Adoption of service robots: exploring the emerging trends through the lens of bibliometric analysis

Kumar Madhan
NSB Academy, Bangalore, India
Shameem Shagirbasha
Great Lakes Institute of Management, Chennai, India
Tanmaya Kumar Mishra
NSB Academy, Bangalore, India, and
Juman Iqbal
University of Kashmir, Srinagar, India

Abstract

Purpose – The aim of this study is to examine the existing literature on service robots in order to identify prominent themes, assess the present state of service robotics research and highlight the contributions of seminal publications in the business, management and hospitality domain.

Design/methodology/approach – This study analysed 332 Scopus papers from 1985 to 2022 using bibliometric techniques like citation and co-citation analysis.

Findings – The study findings highlighted that there has been a consistent rise in publications related to service robots. The paper identifies three significant themes in the service robot literature: adoption of service robots in the context of customer service, anthropomorphism and integration of artificial intelligence in robotic service. Furthermore, this study highlights prominent authors, journals, institutions and countries associated with research on service robots and discusses the future research opportunities in this domain.

Originality/value – This study contributes to the service robots' literature in the hospitality context by compilation of various reference materials using a comprehensive bibliometric analysis. Previous studies do not point out crucial themes in this area, nor do they provide an overview of prominent journals, institutions, authors and trends in this field. Therefore, this study attempts to fill the lacunae.

Keywords Service robots, Bibliometric analysis, Customer service, Anthropomorphism, Artificial intelligence

Paper type Literature review

1. Introduction

Artificial intelligence (AI) powered customer service robots are becoming popular and are predicted to substitute or supplement services that are usually provided by humans in many fields (Song, Xing, Duan, Cohen, & Mou, 2022; Yoganathan, Osburg, Kunz, & Toporowski, 2021) including, hospitality and tourism services. Customers have become more risk-averse because of the pandemic, which has spurred the use of service robots in the hospitality

industry. A recent projection showed that from 2020 to 2024, the market for hotel service robots will grow by $942 million. AI-powered customer service robots will help the organisation to reduce the interpersonal contact, diminish the risk of infectious transmission and improve the likelihood of a visit (Wan, Chan, & Luo, 2020). Therefore, restaurants, hotels and airports have begun using service robots to conduct activities such as bringing food and beverages to guests and processing their payments. As a result, consumers prefer robot-staffed (as opposed to human-staffed) service more than ever before (Kim, Kim, Badu-Baiden, & Giroux, 2021; Shin & Kang, 2020). Customer service robots aid organisations by decreasing costs, boosting productivity (Wirtz & Zeithaml, 2018), increasing profits and even making managers more creative (Xiao & Kumar, 2021). Experts anticipate that roughly 50% of the current jobs will be automated and mechanised by 2055 (World Economic Forum, 2017), and it is also anticipated that 175 million jobs could be lost by 2022 due to the increasing deployment of robotic technologies. Unlike the traditional robot employed in industrial applications, service robots are primarily intended to assist humans in their daily lives. As a broad definition, customer service robots are "*system-based autonomous and adaptable interfaces that interact, communicate and deliver services to an organization's customers*" (Wirtz, Patterson, Kunz, Gruber, Lu, Paluch, & Martins, 2018, p. 909). In a nutshell, when it comes to communication, service robots are a cutting-edge, interactive technology that can benefit greatly from strategic interventions. The hospitality industry is rapidly adopting service robots to do tasks such as greeting guests, serving meals and processing guest checkouts (Battour *et al.*, 2022). In recent decades, service robot research has increased significantly across various disciplines like information systems (Collins, Dennehy, Conboy, & Mikalef, 2021), robotics (Pinillos, Marcos, Feliz, Zalama, & Gómez-García-Bermejo, 2016), social psychology (Kiesler, Powers, Fussell, & Torrey, 2008) communication studies (Wang, Tian, & Shao, 2020), neuroscience (Westlund *et al.*, 2017) and indifferent countries like Taiwan (Kuo, Chen, & Tseng, 2017), China (Zhang, Balaji, & Jiang, 2022), India (Sinha, Singh, Gupta, & Singh, 2020), Australia (Khosla & Chu, 2013), Italy (Brondi, Pivetti, Di Battista, & Sarrica, 2021) and US (Dootson, Greer, Letheren, & Daunt, 2022).

Prior studies have determined how the features and design of robots affect interactions with customers and have explored more about general acceptance (Chuah & Yu, 2021; De Keyser, Köcher, Alkire, Verbeeck, & Kandampully, 2019; Rafaeli *et al.*, 2017; Wirtz *et al.*, 2018; Heerink, Kröse, Evers, & Wielinga, 2010). It has been highlighted by existing studies that various forms of service robots exist. They can be virtual such as Jamie which is the virtual agent for ANZ bank or the personified one such as Nao, and the appearance can vary from machine form such as robots handling luggage to a non-human entity in the form of human such as Pepper or Sophie. Researchers have looked at how customers react to robots based on their level of anthropomorphism (Choi, Choi, Oh, & Kim, 2020), their personality (Tay, Low, Ko, & Park, 2016) and the type of interaction they have with them which can be through text, voice or the touch-based interactions (Lestingi, Askarpour, Bersani, & Rossi, 2020). Significant effort has been put forth in recent years on getting an understanding of the function that anthropomorphism serves pertaining to service robots, and it has resulted in contrasting findings (Blut, Wang, Wünderlich, & Brock, 2021). Few researchers have discovered that humanoid service robot interactions actually reduce client comfort (Mende, Scott, van Doorn, Grewal, & Shanks, 2019), which in turn can decline the consumer acceptance of robots. This is probably because of the enhanced feelings of obscurity and uneasiness associated with human-like robots (Kim, Baik, & Kim, 2019). In contrast to this, there are few studies that have demonstrated the human-like elements, like a face, limbs or a voice, that can favourably impact customer responses via social cognitive evaluations, resulting in improved conviction and satisfaction (Belanche, Casaló, & Flavián, 2021; Yoganathan *et al.*, 2021). For example, it has been investigated by Nakanishi *et al.*, (2019) that if humanoid robots provide comforting interaction service in hotels and found that it

enhances customer satisfaction positively. On the other hand, research has found that robotic service diminished affective experience of customers in hotels (Chan & Tung, 2019). This may be because of a major drawback of current robotic technology that prevents service robots from accurately mimicking human emotions. Contrarily, Ivanov and Webster (2019) have highlighted that robots and AI have the potential to replace human workers in the hospitality industry. However, it has also been argued by the above-mentioned scholars that all the service procedures cannot or should not be mechanised or carried out by robots as it totally depends on economic efficiency and other interrelated factors. Despite the progress on AI technologies, there has not been enough progress in the study of service robots to warrant their widespread implementation (Wang, Cai, Xu, & Li, 2021).

