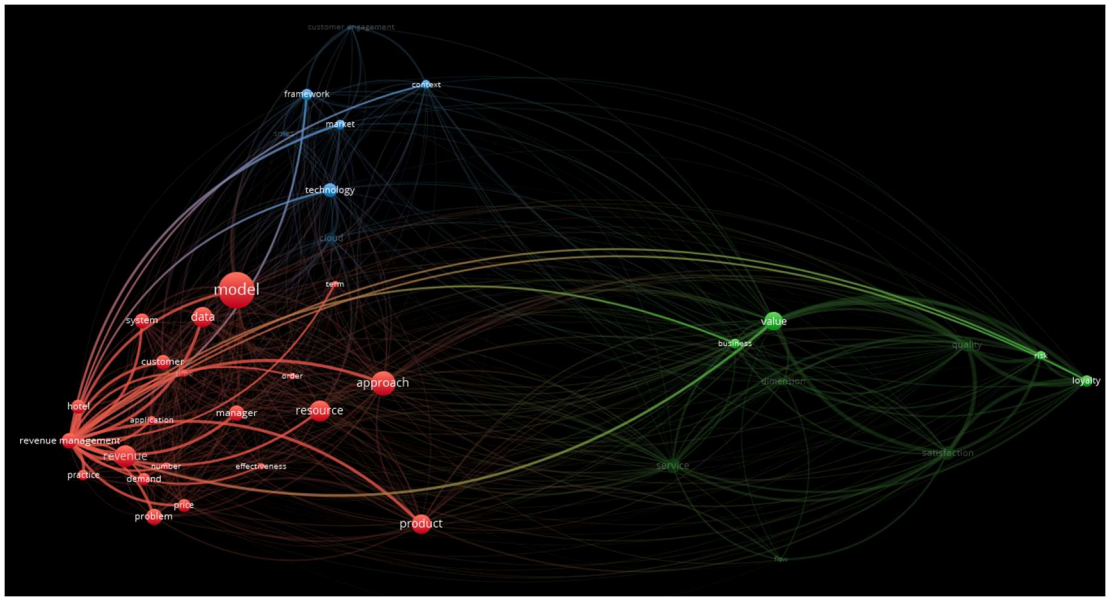

Figure 4. Network visualization of the total keywords connected to Revenue Management.
Source: VOS viewer.

Literature justification

The above-described organization and extraction have resulted in referencing several understandings; however, besides the focus on metadata of Quartile, Indexed Journals per database, there was also a focus on main authors, and it was also possible to identify the ones that have approximately written something about this article's subject, as identified below.

A few works prior to 2017 were used just to illustrate longitudinal evolution.

3.3. Methodology option

Sample for qualitative data collection

Over the retrieved articles, the relevant information was gathered to analyze the application of both tools and techniques (cloud and e-commerce management), connected to RM, within which there was an in-field presence of Hotel RM meetings to understand if it is: 1) applicable to hotels in Portugal—according to the Portuguese hospitality culture; 2) if yes, how it is being applied and developed, whereas it was expected to retrieve enough intel to answer the research question proposed. In total, there were interviews with 11 top managers, of whom 5 were from independent hotels and 6 from chains of hotels.

After the process of gathering all the information on the personal library and revising it, the research question was established, which was chosen to get insight to answer through the top managers interviewed.

3.4. Tools for data analysis

For the article's development, there was the use of Microsoft Excel, where all metrics concerning the data prior presented in **Figure 2**, which through the pivot table, were possible to summarize. After that, it was possible to extract the articles from the databases described, upload them to Mendeley for review, and use this last program for two purposes: 1) as cite and reference manager; 2) to select all data (after upload) and extract as ris.file to get the clusters' information presented in **Figures 3** and **4**. To get the clusters and corresponding image, it was used in the Voice Viewer program, where it was uploaded the previously mentioned ris.file, which was required on the program to "map based on bibliographic data", to achieve the presented information.

The data extracted from the interviews was passed into a manuscript with the help of the recordings from

Microsoft Teams, which were then written in Microsoft Word, mainly in Portuguese as it was the language of the interviewees. Then, the data was scrutinized. Among the transcriptions of the manuscript, upon review of the answers, the word localizer was applied, which showed the number of times each word was repeated and therefore made it possible to establish patterns.

4. Discussion

Empirical discussion

The literature review indicates that the online presence of hotels has become an integral part of their overall strategy[39], It involves the active participation of various managers, such as the General Manager, Revenue Manager, Marketing Manager, and Sales Manager, who contribute to approving suggestions and tactical approaches, complementing data analytics, designing communication and promotional strategies, and determining optimal timing for promotions.

The evolving nature of this strategy poses challenges for system developers. However, it is noted that managers nowadays exhibit a greater emphasis on data-driven decision-making, prioritizing proactive responses to guest needs over-reactive measures.

For system developers, this evolution brings challenges, but according to the CEO of a revenue management system, "managers are nowadays more data-driven," complemented by the opinion of a multi-unit short-term rental, management company. "We are looking to be more active in answering the guests' needs than prompt in reacting to them."

The same person says that with the pilot applications developed with hotels' data and the hotel's General Manager's inputs about the correspondent hotels' operations, "there have been mutations in the algorithms; for sure, we may have a standard to apply techniques and software to hotels; however, the assignment needs to be adapted to the needs of the hotel as the hotel adapts the offer to their clients."

With this, it is possible to better design a tailor-made proposal to fit the market segment desired for the corresponding hotel segment[33], in the sense that, if the hotel uses a data warehouse to forecast how many potential guests will be at the restaurant, this is, in the first place, useful information for the suppliers as well, to organize stocks and lead-times, and furthermore, to deliver the best experience to the guest without incurring stock breaks upon the service.

