RESEARCH PAPER

The adoption of artificial intelligence and robotics in the hotel industry: prospects and challenges

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Abstract

The growth of technology has resulted in the use of state-of-the-art systems such as artificial intelligence (AI) and robot-based applications and services in the hotel industry. Recently, there has been some discussion on the adoption of such technologies and their impact on hotels' operational costs as well as the quality of service to customers. Considering the importance of these new technologies, this paper investigates the trend related to the adoption of AI and robotics in the hotel industry. For this purpose, we interviewed senior hotel asset managers using an in-depth case study method. The context is Dubai-based hotels as Dubai is already established as one of the premier smart cities of the world (Khan et al., 2017). The TOE framework was used, and three domains were investigated: technology, organization, and environment to expose the underlying factors effecting AI adoption. The findings expose the factors that influence the adoption of AI and robotics in hotels. This study is one of early attempts to investigate the full spectrum of AI in relation to the hotel industry while detailing how its adoption could be effectuated.

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Introduction

Artificial intelligence has become popular in recent times as more firms have started to adopt AI and robotics to automate processes. AI-based solutions are considered to be smart enough to completely substitute human activities while improving the speed and accuracy of transactions. To successfully implement AI in business activities, firms need to overcome several obstacles (Davenport & Ronanki, 2018). For instance, AI is still too expensive or risky to adopt because the technology is new and managers generally lack expertise and understanding of how to implement it (Davenport & Ronanki, 2018). Furthermore, uncertainty exists regarding the various impacts AI could cause, which may lead to negative consequences. One of the most notable and commonly described impacts is the effect upon jobs; will AI and robotics replace people (Belanche et al., 2019)? Applying AI in the real world requires a good understanding of the technology, its characteristics and use to ease its adoption and implementation. AI technologies are those which move beyond the simple automation of tasks to being able to learn and make its own decisions (Tussyadiah, 2020). AI is, therefore, able to automatically handle large quantities of complex data, search for

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patterns, and make appropriate and timely decisions. Currently, while research on AI in tourism has been gaining traction, it is still insufficient, and requires further exploration (Tussyadiah, 2020).

AI and robotics have many advantages over human labor. According to a recent study, a minute of work by a robot is equivalent to 15 min of work by one human being (Norfleet, 2017). Some experts predict that about 25% of routine tasks will be performed by robots by 2030 (Marin, 2019). Depending on the complexity of technology, different levels of AI and robotics are employed from the simple routine level to the more advanced complex functions. According to a study conducted by MIT and BCG (Ransbotham et al., 2017), companies adopt AI to sustain a competitive advantage (84%), move into new businesses (75%) and/or markets (75%), or to reduce costs (63%), implying a more strategic role for AI. Apart from the strategic purposes of adopting AI, it is well documented that AI provides several advantages such as cost reduction, operational efficiency, and revenue increase (Ransbotham et al., 2017). However, 54% of companies did not adopt the technology at all, 23% adopted at the pilot level, 18% adopted AI at the basic level and only 5% adopted AI extensively (Ransbotham et al., 2017). The low adoption rate can be explained by several prevalent obstacles, such as lack of data consolidation, technological complexities, cyber-security risk, modelling difficulties, and process-based interactions between people and AI (Cheatham et al., 2019).

Buhalis (2020) predicted that in the near future, Ambient Intelligence (AmI) Tourism will be prevalent, driven by a range of disruptive technologies, including: AI, autonomous devices, Internet of things, diverse smart technologies, blockchain, sensor and beacon networks, etc. During the next 75 years, all tourism industries, including the hotel industry, will be transformed due to the impact of such technology (Buhalis, 2020). In fact, diverse information technologies have created an environment where new value-added services can be provided by service providers and tourists together, in a technology-enabled co-creation ecosystem (Buhalis et al., 2019). Owing to the innovative nature of these disruptive technologies, services in tourism and hospitality have new important features such as real-time, co-creation, data-driven, consumer-centric and experience enhancement (Buhalis and Sinarta, 2019). Several leading hotels have already implemented the latest technologies such as AI and robotics into their business activities, ranging from back office operations to direct customer interactions (Epiknetworks, 2018). As hotels become more aware of the benefits of such technology, there is a possibility that more hotels would adopt the technology. In this light, AI and robotics have already become key components to fulfill some major requirements of smart hotel as well as smart tourism.

Several leading hotels around the world have adopted various AI and robot-based technologies, as can be seen in Table 1. It is reported that AI enhances hotel operations in several ways (Francis, 2019; Haaser et al., 2018; Starfleet Research, 2018; Zhou, 2019): (i) it allows guests to have more innovative and memorable experiences by providing new tools such as robots or voice-activated assistants. These tools also save costs by reducing calls to the concierge desk; (ii) AI helps hotels to meet customer expectations since it provides guests with immediate and accurate responses. For instance, millennials who are familiar with the changes in technology are more receptive to utilizing technological advancements; (iii) AI provides personalized services to the targeted customers and then helps to predict their needs and wants; (iv) AI allows for an expansion of the guests' experience to include the entire journey because hotels can communicate with them interactively anytime and anywhere before and during their travel; (v) Lastly, AI significantly contributes to a reduction in hotels' operating costs by 15%, an increase in revenues by 10% (WTM, 2019), and an improvement in employees' satisfaction by relieving them from tedious, routine and repetitive tasks (Zhou, 2019).

Table 1 classifies diverse types of technologies into four popular types of technology, regardless of difficulties in their application and function (Redmore, 2018), and includes representative hotels that have adopted the relevant technologies. Except for the last type of analytics, the first three are used for direct interactions with customers. Chatbots or voice recognition systems are reported as the most common applications being used by hotels, possibly thanks to their prevalence in modern smart devices. In-room technology, controling temperature, lighting, and curtains is generally accepted by customers with minimal resistance (Hasser et al., 2018). Delivery robots and concierge robots (Murphy, Hofacker, and Gretzel, 2017) are another popular technology that can be easily implemented with minimal resistance to reduce costs as well as to enhance customer experiences (MAZARS, 2018; Starfleet Research, 2018). However, the full impact of AI and robots on existing employees remains unclear (Belanche et al., 2019; Ivanov et al., 2020; Tuomi et al., 2020).

Many applications under the analytics category are used for back-of-house operations that underlie the interactions with customers. It is already well understood that these applications directly contribute to not only increase revenues because AI helps to provide customized and individualized services to customers, but also reduce costs significantly since AI provides optimized solutions. Moreover, owing to such features that many analytic applications are not connected to direct customer interactions, it is expected that hotels can adopt this type of application easily once technical barriers and obstacles are overcome.

In sum, even though several leading hotels have adopted AI and robotics, the total number of hotels adopting them is

Table 1 AI and robot technologies commonly adopted in the hotel industry

Type	Examples	Hotels
Chabot-based voice recognition systems	Control for room temperature and lighting, ordering meals or drinks, scheduling and managing reservation, diverse concierge services	Caesars Entertainment (Caesars, 2018) Hilton Worldwide (Hilton, 2016) Marriott International (Alexsoft, 2018) Clarion Hotel in Stockholm (Makadia, 2018)
Facial recognition systems	Guest check-in and room check-in	FlyZoo Future Hotel (Biron 2019)
Delivery robots	Food, amenities, and luggage delivery	Aloft hotel (Tung and Law, 2017)
Analytics	Customer profiling for customized individual services, occupancy optimization, optimization of energy and water consumption, revenue management, monitoring and automation for the maintenance of operational activities	AccorHotel (OTA Insight, 2019) InterContinental Hotel Group (Escobar, 2019) Starwood Hotel (Boulton, 2016)

still limited, as reflected in Table 1. Currently, most hotels have no clear plans to consider any AI technologies, given the early stages of AI adoption and the lack of demand from customers (Fomby, 2019). Moreover, some hotels are reported to have difficulties in providing seamless services when AI applications are applied to facilitate customer interactions (Fomby, 2019). Given the range of services and quality levels offered by hotels, the role of these disruptive technologies in hotels is unclear. For example, in a broader context, how hotels, their staff, and their guests would accept the implementation of AI in a luxury setting may not be congruent or supportive of one another. A similar level of disagreement seems to exist when considering issues related to sustainability in hotels; concerns have been raised if guests would accept obvious sustainability initiatives being implemented in luxury hotels, the impact on prices, and perception of quality. These concerns, therefore, require extensive research and consideration for enhancing ease of AI adoption and facilitating the concept of smart hotel, smart tourism, and ambient intelligence tourism.

This research delves into the latest trends of adopting AI and robotics to arrive at key findings and implications for the successful implementation of such technologies in the hotel industry. Since AI and robotics are relatively new technologies, this study explores the important determinants of adopting new technologies from a managerial perspective encompassing the hotel's point of view. Most existing studies explored the individual level; whether customers are interested in adopting new technologies or not. However, the decision maker who adopts new technologies is not the individual customer who uses them, but the hotel who allows its customers to use them after adoption. For this purpose, this study employs the technology-organization-environment (TOE) framework to carry out the analysis as this framework explains the various factors affecting the adoption of new technologies at the enterprise level.