Synthesising the above discussion, it is clear majority of the research on service robots in academia have centred on questions of adoption (Čaić, Mahr, & Oderkerken-Schröder, 2019; Lu *et al.*, 2020; Xiao & Kumar, 2021), or evaluation of services (Yoganathan *et al.*, 2021) or human-like elements in services (Belanche, Casaló, Flavián, & Schepers, 2020a). Although the existing studies give crucial insights about service robots literature, the application and interaction of such robots in the field of delivery and logistics, cleaning services, agriculture, tourism and hospitality services remains largely unexplored. Specifically, earlier studies have not explored some of crucial themes like industry resistance to adopt service robots, robot displayed surfaced emotions, ethical and privacy concerns in this area, nor do they provide an overview of the general structure in terms of the impact of journals, institutions, authors and its trends. Therefore, this paper aims to address this gap and enable researchers to comprehend the advancements and knowledge distributions of this scientific research domain.

The current article is an effort to complement previous review studies and offer a clear direction for future research by conducting a systematic literature review utilising the bibliometric analysis technique. One can enable academic and research advancements in the hospitality industry by figuring out what is behind the developments in service robots study. Consequently, three following research questions have been developed for this study:

RQ1. How has research on service robots evolved, and which articles are mostly cited?

RQ2. Which journals, institutes and countries have made the most significant contributions to the field of service robots, and who are the most renowned authors in this area?

RQ3. What are the themes that are becoming apparent in the service robots' literature?

2. Methodology
2.1 Design of the study
In an attempt to answer the research questions, we have adopted a descriptive retrospective study using bibliometric methodology. The bibliometric methodology encapsulates the application of quantitative techniques (i.e. bibliometric analysis and citation analysis) on bibliometric data (Broadus, 1967; Pritchard, 1969). The most notable advantage of this method is its ability to uncover research patterns, which in turn allows researchers to evaluate the body of literature, make sense of the expansion of our understanding and suggest new avenues for investigation (Albort-Morant, Henseler, Leal-Millán, & Cepeda-Carrión, 2017).

2.2 Bibliography data extraction and analysis
Bibliometric data have been collected from Scopus database, which is one of the largest multidisciplinary database of peer-reviewed literature in social sciences. The beginning of the

bibliometric analysis process involves the selection of appropriate keywords. Boolean operators (OR& AND) are used in the SCOPUS database to search for relevant papers in one search: (TITLE-ABS-KEY("service robot" OR "personal robot" OR "social robot" OR "domestic robot" OR "care robot" OR "Assistive robot" OR "companion robot" OR "interactive robot" OR "sociable robot" OR "non-human service agent" OR "collaborative robot" OR "cooperative robot" OR "anthropomorphic robot" OR "frontline service robot" OR "domestic robot") AND (LIMIT-TO (SUBJAREA,"BUSI")) AND (LIMIT-TO (LANGUAGE, "English")). The search was conducted on August 2022, and the results yielded 332 records published between 1985 and 2022 (Figure 1).

2.3 Software Tools for analysis:
With recent development in bibliometric methods, there are several software tools which facilitate bibliometric analysis. The most relevant tools are BibExcel (Persson, Danell, & Schneider, 2009), CiteSpace (Chen, 2006), SciMAT (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2012), CitNetExplorer (Van Eck & Waltman, 2014a), VOSviewer (Van Eck & Waltman, 2010) and bibliometix R package Bibliometrix (Aria & Cuccurullo, 2017). In the current study, two software packages were used in order to perform the bibliometric analysis. For the purpose of performance analysis, science mapping and network analysis, the biblioshiny package of R programming has been used. For the purpose of pictorial depiction of bibliometric map, a bibliometric visualisation tool, VOS viewer was used (van Eck & Waltman, 2014b). Both tools have been expansively employed by several scholars and, as a result, offer greater dependability for a comprehensive and rigorous bibliometric study (Martínez-López *et al.*, 2018; Suban *et al.*, 2021).

3. Results and discussion
Using the aforementioned methodological approach and tools, we carried out our analysis in the following three dimensions:

(1) Performance analysis

(2) Science mapping analysis

(3) Network analysis using multiple correspondence analysis (MCA)

3.1 Performance analysis:
In order to respond to the first research question, we have used performance analysis to examine the contributions of research constituents (e.g., authors, institutions, countries and journals) in service robots' literature. Performance analyses examine the temporal patterns, productivity and citations of publications.

3.1.1 Descriptive analysis of bibliographic data frame. This study reviewed service robots in the hospitality research published during 1985 and 2022. A total sample of 332 relevant research articles published in 123 publications during the past 37 years by 840 authors, with an average of 21.45 citations per document were examined. The increased average number of citations per document indicates a rapid increase in scholarly articles in the field of service robots. The findings also indicated the year 2022 was distinct or has contributed to the field of service robots' during this period, which got 110 publications in Scopus. Most authors (807 authors or 96.07%) are part of multi-authored studies, while only 3.93% are part of single authored studies (33 authors).

