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Artificial intelligence research in hospitality: a state-of-the-art review and future directions

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Abstract

Purpose – The purpose of this study is to analyze state-of-the-art knowledge of artificial intelligence (AI) research in hospitality.

Design/methodology/approach – This study adopts the theory-context-methods framework to systematically review 100 AI-related articles recently published (i.e. from 2021 to April 2023) in three top-tier hospitality journals, namely, *the International Journal of Contemporary Hospitality Management, International Journal of Hospitality Management* and *Journal of Hospitality Marketing and Management*.

Findings – Findings suggest that studies of AI applications in hospitality are mostly theory-driven, whereas most AI methods research adopts a data-driven approach. State-of-the-art AI applications research exhibits the most interest in service robots. In AI methods research, little attention was paid to the amid-service/experience.

Research limitations/implications – This study reveals inadequacies in theory, context and methods in contemporary AI research. More research from hospitality suppliers' perspectives and research on generative AI applications are advocated in response to the unveiled research gaps and recent AI developments.

Originality/value – This study classifies the most recent AI research in hospitality into two main streams – AI applications research and AI methods research – and discusses the gaps in each research stream and latest AI developments. The paper then suggests future research directions to guide researchers in advancing AI research in hospitality.

Keywords Artificial intelligence, TCM framework, Systematic review, Hospitality, Service

Paper type Literature review

1. Introduction

Since the last decade, the focus of technology-related hospitality and tourism research has shifted from interactive technologies such as e-commerce and social media to artificial intelligence (AI)-related technologies such as big data and service robots (Shin *et al.*, 2023). The reason for this shift is that hospitality and tourism are at an important intellectual

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turning point in which AI-driven data science, automation and robotics are penetrating not only the service process but also business innovation and strategies. For instance, Li *et al.* (2021) suggested that AI could enhance customers' experience in service encounters by performing the following four functions:

(1) Supplementation;
(2) Generation;
(3) Mediation; and
(4) Facilitation.

From the supplier perspective, hospitality and tourism enterprises use AI for customer relationship management, business analytics and demand forecasting (Mariani and Wirtz, 2023).

Particularly with the recent rise and rapid diffusion of generative AI models, the AI-driven digital revolution in hospitality has accelerated at an unprecedented speed. These large-scale generative AI models (e.g. ChatGPT, Midjourney and DALL-E2) are capable of answering questions in natural language and generating text, graphics and code, outperforming standards of all times (Maslej *et al.*, 2023). Applications built on these powerful generative AI models will soon become ubiquitous at customers' service (Dwivedi *et al.*, 2023). Likewise, AI research in hospitality is expected to grow exponentially and become multi-dimensional in research focus (Kong *et al.*, 2023). Given this fast-changing landscape of AI practice and research, a structured review of the latest AI research, which distills state-of-the-art knowledge, highlights pivotal research gaps and portrays the future research directions considering recent AI developments, is vital to guide hospitality researchers and practitioners' upcoming research plans and business strategies in this new AI era. This study aims to address this urgent research need by systematically reviewing the AI-focused articles recently published (i.e. from 2021 to 2023 April) in three top hospitality journals, namely, *the International Journal of Contemporary Hospitality Management (IJCHM), International Journal of Hospitality Management (IJHM)* and *Journal of Hospitality Marketing and Management (JHMM)*, with the TCM framework (Paul *et al.*, 2017).

The contributions of this study are threefold. First, this study outlines key future research directions for AI research in hospitality, considering research gaps in the latest top-quality AI research and current trends in AI development. Second, this review categorizes state-of-the-art AI research according to its practical use (i.e. research on AI-driven applications) or methodological use of AI (i.e. research on AI-based methods), providing a clear classification of these two research streams under the AI umbrella. This approach could help hospitality researchers expand these two research streams in accordance with this categorization. Third, this study provides an example of the use of the TCM framework to conduct a structured review of the literature. This framework-based approach could systematically guide researchers to reveal inadequacies in the theory, context and methods of existing research, helping them to identify future research directions to advance understanding of their selected research areas in multiple dimensions.

2. Conceptual background

The concept of AI was introduced by a group of computer scientists in the mid-1950s. These pioneers, including John McCarthy, who is considered the father of AI (Andresen, 2002), envisioned machines capable of using language, leveraging neural nets to form concepts and

abstractions, functioning automatically and self-improving in complex and changing environments in the same ways that humans do (McCarthy *et al.*, 2006). Guided by these principles, AI has grown into a universal field and derived multiple definitions. Russel and Norvig (2010) organized these AI definitions by two dimensions: *cognition – behavior* and *human performance – rationality*. Based on this categorization, these authors concluded that AI refers to systems or machines that can think humanly, act humanly, think rationally and act rationally. To mimic the human thought process and reasoning, systems shall be able to communicate (natural language processing), store what they know (knowledge representation), answer questions and draw conclusions (automated reasoning) and adapt to new circumstances through detecting patterns (machine learning). Turning these human-like cognitions into behaviors, the systems or machines need to perceive (computer vision) and physically manipulate objects (robotics). Therefore, these six areas have become the most developed AI disciplines and most often seen AI manifestations in applications.