In order to achieve the exploratory research objective of this study, eight factors are initially chosen based on the TOE literature. Under the technology category, *relative advantages, complexity, and IT expertise* were chosen as

relevant factors. Under the organization category, *financial justification*, and *resistance by employee* were chosen. Finally, *customer, competition* and *legal issue* were relevant under the environment category. As the next step, eight senior hotel asset managers were interviewed, who make key decisions regarding AI and robotics in their hotels, on behalf of the owners. Besides the aforementioned eight factors, further factors were explored during the interview to explore additional issues for the adoption of the technology. For instance, *Market position* was additionally found to be an important factor alluded to by the executives during the interview process. This study reports findings with respect to the nine factors in detail and provides a typology of AI and robotics in the hotel industry. As a future study, it is proposed that factors affecting AI and robotics should be investigated depending on the types of applications because of the diversity of technologies as explained by the typology.

AI and robotics are still new in the hotel industry (Fomby, 2019). Depending on the type of industries and the maturity of technology, adoption of new disruptive technologies is generally influenced by different factors. As a result, the contribution of this study is in determining important decision factors affecting the adoption of AI and robotics. Hence, it is hoped that it will provide foundations for more advanced empirical studies.

In the next section, this study reviews the relevant literatures on adoption of AI and robotics in tourism and hospitality. Several technology adoption theories are briefly reviewed, and the TOE framework is introduced. Next, the research setting and methodology is described to explain how the case study was conducted. Following this, the analysis section shows how the factors pertaining to the TOE framework relate to this study. Finally, the implications are discussed followed by conclusions.

Theoretical background

In tourism and hospitality, previous studies of AI and robotics can be grouped into three categories. The first group primarily

focuses on the topic of robotics; the second group studies human resource issues such as employee turnover, resistance, or acceptance; the third group focuses on the development of conceptual frameworks or perspectives about the impact of technologies on tourism and hospitality, and discusses the various research issues related to the AI adoption and implementation.

As for the first group on robotics, there are early studies that explore customer experiences and the importance of robots in hospitality (Tung and Au, 2017; Tung and Law, 2017). Bowen and Morosan (2018) claimed, in their overview of AI and robot hospitality and tourism applications, that service delivery systems need to be redesigned to maximize the benefits from these technologies. Webster and Ivanov (2019) described the important role of robots in the future and claimed that the 'robonomic' economy would have profound impacts on the nature of work, income, leisure time, trade, social, economic, and political aspects. Go et al. (2019) described the typology of diverse robots in the hospitality industry and proposed a structural equation model to explain the adoption of those robots using the Technology Acceptance Model (TAM). Technology and individual factors were included to explain the interactive nature of technology, however, whiles everal diverse research issues were proposed, the final model was not validated. Murphy et al. (2019) considered the role of humanoid robots in developing effective robotic services in hospitality and tourism. By exploring anthropomorphic characteristics of robots, Murphy et al. (2019) proposed 11 robot capabilities and consequently a future research agenda was raised and discussed. Zlatanov and Popesku (2019) discussed diverse types of robots such as customer service travel bots, Facebook chatbots, AI empowered travel bots and discussed their importance in the tourism and hospitality context. Imad (2019) on the other hand, proposed similar AI-based solutions, such as a 'digital operations manager', which will be useful in the hospitality industry to enhance users' choices and experiences, as well as efficiency in resource and revenue management. Drexler and Lapre (2019) discussed the pros and cons of technological advancements in the hospitality industry and raised the diverse management and labour-related issues that need to be considered in the future, especially in instances of greater guest involvement in the service delivery process. Belanche et al. (2019) developed a theoretical framework for the successful implementation of robots, which is composed of robot design, customer features, and service encounter characteristic. Their study highlighted several important factors and presented a future research agenda. In contrast, Yu and Boyol Ngan (2019) investigated perceptual body language differences, notably smiling and head movements, between human-like robot and human staff. They found differences in terms of interpersonal warmth between male and female employees with different cultural backgrounds. Their experimental

study signified the role of robots since several hotels have already adopted the technology in their front desk for direct interactions with customers. Gursoy et al. (2019) proposed and tested a three-staged model of accepting AI-based delivery devices using survey data collected from an online consumer panel. Hwang et al. (2019) developed a conceptual model to explain how four different types of consumer innovativeness affect the intention of using drone food delivery services. A structural equation model was developed and tested using 320 participants and found that customer's innovativeness motivated by functionality, hedonism, and social motivation positively affected the attitude towards the technology. However, behavioural intentions were affected only by functionally motivated consumer innovativeness. This suggested that while the technology's functionality, entertainment, and social image of the customer could improve the attitude towards the said technology, it was the functionality which finally determined the adoption. This is an important note for businesses as they seek to include more technology in guest contact areas (Drexler & Lapre, 2019). de Kervenoael et al. (2020) studied the determinants that affect visitors' intentions to use social robots and empirically tested the model using a survey of 443 consumers in Singapore. Conducting interviews with persons who operate or use service robots in Japan and the US, Tuomi et al. (2019) studied the impact of service robots in the hospitality industry based on the five types of role: support, substitute, differentiate, improve, and upskill. Various issues such as people management and social responsibility were discussed for hospitality executives to highlight the importance of balance between operational efficiency and customer expectations. Aligned with this study, Tuomi et al. (2020) compared the role of robots between the US and Japan and found that there are differences due to cultural reasons. Ho et al. (2020) investigated the interactions among human staff, service robot, and fellow customers when service failures happen. They found that customers would prefer assistance from employees or fellow customers over a service robot, suggesting a certain degree of customer resistance to AI and robotics.

As for the second group of studies on human resource issues, Neuhofer et al. (2015) presented the process model of creating personalized experiences between employees and tourists. As requirements of personalized experience, information aggregation, ubiquitous connectedness, and real time synchronization were listed as components of the smart mobile technology platform. Using a case study, Leung (2019) completed one of the earliest studies of AI in hospitality by conducting nine interviews to uncover the barriers to operating smart hotels in Taiwan. It should be noted that the issue of employee resistance to AI and robotics was raised as a significant potential barrier. Huang and Rust (2018) developed a theory of AI job replacement which shows five development stages. In this model they showed certain types of job

are more exposed to AI replacement than others and added the additional consideration of the nature of AI's involvement in service businesses being dependant on the job role rather than the job level. Li et al. (2019) found that the adoption of AI could create a more competitive working environment, possibly increasing turnover intentions. The focus on employee *intentions* and AI *awareness* are, however, a notable limitation due to the fact that technology adoption in China is still in the infancy stage, potentially limiting future generalizability of the findings. Yang et al. (2020) discussed the current status of using AI and robotics in the hospitality industry and raised concerns regarding the various impacts on labor, employment, customers, companies, and communities including risk factors. As a survey-based empirical study, Prentice et al. (2020) investigated the moderating impact of AI on employee retention, internal service performance, and external service performance and found that AI plays a significant moderating role in employee performance. Ivanov's (2020) conceptual paper suggested that AI's role in replacing or enhancing job roles is likely to be balanced. However, whether the human incumbent of replaced jobs can work in enhanced roles is uncertain.

As for the third group of studies, Ivanov and Webster (2019) edited a book that includes 13 articles discussing theoretical and application issues of robots and AI. This was the first book that comprehensively covers the latest trend, research topics, and practical issues. There are early papers that note the importance and the role of robots in hospitality and tourism. Murphy et al. (2017) classified the robot into four types and discussed four research areas such as customer acceptance, impact on workforce, robot design, etc. Ivanov et al. (2020) analyzed previous research publications on robotics in travel, tourism and hospitality. They presented several research domains and discussed the role and implication of each domain. Huang and Rust (2020) developed a strategic framework for using AI and illustrated various AI applications to enhance the benefits of using them. Among this group of studies, AI and robotics need to be studied as a major component of smart tourism (Gretzel et al., 2015; Koo et al., 2017) and ambient intelligence tourism (Bhualis, 2020, Buahlis and Sinarta, 2019). Smart ecosystems, disruptive technologies, and co-creation of services are major concepts where AI and robotics are understood to facilitate this trend. Among recent studies, Buhalis and Leung (2018) explained the role of AI while proposing the architecture of smart hospitality ecosystem which consists of three layers: network, cloud and data, and AI. AI performs various intelligence related analyses combining internal and external data stored in the cloud and data layer. In line with the smart hospitality, Jayawardena (2019) studied the key innovative strategies related to the future of tourism using 13 papers from 17 countries and found that new technologies, including AI, will be the key component among innovative strategies. Nevertheless, empirical studies in this group are scant.