3.1.2 Publication trend. Figure 2 depicts the evolution of service robots-related papers from 1985 to 2022, as depicted by the Scopus database. The total articles published have increased
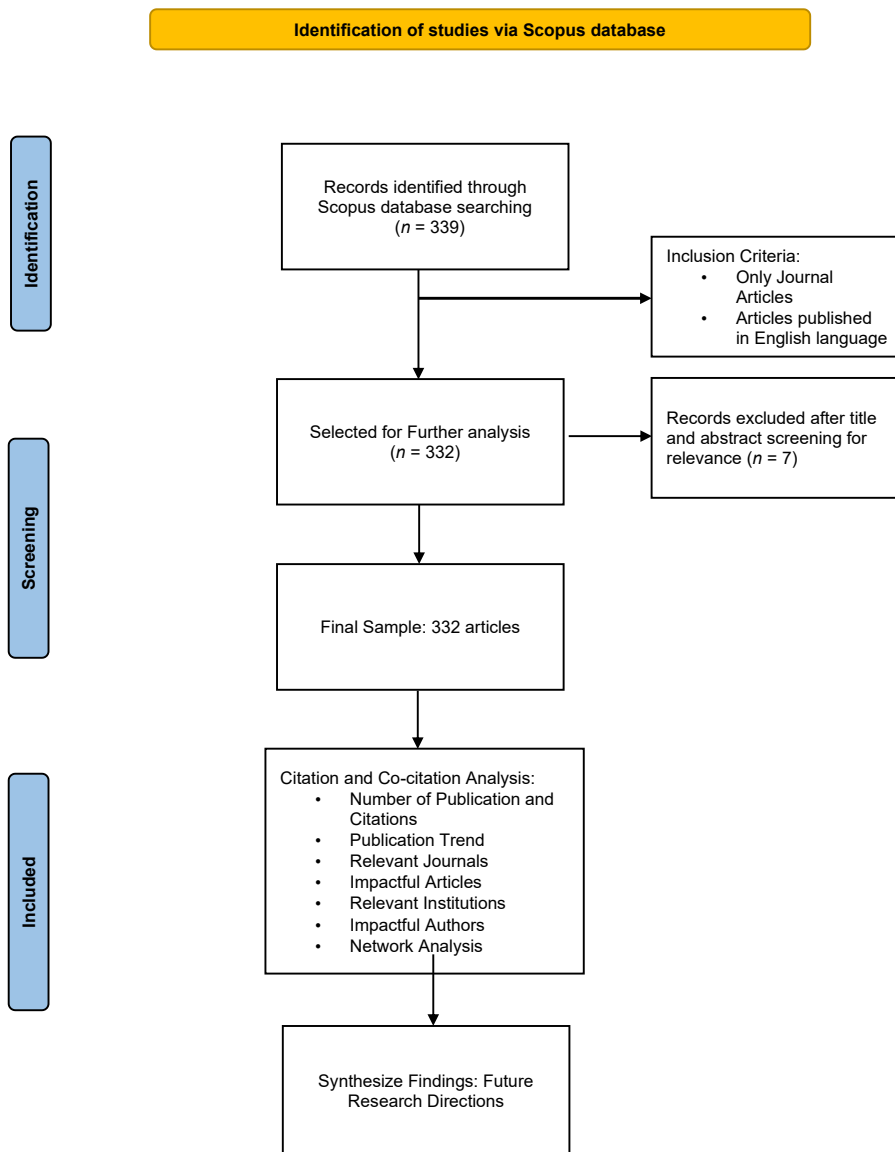
Figure 1.
Identification of
studies

Source(s): Figure from authors' analysis

tenfold, from five in 2010 to 110 in 2022. The integration of AI and robotics during the last
decade has seen a sudden upsurge from 2010.

3.1.3 Most influential journals. The selected 332 papers are distributed across 123 journals.
Table 1 lists the highly influential journals that publish articles on service robots. The top ten
journals published 125 of the total papers analysed, accounting for 37.65% of the total.

International Journal of Contemporary Hospitality Management is the most productive publication with 20 articles, followed by *International Journal of Hospitality Management* with 16 publications in service robots research. The interest of customers in service robots in the marketplace supports their inclusion within the scope of these journals.

Figure 3 demonstrates the strong connections between the topic of service robots and a variety of academic disciplines, including social science, computer science, engineering decision science, psychology and medicine. This indicates that the subject is multidisciplinary in nature. Intriguingly, there is not much study being done in other subject areas, particularly neuroscience.

3.1.4 Prolific authors and their affiliated institutions and countries. On the basis of our data, 840 authors have contributed to service robot's research. These authors are associated with 477 organisations spread across 37 different countries. The top contributors by number of publications are displayed in Table 2. *Ivanov, S.* has published the most articles (N = 8), followed by *Mahr, D.* (N = 6) and *Seyitoglu, F.* (N = 6). Paluch S and Wirtz J also have the most citations, with 718 and 653, respectively. *Grewal D, Mende M and Vandoorn J* shares third rank with 643 citations. Moreover, Table 2 shows the top institutions associated with service robots research along with author's name. In terms of publication, the most productive university is Maastricht University with 17 publications. The University of Surrey is second on the list with 12 publications. The Varna University of Management succeeds them with nine publications.

To some extent, a country's prominence and influence in the area of service robots can be inferred from the number of papers published therein. Between the years 1985 and 2022, a

Figure 2.
Annual publication trend of 332 papers between period 1985 and 2022 retrieved from Scopus

Source(s): Figure from authors' analysis

Journal names	Count
International Journal of Contemporary Hospitality Management	20
International Journal of Hospitality Management	16
Journal of Service Management	16
International Journal of Production Research	14
Technological Forecasting and Social Change	13
Technology in Society	11
Science and Engineering Ethics	10
Knowledge-based Systems	9
Annals of Tourism Research	8
Journal of Retailing and Consumer Services	8
Source(s): Table from authors' analysis	
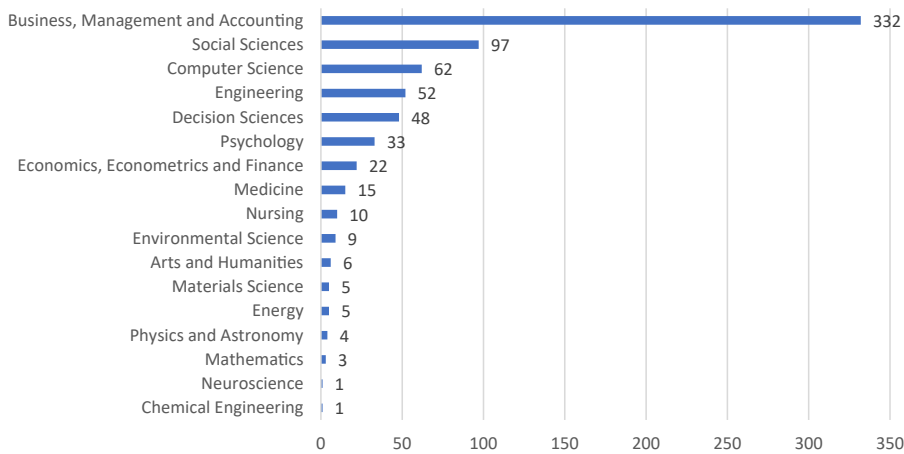
Table 1.
Leading journals publishing on service robots