Despite AI emerging as a critical theme in hospitality technology research (Shin *et al.*, 2023), hospitality researchers have shown unbalanced attention to these diverse yet closely related AI technologies. Knani *et al.* (2022) bibliometric analysis of 1,035 AI articles published from 1984 to 2021 revealed that the majority of existing AI studies in hospitality and tourism are relevant to "big data". Additionally, most of the frequently occurring keywords (e.g. "text mining", "neural network" and "machine learning") in these articles are methodological tools mimicking human cognition for automated data analytics. These articles tend to use AI-based methods such as natural language processing and machine learning for data collection or analysis. The overwhelming presence of AI models and algorithms in overall AI research may cause confusion because AI narrowly refers to an array of data analytics techniques, such as machine learning, deep learning and text mining (Saydam *et al.*, 2022).

To avoid the above potential confusion and better illustrate the opportunities that AI could bring to the industry, researchers have endeavored to study the practical use of AI technologies in service (Li *et al.*, 2021). These studies cover various embodied and disembodied AI and tend to focus on the acceptance and application of these intelligent technologies in customer experience facilitation and service operation (Tussyadiah, 2020). Embodied AI refers to machines integrated with AI algorithms and robotics that enable machines to make physical effects in the world, such as service robots. For instance, Gaur *et al.* (2021) suggested that service robots largely reduce direct human contacts and customers' perceived risks of coronavirus infection. Disembodied AI means systems that perform cognitive tasks without possessing a physical body, such as chatbots and voice-based AI assistants.

To advance this burgeoning field, scholars have conducted many AI literature reviews (in supplementary material). Some of them have focused on customers and suppliers' AI applications in the industry (Saydam *et al.*, 2022). While most of them have adopted a methodological lens to examine data analytics research in hospitality and tourism (Mariani and Baggio, 2022). Despite illuminating AI research in hospitality, the narrow focus of these AI literature reviews may result in hospitality researchers and practitioners' incomplete understandings of the overall impact of AI in hospitality. Nonetheless, a comprehensive literature review separating research using AI as a methodological tool from research on practical use of AI in service is mostly absent, with only a few exceptions (Doborjeh *et al.*, 2022). Therefore, this study aims to fill this pivotal research gap by classifying these two streams of AI research, followed by a systematic review of each stream. In this way, this study could draw a holistic picture of state-of-the-art AI research, highlight research gaps and provide suggestions on future research agendas considering the latest AI developments

to move forward in this research field. Figure 1 presents the overall conceptual framework of this study.

3. Methodology

To critically aggregate and appraise state-of-the-art knowledge of AI in the hospitality context, this systematic review follows a four-stage review protocol, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (i.e. identification, screening, eligibility and inclusion) suggested by Lim *et al.* (2021), and adopts the TCM framework. Figure 2 provides a methodology overview of this study. Every member of the research team has published review articles in SSCI journals. Their experience contributes to improving the quality of research design and writing of this study. Moreover, the entire research team participated in the research design and review process together to attenuate personal bias and ensure the validity of the study.

3.1 Theory-context-method framework

The theory-context-method (TCM) framework was introduced by Paul *et al.* (2017). In the TCM framework, "theory" refers to the theoretical foundations used by the researchers to explain the observed phenomena. "Context" means the contextual settings that the research situates. "Methods" refer to the methodologies (i.e. research design, data collection and analysis methods) used in the research. These three pillars are the essential underpinnings of research and are able to guide researchers to systematically present "why" (theory), "where" (context) and "how" (method) that the accumulated knowledge has been acquired (Paul *et al.*, 2021). To date, most reviews of AI-focused hospitality research are bibliometric reviews, using statistical software such as VOSviewer to visualize the relationships between authors, affiliations, citations and co-citations in published articles. Although these

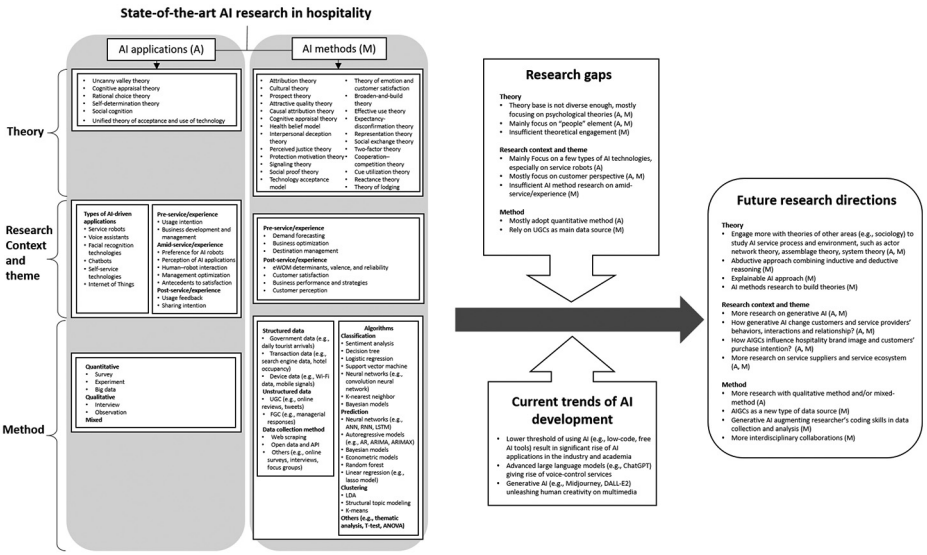
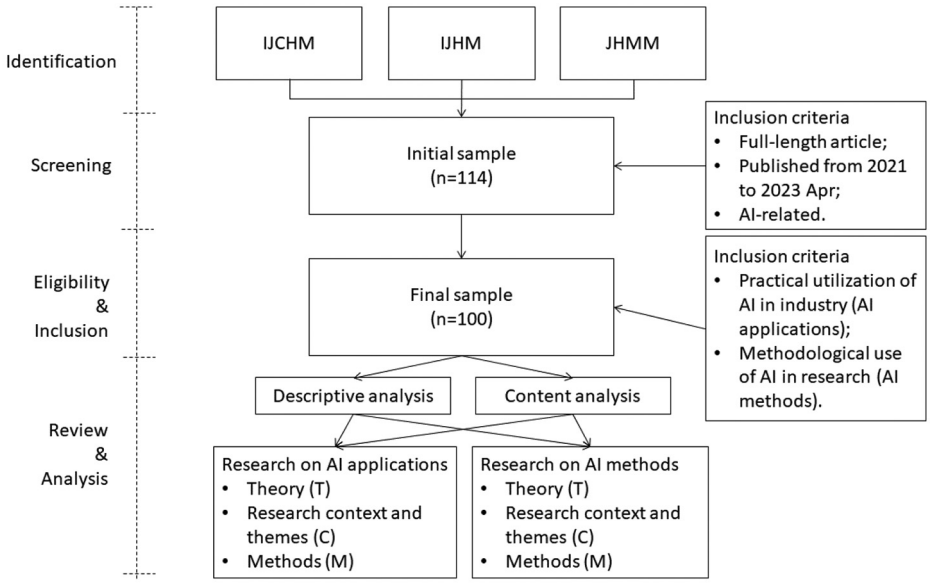