Tussyadiah (2020) recently discussed diverse research issues of AI and robotics in tourism from a research perspective. Using the list of automation applications in tourism experiences, four research agendas were proposed: designing beneficial artificial intelligence, facilitating adoption, assessing the impacts of intelligent automation in tourism, and creating a sustainable future. As diverse issues are pointed out by Tussyadiah (2020), three implications are found through previous studies. First, academic studies regarding the adoption in the hotel industry are relatively scant due to the recency of the topic. Second, except for several recent studies regarding robots, most studies are conceptual and descriptive in nature. Therefore, empirical studies need to be conducted in the future to enhance and confirm the existing findings. And, third and more importantly research on AI and robotics needs to be conducted as a part of the tourism ecosystem.

Analytical strategy

To understand the key factors influencing the adoption of AI in the hotel industry it is important to delve into the technology adoption models that theoretically explain the adoption of new technology. A review of these models provides a basis to use an analytical strategy that helps better understand the factors influencing the AI adoption process. This section provides a synopsis of the various technology adoption models and focuses primarily on the Technology-Organization-Environment (TOE) framework as the basis to explain the adoption of AI in the hotel industry.

According to Oliveira et al. (2014), three factors influence the adoption of innovation, which are: "individual (leadership attitude towards change), internal organizational structure (centralization, complexity, interconnectedness, the number of employees, and organizational slack) and external characteristics (system openness) of the organization" (p. 499). In line with this argument, it is argued that user acceptance theories, such as Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM), and Diffusion of Innovations Theory (DOI), are not appropriate to study the determinants affecting the adoption at the enterprise level. In this sense, the TOE framework is discussed below as an analytical framework because of its enterprise-level focus, and ability to offer interorganizational practical and theoretical insight (Baker, 2012).

Technology-organization-environment (TOE) framework

Introduced by Tornatzky and Fleischer (1990), TOE relates to the process of innovation from an organizational perspective. The framework has received much scrutiny and has been used

to study contextual factors influencing e-business assimilation and innovations (Abu Khadra and Ziadat, 2012).

There are three factors that influence a firm's ability to assimilate a given technological innovation. They include technological, organizational and environment factors. According to Baker (2012), technological factors include all factors, both internal and external, that are relevant to the firm. Such technologies encompass not only those that are currently in use but also those that are available in the market at large. Van de Weerd et al. (2016; p. 917) review the TOE framework and include compatibility, relative advantage, trialability, complexity, uncertainty, perceived benefits, observability, technology readiness, cost savings, accessibility and data security as examples.

The organizational factor includes "the organizational characteristics and resources such as scope, size, degree of centralization, degree of formalization, managerial structure, human resources, amount of slack resources, and linkages among employees" (Abu Khadra and Ziadat, 2012; p. 165). The adoption of innovation is dependent on factors such as organizational structure, size, intra-firm communication processes and the availability of slack resources (Baker, 2012). Organizational factors include top management support, organizational readiness, organizational size, innovativeness, technology-sensing capability, and knowledge resistance to new technologies (van de Weerd et al., 2016).

The environmental construct relates to external factors which influence the firm's ongoing business, and includes the industry, competitors, macroeconomic, regulatory contexts (Abu Khadra and Ziadat, 2012; p. 165), and the role of service providers (Baker, 2012). Typical factors are competitive pressure, industry, supplier computing support, trading partner pressure, competition intensity, market scope, government support, service-level agreement, supplier competences, among other extraneous factors such as advice of friends and families, advice of business network, advice of IT specialists and consultants and choice of skilled vendors (van de Weerd et al., 2016).

The TOE model has been utilized in several studies: for the study of internet adoption (Teo, Tan, & Buk, 1998), for the adoption of cloud computing in manufacturing and service sectors (Oliveira et al., 2014), for the factors affecting the service-oriented architecture (MacLennan and Van Belle, 2014), for the adoption of RFID (Lee and Shim, 2007), and for the adoption of software as a service in Indonesia (van de Weerd, 2016). In these studies, the three TOE factors have consistently helped firms more efficiently adopt new technologies.

This study adopts the TOE model as an analytical framework because (i) TOE is more effective to study the phenomenon of technology adoption within the context of a firm; (ii) TOE has been employed across different technologies, industries, and nations with reasonable explanatory power; and (iii)

this framework allows for the integration of new factors without conflict (Baker, 2012). In the case of the hotel industry, the decision to adopt AI and robots is made at the enterprise level and there are several factors from different domains affecting the adoption decision. For this reason, while applying the TOE framework to this study, a two-step analysis was employed. As the first step, eight important factors were investigated during the interviews. The interviewees were also asked to identify additional factors besides those eight items. Finally, all the factors were integrated into the TOE framework to arrive at the findings of this study.

Factors from the TOE framework

Even though there are many factors under each TOE category, this study chose eight factors from prior TOE studies since they are frequently mentioned and emphasized in the literature (Baker, 2012; MAZARS, 2018): *Relative advantage*, *complexity*, and *IT expertise* are considered under technology; *financial justification* and *resistance by employee* are under organization; and *customer*, *competition* and *legal issue* are chosen under environment.

Technology

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 1995). Accordingly, innovations that are perceived to be operationally and strategically value-adding in that the "benefits of the technology exceed existing practices and processes, the merits will positively influence its adoption" (Oliviera et al., 2014; p. 501). AI and robotics are perceived to provide several useful benefits ranging from strategic motivation to operational advantages (Tussyadiah, 2020; Ransbotham et al., 2017). For this reason, this study investigates these diverse benefits to explore how they impact the adoption of new technologies.

Complexity is the degree to which an innovation is perceived to be difficult to understand and implement (Rogers, 1995). Therefore, there is a greater chance of adoption if the AI technology is less complex or easy to integrate with current architectures. This factor is frequently mentioned as one of the major obstacles in AI literature (Davenport and Ronanki, 2018) and considered as one of the important determinants in previous TOE studies (Oliviera et al., 2014). Outdated legacy systems and fragmented information systems are also noted as part of obstacles (Bowen and Morosan, 2018).

IT expertise is the level of knowledge and skills available as a resource base for implementation of the technology. There are two types of competency which needs to be in place for the effective implementation of the technology (Davenport and Ronanki, 2018; Oliviera et al., 2014; van de Weerd et al., 2016); internal IT expertise and external IT expertise. This

factor is often considered as one of the critical success factors in the new technology adoption and innovation literature (Jukic, Jukic, and Velasco, 2009).

Organization

Financial justification is the added value that the decision to invest in the technology will bring about. It is the prospective rate of return that the investment is projected to have and, benefits of investing need to exceed the cost for successful implementation to take place. When the adoption is studied at the individual level, this factor is often disregarded because it does not incur significant extra costs to individuals. At the enterprise-level study this technology usually requires an additional investment and, hence, this factor is analysed (van de Weerd et al., 2016).

Resistance of employees is the employees' inertia to accept change that the new technology would bring about. In general, employees prefer the status quo with a resistance to accept a shift from it when new technology is implemented, which requires consideration during implementation. Therefore, resistance of employees has been included as an important factor for new technology adoption in the literature including AI (Ransbotham et al., 2017; van de Weerd et al., 2016).

Environment

Customer implies that customers have a different level of skills and expectations depending on age, education, income, and culture when they experience certain services (Hasser et al., 2018). With distinct technological features embedded into services, hotels may provide a differentiated set of services to distinct groups of customers with distinct levels of expectations (Haaser et al., 2018). Hotels need to be more cognizant of divergent types of consumer behaviors and expectations which may be based on age and nationality (Haaser et al., 2018). For instance, millennials as digital natives are more open to use new technologies as compared to other generations. Chinese travellers easily accept new technologies while German travellers are least in accepting them (Singer, 2016). This study includes the customer as one of the important aspects of an external environment that impacts the adoption of technology in the hotel industry.

Competition would influence the rate of technology adoption because a new technology sometimes has the potential to vary the degree of competitiveness among firms in the market. If a firm has gained a competitive position by implementing a new technology, the competitors would need to consider the adoption of similar technology to remain competitive (Oliviera et al., 2014). Since this factor is often included in previous TOE research (Baker, 2012; Teo et al., 1997/1998), this study employed it as part of a conceptual model to investigate the impact on adoption.

Finally, the adoption of technology would require the firm to consider *legal issues* that would have an impact on the implementation process. Abiding by the legal requirements is a prerequisite that the firm should consider in the implementation of the new technology (Oliviera et al., 2014). Typical examples of legal issues are privacy, security, and government regulations (Baker, 2012). For instance, hotels should be cautious using personal data while complying with data privacy laws and ethical issues, especially internationally.

Research methodology

In this exploratory study, qualitative research methods were utilized to gain insights and deeper understanding into the adoption of AI and robotics in hotels. In particular, a case study approach was adopted to move beyond structured questions such as "what", "how often" or "how many" to probing questions related to "what was done", "why" and "how" (Miles and Huberman, 1984; Myers, 2013; Gummerson, 2008). As such, eight case studies were conducted and analyzed. Eisenhardt (1989) suggested that studies of four to ten cases are optimal. With more than ten cases, the volume of data could become quite challenging to cope with, whereas with less than four cases, it might be difficult to generate theories.

