

## Artificial intelligence and hospitality industry: systematic review using TCCM and bibliometric analysis

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**Abstract:** This study gives an extensive review of the literature that exists concerning artificial intelligence. This paper helps identify the recent trends in AI in the hospitality industry and research gaps. The use of primary data for qualitative analysis is still low due to the industry's newness of AI applications. The theory development, characteristics, context and methodology (TCCM) framework has been employed for theory development and to identify gaps in existing research and future research directions. This paper provides a qualitative analysis of the relationship between varied use of AI in the hospitality industry holistically using bibliometric analysis and TCCM. Results show that 'consumer experience', 'robots', 'forecasting', 'willingness to accept', 'technology development', 'human-robot interaction' are the main domains. The perception of customers, experience, and technology development are a few factors that impact a firm's competitiveness immensely. This analysis provides a picture of the current state of AI in the hospitality domain.

**Keywords:** artificial intelligence; robots, internet of things; automation; hospitality industry; tourism industry; bibliometric analysis; systematic review.

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## **1 Introduction**

The current issue of COVID-19 has created an extremely challenging and tough situation for the world economy (Kenny and Dutt, 2021; Nadeau et al., 2021). Artificial intelligence is becoming an integral part of service industries' day-to-day activities, especially the hospitality industry (Lin et al., 2019). Although the hospitality industry has been lagging compared to others when it comes to the adoption and implementation of artificial intelligence, the situation has been changing recently (Nadkarni et al., 2019; Pizam, 2017). With increasing service demands, advancements in technology being used in hotels, restaurants, etc., are on the rise and profoundly impact the host-guest interaction (Kriechbaumer and Christodoulidou, 2014; Nadkarni et al., 2019). Multiple colloquial meaning of artificial intelligence has been generated since John McCarthy founded the term in 1955. The most used definition is that artificial intelligence imitates intelligence special to the mind and can gain knowledge from it (Arel et al., 2010). Robots, service automation, the internet of things, and artificial intelligence are being used in various industries in various capacities (Zlatanov and Popesku, 2019). The hospitality industry and the tourism industry have been running for years on the basic principle of human-human interaction, replaced by machine-human interaction (Bowen and Whalen, 2017). The hospitality industry uses artificial intelligence-based operations to increase efficiency and reduce the human resource load by standardising repetitive tasks that machines can easily perform. Artificial intelligence in hospitality has multiple uses in robotics, service automation, Chatbots, trend analysis, customer preference

analysis with big data and forecasting. Another form of tourism that is emerging in the market is augmented and virtual reality tourism which allows the consumer to experience a tourism destination in real-time and enhance their experience (Liang and Elliot, 2020). Tourism firms use various machine learning and time series models for accurate tourist arrival forecasting to better prepare and increase their revenues (Claveria et al., 2020). Due to its unique calculation system and ability to deal with enormous amounts of data will be highly useful in tourism and hospitality forecasting (Li and Jiao, 2020). Hilton worldwide partnered with IBM to implement robotics in their hotels by introducing their first robotic concierge, ‘Connie’ (Lu et al., 2019). Robots such as ‘Relay’ and ‘Wally’ are becoming an integral part of various hotels across the world, such as residence inn by Marriott, Holiday Inns and Aloft Hotels, etc. (Lu et al., 2019; Crook, 2014; DeSocio, 2016). Chatbots have also depicted tremendous growth and potential in the tourism and hospitality industry by fulfilling customers’ and firms’ needs and requirements accordingly (Zlatanov and Popescu, 2019). Hospitality firms are also using artificial intelligence for competitive intelligence by collecting knowledge and analysing a large amount of data to increase their competitiveness (Köseoglu et al., 2019). The innovation employed by tourism firms directly relates to their competitiveness, however positive or negative (Zuñiga-Collazos et al., 2020; Basri et al., 2019; Triantafyllidou and Tsiaras, 2018). There are multiple other factors as well that impact the performance of the organisation such as business strategy, administrative decisions, operations, etc. (Ahmad and Ramadan, 2018). With the increased application of AI and robotics, issues related to them have come into the limelight (Lin et al., 2019). The research on artificial intelligence has been more from the aspect of science rather than social science until recently (Berezina, 2018; Ivanov et al., 2017, 2018; Collins et al., 2017; Ivanov et al., 2019; Murphy et al., 2017a, 2017b; Kuo et al., 2017; Tung and Law, 2017; Tussyadiah and Park, 2018; Tung and Au, 2018; Tussyadiah et al., 2017). The existing literature on multiple uses of artificial intelligence is scant as it is a young, dynamic, and fragmented concept (Chi et al., 2020). Although the number of researchers focusing on the applicability of artificial intelligence and its implication in the hospitality industry is increasing, there is still a lack of comprehensive studies focusing on certain major aspects. This study reviews the research conducted from 1984 to 2020.

This study is different from others as it provides a systematic review of the state of artificial intelligence in the hospitality industry rather than focusing on a certain aspect of it.

## **2 Research methodology**

This paper follows a systematic literature review methodology. The literature relevant to the topic was searched on two online databases, Scopus, and Web of Science. We primarily focus on Scopus as it has more coverage than the Web of science related to the topic. Scopus also has a higher percentage of 20% more research articles than WoS (Singh et al., 2020a; Martín-Martín et al., 2018; Singh et al., 2020b). In this case, Scopus has six times the number of articles that came out compared to Web of Science with the given keywords. Another added benefit of Scopus is that it provides more fields for an advanced search for bibliometric analysis. The Scopus search is done based on the following keywords in the article’s title- ‘artificial intelligence’, ‘hospitality’, ‘robotics’, ‘IoT’ and ‘automation’. The result initially had 133 articles.