Figure 1. Conceptual framework

Notes: A = AI applications; M = methods
Source: Created by authors



Source: Created by authors

Figure 2. Methodology overview

bibliometric reviews have provided a bird's-eye view of prior work in the AI domain, they have yielded limited insights into research gaps in theories, contexts and methods (Paul *et al.*, 2021). Therefore, the TCM framework is deemed suitable to be the organizing framework to guide this systematic review, given its structured guidance and scientific rigor.

In the current study, after the researchers classify the retrieved articles into two streams (AI applications vs. AI methods), they conducted subsequent analysis guided by the TCM framework in each stream. For theory and method, the researchers extracted the theoretical foundation or frameworks, and methodologies reported in the analyzed articles and conducted descriptive analysis to reveal the dominant approach in each article. For research context, the researchers first deductively classified the selected articles into three stages of customer experience process (i.e. pre-, amid- and post-service/experience; Lemon and Verhoef, 2016). The researchers then coded the articles based on their research topics and grouped the codes into themes using an inductive approach to reveal more details regarding specific research context.

3.2 Data identification, screening, eligibility and inclusion

3.2.1 Identification. To ensure the quality and consistency of the research scope, this study considers only AI-relevant articles published in three top-tier (i.e. Q1) SSCI-listed hospitality journals (*IJCHM*, *IJHM* and *JHMM*). In early October 2022 and mid-April 2023, two of the researchers conducted two rounds of literature identification by independently accessing the titles, keywords and abstracts of all articles published in the selected journals from 2021 to April 2023 from the journals' websites.

3.2.2 Screening. The screening criteria were determined based on the agreement of all researchers. The selected articles were required:

- to be full-length empirical articles;
- to have been published in recent years (i.e. from 2021 to April 2023); and
- to be AI-related.

Using these selection criteria, two of the researchers retrieved 114 articles as the initial sample (excluding duplicates).

3.2.3 Eligibility. To ensure the content relevance of the selected articles, two of the researchers read the full text of each of the retrieved articles thoroughly and independently assessed their eligibility for inclusion in the review. Only articles that addressed the practical use of AI (i.e. machines or computer programs that exhibit human-like cognitions and/or behaviors) and/or the methodological use of AI (i.e. data analytics involving collecting or/and analyzing massive-scale data, often with machine learning methods) were included. Articles that did not fulfill these two criteria were removed.

3.2.4 Inclusion. Following the two researchers' individual eligibility assessments, each researcher's results were passed to the other for a countercheck. Discrepancies were discussed until a consensus was reached. Afterward, the results were verified and approved by the rest of the researchers. Ultimately, 100 articles were included in the final sample for further scrutiny and analysis.

3.3 Data analysis

To demonstrate the status quo of contemporary AI studies, the selected articles were first categorized into two research streams, as follows. Articles on the practical use of AI, which meant articles that focused on AI-driven applications in hospitality (e.g. service robots and AI assistants); and articles on the methodological use of AI. The results show that 47 articles (47%) focused on the practical use of AI in hospitality, whereas the other 53 articles (53%) involved the methodological use of AI. Subsequently, the researchers used the TCM framework to guide descriptive analysis and content analysis of the articles in each research stream to present the established knowledge in logical clusters.

From late October to late November 2022, two researchers independently analyzed the 87 articles included in the first round of data collection. In the first round of data analysis, the coded results were compared, and the researchers' inter-rater reliability was found to be 86.5%, exceeding the suggested threshold for Cohen's Kappa index (Hallgren, 2012). In mid-April 2023, two researchers executed the second round of data analysis on the newly added 13 articles. The inter-rated reliability between two researchers was 93% and reached the acceptable threshold for Cohen's Kappa index. Discrepancies were discussed among the whole research team until an agreement was reached.