Eight interviews were conducted with hotel asset managers who represented a variety of hotel operators and exhibited a diverse set of experience. Saturation was achieved at the eighth interview in terms of the consistency of opinions and the quality of contents. In effect, towards the end of the seventh interview, the answers and insights from interviewees became repetitive. One additional interview was conducted to confirm saturation. Once confirmed, a decision was made not to seek more informants. Since one asset manager manages several hotels, the number of hotels included in this study exceeds 40 units and over 7000 rooms (16% of the total number of five-star hotel rooms in Dubai (DTCM, 2020a), which reflects that this study comprehensively represents most major hotels in Dubai. In terms of the number of interviewees and hotels, this study achieved the requirement for obtaining validated results. Table 2 shows the role of interviewees who participated in this study and the number of hotels they manage. However, information on exact number of hotels is concealed here given the participants' request for anonymity.

Research setting

This paper focuses on the trends of using AI in hotels located in Dubai, which is the leading tourism destination in the region. In 2019, Mastercard's Global Destination Cities Index rated Dubai the fourth most visited city in the world for the fifth year in a row (Hamel, 2019). The latest figures released

Table 2 Profiles of interview participants

No.	Role	Number of hotels	Hotel size	Location	Star-level	Market	Ranking[a]
1	Asset manager	Less than 5	500+ in total	Beach-side	5	Leisure	Top 50–100
2	Asset manager	More than 10	300+ for each hotel	Beach-side	5	Leisure	Top 20–250
3	Asset manager	Less than 5	350+ for each hotel	City	5	Business	Top 50–100
4	Asset manager	Less than 10	150+ for each hotel	City	5	Business & Leisure	Top 10–120
5	Asset manager	Less than 5	200+ for each hotel	City & Beach	5	Business & Leisure	Top 150–200
6	Consultant & Asset manager	Less than 10	200+ for each hotel	City & Beach	5	Business & Leisure	N/A
7	Asset manager	Less than 5	200+ for each hotel	City	5	Business	Top 120
8	Asset manager	More than 10	70–500 + for each hotel	City & Beach	5	Business & Leisure	Top 10–400

[a] Ranking is found from TripAdvisor. TripAdvisor shows the ranking out of 689 hotels in Dubai area

by Dubai's Department of Tourism and Commerce Marketing (DTCM) report that over 16.73 million international guests visited the city in 2019, resulting in approximately 35.5 million occupied room nights and a Revenue per Available Room slightly above 80 USD (DTCM, 2020b; DTCM, 2018). In recent years, Dubai's government has launched a Smart Dubai program, which is an initiative under the emirate's Smart City program to maintain its current position as a hub for business and tourism while integrating IT, AI, and smart solutions into the city's infrastructure and processes (Khan, et al., 2017; Smart Dubai, 2020). This falls under the city's broad push to generate positive experiences for all key stakeholders through technological advancements. The overarching vision is to become the world leader in AI by 2031, which includes the creation of a National Program for Artificial Intelligence to drive technological and procedural changes within all industries (Ministry of AI, 2020). The corresponding shift towards AI and smart services is already visible within Dubai's tourism and hospitality sectors. Marriott, for example, has introduced Marriott Bonvoy, an application that enables guests to check-in without the need for keys or cards (Sanu, 2019). Similarly, Atlantis has introduced Blockchain for payment management, while Emaar has partnered with Winnow to reduce food waste through AI across its kitchens in Dubai (Sanu, 2019). Thus, the advancing technological landscape of Dubai's AI and hospitality sectors provides a rich context for this exploratory investigation.

Before starting the selection of interviewees, three criteria were used to decide whom to interview: (i) a person who is in charge of the investment decision of implementing new AI or robotics, (ii) a person who knows and understands the important issues and trends of AI and robotics in the hotel industry, and (iii) a person who is willing to respond to semi-structured and open-ended interview questions. As for the first criterion, a decision was made to contact hotel asset managers because (i) the decision to adopt AI in Dubai-based hotels is not only a complex one but also highly confidential, and (ii) this decision is made by a few asset managers who are typically unknown

to the public and who clearly prefer not to be identified by name or by organization. In the case of the hotel industry, significant capital expenditure decisions, including the adoption of AI, falls under the responsibility of the Asset Manager, who plays a key intermediary role between the hotel facility owner and the hotel operator. Hotel owners are increasingly relying on the help of asset management firms, as they enter risky and complex agreements with hotel operators (Feldman, 1995). Therefore, the level of analysis is the Asset Manager, representing a single and distinct asset management organization who are in charge of multiple hotels for several operators. On an average all asset managers have more than 10 years of experience in the hotel industry.

For the second and third criteria, a purposive sampling approach was adopted to select information-rich cases from which insights could be gained and an in-depth understanding of the issues of central importance to the purpose of -this study was established (Patton, 2002). Moreover, informants were deliberately chosen based on the qualities they possess. These key informants are observant and reflective members of the community of interest (i.e., asset management community) who know a lot about the issue under study (i.e., AI adoption in hotels) and who are willing to share their knowledge and expertise (Bernard, 2002). This non-random selection process is not based on a specific theory or a set number of key informants. Given this stringent research constraint, a snowball sampling strategy was used to overcome the accessibility constraint. Hence, the process was started off by identifying respondents who can later be used to connect with other potential respondents (Vogt, 1999) who satisfy the three required criteria. The first key informant was identified through personal connection of one of the authors. Subsequently, using a snowballing approach, this asset manager provided a reference to other qualified interviewees in a series until the saturation point of eight interviews was reached.

A series of in-depth, face-to-face one-hour discussions revolved around the main components of the TOE framework, namely technology, organizational and environmental factors

affecting hotel's adoption of AI and robotics technologies. The discussion guide was pretested and validated with experts in the fields of hospitality and information technology. A case protocol was developed for face-to-face interviews to ensure consistency. Data collection occurred between the months of May 2019 and May 2020. Interviews were conducted in pairs, which allowed one researcher to conduct the interview and another to take notes and/or record the interview. All participants were promised anonymity and confidentiality of their responses. Each interview, except one, was tape recorded for transcription and analysis, using the platform Otter.ai and supported by interviewer notes. Otter.ai is an AI tool, which partially transcribed the interviews, meaning the researchers only need to check and edit the transcription, thereby accelerating the process. In the one instance where the tape recorder was not used, at the request of the interviewee, copious notes were taken and sent back to the interviewee for them to confirm the accuracy of the notes. All the interview questions were open-ended and exploratory in nature. It should also be noted that the questions were kept deliberately broad to allow the interviewees as much freedom and flexibility in their answers as possible. At the same time, additional materials were requested if available and their hotel websites were visited to understand the current status, operations, etc. All follow up communications through emails were saved for further analysis.

Data analysis

The qualitative software QDA Miner was used to assist with coding the interview transcripts and identify patterns in the interview data (Miles and Huberman, 1984). Data analysis obtained from interview, websites, additional materials, and email was carried-out in the following steps. First, write-ups of each case (within-case analysis) was performed, followed by cross-case analysis where patterns across the different cases were explored. For each individual case, a full transcript of the interview discussion was prepared and checked against the transcriptions. A high-quality interview transcript was defined as a complete and accurate reflection of the verbal and written communication between the interviewer and the interviewees (Maxwell, 1992). The transcripts were read and manually summarized question-by-question. For each discussion topic, the transcripts were carefully studied and detailed notes were made from the interviewees' points of view. The notes were, subsequently, condensed into brief summaries of each interview allowing us to cluster them accordingly. Once the analysis on the individual case was completed, the cross-case analysis was considered by looking at the similarities and differences among the cases. This process resulted in important insights regarding each factor. While comparing them to the literature (Eisenhardt, 1989).

Findings A total of eight interviews were conducted with hotel asset managers based in Dubai, because of their role as decision makers for the properties. As described in the methodology section, transcriptions were read multiple times to look for existing and emerging themes. Overall, participants felt that AI would be, if it was not already, an effective tool to improve hotel operations. Saturation was reached quickly, with participants quickly describing similar elements which influenced their decision-making process when contemplating the adoption of AI in their property.

Understanding of AI among participants

Before asking about TOE factors, the participants were asked about their understanding of AI and robots and asked for current or planned examples. Table 3 shows the diverse examples of AI and robotics that are either being implemented or will be implemented soon. The mix and interchangeable use of AI and robotic and non-AI and robotic technologies is notable. Participants mentioned voice-activated systems, diverse analytics, and delivery robots as examples as reported in trade journals, but the number of cases were still limited.

> *… the initial step of AI is to automate things which was repeatedly done using rules and fixed algorithms and then later cognitive capabilities are added to understand the patterns and to make decisions based on the patterns.* (Participant 5)
> *AI is something that is a source, which is a learning source, and which adapts based on what it has learned and evolves from there without any human intervention.* (Participant 2)

However, some of them referred to AI as an automated system with examples such as purchasing applications or voice-guided service desk solutions, such as the non-AI applications provided in Table 3. In terms of diversity of AI and robotics, it was difficult to find more advanced features such as deep-learning or more complicated AI-based robot applications. These examples are shown in Table 1 as non-AI cases since some participants regarded that they have the same impacts on hotels as AI and robots. Even though the level of understanding was different across the eight interviewees, they clearly understand the role and purpose of adopting AI and robotics. It is interpreted that hotels understand that AI should increase the productivity in terms of reducing labor costs and stabilizing operations for repetitive tasks.