Figure 3.
Top disciplines of
service robots research
in 332 papers

Source(s): Figure from authors' analysis

Top authors			Top institutions		Top countries		
Authors	TP	TC	Affiliation	Articles	Country	TP	TC
Ivanov S	8	224	Maastricht University	17	China	109	320
Mahr D	6	279	University of Surrey	12	USA	95	566
Seyitoğlu F	6	165	Varna University of Management	9	UK	55	374
Wirtz J	6	653	Queensland University of Technology	7	Germany	53	255
Belanche D	5	274	Aarhus University	6	Netherlands	42	1254
Čaić M	5	267	Eindhoven University of Technology	6	Australia	41	219
Mattila AS	5	150	Hanken School of Economics	6	Italy	40	177
Odekerken-Schröder G	5	211	Mardin Artuklu University	6	France	29	198
Paluch S	5	718	National University of Singapore	6	Spain	29	165
Tuomi A	5	82	University of Zaragoza	6	Finland	26	60

Source(s): Table from authors' analysis

Table 2.
Analysis of total
publications of
universities, authors
and countries

total of 46 different countries or regions contributed to the publication of service robot-related materials. Figure 4 reveals that out of the top 10 countries, seven are located in European countries (the United Kingdom, Germany, Italy, Spain, the Netherlands and France), one is located in Oceania (Australia), one is located in North America (the United States of America) and one in Asia (China). In terms publications, China has published 109 service robot-related materials, followed by the United States with 95 publications and the United Kingdom with 55 publications.

3.2 Science mapping
Science mapping explores the association between research constituents (Baker, Kumar, Goyal, & Sharma, 2021). Science mapping analysis pertains to the structural relationships

and intellectual interactions among research constituents. By using science mapping analysis, the following section provides the results of the most commonly cited primary authors and journals which have been most frequently cited.

3.2.1 Most frequently cited authors. Based on our data, a total of 25270 authors were identified from 332 publications. In order to conduct a comprehensive analysis, authors with at least 50 citations were incorporated in the analysis, resulting in a total of 94 articles. A co-citation analysis identifies the most repeatedly referenced authors, as evidenced by the nodes that are enlarged (see Figure 5). Among the authors that have been cited most frequently includes 362 citations, followed by *Webster, C.* (304 citations), *Wirtz* (242 citations), *Grewal* (220 citations), *Paulch* (215 citations) and *Mende* (193 citations). These widely-cited scholars have made important strides in the development of robots that provide human-like services.

3.2.2 Most frequently cited journals. The analysis of cited references yielded 7721 sources across 332 articles. In order to conduct a comprehensive analysis, journals with at least 50 citations were included in the analysis, resulting in a total of 43 journals. As the larger nodes in this illustration show, a co-citation analysis can identify which publications are the most
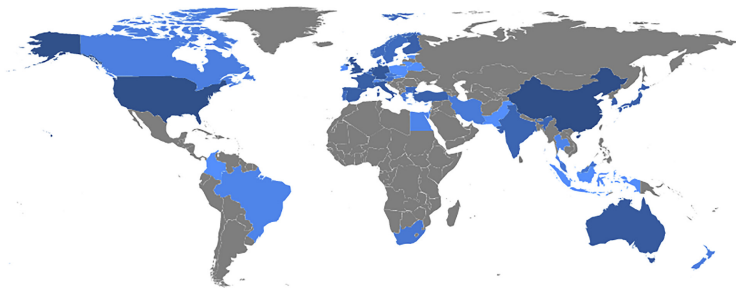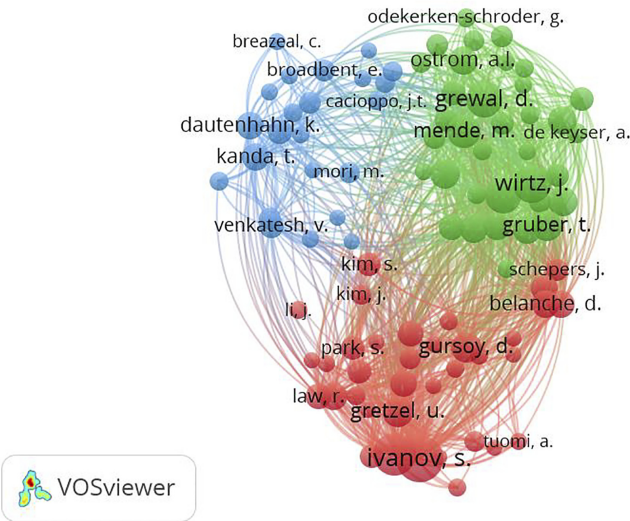

Figure 4.
Country-wise distribution of service robots research

Source(s): Figure from authors' analysis

Figure 5.
Analysis of co-citations

Source(s): Figure from authors' analysis

often cited (see Figure 6). Results reveals that *Journals of Service Research* (540 citations), *International Journal of Contemporary Hospitality Management* (386 citations), *International Journal of Social Robotics* (376 citations) and *Journal of Service Management* (337 citations) are the most often cited publications.

3.2.3 Co-occurrence of author keywords. The article's major ideas are summarised in the list of keywords. The article's theme and writing direction in the field of service robots are represented clearly and comprehensibly using keyword analysis. Using the biblioshiny software package, data mining and statistical analysis are performed on the keywords having high-frequency among the research publications. The selection of keywords with a frequency greater than or equal to 10 is done, and Word TreeMaps and network maps are created to display the results (see Figure 7). The most commonly appearing keywords related to service robots research are AI, anthropomorphism, robotics and human robot's interaction, accounting for 11%, 6%, 4% and 4%.

3.2.4 Relationship between authors, keywords and countries. Figure 8 depicts three field analyses illustrating the association between authors, keywords and countries, with authors in the left column, keywords in the middle and countries in the right column. Three field plot analyses confirm that most of the authors have considered service robots as their keyword. However, "social robots", "care robots", "human robots", "collaborative robots" and a number of other terms closely related to service robots were also utilised in numerous research articles. In general, countries like, USA, China and UK focus mostly on service robot research.