4. Findings

4.1 Research on AI-driven applications

4.1.1 Theory. Concerning the theoretical foundation of articles focusing on AI-driven applications in hospitality (Table 1), 11 articles did not address any theory, whereas the other 36 articles were based on theoretical frameworks. In total, 36% of these articles ($n = 17$) were based on one theory, and 40% ($n = 19$) applied more than one theory. Six theories appeared more than once among the articles in this research stream. These theories were mostly used to justify customers' psychological and behavioral responses to AI-driven technologies such as

Theory	Main focus#	N articles*	%
Without theory		11	23
With theory		36	77
One theory		17	36
At least theories		19	40
Total		*47*	*100*
Uncanny valley theory	People	9	19
Cognitive appraisal theory	People	3	6
Rational choice theory	People	2	4
Self-determination theory	People	2	4
Social cognition	People	2	4
Unified theory of acceptance and use of technology	People	2	4

Notes: *This table only shows theories that were applied more than once. #Main focus categorized based on the "3 Ps" (i.e. people, process and physical environment) of the services marketing mix (Yarimoglu, 2014)
Source: Created by authors

Table 1. Theoretical foundation of AI applications in hospitality

service robots. The most frequently cited theory in the AI applications research was uncanny valley theory ($n = 9$).

4.1.2 Research context and themes.

4.1.2.1 Types of AI-driven applications. Among the 47 AI applications articles examined, half ($n = 25$) studied service robots (Table 2). This finding shows that hospitality researchers are eager to study both human-level AI, which can handle complex, creative and contextual tasks ("strong AI" or "intuitive AI"), and more advanced "empathetic AI," which exhibits anthropomorphic traits and fosters its users' psychological comfort or well-being (Huang and Rust, 2018). Besides, compared to Saydam *et al.* (2022) findings on most studied AI technologies, this study found a growing trend of research on disembodied AI such as voice assistants ($n = 4$), AI chatbots ($n = 2$) and facial recognition technologies ($n = 2$). The spike of research in service robots and disembodied AI may be largely attributable to hospitality suppliers' deployment of these AI technologies to reduce direct human contact in customer service during COVID-19 and customers' wider acceptance of such AI-facilitated services (Li *et al.*, 2021).

4.1.2.2 Research context and themes. Table 3 summarizes the research contexts and themes of the reviewed research on AI applications in hospitality. The 47 articles examined were thoroughly reviewed and assigned to one of the three categories (i.e. pre-, amid- and

AI services	N articles	%	Sample article
Service robots	25	53	Fu *et al.* (2022)
Voice assistants	4	9	Cai *et al.* (2022)
Facial recognition technologies	2	4	Xu *et al.* (2021)
Chatbots	2	4	Jiménez-Barreto *et al.* (2021)
Self-service technologies	1	2	Liu and Hung (2022)
Internet of Things	1	2	Pelet *et al.* (2021)
Others	12	26	Filieri *et al.* (2021)
Total	*47*	*100*	

Source: Created by authors

Table 2. Types of AI-driven applications

Table 3. Research context and themes of articles on AI applications

Research context and themes	N articles	Sample article
Pre-service/experience	*16*	
Usage intention	12	Romero and Lado (2021)
Business development and management	4	Filieri *et al.* (2021)
Amid-service/experience	*28*	
Preference for AI robots	10	Seo (2022)
Perception of AI applications	7	Liu and Hung (2022)
Human–robot interaction	7	Xie *et al.* (2022)
Management optimization	2	Qiu *et al.* (2022)
Antecedents to satisfaction	2	Jiménez-Barreto *et al.* (2021)
Post-service/experience	*3*	
Usage feedback	2	Huang *et al.* (2021)
Sharing intention	1	Chen *et al.* (2021)

Source: Created by authors

post-service/experience). Overall, most of the AI application studies in the sample investigated customers' experiences during a service ($n = 28$).

4.1.2.3 Pre-service/experience. In all, 15 articles researched pre-service experience issues. This research stream included the usage intention of AI applications ($n = 12$) and business development and management ($n = 4$). For instance, Romero and Lado (2021) found that during the COVID-19 pandemic, Generation Z preferred contactless services provided by robots over human contact because of the lower infection risk posed by robots. However, privacy issues associated with biometric technologies such as facial recognition were a major concern that influenced customers' trust (Xu *et al.*, 2021). Based on hotel employees' opinions, Fu *et al.* (2022) concluded that service suppliers' resistance to service robots was primarily attributable to the psychological factors of insecurity and uncertainty about new technologies. Nevertheless, the important and thriving AI trend has inspired many STEM (science, technology, engineering and mathematics) graduates to establish AI-related start-ups, especially in Europe (Filieri *et al.*, 2021).

4.1.2.4 Amid-service/experience. In all, 28 articles explored phenomena arising during a service. Researchers commonly adopted uncanny valley theory to investigate users' responses to robot anthropomorphism. For instance, Seo (2022) found female-looking robots were better at providing pleasure-related services than male-looking robots. This phenomenon was amplified when the robots exhibited a higher level of anthropomorphism.

Perceptions of AI-driven services varied according to different perspectives and types of applications. Drawing findings from a mixed-method research, Liu and Hung (2022) identified gaps in customers' and hoteliers' perceptions of SSTs. Likewise, Byrd *et al.* (2021) compared customers' expectations of food delivery robots with the robots' actual performance. Human–robot interactions, such as customers' robotic service encounters and employees' collaborations with robots, are another mostly researched area. For example, drawing on social response theory, Xie *et al.* (2022) found that the proactive behavior of service robots positively influenced customer co-creation intention with service suppliers. Other studies in this stream are on management optimization and antecedents to users' satisfaction with AI applications. For example, Qiu *et al.* (2022) discovered that the anthropomorphic, functional and informational aspects of AI technologies reduced employees' physical and mental fatigue, thereby improving overall service quality. Jiménez-Barreto *et al.* (2021) found that self-determined interaction (e.g.

competence) and experience (e.g. sensory and affective) with chatbots affected customer satisfaction.