> *I want to say that it is helpful for those owners, whose turnover is significant. And they are looking for those departments, I wouldn't include everyone, those*

Table 3 Examples of using AI and robotics including other smart technologies

Technology	Type	Explanation	Reason
Non-AI	Automation of purchase order process	Routine and repetitive purchase order activities that made many errors and delays have been replaced by a software to automate the process	Cost reduction Reduced errors Reduced cycle time
Non-AI	Voice-guided service desk	Small number of operators are able to take care of more external calls for booking while automated systems handle 80–90% internal calls such as complaints, service request, etc.	Revenue increase Better customer response
Non-AI	Message box	350 employees share and exchange information using their own languages and the message box automatically translates it	Efficient communication
Non-AI	Virtual concierge	Multi-language web-based touch screen concierge	Cost reduction Enhanced customer experience
Non-AI	Chemical management dashboard	It shows the current status of using diverse types of chemical usage and helps to control them efficiently	Cost reduction
AI	Blockchain-based virtual wallet	It allows to distribute costs of package deals into corresponding accounts while customers use several services such as food and beverage	Increased productivity Reduced errors
AI	Voice recognition for room control	It controls lights, curtains, TV, temperature, etc.	Enhanced customer experience
AI	Room service robot	Robots deliver room service items upon request	Cost reduction Enhanced customer experience
AI	AI-based electricity back-up system	Electric battery pack replaces the emergency backup generator and AI charges and releases the electricity based on usage rates and demands. This AI system also automatically controls the pool heater depending on the occupancy rate	Cost reduction
AI	Customer profiling	Using rule-based engine, customer data are collected from diverse channels such as restaurant, golf club, spa, etc., to create a unified customer profile	Revenue increase Better customer service
AI	Menu creation and validation	It automatically calculates the cost of changing menu and streamlines the routine validation process	Cost savings Increased productivity
AI	Passport validation	It automates the entry and validation of passport information including automatic translations	Increased productivity
AI	Room allocation	AI optimizes the room utilization rate to maximize profits	Revenue increase
AI	Motion detection	A sensor detects whether the guest is in the room or not and then the room temperature is automatically adjusted	Cost reduction

departments which they would love to go ahead as automated. (Participant 1)

Technology

Under the technology category, three factors arose, which were relative advantage, complexity of AI, and IT expertise.

Technology: Relative advantage

Participants generally divided the advantages of AI into three aspects: cost reduction, revenue generation, and customer experience. From a cost perspective, AI was seen as a tool which could improve the efficiency of operations, resulting in a cost saving. Good examples among participants were AI-based electricity back-up systems, chemical management systems, and motion detection systems which reduce electricity usage automatically. These examples were also provided from a sustainability perspective, that is, how they could use AI to improve their energy efficiency or water usage etc. resulting in

lower costs. Interestingly, while the sustainability benefit was commented on, the greatest value was seen in terms of cost savings.

> *Where artificial intelligence can play a major role is in being energy efficient. This is going to be more and more even in luxury.* [Customers] *like to know when they go into place, they are environmentally friendly…. AI can also help you to balance the room temperature so that you don't waste energy; it can help you to also manage the lights* (Participant 3)
> *For owners, I think it can save significant money, eliminate human error and maybe provide superior service…* (Participant 8)

From a revenue side, participants felt that analytic AIs offered opportunities to hotels to market other aspects of their business or reorganize business to maximize revenue.

> *…I could take two days booking this room, because there is a demand for the deluxe room….AI helps us in upselling and cross selling.* (Participant 5).

Participant 5 offered the additional food and beverage example of how analytic AIs could increase revenue by upselling.

> *…if he orders a sandwich, this is the drink that goes with it. If he stayed with his friends, but this time he is on a business trip, he will not be doing that. So, to get to that level of detail, I definitely need an AI engine to do that.* (Participant 5)

The third common advantage of AI cited by participants was related to customer experience. Participants felt that the incorporation of AI could allow the hotel to offer a more unique and customized experience to the customer. If a solution was able to provide this, it was perceived as a suitable ROI and an effective method to promote satisfied and loyal customers. This advantage clearly points out that AI forms a basis for hotels to be smart as a part of the smart tourism ecology.

> *So now assume when he wakes up in the morning, the TV, the first thing that he turns on the TV, AI helps the TV starting with his favorite channel… We rolled out something called NBA (next best action). The engine found the recommendation that should be provided to the customer as the next action. It could tell me about the particular persona. I would have an opportunity to recommend a golf event… a good Chinese dinner… rather than blindly recommending something. We could make an emotional connection with customers* (Participant 5).

As a final perspective, some participants felt that the presence of AI could itself be an advantage.

> *Artificial intelligence also became a sort of a, you know, PR tool or a marketing tool to position, even standalone hotels or small brands* (Participant 3)

Technology: Complexity

One of the biggest issues participants addressed was the integration of AI with existing technologies, for both hotels and customers. The participants explained that hotels operated several often non-related systems for years. Furthermore, these systems could be relatively dated, resulting in integration issues with newer technology that include both single and collective systems.

> *…the challenges were in hospitality that typically hotel systems are very fragmented. So your guest data comes from PMS* [Property Management System] *solutions, where your restaurant customers comes into your restaurant reservation systems and POS* [Point of Sales] *systems where your spa customers comes into another set of systems…so a customer easily can have about four or five different profiles…major problem is that systems are disconnected.* (Participant 5)
> *You can't have data mining…where 10 devices that don't talk to each other…it will be impossible to mine it.* (Participant 7)

At the same time, participants explained that if guests' personal technology for example cell phones were not up-to-date, there was a risk that they would not be able to interact with or utilize some of the technology the hotel implemented – particularly in the case of technology designed to improve the in-room experience.

> *Issues could exist if the guests' device is not upgraded – their technology does not talk to the hotel systems* (Participant 4 – recorded from interview notes)

In general, participants were not concerned about the complexity of the AI technology itself, but more about how the technology would interact and correspond with the existing technology in the hotel.

Technology: IT expertise

For this issue, questions regarding the capability and role of IT department were posed. Participant's believed that the ability of the IT department to recommend and implement AI-based solutions into hotels was hampered by a currently busy

schedule with old, often outdated, existing technology, and a lack of interaction with guests. In the first instance, the IT department is tied up with fixing and maintaining systems that they do not have the time nor willingness to search for or implement AI technology.

> *They, IT people, don't have the capability to implement new technology because normally they are so busy. They're not much even bothered to propose what would be better for the hotel. …They don't want to be bothered to replace or to implement…* (Participant 1)
> *It is hard for IT department to work with their vision. I don't blame them. If you give them an obsolete system or the obsolete system exists in the property, all they have to do is maintain, maintain, and maintain, because there is so much breakdown in it. You cannot ask them to 'look at some efficiency or look at some new things'. No, you have to respect that…* (Participant 2)

The final issue facing IT was the lack of interaction with guests. Given that most of IT's role, according to participants, was as a support function, it was felt that they were not always aware of the guests' actual needs and, therefore, were not able to recommend the most appropriate solutions. Instead of using internal IT experts, hotels find the solutions by outsourcing to a reliable vendor. That is, finding and managing outsourcing vendor is still important for AI and robotics.

> *I expect them [IT department] to be familiar with AI… But I'm not sure how much they interact with the guests. I'm not sure how much they understand about the guest needs.* (Participant 3)
> *In the market, there are competent and software vendors. But I would say, who to trust is a big issue. Here I believe…the hotel brands have to step up in the regional or the headquarter/head offices.* (Participant 1)

In sum, regarding the technology factor, the following findings are proposed based on the interviews. These findings are generally consistent with the previous reports on AI and the hotel industry. One of major differences is that Ransbotham et al. (2017) highlighted the strategic role of AI as one of the major reasons for adopting AI. However, in the case of hotels, it is found that the motivation is more initiated by operational issues such as reducing costs and enhancing the productivity of back-office operations.

Finding 1 The importance of AI and robots is already well recognized in hotels and adoption cases are frequently found where the automation of the process increases productivity. That is, rather than a long-term oriented strategic purpose such as sustaining a competitive advantage, hotels will use more AI and robotics where benefits are realized within a short period of time.

Finding 2 In addition to cost reduction, analytics have high potential to contribute to increased revenues and enhanced customer experience. Since most analytics do not require direct interactions between customers and systems, hotels will consider adopting analytics more positively soon, but outdated hotel information systems are obstacles to overcome due to integration difficulties.

Finding 3 Due to the lack of internal IT expertise, AI and robots are often implemented by outsourced IT. As long as external IT vendors provide a reliable technology, hotels consider that the complexity of AI itself is not a reason to hinder the adoption of such technology. Finding competent external IT experts is a critical issue when adopting AI and robotics.