3.3 Emerging themes using multiple correspondence analysis
MCA is an exploratory technique for the numerical and graphical analysis which helps to identify a cluster of documents that expresses common concepts by identifying Euclidean representation of the original data (Gifi, 1990). As depicted in Figure 9, conceptual structure map using MCA identified three dominant research clusters in the literature on service
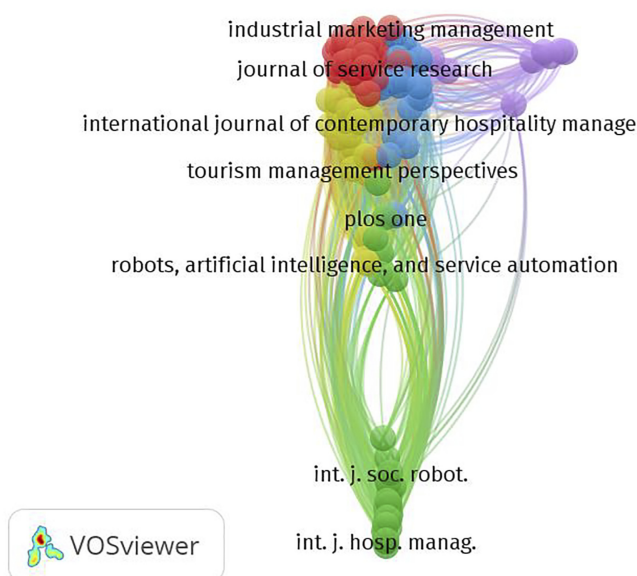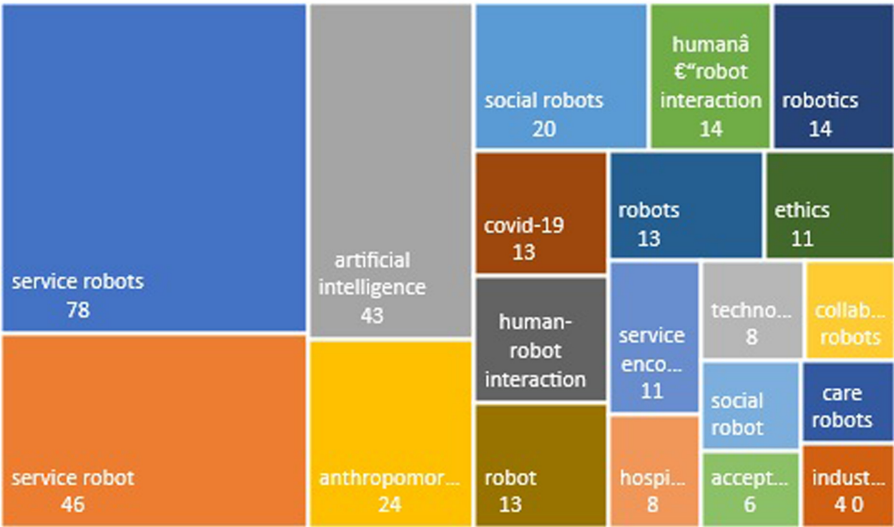

Source(s): Figure from authors' analysis

Source(s): Figure from authors' analysis
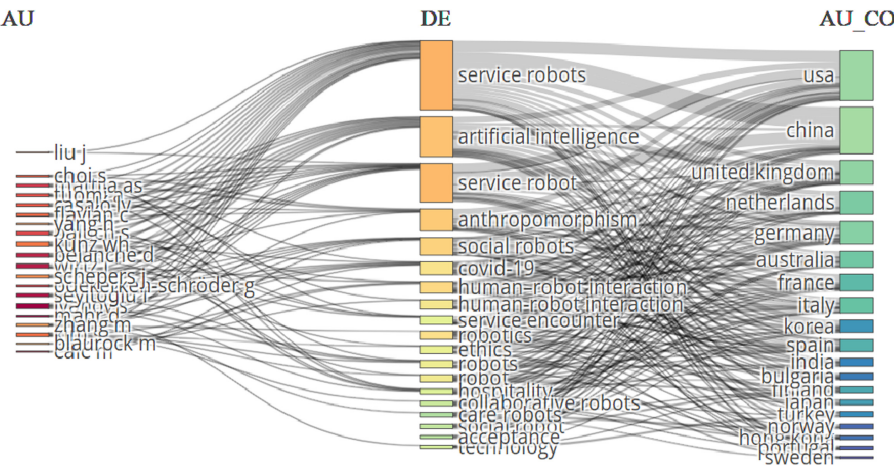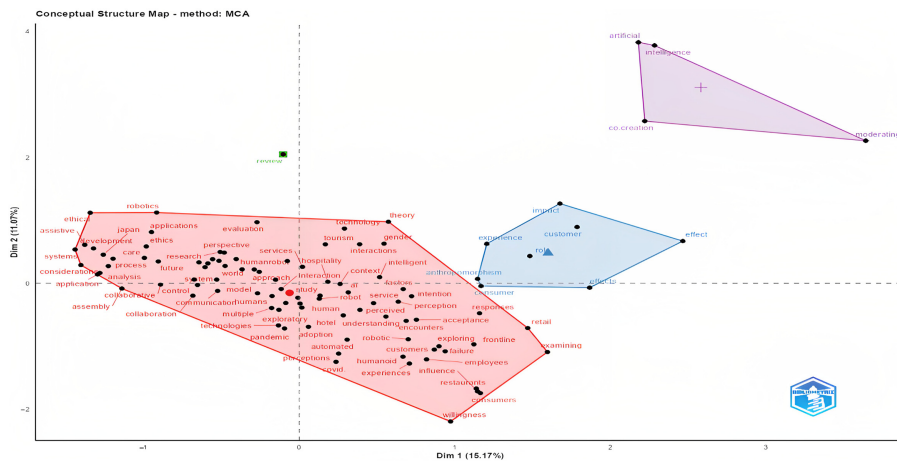
Source(s): Figure from authors' analysis

robots. Each cluster is distinct from the others in a significant way. As determined by the analysis, the largest research cluster in the area of service robots focuses on the adoption and integration of service robots in customer service. Anthropomorphism is another dominant research domain in service robot's research. The final cluster describes the incorporation of AI into robotic service.

3.3.1 Cluster 1: adoption and integration of service robots in customer service. In cluster 1, the citing articles are mainly concerned with the adoption and integration of service robots and its impact on customer service. In cluster 1, Wirtz *et al.* (2018) has the highest citations (466 citations), followed by *Vandoorn, J* (368 citations), *Bolton, RN.* (227 citations) and *Mende* (222 citations). Robots powered by AI have expanded beyond warehouses and factory

Source(s): Figure from authors' analysis

equipment. AI-powered solutions are making their way into the hospitality, healthcare and travel industries (Buhalis *et al.*, 2019). AI service robots have broadened the definition of customer service beyond human interaction to include interactions between humans and machines (Tussyadiah & Park, 2018). For instance, Pepper, a humanoid service robot, greets clients at a Pizza Hut in Singapore, takes orders, processes payments and even provides entertainment. Increasingly, businesses are using service robots to enhance the quality of their services, cut expenses and better compete in the market (Chuah, Aw, & Yee, 2021). Besides, most research on public attitudes concerning robots has relied on pre-existing technological acceptance models or extended versions of these models.