4.1.2.5 Post-service/experience. Three articles fell into the post-service/experience category. These articles primarily addressed user feedback ($n = 2$) and user sharing intention ($n = 1$). For instance, Huang *et al.* (2021) conducted a content analysis of customers' feedback to identify the following four dimensions of customers' robotic service experience:

(1) sensory;
(2) cognitive;
(3) affective; and
(4) conative.

Chen *et al.* (2021) found that hotel customers were more willing to share their contactless service experience after the COVID-19 outbreak than before.

4.1.3 Methods. As shown in Table 4, in line with the overall trend in hospitality and tourism research, quantitative methods ($n = 42$) were the most commonly applied methods in studies focusing on AI applications in hospitality. Surveys were the most frequently used quantitative method ($n = 20$), followed by experiments ($n = 19$). In addition, three studies used Web scraping to collect data. Only three studies applied qualitative approaches such as interviews and observations to generate insights. Furthermore, seven articles used a mixed-method approach.

4.2 Research on artificial intelligence-based methods

4.2.1 Theory. Table 5 lists the theories cited in the articles addressing AI methods. Unlike the AI applications studies, most of which had a solid theoretical foundation, more than half of the articles on AI methods ($n = 32$) did not use any theory and only 21 articles adopted one or more theories. Among the 21 AI methods articles with a theoretical basis, a large proportion studied the cognitions and behaviors of customers and/or service providers (i.e. the "people" element in the services marketing mix). psychological theories explaining an individual's attitudinal and behavioral responses or decision-making processes, such as attribution theory ($n = 3$) and cultural theory ($n = 3$), were the most frequently applied in the research involving AI methods. In addition to psychological theories, a few sociological theories (e.g. social exchange theory) were used to explore aspects of the service process and physical environment in the hospitality context.

Method	N articles
Quantitative	*42*
Survey	20
Experiment	19
Big data	3
Qualitative	*3*
Interview	2
Observation	1
Mixed	*7*

Source: Created by authors

Table 4. Methods used in articles on AI applications

Table 5. Theories used in research on AI methods

Theory	Main focus	N articles	%
Without theory		32	60
With theory		21	40
One theory		12	23
Two or more theories		9	17
Total		*53*	*100*
Attribution theory	People	3	6
Cultural theory	People	3	6
Prospect theory	People	2	4
Attractive quality theory	People	1	2
Causal attribution theory	People	1	2
Cognitive appraisal theory	People	1	2
Health belief model	People	1	2
Interpersonal deception theory	People	1	2
Perceived justice theory	People	1	2
Protection motivation theory	People	1	2
Signaling theory	People	1	2
Social proof theory	People	1	2
Technology acceptance model	People	1	2
Theory of emotion and customer satisfaction	People	1	2
Broaden-and-build theory	Process	1	2
Effective use theory	Process	1	2
Expectancy-disconfirmation theory	Process	1	2
Representation theory	Process	1	2
Social exchange theory	Process	1	2
Theory of forecasting	Process	1	2
Two-factor theory	Process	1	2
Cooperation-competition theory	Physical environment	1	2
Cue utilization theory	Physical environment	1	2
Reactance theory	Physical environment	1	2
Theory of lodging	Physical environment	1	2

Source: Created by authors

4.2.2 Research context and themes. Figure 3 illustrates the distribution of AI methods articles conducted in the three research contexts (i.e. pre-, amid- and post-service/experience) according to their research themes. The reviewed hospitality research on AI methods concentrated on the pre-service/experience ($n = 19$) and post-service/experience ($n = 34$).

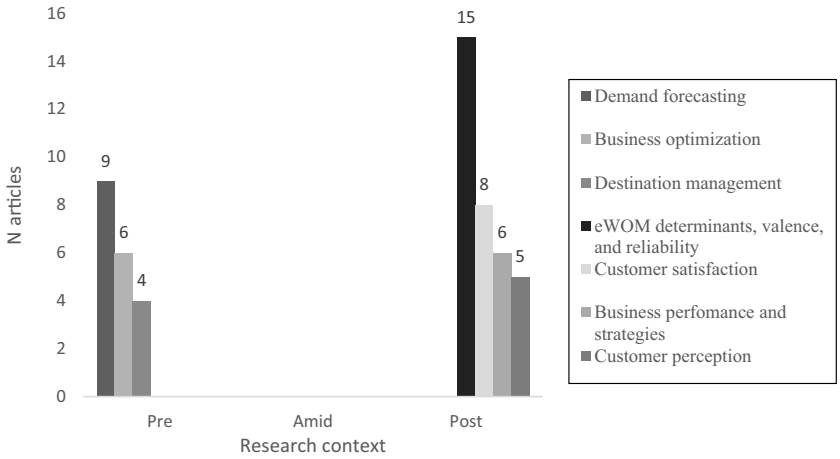
4.2.2.1 Pre-service/experience. Recent AI methods articles about the pre-service/experience were categorized into the following three research themes:

(1) demand forecasting ($n = 9$);

(2) business optimization ($n = 6$); and

(3) destination management ($n = 4$).

The primary reason for the great number of articles on demand forecasting was a special issue of *IJCHM* entitled "Big Data Analytics and Forecasting in Hospitality and Tourism" in 2021. This recently published demand forecasting literature on AI methods primarily explored the applicability and superiority of sophisticated AI algorithms, such as the support vector machine (SVM), artificial neural networks (ANNs) and recurrent neural networks (RNNs).