Organization

Under organization category, financial justification in terms of ROI and resistance by employees were studied.

Organization: Financial justification

A key element that participants referred to was the financial justification required for the adoption of new technologies. In particular, participants were looking for an acceptable return on investment (ROI) which would justify the business-worth of the technology.

> *I'm not going to fund something that is not giving me an ROI right away or maybe it may never give us. The ROI mechanism is quite important for us.* (Participant 2)

Importantly, an ROI needed to be a financial return; if the adoption of a technology would provide a suitable cost saving, revenue increase, or improvement in customer experience, it was deemed acceptable.

> *To me, AI adoption with the right use cases in those three areas I said, you don't need to be…I mean definitely gives you a competitive edge. Because when your guest experience is much better, because you are staff is empowered with more customer insights, actionable insights, so that they interact with the customer better. So there is a chance that the customer builds that emotional connection with the hotel, which improves your 'customer stickiness', so that is a competitive advantage.* (Participant 5)

However, participants admitted that the flexible definitions of ROI and the inherent nature of AI technology meant that the calculation of return is difficult.

> So let's say an owner has five or six hotels and they implement that technology across the board. That way they can achieve the economies of scale and save as well. But in terms of your actual ROI it is very difficult to calculate. (Participant 6)

Another important issue that arose in relation to the finance was the responsibility; with whom did the responsibility lie to locate the technology and fund its implementation? Overall, there was a general belief that the operators (brands) should be the ones to find the appropriate technology and recommend its implementation to the local hotel owners. However, since the cost of the implementation was likely to fall on the owner, the operator needed to clearly identify the anticipated ROI.

> …they [the operators] have…a very big guy well paid, sitting in an office…and all what they are doing is to study artificial intelligence and see how this can enter into the business model…. But don't forget that there is an owner who actually pays specific IT fees to the operator. The operator should show me the ROI that can be obtained in one year. (Participant 3)
> …That is one thing I would advise owners; not to get too much involved in this [AI] investment. Because we are in the early stage, right, so we may take some risks here…you don't want to be the first one who invests who has to reinvest in two years, but you don't want to be the last one either. (Participant 8)

However, the role of the operator sometimes provided limitations when concern over brand image arose. Participants explained that in some instances, the operator would resist adopting a new technology over concern that its failure may have a wider impact on the perception of the brand globally.

> …for example, if it was a Marriott system and it did not work, all around the world, people will start talking about that there was a Marriott system that was implemented and did not work. But for this hotel, if something does not work, it's all in the house… (Participant 2)

It was, therefore, clear that an acceptable ROI was necessary for a certain technology to be adopted. Furthermore, it was felt that it was the operator's responsibility to locate the appropriate AI and recommend its adoption, with an acceptable ROI. In particular, it was also the larger operators who would sometimes resist new AI technology over fear that their brand reputation could be harmed, in cases where the technology failed.

Organization: Resistance by employees

Overall, the participants felt that the staff would not resist the new technology to the extent that it hampers the adoption of the technology. Some felt that if there would be resistance at first, it often exits until they could experience the technology for themselves.

> …We didn't face a number of the resistance, maybe one or two. However, it was welcomed as an idea itself, welcomed in terms of the implementation itself as well. Obviously, staff don't like it because they do not know why you are doing it… But later when they become more familiar with it, they're saying that okay it's actually a good one. (Participant 1)
> I think in the beginning people resist, because obviously some people will definitely lose jobs when the intelligence will come in. (Participant 6)

Regardless of whether employees supported AI or not, there was consensus that staff would support the technology when they saw the benefits it would bring them. The staff's resistance was, however, related to the hotel's position in the market; more luxurious properties did not need to replace staff, while lower positioned hotels may be incentivized to replace staff, thereby leading to resistance.

> I don't see much [resistance] coming apart from lower tier segment where staff is anyhow, reduced to the bone. But at the luxury hotels… to improve the experience… you will always need a person at the front desk even to sort the technical issue… that is, you can make it faster through artificial intelligence, (Participant 3)

Other forms of resistance occurred from the managerial level; if management were unfamiliar with the new technology or were not convinced the promised ROI was sufficient as explained in the *financial justification* factor, they would resist the adoption of the new technology.

There were, overall, two forms of resistance that participants felt could arise: staff and managerial. It was felt that staff would resist over fear of losing their jobs even if the resistance is not considered serious. However, participants believed that staff working in higher category hotels would be less resistant – or be more supportive sooner – because the technology would not actually replace them. The second form of resistance occurred from managers over a lack of knowledge and understanding about the new technology and was most frequently related to seeking support of adopting the technology.

There are two interesting phenomena pertaining to organization factors. The first one is that the relationship between operator and owner is a factor that affects the technology adoption decision. The second is that AI and robots are often

welcomed by staff and managers because new technologies improve their productivity. The findings are proposed as below.

Finding 4 The ROI in terms of financial measurement such as cost reduction or revenue increase is used as the main judgment criterion to adopt the new technology. However, depending on the market position of hotels, ROI could be qualitative such as customer experience. Hence, as long as one of the three types of ROI (cost reduction, revenue increase, and customer experience) is apparent to the hotel owners (who invest in such technologies), the likelihood of adoption is higher.

Finding 5 Resistance by staff was expected to be more noticeable and significant in lower positioned properties where AI may replace people. At higher positioned properties, however, the participants believed that AI would enhance the abilities and efficiency of staff, not replace them.

Environment

Under the environment category, three factors, i.e., customer expectations, competition, and legal issues are chosen to study the impact on adoption.

Environment: Customer

As for the customer, participants regularly referred to two similar but distinct factors: i) customer readiness in terms of accepting and using new technologies; and ii) customer experience in terms of potential benefits to customers by providing customized AI and robotics related services. In the case of customer readiness, the participants mentioned that customers have different experiences depending on age, culture, purpose of travel, and even personal preference of using technology.

> *Some of them are from the younger generations, they prefer the electronic ones* [check-in] *they see the queue, for example, they go to the electronic system.* (Participant 1).
> *Also depending on the culture and nation, the way people behave and interact is quite different. For instance, in Japan they want the old things to work as good as something new and shiny. … Even if you put a brand-new technology, it will not work unless this hotel is targeted to a different audience.* (Participant 2).
> *Based on consumer demographics in terms of the preferences and wants, especially of the GCC families, they are very different from corporate or leisure travellers in countries like Europe… (*Participant 6).

In the second case of customer experience, the participants explained that delivering better customer expectations was one of key advantages using AI, along with lower costs or improved revenue. Participants felt that AI technology allowed hotels to better understand their customer and offer more personalized experiences with respect to their different expectations.

> *Personalized information can also be provided of suitable restaurants/activities etc. in close proximity, based on the guests' profile.* (Participant 4 – recorded from interview notes)
> *But at the same time maybe AI can still play a major role in the luxury arena, when it comes to the in-room guest experience.* (Participant 2)

The personalized focus on the guest was, therefore, central to the participants' perspectives of AI. The guests' expectations and preferences influenced which type of AI was adopted and how well it would succeed – especially when guests have different expectations due to demographics or personal characteristics, and allowed properties to provide a better, more personalized experience to the guest.

Environment: Competition

When asked about the role of competition in motivating hotels to adopt AI, participants unanimously claimed that keeping up with competitors was not a sufficient motive yet. AI tools were seen as an optional advantage and benefit, but not something that is important enough to encourage adoption solely based on the competitors' actions.

> *… it's not a swimming pool. AI is not a necessity as of now. If my competitor has a pool and I don't have a pool, that is a problem, I will lose money. If my competitor has a Michelin star restaurant and I don't, I start losing money. Not yet. Not yet for AI.* (Participant 2)

However, the participants did explain that they would draw inspiration and ideas from competitors globally.

> *If you see a successful AI idea being implemented by a competitor, you want to be a part of the market trends. But, to be frank, I haven't seen others in the luxury segment, even here locally doing more than what we do.* (Participant 3)

Therefore, if they saw or experienced a particular AI solution, they would consider implementing a similar version, if they felt it would add value and provide a suitable ROI. AI is not yet recognized as one of critical technologies determining the competitiveness in the market.

Environment: Legal issue

One the most significant concerns raised by participants was the legality of the AI tools they considered for adoption. From a customer-privacy perspective, participants did raise concern about customers' willingness to share data. However, they mostly dismissed the severity of this because they believed that guests would appreciate the personalization in exchange for sharing their data or could opt-out if they wished.

> It [an opt-out option] *has to exist otherwise you have other problems, privacy issues and everything. A nice big red button is your choice. This is your choice if you want to engage. However, if you don't want, let it be.* (Participant 2)

Furthermore, some of the participants explained that the data they were collecting could be used to create personas, and not be related to a particular individual. This would, in their view, not cause significant concern or discomfort for guests because data were being analyzed collectively.