A top manager states, "We are building our internal data warehouse to easily read information from all systems to guide us for proper decision-making." Going forward on applications, "it is very difficult for us to manage so much information from so many software, so we need a place where we are able to visualize everything in one place, so we are translating everything in a Business Intelligence program."

According to recent developments, as the topics to explore inside the RM strategy are connected to business analytics, the data warehouse should be built around all KPIs to be associated with the predictive model[8,33,35–37,55].

There is also a clear intention to minimize human error and common mistakes, and so, as one manager stated, "On the purchase control of the chain, it is very important to use the cloud, as we update data and it is available for every unit, just-in-time, and every colleague is able to understand the best price, the best supplier, and the best lead-time. With this, we are able to better manage our stocks."

On the field, managers are building Business Intelligence tools over the data warehouse for predictive models, but still, there is a lack of information to be added, as stated by one top decision-making manager of a chain of hotels. "We lack understanding of the value added and the corresponding value retrieved from the

investment in promotions through the "cost per click", on Google Ads or Facebook Ads, and its relation to the return that we have on it, in revenue, profit, or even bookings".

In existing theories proposed by several studies[6,56–58], understanding digital content management is crucial for capitalizing on opportunities in the hospitality industry. Integrating digital content management with hospitality operations becomes pivotal in creating a knowledgeable roadmap that guides the design of effective predictive models.

Bringing together all insights, there is a need to integrate theoretical background into the systems back-office and into the operations front-office, as mentioned by one of the hotel managers: "Information is worthless if you do not understand it. Systems are there to help you and guide you to the best strategy to implement, but you need to be educated and to educate your team to know how to work with it."

It is worth mentioning that, in terms of cloud and e-commerce implementations, it is not an easy procedure, as there is reluctance and inertia to the implementations. As stated by the Head of Strategy of a chain of hotels, "Even from top managers that at first impression feel like it is difficult to manage, only when they start retrieving information from the system from themselves, they understand the full potential."

The input from this Head of Strategy of a chain of hotels corroborated what was happening in another Portuguese chain of hotels, which gave the input that "the system updates are not many, the investment was moreover channel manager," so the hoteliers from several units and chains of hotels are not looking to the potential evolution of business intelligence. Even when directly pointed to revenue management, the answer was "Yes, we have one, but we are not retrieving the full potential from it because we lack time."

The General Managers that were participating in the answers gave a common input to the research, which relies on WWW. The world wide web opens opportunities for hotels, from new openings to hotels developing their market, either to approach new clients or to customize the experience of actual guests.

5. Conclusion

Considering the research question for this essay, according to the data retrieved from the hoteliers, the RM frameworks are fundamental to interacting with the online presence of a hospitality business in the sense that, dynamic pricing overbooking, and cancellation policies, are determinants that will impact the conversion of online bookings. In terms of cloud management, the interaction is seen as extremely relevant, as every department can access real-time real data for marketing purposes, sales, and other decision-making departments.

To achieve successful integration, theoretical knowledge should be incorporated into both the systems back-office and the operations front-office, connected by the cloud, using the hotels' needs according to their clients' needs.

This integration ensures that information is not rendered meaningless but instead serves as a valuable tool for formulating and implementing strategies. It is important to note that cloud and e-commerce implementations face challenges due to reluctance and inertia among hoteliers. However, feedback from the Head of Strategy of a hotel chain highlights that once managers begin extracting information from the systems, they recognize the system's full potential.

Answering the research question on how RM AI affects the sustainability of hospitality Supply Chain Management (SCM), using all the information gathered, it is possible to understand that revenue management artificial intelligence techniques and technologies are positively affecting the sustainability of the hospitality supply chain; however, the design of the AI needs to be considered for each hotel individually, as stated by

developers and managers in the field who understand the assignments for each part.

It is also essential, as described by the respondents, to have a well aligned strategy of RM to apply to the hotel.

As Revenue Management develops the maximization of the potential of each department, the artificial intelligence and data implied should be used nowadays to generate a data warehouse model for constant updates on the predictive models, which emphasizes the importance of Revenue Management in the aspect of forecasting[5,33,59,60].

From the research applied and the given results from the literature review, to answer the success factors, it is possible to understand that besides the emerging cloud management made internally by hotels, there is also the need to develop and implement the API solutions available to reach the final customer, where there are already some techniques being analyzed by hotels to surpass the dependence of OTA's to get reservations and return on the initial investment.

Also, there is the need to focus on just-in-time data rather than looking for historical data, as events are emerging and not a constant matter, so occasional events will influence historical data. Therefore, if just-in-time data is provided, there will be better quality forecasting and overall management.

Besides tracking data and having system connections and communications, there is the need to understand task management, resource allocation, and corresponding schedules. As the IoTs, communications are happening in continuous activity, a room rate update that is posted at this moment will be seen only within 6 to 7 hours later in other continents (e.g., Portugal updating prices for the USA), which can have a negative impact on the market approach, and potentially, a loss on reservation conversion.

6. Further studies

As further studies are concerned, it is still interesting to proceed with the research on the new processes and procedures of e-commerce and revenue management strategies being developed by cluster, contrasting rooms, F&B, and wellness, and how this is being connected to cloud management and the interface supply chain to reach the consumer.

7. Impact statement

This research brings new information regarding the applications of cloud management and revenue management to corresponding hospitality management and a disruptive new era of business intelligence management in hotels.

Conflict of interest

The author declares no conflict of interest.

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