Source: Created by authors

Figure 3. AI methods article distribution by research context and themes

These articles tended to use advanced AI-based models to predict tourist arrivals, destination crowdedness and lodging occupancy and rates (Ghosh *et al.*, 2023).

Business optimization was another area of focus of many recent articles on AI methods. These studies often explored the value of AI-based data analytics in business strategy formulation. For example, Yi *et al.* (2021) demonstrated how Airbnb accommodation hosts could adjust their prices and maximize their profits by analyzing nearby hotels' number of reviews, ratings and prices. The other four AI methods articles addressed destination management. These articles mainly used topic modeling to understand visitors' perceived destination image and visiting behaviors in an effort to improve destination planning and development.

4.2.2.2 Post-service/experience. The AI methods articles on post-service experience encompassed the following four research themes:

(1) electronic word-of-mouth (eWOM) determinants, valence and reliability ($n = 15$);

(2) customer satisfaction ($n = 8$);

(3) business performance and strategies ($n = 6$); and

(4) customer perceptions ($n = 5$).

Since the emergence of Web 2.0, eWOM has become a popular research field in hospitality because of its strong influence on customers' purchase behaviors. The emergence of automated natural language processing, for instance, with topic models and sentiment analysis, has enabled researchers to easily decode customers' unstructured textual comments. This technological advancement has made eWOM one of the most dominant fields in AI methods research. The reviewed AI methods studies on eWOM primarily addressed the valence of eWOM, antecedents that influence customers' eWOM and the reliability of eWOM (Wang *et al.*, 2022).

For business performance and strategies, most of the studies associated with this research theme explored hospitality enterprises' online managerial responses. For example, Guo *et al.* (2022) found that the number of hotel reviews that received apologetic responses from the hotel was significantly positively associated with the number of future reviews. Some researchers

adopted the perspectives of customers and employees to examine the performance of hospitality businesses. For instance, Gambetti and Han (2022) studied the aesthetic differences between food images posted by businesses and pictures posted by customers.

The final two research themes focused on generating insights regarding consumers' satisfaction and perceptions. Most of these research efforts used topic modeling and sentiment analysis to investigate customers' positive or negative emotions regarding hotels' or restaurants' various attributes. For instance, based on customers' reviews on a Chinese restaurant review site (Dianping) from 2004 to 2021, Liu *et al.* (2022) found that two polarized emotions – love and anger – had the greatest impact on online ratings.

4.2.3 Methods.

4.2.3.1 Data source and collection. Table 6 summarizes the data sources and data collection methods used by the analyzed studies of AI methods. Of the 53 articles using AI methods, most ($n = 36$) used a single data source (e.g. customers' online reviews), while 16 articles combined two data sources (Lee and Kim, 2021) and one combined three data sources (Tian *et al.*, 2021). This finding suggests that research with a single data source continues to dominate recent data analytics research in hospitality. However, scholars have stressed the importance of using multiple data sources in data analytics research (Mariani and Baggio, 2022).

Regarding data sources, user-generated contents (UGCs) such as customers' online reviews, tweets and posted pictures were most frequently used in the AI methods research because of their wide availability, easy accessibility and low cost. However, hospitality researchers are beginning to adopt a broader perspective in AI methods research, shifting from the individual level to the organizational and destination levels. Therefore, in recent research using AI methods, researchers have often incorporated unstructured firm-generated content (FGCs), along with structured and rich data such as government reports, transaction data and device data, to generate more comprehensive insights (Tian *et al.*, 2021).

Web scraping was the most popular approach to data collection ($n = 35$). Consistent with Mariani and Baggio (2022), this study found an increase in data analytics research using data from open databases and application programming interfaces (APIs), which was

Table 6. Data sources and collection methods used in AI methods research

Category	N articles	%
Number of data sources		
One	36	68
Two	16	30
Three or more	1	2
Structured data		
Government data (e.g. daily tourist arrivals)	12	23
Transaction data (e.g. search engine data, hotel occupancy)	10	19
Device data (e.g. Wi-Fi data, mobile signals)	2	4
Unstructured data		
User-generated content (UGC, e.g. online reviews, tweets)	37	70
Firm-generated content (FGC, e.g. managerial responses)	4	8
Data collection method		
Web scraping	35	66
Open data and API	16	30
Others (e.g. online surveys, interviews, focus groups)	5	9

Source: Created by authors

attributable to various hospitality and tourism stakeholders making their collected data available to the public (Egger *et al.*, 2022).

4.2.3.2 Data analysis. Table 7 provides a summary of the algorithmic models used in the reviewed AI methods research. Inspired by Doborjeh *et al.* (2022), the models were organized into three categories based on the nature of the tasks performed in the research, including classification, prediction and clustering. Li *et al.* (2018) concluded that early AI-related hospitality research tended to focus on pattern discovery in an effort to understand customers' key opinions. Methodologically, many pre-2021 AI methods studies used unsupervised machine learning with limited human intervention to pre-process data (e.g. to label data). However, this study found that clustering tasks were performed less often than the other tasks described above in recent empirical research using AI methods. In contrast, supervised machine learning tasks such as classification and prediction were more frequently carried out.