Further, we apply stricter filters such as articles and review articles only published in journals and ignore conference papers. Only English language documents are selected as a language filter is applied. Hence, the number of papers comes out to be 70. The papers which focus on artificial intelligence only in the hospitality industry are selected, and the final count of research articles is 56. Cite Score is not kept as a criterion for selection as the number of articles published related to the topic is limited. In addition to Scopus' search, the articles which might have been left out as they might not have the keyword in the title but still dealt with AI in hospitality are searched individually in each journal which came out in the result. Those articles are also included in this study to make it more comprehensive.

TCCM framework helps provide a summary of the research articles used so that theory can be developed with its help. T in TCCM is for theory development, C is context, C for characteristic and M for the methodology used in that respective research article (Shaik and Dhir, 2020).

The information gathered from the research articles is systematised in an Excel spreadsheet in the following categories: author(s), the title of the article, year of publication, source title, key finding(s), theories used in the paper, the context in which artificial intelligence is being used, characteristics of artificial intelligence and research methodology (Singh et al., 2020a). The majority of studies focus on domains such as artificial intelligence acceptance, forecasting, machine learning, big data analytics, hospitality education, employment, and various others.

## 2.1 Software used

- a RStudio: Rstudio (V3.5.1), a software-based programming language R, is used for statistical computing and graphical data representation. It is an integrated development environment. It makes the graphics more accessible to the researchers. The BibExcel file downloaded from Scopus is used for statistical analysis and clustering.
- b VOSviewer: VOSviewer is software that helps the user in the visualisation and construction of bibliometric networks. VOSviewers present the bibliometric data in the form of easy to understand and interpret networks or maps. VOSviewer has the option of presenting multiple outputs like bibliographic coupling by author, countries, etc. co-citation, citation, keyword occurrence in a graphical representation of data.

## 2.2 Output

The output from the analysis of the bibliometric Excel is presented in different clusters, displaying various information.

Figure 1 presents the data related to the most productive countries regarding the highest amount of publication, whether a single country or a multiple country publication. We can easily infer from the graph that the USA, whether a single country or a multiple country publication, is working quite aggressively in the field. Whereas countries like China, India, Malaysia, etc. are still lacking in the number of publications despite them having a huge tourism and hospitality industry base.

The multiple outputs help us analyse the countries that are working diligently in the field and why these countries are the leaders in this domain. It might be the advancement in technology, customer demand, and even in some cases, the policies and regulations of the government play a huge role.

**Figure 1** Top 10 most productive countries with the highest amount of publication (see online version for colours)

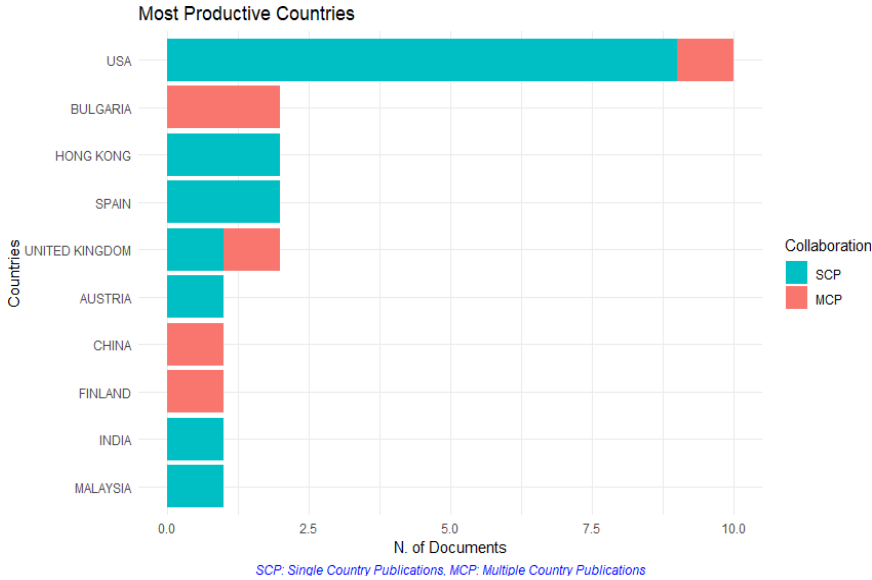


Figure 2 depicts the average total citation per year, and we can see that in 1987, this field picked up well as the number of average total citations was highest at that time. The citations again picked up in the year 2017 and went down but a boom was seen in the post-COVID era.

Figure 3 shows that the authors in the green cluster have the highest amount of citations to date as the strength of the link is the maximum in green. There are different clusters, and the density of the clusters depicts which cluster of authors has more citations. Authors such as Ivanov, Gretzel, Berezina, etc. have the highest number of citations.

As represented in Figure 4, the top 12 most cited documents are depicted above and it helps us understand the theories, research, area, context, etc., which are the most relevant in the given field. The number of citations can also help understand the current trends in the research domain about the topics being explored and the factors being used. As observed from the figure, most citations have been done for the work published in the past decade and only one reference of a paper from 1984. This can also prove that the amount of work being done in this field has increased recently, particularly in the last decade.