3.3.2 Cluster 2: anthropomorphism and its impact on customer service. In cluster 2, the citing articles are mainly concerned with the anthropomorphism and its impact on customer service. In cluster 2, Belanche, Casaló, Flavián, and Schepers (2020b) has the highest citations (130 citations), followed by Tung (2017) (127 citations), Lu *et al.* (2020) (113 citations), Van Pinxteren (2019) (91 citations) and (Blut *et al.* (2021) (55 citations). The term "*anthropomorphism*" refers to the practise of imputing human emotions, thoughts and behaviours to things that are not actually capable of them (Epley, Waytz, Akalis, & Cacioppo, 2008).The tourism and hospitality industries have found that anthropomorphism is a fruitful medium for marketing and communication (Ding, Lee, Legendre, & Madera, 2022). Its purpose is to place a company's name or product favourably in the minds of prospective customers by analysing the hospitality and tourist industry's competitive landscape (Lee & Oh, 2021). Furthermore, it has been established that anthropomorphising technology can enhance advertising results. Interfaces that mimic the human experience strengthen client confidence in technology by boosting their own sense of competence (Waytz, Heafner, & Epley, 2014) and are less likely to suffer trust breakdowns (De Visser *et al.*, 2016). In a similar fashion, anthropomorphism induces people to remain more connected to something that is not human (Yang, Aggarwal, & McGill, 2020), it can also be used to get people interested in a brand, a place or a product (Shao, Jeong, Jang, & Xu, 2020). Mascots are often utilised in the hospitality and tourism industries as one illustration symbolise an organisation (like Mr. Balloo Bear from the Epirus Palace Hotel).

3.3.3 Cluster 3: Integration of artificial intelligence in the customer service. In cluster 3, the citing articles are mainly concerned with the integration of technology (i.e. AI) in the

customer service. In cluster 3, Tussyadiah (2020) has the highest citation (126 citations), followed by Jörling (2019) (70 citations), Fernandes (2021) (63 citations), Mettler (2017) (52 citations) and Benbya (2020) (51 citations). AI refers to the programs, machines and algorithms that demonstrate intelligence (Shankar, 2018). Big data, machine learning, smart robotics, the Internet of things, virtual and augmented reality applications, artificial neural networks and so on are all part AI (Pereira, Hadjielias, Christofi, & Vrontis, 2021). The hospitality sector and tourism is one that has been affected by technological development (Buhalis, 2020; Tussyadiah, 2020). Over the last two decades, several information and communication technologies (ICT) have been adopted to enhance the pre-, during- and post-trip experiences of visitors. AI has improved ICTs by making it easier to combine offline and online/virtual components (Ding *et al.*, 2022). In greater or lesser measure, all of these innovations have contributed to the customisation and provision of technologically enhanced tourist encounters (Grundner & Neuhofer, 2021). In the hospitality industry, AI has increased the usage of robotics applications that increase client interaction, such as in hotels and restaurants (Doborjeh, Hemmington, Doborjeh, & Kasabov, 2021). Travellers may make better informed decisions and have more enjoyable vacations, thanks to AI's ability to quickly sift through vast amounts of data (Bulchand-Gidumal, 2020).

AI and robots (AIR) are only two examples of the cutting-edge technologies being used by the hospitality and tourism sector to enhance the guest experience. Due to these technological developments, tourism is now smart tourism, which opens up brand-new fields of study (Goel, Kaushik, Sivathanu, Pillai, & Vikas, 2022). Marketers need to keep in mind how end-users feel about AIR because consumer acceptance of technology, notably AIR, is on the rise and will provide the necessary boost to the tourism industry. Marketers and service providers face a formidable challenge in trying to decipher how customers feel about and react to AIR. Besides, some of the most fundamental functions for guests, including porters, room service and concierge, have been automated by AIR. Games, stories and other forms of entertainment are also being played out on AIR. Studies have contended that consumers perceive AIR as more practical and simpler to use because of the automation of services (Wirtz *et al.*, 2018). Tussyadiah, Zach, and Wang (2020) note that the availability of humanoids to act as guides or companions to visitors increases customer involvement. AI is being used by service providers to provide customers with virtual tours of properties and locations (Buhalis *et al.*, 2019). AIR assists the hotel sector in surprising visitors through the provision of customised and individualised services. For instance, tailored itineraries are created for guests by mapping their interests and habits (Pan, 2021). Guests can now control the atmosphere of their rooms without human interaction (Lin, Cui, Wang, Wu, & Lin, 2022).

4. Discussion and implications

This paper attempts to investigate service robots research and chart its progress over the last three-and-a-half decades. This study used a comprehensive bibliometric analysis of 332 publications from 123 journals published between 1985 and August 2022. For the purpose of addressing the research questions that were predefined, this study used bibliometric method such citation, co-citation and keyword co-occurrence analysis.

Analysis of citations shows that the number of articles has increased steadily pertaining to service robots over the last decade. First stage (1985–2015) represents the field's early years with few publications. Post-2015, the literature on service robots enters a second phase with a steady increase in publications. The most-cited work in this field has been "Brave new world: service robots in the frontline" (Writz *et al.*, 2018) with 508 total citations. In addition, *Paluch S and Wirtz J* are the most prominent authors based on total citation and average

citation per document. When it comes to research on service robots, the *International Journal of Contemporary Hospitality* has published the most articles with a total of 20 publications. One of the most influential universities in the world in terms of productivity is the Netherlands' Maastricht University. China wins out as the most influential country in terms of output, but the Netherlands takes the cake in terms of overall citations. These findings feature the most influential researchers on the topic of service robots, and they demonstrate that top researchers and academics are becoming increasingly interested in this field. *Ivanov S and Wirtz J are* the most frequently mentioned researchers in the subject of service robots, according to a co-citation analysis. The *Journal of Service Research, The International Journal of Contemporary Hospitality Management*, and *The International Journal of Social Robotics* are among the most cited journals. These results suggest that the leading marketing journals have also been the leading outlets to the field of service robots. Keyword analysis reveals "Service robots", "artificial intelligence", "anthropomorphism", "robotics" and "human robots" interaction' are the most often used keywords in service robots' literature. These keywords offer insight into the focal areas that have dominated service robot research over the years.

Finally, we employed multiple correspondence analysis to identify emerging themes from the literature on service robots. Results demonstrate that three study streams have primarily influenced service robots research: "adoption of robots in customer service", "anthropomorphism" and "Integration of Artificial Intelligence".