In terms of the variety of algorithms, the findings were similar to those of Doborjeh *et al.* (2022), who found that well-known machine learning algorithms, such as sentiment analysis and SVM, were commonly used in hospitality and tourism research. Moreover, this study found that sophisticated neural networks and deep learning algorithms, such as convolution neural networks (CNNs) and long short-term memory (LSTM) models, were on the rise in AI methods research during the study period. These advanced neural network algorithms were used mostly for classification and prediction, given their ability to handle complex data and their high accuracy (Liu *et al.*, 2023). In line with Doborjeh *et al.* (2022), this study found that these advanced AI-based models were most frequently adopted in research on demand forecasting. For example, Ramos *et al.* (2021) compared the performance among four AI methods (the SVM, ANNs, RNNs and LSTM), seasonal autoregressive integrated moving average (SARIMA) and autoregressive integrated moving average (ARIMA) in predicting destination crowdedness.

Algorithms	N articles	%
Classification		
Sentiment analysis	18	34
Decision tree	5	9
Logistic regression	5	9
Support vector machine	4	8
Neural networks (e.g. CNN)	4	8
K-nearest neighbor	4	8
Bayesian models	3	6
Prediction		
Neural networks (e.g. ANN, RNN, LSTM)	10	19
Autoregressive models (e.g. AR, ARIMA, ARIMAX)	7	13
Bayesian models	4	8
Econometric models	4	8
Random forest	4	8
Linear regression (e.g. lasso model)	3	6
Clustering		
LDA	8	15
Structural topic modeling	3	6
K-means	1	2
Others (e.g. thematic analysis, T-test, ANOVA)	*19*	*36*

Source: Created by authors

Table 7. Overview of algorithms used in research on AI methods

5. Conclusions

5.1 Discussions

5.1.1 Theory. According to the findings, recent research on AI-driven applications has a solid theoretical foundation. This theory-driven approach, using established knowledge, aids in deconstructing users' complex understanding of, and responses to, acceptance of (or resistance to) new AI-driven technologies in hospitality, such as various types of service robots. However, this study suggests that recent AI application research has mostly used psychological theories, such as uncanny valley theory, to understand users' attitudes and behaviors – that is, the "people" element in the service marketing mix. However, there is a concern about the lack of research on the service process and physical environment, which greatly influence the overall service quality. Thus, research on these two important aspects warrants further investigation.

In contrast with AI applications research, this study found that AI methods research was mostly data-driven and lacked theoretical engagement. This research stream is often designed inductively to generate scientific insights from data. An emphasis on obtaining scientific findings and conclusions from large-scale data sets was also observed in the overall AI research, as according to the findings of this study, more than half of recent AI research fell into this category. These findings validate the ongoing epistemological paradigm shift from deductive to inductive reasoning in the knowledge discovery of hospitality and tourism research (Egger and Yu, 2022).

5.1.2 Research context and theme. The findings suggest that most state-of-the-art AI applications research studied only a few types of AI technologies, with a heavy emphasis on service robots. These service robots play an important role in augmenting the relationship between customers and employees and provide the most sophisticated AI-facilitated service in the post-pandemic era (Li *et al.*, 2021). However, as suggested by Li *et al.* (2021), AI facilitates service exchange in various forms that are not limited to service robots. Particularly, with the rapid diffusion of generative AI models, further study on these most advanced AI-based service applications (e.g. intelligent chatbots, AI-integrated voice assistants and augmented reality devices) is merited to present updated knowledge on the impact of AI in hospitality (Dwivedi *et al.*, 2023). Furthermore, a plethora of existing AI applications studies focused on the customer perspective, showing a research void of studies from the perspectives of other stakeholders who provide and govern these AI applications.

This study also reveals a lack of AI methods on the amid-service/experience; most, if not all, recent AI method studies have drawn on archival data (e.g. government reports and transaction data) and customers' online reviews. Real-time data collected during the service, such as through IoT devices or end-user applications, have rarely been included (Mariani and Baggio, 2022). The primary reason for this research inadequacy is the difficulty of obtaining massive amounts of first-hand data generated during AI-facilitated service. Hospitality researchers are encouraged to collaborate more closely with hospitality enterprises than they do at present to address this data availability issue. In the digital revolution era, AI methods research on the amid-service/experience could offer a theoretical basis for practitioners to satisfy customers' immediate demands and provide prompt and strategic responses to constantly changing business environment (Stylos *et al.*, 2021). Therefore, this research area warrants more attention.

5.1.3 Method. The findings regarding the methods adopted in AI application articles echo the discussion in the theory section. More than 80% of the AI application articles studied involved quantitative research using methods such as surveys and experiments. Very few studies adopted an inductive and qualitative approach to examine in what

situations innovative AI-facilitated service and operation emerge and succeed, and how much impact these services bring to transform the service environment and workplace.

For AI methods research, in line with Mariani and Baggio (2022) findings, this study found that an increasing number of AI methods studies used two or more data sources to generate insights, showing researchers' efforts to produce comprehensive and reconcilable results. Although an increasing number of studies incorporated transaction data and device data, UGCs remained the dominant data source in AI methods research. Given the rapid digitalization of hospitality and tourism, the amount of transaction data and device data collected by hospitality enterprises is expected to show an enormous increase. By engaging in close industry–academia collaboration, researchers should have a closer reach to these objective data for more diverse hospitality research topics.

5.2 Future research directions

Since the launch of ChatGPT in November 2022 and rapidly reaching 100 million monthly active users in two months, AI has entered its era of deployment and taken all industries by storm (Boulton, 2023; Maslej *et al.*, 2023). Therefore, more timely and insightful research shedding light on how innovative AI technologies and AI-facilitated services reshape hospitality is urgently needed in this contemporary era of AI (Dwivedi *et al.*, 2023). To provide guidance for future researchers to advance this research realm, some future research directions on theory, research context and theme and method are provided below.