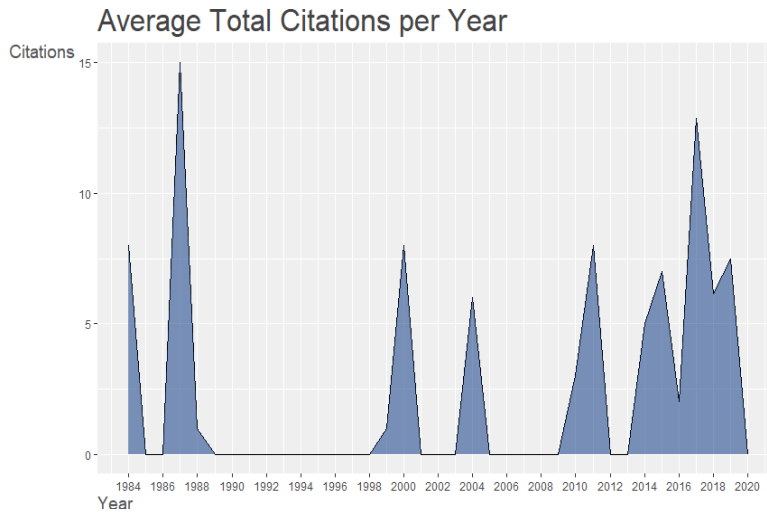
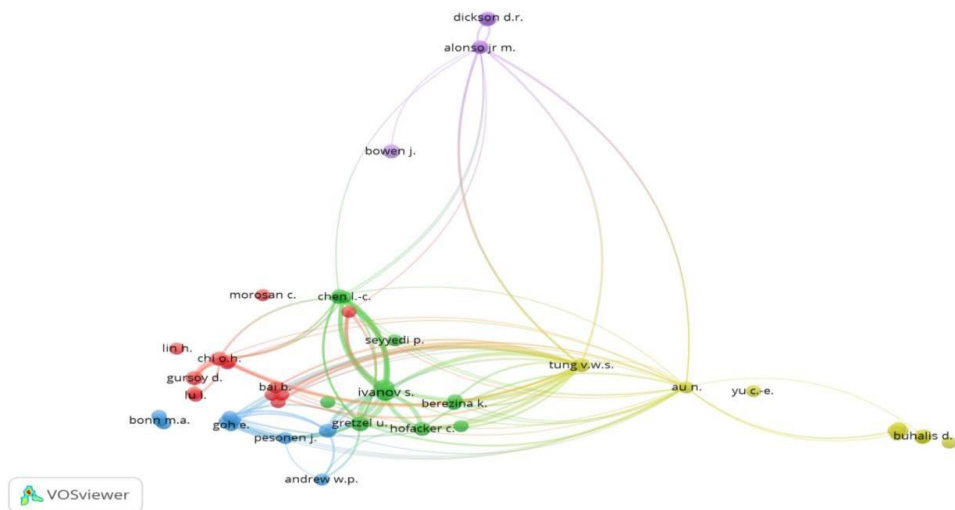
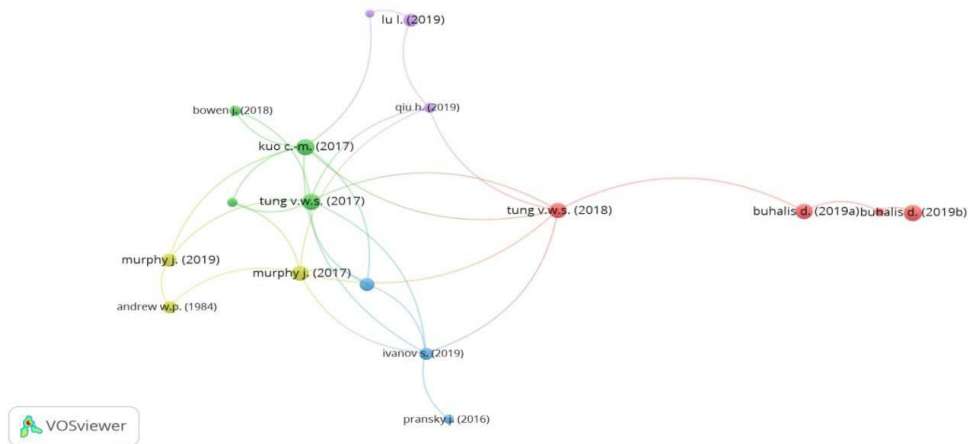
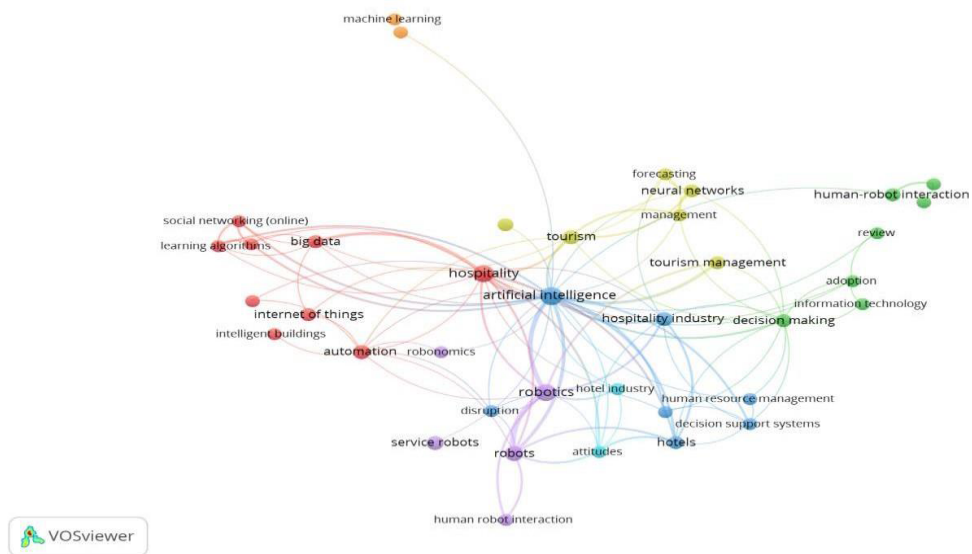
**Figure 2** Average total citations per year (see online version for colours)**Figure 3** Highest amount of citation\_authors (see online version for colours)

Figure 5 presents the analysis of the occurrence of all the keywords from the bibliometric analysis. The most highly occurring keywords are ‘artificial intelligence’, ‘hospitality industry’, ‘robotics’, ‘decision making’, ‘automation’, ‘neural networks’, ‘tourism’, ‘hospitality’, ‘internet of things’, ‘big data’, ‘human-robot interaction’. These keywords help us analyse the direction in which the current research is happening so that we can formulate our future research agenda.