Both academics and business leaders can learn a lot from our findings. This research has substantial scholarly insights since it identifies the most important papers, journals and institutions that have affected the field of service robotics research and provides insights into the most influential contributors to this area of study. We also contribute to theory by outlining the major themes arising from the literature on service robots, and we track the field's steady development over time. Our research aims to provide managers with an in-depth explanation of the service robot concept so that they may better grasp the complexities of the idea before committing to implementing it in their firm. That is, this research would be useful for managers in comprehending the central conception of service robots as a strategy, which in turn would encourage them to think about this idea as an element of strategic intervention for their firms. In addition, managers would benefit from conducting research since it would lead them to potential informational resources.

4.1 Limitations and future research opportunities
This research is a rare attempt to give a systematic summary of the literature on service robots. Despite the rigour, significance and scope of this study, there are several limitations that must be acknowledged. The most notable limitation of this inquiry is its reliance on only Scopus database for gathering the data. To prevent unnecessary redundancy and duplication, the vast majority of bibliometric research relies on a single database for analysis, but doing so can mean missing out on papers that could be very helpful to the field of service robots. Regarding the prospects for future study, the broad literature evaluation using bibliometric methodologies identifies several crucial future research directions. This study focuses exclusively on value service robots within the business and management disciplines. Therefore, more research in the future should focus on exploring this idea from multiple disciplinary perspectives. Secondly, considering the infancy of this discipline and its quick expansion, there will undoubtedly be a plethora of future seminal works written in this field. Therefore, there should be a continual research effort through a bibliometric analysis focused on service robots every 5–7 years. This would ensure that the field remains pertinent for future scholars, which will thus help it to continue to advance.

In conclusion, there are plethora of methods for doing a literature review using bibliometric analysis. Three of these analytic approaches were used in this investigation. Therefore, other bibliometric methods should be used in future research in order to better understand this topic.

References

Albort-Morant, G., Henseler, J., Leal-Millán, A., & Cepeda-Carrión, G. (2017). Mapping the field: A bibliometric analysis of green innovation. *Sustainability, MDPI*, *9*(6), 1011.

Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, *11*(4), 959–975, Elsevier.

Baker, H. K., Kumar, S., Goyal, K., & Sharma, A. (2021). International review of financial analysis: A retrospective evaluation between 1992 and 2020. *International Review of Financial Analysis*, *78*, 101946, Elsevier.

Battour, M., Mady, K., Salaheldeen, M., Elsotouhy, M., Elbendary, I., & Boǧan, E. (2022). AI-enabled technologies to assist Muslim tourists in Halal-friendly tourism. *Journal of Islamic Marketing*, *ahead-of-print*(ahead-of-print). doi: 10.1108/JIMA-01-2022-0001.

Belanche, D., Casaló, L. V., Flavián, C., & Schepers, J. (2020a). Robots or frontline employees? Exploring customers' attributions of responsibility and stability after service failure or success. *Journal of Service Management*, *31*(2), 267–289, Emerald Group Holdings, Department of Marketing and Market Research, University of Zaragoza, Zaragoza.

Belanche, D., Casaló, L. V., Flavián, C., & Schepers, J. (2020b). Service robot implementation: A theoretical framework and research agenda. *Service Industries Journal*, *40*(3-4), 203–225, Routledge, Faculty of Economy and Business, Universidad de Zaragoza, Zaragoza.

Belanche, D., Casaló, L. V., & Flavián, C. (2021). Frontline robots in tourism and hospitality: Service enhancement or cost reduction?. *Electronic Markets*, *31*(3), 477–492, Springer Science and Business Media Deutschland GmbH, Faculty of Economy and Business, University of Zaragoza, Gran Vía 2, 50.005, Zaragoza.

Benbya, H., Davenport, T. H., & Pachidi, S. (2020). Artificial intelligence in organizations: Current state and future opportunities. *MIS Quarterly Executive*, *19*(4). doi: 10.2139/ssrn.3741983.

Blut, M., Wang, C., Wünderlich, N. V., & Brock, C. (2021). Understanding anthropomorphism in service provision: A meta-analysis of physical robots, chatbots, and other AI. *Journal of the Academy of Marketing Science*, *49*(4), 632–658, Springer, Durham University Business School, Durham University, Mill Hill Lane, Durham, DH1 3LB.

Broadus, R. N. (1967). A citation study for sociology. *American Sociologist*, *2*(1), 19–20.

Brondi, S., Pivetti, M., Di Battista, S., & Sarrica, M. (2021). What do we expect from robots? Social representations, attitudes and evaluations of robots in daily life. *Technology in Society*, *66*, 101663, Elsevier.

Buhalis, D. (2020). Technology in tourism-from information communication technologies to eTourism and smart tourism towards ambient intelligence tourism: a perspective article. *Tourism Review*, *75*(1), 267–272.

Buhalis, D., Harwood, T., Bogicevic, V., Viglia, G., Beldona, S., & Hofacker, C. (2019). Technological disruptions in services: Lessons from tourism and hospitality. *Journal of Service Management*, *30*(4), 484–506. doi:10.1108/JOSM-12-2018-0398.

Bulchand-Gidumal, J. (2020). Impact of artificial intelligence in travel, tourism, and hospitality. *Handbook of E-Tourism*, 1–20, Springer.

Čaić, M., Mahr, D., & Oderkerken-Schröder, G. (2019). Value of social robots in services: Social cognition perspective. *Journal of Services Marketing*, *33*(4), 463–478, Emerald Group Holdings, Department of Marketing and Supply Chain Management, Maastricht University, Maastricht.

Chan, A. P. H., & Tung, V. W. S. (2019). Examining the effects of robotic service on brand experience: The moderating role of hotel segment. *Journal of Travel and Tourism Marketing*, *36*(4), 458–468, Routledge, School of Hotel and Tourism Management, The Hong Kong Polytechnic University, Tsim Sha Tsui East, Kowloon, Hong Kong.

Chen, C. (2006). CiteSpace II: Detecting and visualizing emerging trends and transient patterns in scientific literature. *Journal of the American Society for Information Science and Technology*, *57*(3), 359–377, Wiley Online Library.

Choi, Y., Choi, M., Oh, M., & Kim, S. (2020). Service robots in hotels: Understanding the service quality perceptions of human-robot interaction. *Journal of Hospitality Marketing and Management*, *29*(6), 613–635, Routledge, School of Hotel and Tourism Management, The Hong Kong Polytechnic University, Kowloon, Hong Kong.