5.2.1 Theory. AI-facilitated services have infused customer' daily life since the rise of generative AI models. According to the extended service-dominant logic (Vargo and Lusch, 2016), the value co-creation process often involves complex interrelationships and communication between various actors in the service ecosystem. AI technologies should be considered key resource integrators that engage in service exchange and value co-creation (Li *et al.*, 2021). Therefore, more AI applications research shifting from an individual to an organizational and sociological perspective, probably using sociological theories such as the actor network theory, assemblage theory and system theory, is needed to reveal the institutions and mechanisms of coordination and cooperation within the AI-facilitated service ecosystem. For example, drawing on the assemblage theory, Jiménez-Barreto *et al.* (2023) explored how tourists produce and process information and express themselves during their interactions with smart speakers before travel.

With the advancement and wide application of AI algorithms and automated analytics, future research with an inductive approach is expected to increase. To avoid potential epistemological pitfalls in big data research, such as the streetlight effect (Rivera, 2020) and researchers' overemphasis on correlations instead of causality, future AI methods research should consider taking either an abductive approach combined with inductive and deductive reasoning (McAbee *et al.*, 2017) or an explainable AI approach (Miller, 2019). In addition, standing with Mariani and Baggio (2022), this study calls for more data analytics research using AI methods to build theories rather than merely reporting discoveries. In this way, researchers could unleash the potential of AI to advance hospitality research both methodologically and theoretically.

5.2.2 Research context and themes. AI makes constant strides in its applications across fields at this present moment. The low-code interfaces and free access of generative AI applications have significantly lowered users' thresholds for using AI, leading to the rise of AI adoption in the industry and academia (Maslej *et al.*, 2023). Industry executives and researchers estimate the surge of voice-control services and AI-generated contents (AIGCs, e.g. text, graphics, videos and code) enabled by these powerful generative AI models, which largely improve users' productivity, unleash their creativity and reshape their behaviors

(Boulton, 2023; Dwivedi *et al.*, 2023; Maslej *et al.*, 2023). Thus, more studies on generative AI applications should be conducted to validate these speculations in hospitality. For example, hospitality researchers could delve in depth about in what way and to what extent generative AI applications alter customers and service providers' behaviors, interactions and relationships in their future research. Moving the research focus beyond customers, further research on other important stakeholders (e.g. hospitality managers and policymakers) and the entire AI service ecosystem is advocated to reveal and bridge the knowledge gap between customers and suppliers (Ozdemir *et al.*, 2023). For instance, to objectively evaluate the role of AI in hospitality, research on the performance and governance of these AI applications warrants further examination.

For AI methods research, future research could study the emergence and value of AIGCs in hospitality. Possible research questions would be who produces these AIGCs and why, and how these AIGCs influence hospitality brand image and customers' purchase intention. Besides, with the emergence of the metaverse's hospitality and tourism marketspace and related activities, the number of AI methods studies conducted during the service experience is expected to increase sharply because researchers can use AI models to automatically capture, store and analyze users' digital footprints (e.g. transaction records through fungible and non-fungible tokens) in the digital experience space (Buhalis *et al.*, 2023).

5.2.3 Methods. This study advocates the increased use of qualitative methods such as in-depth interviews, focus groups and case studies to delve deeper into the AI-equipped service ecosystem. For instance, Allal-Chérif *et al.* (2021) conducted multiple case studies on how service provided by AI-based procurement management systems redefines the purchaser's role, supplier relationship, interdepartmental collaboration and other business functions in the workplace. Furthermore, a mixed-methods approach can compensate for the drawbacks of each selected method, a strategy that is encouraged in future AI studies to provide inclusive and robust interpretive and descriptive results (Huff, 1999).

Recent top-quality AI methods research often involved large-sale data sets, complex data preprocessing steps and advanced AI algorithms. Advanced generative AI applications such as ChatGPT can help hospitality researchers to achieve methodological breakthroughs in two aspects. First, AIGCs, such as AI-generated editorials, graphics and videos, could be a new type of data source in AI methods research. Second, hospitality researchers could leverage the co-pilot of generative AI applications to augment their coding skills in data collection and analysis (Liu *et al.*, 2023). Albeit with assistance of these tools, researchers still need to improve their capability in searching for valuable research questions, selecting appropriate research method and algorithms and properly applying and communicating this knowledge in their research to publish in top hospitality journals. In addition, researchers could engage in interdisciplinary collaborations (e.g. computer science, psychology and sociology) that spark multi-dimensional knowledge innovations to advance AI research in hospitality.

5.3 Practical implications

This study also provides several practical implications for practitioners and researchers. First, AI is a broad field housing various technologies that mimic human cognitions and behaviors, from natural language processing and machine learning to robotics. Therefore, hotel practitioners can leverage various AI-facilitated services, such as service robots and automated data analytics, to assist operations and decision-making. Second, the proliferation of disembodied AI agents such as voice assistants and facial recognition may raise ethical and privacy issues when implemented. Hence, to ensure moral correctness and data security, the managers need to understand the rationale behind these models and make

objective and rational judgments regarding the deployment of relevant AI tools. In addition, this study advocates more research combining UGCs and objective transaction and device data and deeper level of industry–academia collaboration, hoping to address the issue of data availability and generate practical and meaningful findings that benefit both groups.

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Supplementary material

The supplementary material for this article can be found online.

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