**Table 1** Widely used variables/constructs and methodologies

<i>Independent factors</i>	<i>Dependent factors</i>	<i>Methods</i>
Artificial intelligence acceptance/ willingness to use	Social impact, motivation, efficacy, anthropomorphism, positive emotion (Lin et al., 2019); ease in recruiting process (Dickson and Nusair, 2010); perceived usefulness and performance, service delivery, labour shortage (Bowen and Morosan, 2018); TAM, SMACIT model (Nadkarni et al., 2019); experience, robots disadvantages, advantages, Social skills of robots (Ivanov et al., 2018); ease of maintenance, simple and cost-effective backup, development of technology (Doren and Blackman, 1993); motivation, anthropomorphism, social impact, conditions, emotions, perceived ease of use, habit and experience (Lu et al., 2019); collectivism, discomfort, long term orientation, masculinity, perceived usefulness	In-depth interview (Dickson and Nusair, 2010); SEM (Lin et al., 2019; de Kervenoael et al., 2020); systematic literature review (Chi et al., 2020; Cain et al., 2019; Bowen and Morosan, 2018); factor analysis (de Kervenoael et al., 2020); case study (Go et al., 2019; Fornells et al., 2015); concept mapping (Fornells et al., 2015)
Consumer experience	Human-aligned variables, security and co-experience (Tung and Au, 2017); real-time co-creation (Buhalis and Smarta, 2019)	Review (Tung and Au, 2017); thematic analysis (Tung and Au, 2017)
Barriers to the use of AI	financial, technological, behavioural and attitude barriers, sales, job insecurity (Leung, 2019)	Review (Mariami, 2019)
Forecasting	Input variables of hotels (Al Shehhi and Karathanasopoulos, 2020); factors related to hotels such as hotel room, tourist stay, hotel number, etc. (Law, 1998); occupancy rate, booking rate, hotel capacity, demand (Fiori and Fironi, 2020)	Dickey-fuller test (Al Shehhi and Karathanasopoulos, 2020); ANFIS (adaptive network fuzzy interference system) model (Al Shehhi and Karathanasopoulos, 2020)
Hospitality technology (development perspective)	customer acceptance of the robots, the impact of robotics on the financial service, robotics effect on the food department workplace environment, the impact on the skills and training needed for successful management, impact on equipment design and foodservice facilities layout (Andrew, 1984); use of technology in the hospitality sector, lodging, and food sector (Borsenik, 1993); government support, demand and supply-side capabilities (Kuo et al., 2016); industry application feasibility (Mecool, 1987)	Review (Borsenik, 1993); conceptual (Andrew, 1984; Mecool, 1987); mixed method (Kuo et al., 2016)

**Figure 4** Most cited documents (see online version for colours)**Figure 5** Occurrence of all keywords in the bibliometric analysis (see online version for colours)

### 3 Artificial intelligence

The recent trend in hospitality industry and tourism depicts that the use of robotics and forecasting is gaining momentum. As the advancement in artificial intelligence, especially robotics, is growing, the research being carried out in the field is also increasing (Ivanov et al., 2019). Robotics is the primary field of research because it has the maximum amount of application in hospitality, as it is a service industry. Robotics finds its main use in the hospitality industry at the front desk as concierge, waiters in the restaurants, at check-in, etc. Besides robotics, big data analytics for forecasting, whether



it is hotel room occupancy, hotel room rate forecasting, reservation-based forecasting method, or tourist arrival analysis, is an upcoming field (Al Shehhi and Karathanasopoulos, 2020; Fiori and Foroni, 2020; Law, 1998). The websites and reviews are useful tools for judging the customer's feedback regarding various experiences (Ajanovic and Çizel, 2020). In the bibliometric study, more than 50% of the research articles focused on the theme related to robotics in hospitality. Artificial intelligence is being used in hospitality services, especially at restaurants and hotels, followed by airports focusing on human-robot interaction (Ivanov et al., 2019).

As technology advancements are taking place and changing the way how customer service or operations are done, the inclusion of artificial intelligence by researchers and practitioners is also on the rise (Huang and Rust, 2018; Marinova et al., 2017; Van Doorn et al., 2017; Wirtz et al., 2018). The future consumers will rely heavily on the utilisation of artificial intelligence as they become more time-driven and will delegate plenty of their tasks to technology (Stylos, 2019). The willingness of customers to use the new advancements in technology also depends on the product being offered and the novelty of the same (Bahl et al., 2019). Willingness to use artificial intelligence has been explored in the past literature from the perspective of organisational setting, consumer perception, and consumer willingness (Lu et al., 2019). There are multiple theories, such as the TRA, consumer acceptance of technology and the TAM, which talk about the willingness of the consumer to accept the said technology (Venkatesh et al., 2012). Multiple articles focus on organisational and consumer experience factors. Majority of the studies conducted on the willingness of technology acceptance focus on the employee aspect of the organisation and the consumer experience aspect. The analysis of the articles shows that the willingness to accept artificial intelligence in the hospitality industry increases if the consumer prefers it and finds improvement in the quality of service.