> *If you are touching the personal data, it can be done as long as it's anonymous…if I'm mapping you to a profile…identifying you in this way,…age bracket, he's a Middle Eastern individual, he is married … these details are not private…because I'm not identifying the individual against it. So those level of details can be still be collected.* (Participant 5)

Of more significance was the legislation and regulations within the city or country the hotel was located. Regulations governing the operations of the hotel could limit the type of AI that could be implemented or, at the very least, require changes to the technology.

> *…law stipulates that you have to have the passport or ID has to be physically verified by an individual at the front desk* (Participant 5)

Legally, therefore, participants did not seem overly concerned about implementing AI or robotics from a guest's perspective. The larger concern arose from country legislation. However, participants were confident that these would change to support AI and robotics.

These are the findings from environmental factors. Interestingly, it is often discussed that privacy is one of major obstacles (Ransbotham et al., 2017), but the findings suggest that privacy is not such a serious concern limiting the adoption of AI.

Finding 6 Customers are one of major factors affecting the adoption of a new technology. There are two types of customer factors: customer readiness and customer experience. Depending on the readiness such as age and culture, hotels need to decide what types of AI and robotics to provide to customers. As for the customer experience, AI helps to provide personalized services since analytic functions assist in the identification of customer expectations based on their profiles and to maximize the experience.

Finding 7 Competition is not seen as a major factor in influencing the adoption of new technology. That is, hotels rarely adopt AI and robotics to keep up with competition in the market, rather adoption decisions are made primarily based on internal factors.

Finding 8 Legal factors were rarely seen as a major barrier but were restrictions that hotels would need to consider when designing solutions or interacting with customers.

Additional factor: Market position

Besides the current TOE factors, the interviewees were asked an open-ended question at the end if there are any additional important factors. There were other factors such as technology compatibility, IT infrastructure, perceived benefits, and technical competency, but most of them could be explained by the eight factors identified previously. The only factor that the participants included, which cannot be explained by the previously identified factors, was the market position, i.e. the hotel's star rating. *Market position* refers to the strategic position of a brand or product in the marketplace in terms of customer perception in relation to competition. In the case of the hotel industry, hotels are categorized and perceived differently by customers based on star rating. For instance, 5-star hotels target the high-end customers who expect high quality services and unique facilities. Likewise, other hotels with lower than 5-star ratings are considered less luxurious in their appeal.

All participants felt that luxury hotels, (the 5-star hotels), would want minimally invasive solutions which prioritized guest experience, or affected back-of-house operations.

> *…especially for the luxury properties. Technology is not welcome because they are very traditional. I mean there is a culture behind it, there is the styles which cannot be changed. Maybe in the different segmentation mid-scale or upper scale possible, but luxury for sure not.* (Participant 1)
> *Depending on the nature and position of the hotel, I see AI is less on the luxury segment and more on the 2 or 3 starred economy segment. I believe that there are mostly two reasons: one is that in the luxury people still expect more human interaction rather than AI or robot interaction. But at the same time AI can still play a major*

role into the luxury arena, when it comes to the in-room guest experience for connectivity, for example, TV system control. I think luxury hotels will be less influenced by AI, apart from the guest experience. Now in the economy hotel segment, AI could be used a lot because of cost constraints. They need to invest because technologies reduce manpower. (Participant 8)

… if you look at the luxury segment, and people they want experience when they're coming right and when you want luxury experience, they actually want touch points where you are interacting with individuals. You don't want just to be communicating with the machine. (Participant 6)

The hotel's market position seemed to be one of the most significant factors affecting the decision whether or not to adopt AI technology, and which technology should be implemented. For this reason, participants unanimously felt that non-invasive AI would work well in luxury hotels, in a way either to enhance current services by providing greater customization to an individual customer or to enhance internal efficiencies by optimizing operations to reduce operating costs. In this study, this factor is included under the organizational category because hotels are often reported to use different facilities and technologies depending on their strategy, brand and quality of services (Muthumanicam, 2019) which represent the organizational characteristics of the hotel.

Finding 9 Of high importance from the organization's perspective was the market position of the property, i.e., the star-rating of the hotel. Participants felt that more luxury properties would prefer less invasive solutions. This finding influenced all other subsequent decisions regarding the adoption of AI.

Discussion

This study explored eight factors from previous TOE framework and proposed 11 factors. These factors include market position which was derived directly from the interviews. They also include the customer, encompassing customer readiness and customer experience, whereas IT expertise that includes external IT expertise and internal IT expertise. In total, eight interviews were conducted with senior asset managers who manage over 40 hotels in Dubai. Based on the analysis, a future research model is proposed for the empirical validation of the relevant factors as shown in Fig. 1. In total, 11 factors are included with respect to three TOE categories and they are reclassified into three groups from the first order to the third order influencers based on the findings in terms of the different degree of impact on the adoption of AI and robotics.

Based on the current findings, market position, customer readiness, and customer experience are classified into the first order influencer affecting the adoption of technologies. Market position appeared to be the most significant influence in terms of whether AI would be adopted or not, and what types of AI would be adopted. Customers are another important factor affecting the adoption. High-end customers who visit luxury hotels would have higher expectations of services due to their market position. Utilizing AI and robots allows hotels to maximize customer experience and expectations by providing customized services to different types of customers.

The second order influencers include relative advantage, complexity of technology, external IT expertise and financial justification. This study found that technological factors are not the primary determinants affecting the adoption. The participants pointed out the importance of financial justification in terms of ROI which essentially refers to cost savings, revenue increase, or customer experience improvements in accordance with the literature (Davenport and Ronanki, 2018). Lastly, among the third order influencers, internal IT expertise, resistance by employees, competition with rivals, and legal issue such as privacy are identified. These factors are still very important and frequently cited in trade journals as important influencers. The participants agreed as to the importance of these factors, but not as much when compared to the first and second influencer groups.

Most prior studies were conceptual (Bowen and Morosan, 2018; Go et al., 2019; Murphy et al., 2019) and descriptive in nature offering guidelines (Webster and Ivanov, 2019; Zlatanov and Popesku, 2019), or focused on the behavior of individuals (Yu and Boyol Ngan, 2019; Gursoy et al., 2019) in terms of the adoption of technology. The conceptual papers presented diverse frameworks for effective design and implementation of AI and robots and also discussed important research subjects and agenda for future studies. The limitation is that empirical studies validating these proposed frameworks or guidelines are insufficient, mostly since real AI and robot applications were still scant. For instance, the human resource issue is still one of the major topics of AI and robots because employee resistance and job replacement are considered to be serious obstacles to overcome (Ho et al., 2020; Tuomi et al., 2019, 2020). However, this study found that employee resistance is not as significant, from the hotels' point of view, as previously thought. Likewise, it was found that hotels' market position is one of the primary determinants that affect the decision of what types of AI and robots need to be adopted. Several empirical studies have been conducted on robot adoption, while AI remains limited. Now data-oriented empirical studies are required to validate the proposed frameworks or guidelines to derive more practical lessons and meaningful implications to practitioners and to researchers.

The current findings need to be validated by further empirical studies in future using survey data and statistical analysis.
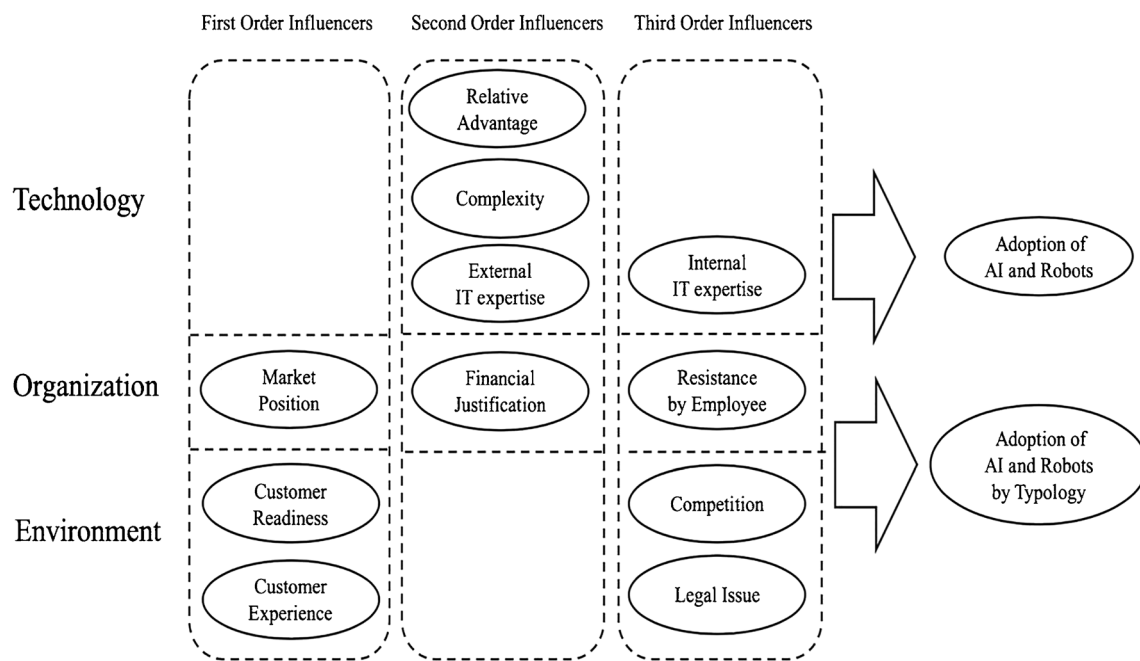
Fig. 1 Factors affecting the adoption of AI and robotics in the hotel industry

That is, future studies of AI and robotics need to be fine-tuned by their types and characteristics, i.e., the typology of AI and robotics. For this reason, based on current findings and discussion, this study classified different types of AI and robot applications in the hotel industry into four types as shown in Fig. 2.