#### **4 TCCM framework**

The literature review in the above section depicts that artificial intelligence is a niche field of research in the hospitality domain as its application is quite recent. The extant literature only focuses on certain aspects of artificial intelligence rather than looking at it holistically. Factors such as willingness to use, technology adoption, and consumer experience are quite common and old topics. Still, a trend has been observed in the articles focusing on artificial intelligence's challenges and forecasting aspect. The literature only focuses on one aspect of artificial intelligence as it is a nascent field but it's imperative to focus on certain other aspects of it as well to avoid major failure from occurring. The TCCM framework helps examine the research gaps in the existing literature so that a future direction of work can be determined.

**Table 2** TCCM framework table

<i>S. no.</i>	<i>Author/year</i>	<i>Theory</i>	<i>Context</i>	<i>Characteristic/findings</i>	<i>Methodology</i>
1	Dickson and Nussair (2010)	HR process	Resume scanning process (technology-based) in the hospitality sector	Use of artificial intelligence in HR process and benefits of AI in that process	Interview
2	Lin et al. (2019)	AIDUA framework	Customers' AI service acceptance in hospitality service	Customer willingness and objections to AI and antecedents affecting the robotic device	Survey and CB-SEM
3	Chi et al. (2020)	UTAUT, AIDUA, uncanny valley theory	AI technology adoption for service delivery	Multiple themes are identified after review such as current AI technology, AI agents, levels, potential challenges, human service encounters, etc.	Systematic literature review
4	Bowen and Morosan (2018)	Service models	Adoption of robots in the hospitality industry	Service delivery, labour shortage, tourist acceptance, systems' perceived usefulness and performance	Conceptual paper
5	Mariani (2019)	Big data analytics	Challenges, use and future scope of big data in hospitality	Embedding data science skills and competencies in cross-disciplinary research teams	Conceptual paper
6	Verevka (2019)	Theory of digital vortex, business model	Role of digital innovation	Adaptation of management of the enterprise to the possibility of the revolution (digital) and the breakthrough	Conceptual paper
7	Tung and Au (2017)	USUS framework	Consumer experience with robotics in the USA and Japan	Human-oriented perception, embodiment, emotion	Thematic analysis
8	Al Shehhi and Karathanasopoulos (2020)	Support vector regression, DEMATEL, ANP	Demand and price forecasting in the cities in the Persian	AI application modelling would reduce the costs of multiple works in hospitality industry	Dickey-Fuller test, deep learning non-linear PSSVM
9	Cain et al. (2019)	TAM, USUS framework, logical positivism and confirmation theory; decision theory; game theory; control theory; service robot acceptance model (SRAM)	State of hospitality research in AI and robotics	Interaction between hospitality experts and technology producers to be able to create robots and other AI-based technology with excellent skills	Systematic literature review
10	Webster and Ivanov (2019)		State of robotics, AI, and automation technologies (RAIA) in the hospitality sector	Drastic changes in society due to innovative and labour-saving technologies	Conceptual perspective paper

**Table 2**      TCCM framework table (continued)

<i>S. no.</i>	<i>Author/year</i>	<i>Theory</i>	<i>Context</i>	<i>Characteristic/findings</i>	<i>Methodology</i>
11	Andrew (1984)	Robotics technology	How technology affects hospitality graduates and makes them understand the implication of the technology being used	customer acceptance of the robots, the impact of robotics on the financial service, the effect of robotics on the foodservice workplace environment, the impact on the skills and training needed for successful management, and the foodservice facilities layout	Conceptual paper
12	Borsenik (1993)		state of technological development	Difference between development and current technology use, current hospitality education programs lead to reluctance in the industry toward technology	Systematic literature review
13	Kuo et al. (2016)	Den Hertog's six-dimensional capabilities	service innovation strategic mindset is applied and analysed in the hotel industry of Taiwan	Multiple factors are analysed for demand and supply – side such as government support, capability for market development, technology development capability, etc.	Mixed – method approach
14	Kervenoael et al. (2020)	(UTAUT); TRA and theory of planned behaviour; cognitive evaluation theory; uncanny valley theory; TAM; RATER model	visitors' intention to use social robots in Singapore is conceptualised and empirical measured	Perceived usefulness, usage, assurance of service, personal engagement, empathy, perceived value, information sharing	Interview, survey, photographic evidence; PLS-SEM; CFA
15	Solnet et al. (2019)	relationship orientation models, guest service preference model	Introduction of hospitable service (AI – based) for creation of value in service organisations	Opening up new research opportunities through leveraging the human touch in service-based organisations	Conceptual paper
16	Go et al. (2019)	iTAM framework	Acceptance of robots and artificial intelligence in the hospitality industry, tourism industry by the customer	perceived usefulness, perceived usage, attitude towards using	Systematic literature review
17	Mccool (1987)	Expert systems	use of expert systems or developing an expert system for the firms in the hospitality industry for various purposes	As the technical and economic feasibility of AI system increase, there will be a boost in interest in their usage by firms.	Conceptual paper
18	Ivanov et al. (2019)	Technology acceptance model (TAM)	Review of research on robotics	The paper identifies application areas for robots	Qualitative thematic analysis

**Table 2** TCCM framework table (continued)

<i>S. no.</i>	<i>Author/year</i>	<i>Theory</i>	<i>Context</i>	<i>Characteristic/findings</i>	<i>Methodology</i>
19	Fornells et al. (2015)	Data clustering theory, information theory	Analysing excellence in the Barcelona hospitality industry through a case study	Improving the clustering determination through a new method	Concept mapping methodology
20	Buhalis and Sinarta (2019)	Resource advantage theory of competition, Marketing theory, Management theory, a conceptual framework of a real-time service	Use of technology to enhance customer experience via co-creation	Innovative approach towards real-time co-creation and now ness service for co-creating value with consumers	Exploratory research
21	Bashynska et al. (2019)	Sales tunnel in messengers	Effective internet marketing in the hospitality industry	A lead magnet, tripwire, core product, profit maximiser	Conceptual paper
22	Leung (2019)	Business model and forecasting model	hospitality industry in Taiwan	Dependent- barriers to becoming smart, independent- financial, technological, behavioural and attitude barriers, sales, job insecurity,	In-depth interview
23	Buhalis et al. (2019)	Theory of value co-creation; theory of mind and self-aware, extended self – theory, system theory view of tourism	Value co – creation using technological disruptions in service innovations in hospitality and tourism firms	3 areas are conceptualised for future direction in experiences such as extrasensory, beyond automation and hyper-personalised	Conceptual paper
24	Gamble and Lockwood (1989)	Game model, garbage can model	EXMAN project	Corporate battlefield command skills among business students are developed through designed case studies	Conceptual paper
25	Nadkarni et al. (2019)	Internet of things – big data triple impact intensity model, business model, tourism service consumption model, input- process-output model, triple bottom line model, TAM, artefacts model, SMACIT model	Use of the internet of things and big data relation	Contextualisation of applications of IoT by applying an input–process – output model	Conceptual paper
26	Tung and Law (2017)	TAM	Identify future opportunities for tourist experience research in HRIs	Consumer experience with the robots used in hospitality in different capacities, service robots use, Implications of using robots in hospitality, an embodiment of robots	Conceptual paper

**Table 2**      TCCM framework table (continued)

<i>S. no.</i>	<i>Author/year</i>	<i>Theory</i>	<i>Context</i>	<i>Characteristic/findings</i>	<i>Methodology</i>
27	Saravanakumar and Narayanan (2018)	Service automation	Automation in the hospitality sector	IoT, Automated and robotic concierge services, AI for guest service, chatbots for information service, VR, and AR; challenges in adoption: device compatibility, collaboration of stakeholders, cost, risk of data security and invasion of privacy, missing the personal touch	Descriptive paper
28	Bowen and Whalen (2017)	Trend analysis	Changing trends	4 trends such as economy sharing, technology such as robotics and AI, etc. are identified	Systematic literature review
29	Aluri et al. (2019)	Dynamic customer engagement model	machine learning-based customer engagement-to-value loyalty chain	Results indicate that the methodology – aided in increasing the revenue in the Top segment rather than the Intuition segment;	Primary research (Conceptual paper)
30	Borchgrevink (1999)	General systems theory	A visible automated beverage control system in the hospitality industry	Guest satisfaction	Experimental research
31	Ivanov et al. (2018)	Uncanny valley theory	The attitude of the young adults in Russia towards robots providing various services in hotels	Dependent – personal attitude towards robots serving in a hotel; independent – experience, robots disadvantages, advantages, social skills of robots	Regression and EFA
32	Law (1998)	Box-Jenkins or the naïve extrapolation models, forecasting models	The Hong Kong hospitality industry hotel room occupancy forecasting	Multiple features are forecasted such as Independent- number of tourists, average stay length, number of hotel rooms, tourists per room, dependent – hotel room occupancy rate	Multiple regression and naïve extrapolation, neural network
33	Doren and Blackman (1993)	Hotel technology	Converting normal hotel rooms into an intelligent bedroom to increase accountability and reduce the staff turnover cost	Dependent – integration of technology, independent – ease of maintaining, cost-effective backup, development of technology	Conceptual paper
34	Lu et al. (2019)	Theory of AI job replacement, TRA, TAM, consumer acceptance of technology, UTAUT	Multi – dimensional service robot integration willingness (SRIW) scale	Independent variables – performance efficacy, motivation, anthropomorphism, social impact, conditions, emotions, perceived ease of use, habit and experience; dependent- willingness to use robots	EFA, CFA, nomological validity and invariance analysis
35	Chan et al. (2020)	Psychometric theory, theory of planned behaviour	Adoption of environmental technologies in hotels in Hong Kong	Independent – monopolised after-sales service, limitations, government support, performance, green knowledge lack and network, customer experience, dependent – the adoption of green technology	EFA, ANOVA, T-test, questionnaire

**Table 2** TCCM framework table (continued)

<i>S. no.</i>	<i>Author/year</i>	<i>Theory</i>	<i>Context</i>	<i>Characteristic/findings</i>	<i>Methodology</i>
36	Wu et al. (2015)	Theory of person sensitivity bias, the heuristic – systematic model	Consumers' encounter evaluation and intentions to revisit are decided through employees' adoption of wearable technology	Independent – revisit intention, satisfaction, service outcome, gender of employee; dependent – wearable technology	ANOVA
37	Choi et al. (2000)	KDT Framework	Profit maximisation criteria for a hotel (Hong Kong)	Dependent – yield management, independent- booking level, Competitors, event attractiveness, strategy, season of tourism, occupancy, reserved, walk-in, corporate, FIT, group, rack rate, night stay, accept	Conceptual paper
38	Filimonau and Naumova (2020)	BCT Framework	BCT application evaluates its potential for future integration	BCT holds large potential for application rather than 'pure' tourism industries.	Conceptual paper
39	Shin and Perdue (2019)	TAM	Bibliometric analysis of self-service technology in the hospitality industry	SST adoption from the viewpoint of customers, situational factors, employees, technology readiness, experiences, value co-creation, and service failure bibliometric co-citation analysis	
40	Fiori and Foroni (2020)	A stochastic framework, multiplicative model, generalized linear model, dynamic room pricing model, ARMA model, econometric model, Bayesian model, ODP, and CP models	Framework on the accuracy of forecasting methods used by hotels in Italy	Proposed framework based on factors such as occupancy rate, booking rate, hotel capacity, demand	Stochastic pickup and empirical study
41	Youn and Gu (2010)	Logistic regression model, failure prediction model, (MLP) neural network model, ANN model	Prediction of Korean Lodging firm failure	Interest coverage, EBITDA to CL, Inventory turnover, FA turnover, EBITDA to TL, TA turnover, AR turnover, Debt ratio	Logistic regression model and neural networks mode
42	Claveria et al. (2014)	Grey theory, SVM, ANN, econometrics model, time – varying parameter models, choice model, (ARIMA) models	Tourist arrival forecasting in the context of Catalonia (Spain)	A new forecasting accuracy measure is developed	Multivariate neural network approach
43	Nissan (1987)	BORIS framework	Expert systems employed in hospitality, room rental, and real estate	three systems are discussed- HAVANE, IMP, Eloquent; all are expert systems	Conceptual paper