In Fig. 2, the horizontal axis represents the type of hotel business activities and operations: back-office activities can be carried out without direct customer interactions while front-office activities require interactions with customers. Back-office AI and robot applications will be primarily used by hotel employees while front-office applications are adopted for customers.

The vertical axis represents the role of AI and robotics, whether it would substitute or enhance manpower. This dimension is chosen because the human interface is the most critical factor determining the quality of hotel services, and reducing manpower is one of the important advantages of AI and robotics. At the same time, nowadays the collaboration between human and AI is considered very important to maximize the benefits (Davenport and Ronanki, 2018; Wilson and Daugherty, 2018). For instance, cognitive augmentation and generative design are good examples of collaboration. That is, depending on the purpose, AI can simply substitute the human interface and can be reinforced to enhance productivity. Based on the characteristics, a typology of four cells emerge: *operational substitution*, *operational enhancement*, *strategic substitution*, and *strategic enhancement*.

Regarding *operational substitution*, reducing transactional and psychological costs is the primary purpose of using AI and robotics that pertain to simple, routine, and repetitive

tasks. Traditional smart software can be utilized for this purpose. Implementing the technology may face a certain level of resistance by employees, but this level of automation emerges before the use of AI and robotics. Therefore, the management prefers to use technology at this level despite resistance and the decision would take relatively less time.

In the *operational enhancement* cell, AI and robotics enhance the role of human labor related services. Traditional IT applications were not able to provide proper tools in the domain before because the technology was neither smart nor advanced enough to enhance the human manpower. For instance, it is quite a recent trend that integrating AI into energy management and revenue management helps to save costs and to increase revenues. Employees welcome this technology rather than resist because it increases their productivity without concern of job security. For this reason, hotels have implemented AI relatively early when the technology became available. As AI and robotics mature, hotels will adopt more of such technologies.

Regarding *strategic enhancement*, customers interact with AI and robotics directly through the interface provided by hotels. Such technology will also provide hotels with the flexibility of managing manpower to suit their requirement. Only a limited number of leading hotels have adopted such technology. Most luxury hotels do not use it because of the risk of sacrificing personal touch related to service quality and customer satisfaction. However, if more customized and individualized services could be directly provided to customers using advanced analytic and enhanced user-friendly interfaces, AI would provide strategic value to hotels and customer experiences can be maximized. However, for this to happen, AI and

Fig. 2 Typology of AI and robotics in the hotel industry

	Type of Activity	
	Back Office Activity	Front Office Activity
Enhancement of Manpower	**Operational Enhancement** Diverse rule-based and analytic solutions combined with • Energy management • Environmental controls • Room allocation • Revenue management • Menu creation and Valid.	**Strategic Enhancement** Diverse voice recognition systems with extensive analytic and intelligent capabilities for • Room control • Concierge • Service desk • Reception desk
Role of AI	**Operational Substitution** • Routine & repetitive tasks • Traditional smart solutions • Customer document validation (Passport)	**Strategic Substitution** • Delivery robots for baggage and room services • Facial recognition systems
Substitution of Manpower		

robotics-based technologies need to further develop to become more mature. In the future, even luxury hotels should consider this orientation to provide differentiated and customized services.

Strategic substitution relates to technologies that are used to interact directly with customers to replace manpower. Examples are delivery robots and facial recognition systems that will have direct interface with customers. The major objective of such an orientation will be the reduction of costs. Depending on its strategic position, the hotel has to decide whether to adopt this type of application. Five-star hotels will not adopt the type of strategic substitution since customers prefer to have direct contact with the hotel employees. The adoption in this regard should be more strategically considered because of high risk.

Integrating with the results of current study, the proposed typology is useful to decide which technologies to adopt depending on characteristics of strategic position and customers. In the case of 3- and 4-star hotels, technologies are already adopted without sacrificing the service quality and customer satisfaction because customers who are more cost-conscious accept the technology without any resistance. An example is the FlyZoo in China which has already implemented the full spectrum of voice recognition systems (Biron, 2019). Implementing AI and robotics for the purpose of replacing employees where customer interactions are important should be scrutinized. Hotels must clearly understand their market position and types of customers before the implementation of AI and robotics. It should be noted that the future research needs to be conducted with respect to the typology of technologies. The current study carried out without differentiating the typology, but in order to derive practical guidelines for the

adoption of technology, future studies should be fine-tuned to find different determinants with respect to different dependent variables, i.e., the typology of AI and robotics.

Conclusion

To study the factors affecting the adoption of AI and robotics, an in-depth case study was conducted with senior managers. The data from the interview transcriptions including email, relevant materials, and websites, were scrutinized to report a series of 11 findings with respect to nine TOE factors. Market position and customer are found to be more influential than others while internal IT expertise, competition and legal issues have less impact on AI adoption. Finally, this study proposed four types of AI and robotics in the hotel industry which can be useful to categorize the trend of adoption in the future.

There are two important implications of the study. First, this study found that the customer is one of the most influential factors (Murphy et al., 2017). It supports the fact that AI and robotics have become an important component of smart hotel and smart tourism. The Ambient Intelligence (AmI) Tourism (Buhalis, 2020) driven by a range of disruptive technologies is already prevalent in the hotel industry. Future studies of AI should be carried out as a part of a smart ecosystem. Second, in line with the smart tourism, even though hotels have already adopted diverse AI technologies, this study shows that more diverse applications using more advanced features of machine learning or deep learning need to be developed by IT professionals and implemented by hotels. The participants clearly pointed out that hotels are ready to adopt new applications as long as benefits are apparent. Due to the

lack of competency of the internal IT department, advanced AI-based solutions integrating the feature of real-time, co-creation, data-driven, consumer-centric and experience enhancement need to be produced through close collaborations between hotels and external AI professionals.

This study has several contributions from the research point of view. First, 11 factors were found as determinants affecting the adoption of AI and robotics. The factors are derived based on the TOE framework and in-depth interviews. Since it is one of the earliest studies focusing on the hotel industry, this study provides a theoretical foundation for the future empirical studies. Second, it was found that the market position is one of important organizational factors affecting the adoption of new technologies. This factor has not been studied before in other previous TOE studies even if there were similar variables such as strategy and strategic planning. It is interpreted that this finding resulted from the diversity of AI and robotics. This finding is another important contribution of this study. Third, the typology of AI customized to the hotel industry is proposed, allowing managers and researchers to classify various technologies based on the categories operational and strategic enhancement or substitution. Future study can consider the typology to test its veracity.

Future studies should focus on validating the 11 factors found in this study empirically using hotel managers as their samples in varied contexts. The four types of AI and robotics also need be integrated in the research design as the next step. Additionally, the future study needs to explore the role of hotels' and asset managers' absorptive capacity. This ability to recognize the value of a new and external information, to assimilate it, and then to apply it to commercial ends is essential for reaching high levels of innovation adoption and use within organizations (Cohen and Levinthal, 1990; Zahra and George, 2002). In the context of hotels' adoption of AI and robotics, prior credible knowledge about AI with an adequate understanding of their potential benefits would have a significant influence on reducing uncertainty and subsequently on adoption decisions (e.g. Frohlich and Westbrook, 2002; Daghfous et al., 2018). Hence, future research should explore the adoption of AI and robotics in hotels from a knowledge-based view (Grant, 1996; Kogut and Zander, 1992; Lee and Park, 2014) by taking into consideration the role of the decision makers' absorptive capacity.

As in any research, this study has some limitations. Despite the structured and thorough qualitative research approach, the findings may only be applicable to the sample studied. Therefore, for further generalizability, future research should replicate this study in different settings in terms of geographical location, and the authority to make adoption decisions in relation to AI and robotics. Moreover, interviews with the key informants (i.e., asset managers) were heavily relied on, potentially biasing the findings by the perceptual lenses of these managers. Future studies would enrich these findings by exploring the hotel operators and hotel guests' perspectives.

Longitudinal studies would also provide considerable insights into the adoption process how it evolves over time. Finally, future research should develop testable hypotheses based on the findings; and test these hypotheses via a large-scale survey, not only in Dubai, or the Middle East, but also across other regions of the world. It is our hope that this exploratory study provides a starting point for these investigations.

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