**Table 2** TCCM framework table (continued)

S. no.	Author/year	Theory	Context	Characteristic/findings	Methodology
44	Li et al. (2020)	Customer experience theory; cognitive appraisal theory;	critical review of existing research on theme parks	The theoretical relationship between the practical theme park phenomenon and the definition by creating a conceptual model is explored	Critical review approach
45	Choi et al. (2020)	Language expectancy theory, three- factor theory of anthropomorphism	language style impact on customer evaluation ( technology – infused service)	Service agent, perceived credibility, language style, service encounter evaluation	Experimental research
46	Sun et al. (2019)	TRA, TAM	Impact of culture on technology acceptance and readiness in hotels	Independent- Collectivism, discomfort, long term orientation, masculinity, perceived usage	Questionnaire, EFA, CFA, correlation, reliability, hypothesis testing
47	Alsetoohy et al. (2018)	Diffusion of innovation theory, social cognitive theory, TAM, UTAUT, theory of planned behaviour, TRA, TOE framework	Analysing the factors impacting the attitude of hotel managers regarding intelligent agent Technology	Factors related to technology, organisation and environment are examined	EFA and regression
48	Chiu et al. (2013)	Customer perception, opinion mining	Analysing the online word-of-mouth of hotel customers in Taiwan	Specific hotel attributes are identified and analysed, including services, price/value, F&B, room, hotel image, amenities, and location	Opinion mining, semantic classification and visualisation
49	Chang and Katrichis (2016)	Grounded theory, integrated framework	To draw a framework for tourism management	Framework identifies 10 categories and outlines the interaction process in TM	Content analysis (literature review)
50	Wei (2019)	Self-determination theory, TAM, process theory, theory of reasoned action, hedonic theory,	The main developments which have occurred in VR/AR research and current trends	A theoretical framework is developed based on the synthesis of stimuli, consequences of VR/AR user experience and dimensions	Systematic literature review
51	Li et al. (2019)	AI and robotics awareness	Awareness amongst hotel employees related to AI and robotics and the impact of AI on turnover intention	Organisational support (perceived), employment concern, psychological climate as a moderator	Survey, CFA, hierarchical linear modelling, hypothesis testing
52	Li et al. (2018)	Econometric model, forecasting model, dynamic factor model, regression model	Big data use and direction of big data research in hospitality and tourism industry	Data generated in tourism hospitality is divided into 3 parts: user-generated data, device data, and GPS data and is used for various purposes like forecasting, etc.	Systematic literature review

**Table 2** TCCM framework table (continued)

<i>S. no.</i>	<i>Author/year</i>	<i>Theory</i>	<i>Context</i>	<i>Characteristic/findings</i>	<i>Methodology</i>
53	Yu (2020)	Uncanny valley theory	Analysing the perception of the public regarding human-like robots being the front desk employees	Public showed a negative interest in terms of perceived intelligence and likeability of the human-like robots	Thematic content analysis (YouTube)
54	Choi et al. (2020)	Spreading activation theory	cultural perceptions influence tourists' experiences while interacting with service robots (Robot staffed hotels in Japan)	Non-Japanese valued the functional and technical aspects of robot services and Japanese showed the emotional responses to human-robot interaction and reviews from	Semantic network analysis
55	Domingo-Carrillo et al. (2019)	Revenue management strategies	Evolution, trend, the origin of the scientific production (based on various factors such as countries, researchers, etc.), dissemination and content	Results provide a future direction to researchers, leading authors, universities and countries in revenue management research, evolving research methods and strategies are realised	Scientific production via bibliometric analysis
56	Seyitoğlu and Ivanov (2020)	Customer experience	Analysing whether the application of robots to provide physical distance is going to be beneficial or negative	Important drivers for customer perception are realised that are closely related to the service	Research note



#### *4.1 Theory development (T)*

The review of the extant literature shows a lack of theory building in the domain being discussed. The theories and models such as AIDUA (Gursoy et al., 2019) and UTAUT (Davis, 1989; Lu et al., 2019) are commonly used in the literature. However, TAM (Davis, 1989) and USUS are the most highly used models in the literature. There are multiple variations of the same and researchers are trying to build up new versions of the same. All the models, frameworks and theories mainly focus on either the use of the technology or the acceptance of the said technology. This creates a barrier in the research being carried out as it talks about only one phenomenon. The current literature is mainly focused on one direction and ignores other aspects such as its impacts or actual practical implications. Due to artificial intelligence being a new idea in this domain, research is being conducted on the aspects visible in the short term. Another area that is ignored is the drivers or the enablers of artificial intelligence. The theory development related to the economic and social impact of artificial intelligence is also missing. New theories and models can be developed which can discuss the areas mentioned above.

#### *4.2 Context (C)*

The context in which the research is mainly focused upon in the hospitality industry is adoption and use in hotels and restaurants for customer service. The majority of studies have been done in the area of technology acceptance and use especially robots and forecasting using artificial intelligence. Artificial intelligence in education, corporate firms, day to day operations, transportation, On-site use, etc., has been left untouched. Almost all the studies which have been conducted focus on the use of robotics and big data in hotels and leave out educational institutes of hospitality, airlines, firms, etc. Very few numbers of studies in actuality discuss the implications or impact of artificial intelligence on different aspects such as economy, politics, human resource, environment, society, cultural impact, future of AI, etc. Therefore, this creates an opportunity for the researchers to focus on the said areas in the future.

#### *4.3 Characteristics (C)*

The literature review reveals that factors such as willingness to use, acceptance and forecasting have been explored in quite some detail (Bowen and Morosan, 2018; Dickson and Nusair, 2010; Law, 1998; Lin et al., 2019). However, factors such as the future of AI, cultural and economic impact, artificial intelligence in hospitality education and effects on firms have been left untouched. As the data related to willingness to use AI or big data are easily available, there is a bias towards the said areas in the article. Very few quantitative or qualitative studies have been carried out observing the impact of AI or any other area related to it. Although the previous studies provide us with a solid understanding of the implementation of Artificial intelligence in hospitality, it does not focus on the aftermath of the same concerning various aspects.

#### *4.4 Methodology*

Most of the articles are based on a comprehensive literature review. The studies have worked upon existing models and theories and worked further upon them from the

perspective of the hospitality industry. A few articles have proposed models and frameworks based on primary data. However, a few articles have also conducted empirical research and analysed the data using regression analysis and SEM. Articles focused on forecasting have used machine learning methods and an artificial neural network approach to get the results. The most appropriate research method is mixed-methods approach, which entails using qualitative and quantitative methods for theory building and development.

## **5 Discussion and implications**

The analysis carried out above clearly demonstrates that the factors responsible for being focused upon in the hospitality industry related to artificial intelligence are from a certain perspective only. Factors such as willingness to accept/ use artificial intelligence and consumer experience are at the forefront, whereas barriers to AI, forecasting, and hospitality technology are close behind. Willingness to accept/use is explored in the literature from the point of consumer and employee use in hotels, restaurants, or other services. The strong point of view is considered while elaborating on barriers to the use and hospitality technology development. The robot-based hospitality industry will greatly impact how people live their lives and conduct business (Webster and Ivanov, 2019). Variables such as financial consideration, attitude, job insecurity, and market demand plays an important role. The study's findings help us analyse the crucial factors while discussing artificial intelligence using the variables mentioned above. The study can help in realising multiple benefits of tourism development through artificial intelligence and can have multiple social, cultural and environmental impacts (Drosos and Skordoulis, 2018; Misso et al., 2018). It also helps in providing the researchers with a future agenda or direction to explore.

## **6 Research implications**

The study helps identify the variables/ factors that have been analysed in-depth and the current trend in research. Most of the existing literature discusses or focuses on a certain set of variables, models, and theories related to artificial intelligence. As the amount of research done on the acceptance and use of artificial intelligence in hospitality is plenty, the researchers can focus on other areas of hospitality with artificial intelligence. Academicians and researchers can develop multiple frameworks and models employing new variables or even using the existing ones, but according to the present time rather than 20 years old.

### *6.1 Practical implications*

As the study shows that a huge part of extant literature focuses on the acceptance and use of artificial intelligence, the practitioners can employ the variables which boost the acceptance and use of artificial intelligence. The variables that act as favourable for adopting AI at hotels or restaurants can be adopted by the practitioners to expand the consumer experience and increase the acceptability amongst employees. Policymakers need to focus on the variables that help implement required technological changes at the

education and firm level. Government policies can significantly impact the use of artificial intelligence for day-to-day operations in the hospitality industry. Policymakers should tackle the variables that act as a barrier to the growth of Artificial intelligence technology used in the industry by making policies that counteract them.

## 7 Future research

In this study, we conducted a bibliometric analysis and reviewed the literature using the TCCM framework. This study gives us an insight into the direction of the research in the past and the present. Taking learning from them, the researchers can either modify or work in-depth on the given model from the perspective of the current technological situation or develop their theories to suit the current situation better. Most of the literature talks about the acceptability or the use of artificial intelligence, especially in terms of service robots. For future research purposes, the scholars can investigate the domain of artificial intelligence from the viewpoint of infrastructure, education, barriers, challenges, government support, employability, or artificial intelligence to combat dire economic situations. The impact of society and culture needs to be explored in-depth as they play a pertinent role in the hospitality industry.

## 8 Conclusions

This study presents a systematic summary of the articles published in the area of artificial intelligence in hospitality from 1984 to 2020. With the application of the TCCM framework, this study helps the researchers in deciding the future course of action by identifying the gaps, prominent characteristics and methods used (Singh and Dhir, 2019). The TCCM framework along with bibliometric analysis provides a comprehensive picture of the literature published from 1984 to date related to artificial intelligence. As the findings depict, the hospitality industry is still lagging in using AI to its full extent. Compared to other sectors, the research, and the practical application of AI in the hospitality industry still leaves a lot to be desired. The research in the hospitality industry is more focused on the actual use of artificial intelligence, barriers, human experience, and various types of artificial intelligence technology rather than the technical aspects like in the engineering domain. Therefore, this analysis provides a picture of the current state of artificial intelligence in the hospitality domain and gives us a future direction.

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