Chuah, S. H. -W., & Yu, J. (2021). The future of service: the power of emotion in human-robot interaction. *Journal of Retailing and Consumer Services*, *61*, Elsevier, Institute of Innovation and Circular Economy & Department of Business Administration, Asia University, No. 500, Liufeng Rd., Wufeng Dist., Taichung City, 413, Taiwan. doi: 10.1016/j.jretconser.2021.102551.

Chuah, S. H. W., Aw, E. C. X., & Yee, D. (2021). Unveiling the complexity of consumers' intention to use service robots: an fsQCA approach. *Computers in Human Behavior*, *123*(May), 106870, Elsevier.

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2012). SciMAT: A new science mapping analysis software tool. *Journal of the American Society for Information Science and Technology*, *63*(8), 1609–1630, Wiley Online Library.

Collins, C., Dennehy, D., Conboy, K., & Mikalef, P. (2021). Artificial intelligence in information systems research: A systematic literature review and research agenda. *International Journal of Information Management*, *60*, 102383, Elsevier.

De Keyser, A., Köcher, S., Alkire, L., Verbeeck, C., & Kandampully, J. (2019). Frontline service technology infusion: Conceptual archetypes and future research directions. *Journal of Service Management*, Emerald Publishing.

De Visser, E. J., Monfort, S. S., McKendrick, R., Smith, M. A. B., McKnight, P. E., Krueger, F., & Parasuraman, R. (2016). Almost human: Anthropomorphism increases trust resilience in cognitive agents. *Journal of Experimental Psychology: Applied, American Psychological Association*, *22*(3), 331.

Ding, A., Lee, R. H., Legendre, T. S., & Madera, J. (2022). Anthropomorphism in hospitality and tourism: A systematic review and agenda for future research. *Journal of Hospitality and Tourism Management*, *52*(September), 404–415, Elsevier.

Doborjeh, Z., Hemmington, N., Doborjeh, M., & Kasabov, N. (2021). Artificial intelligence: A systematic review of methods and applications in hospitality and tourism. *International Journal of Contemporary Hospitality Management*, *34*(3), 1154–1176.

Dootson, P., Greer, D. A., Letheren, K., & Daunt, K. L. (2022). Reducing deviant consumer behaviour with service robot guardians. *Journal of Services Marketing*, *37*(3), 276–286. doi:10.1108/JSM-11-2021-0400.

Epley, N., Waytz, A., Akalis, S., & Cacioppo, J. T. (2008). When we need a human: Motivational determinants of anthropomorphism. *Social Cognition*, *26*(2), 143–155, Guilford.

Fernandes, T., & Oliveira, E. (2021). Understanding consumers' acceptance of automated technologies in service encounters: Drivers of digital voice assistants adoption. *Journal of Business Research*, *122*, 180–191, Elsevier, School of Economics and Management, University of Porto, Rua Dr. Roberto Frias, s/n, Porto, 4200-464.

Gifi, A. (1990). *Nonlinear multivariate analysis*. Chichester: Wiley-Blackwell.

Goel, P., Kaushik, N., Sivathanu, B., Pillai, R., & Vikas, J. (2022). Consumers' adoption of artificial intelligence and robotics in hospitality and tourism sector: Literature review and future research agenda. *Tourism Review*, *77*(4), 1081–1096.

Grundner, L., & Neuhofer, B. (2021). The bright and dark sides of artificial intelligence: A futures perspective on tourist destination experiences. *Journal of Destination Marketing & Management*, *19*, 100511, Elsevier.

Heerink, M., Kröse, B., Evers, V., & Wielinga, B. (2010). Assessing acceptance of assistive social agent technology by older adults: The almere model. *International Journal of Social Robotics*, *2*(4), 361–375, Springer.

Ivanov, S., & Webster, C. (2019). Perceived appropriateness and intention to use service robots in tourism. In Information and Communication Technologies in Tourism 2019: Proceedings of the International Conference in Nicosia, Cyprus, January 30–February 1, 2019 (pp. 237-248). Springer International Publishing.

Jörling, M., Böhm, R., & Paluch, S. (2019). Service robots: Drivers of perceived responsibility for service outcomes. *Journal of Service Research*, *22*(4), 404–420, SAGE Publications, School of Business and Economics, RWTH Aachen University, Aachen.

Khosla, R., & Chu, M.- T. (2013). Embodying care in matilda: An affective communication robot for emotional wellbeing of older people in Australian residential care facilities. *ACM Transactions on Management Information Systems (TMIS)*, *4*(4), 1–33, ACM New York, NY.

Kiesler, S., Powers, A., Fussell, S. R., & Torrey, C. (2008). Social cognition. *Anthropomorphic Interactions with a Robot and Robot–like Agent*, *26*(2), 169–181, Guilford.

Kim, H. K., Baik, K., & Kim, N. (2019). How Korean leadership style cultivates employees' creativity and voice in hierarchical organizations, *9*(3), SAGE Open, SAGE Publications, Kookmin University, Seoul. doi: 10.1177/2158244019876281.

Kim, S. S., Kim, J., Badu-Baiden, F., & Giroux, M. (2021). Preference for robot service or human service in hotels? Impacts of the COVID-19 pandemic. *International Journal of Hospitality Management*, *93*, 102795.

Kuo, C. -M., Chen, L. -C., & Tseng, C. -Y. (2017). Investigating an innovative service with hospitality robots. *International Journal of Contemporary Hospitality Management*, *29*(5), 1305–1321. doi: 10.1108/IJCHM-08-2015-0414.

Lee, S. A., & Oh, H. (2021). Anthropomorphism and its implications for advertising hotel brands. *Journal of Business Research*, *129*, 455–464, Elsevier.

Lestingi, L., Askarpour, M., Bersani, M. M., & Rossi, M. (2020). Formal verification of human-robot interaction in healthcare scenarios. *International Conference on Software Engineering and Formal Methods* (pp. 303–324). Springer.

Lin, M., Cui, X., Wang, J., Wu, G., & Lin, J. (2022). Promotors or inhibitors? Role of task type on the effect of humanoid service robots on consumers' use intention. *Journal of Hospitality Marketing and Management*, *31*(6), 710–729, Routledge, College of Tourism, Huaqiao University, Fujian, Quanzhou.

Lu, V. N., Wirtz, J., Kunz, W. H., Paluch, S., Gruber, T., Martins, A., & Patterson, P. G. (2020). Service robots, customers and service employees: What can we learn from the academic literature and where are the gaps? *Journal of Service Theory and Practice*, *30*(3), 361–391, Emerald Group Holdings, College of Business and Economics, The Australian National University, Canberra.

Martínez-López, F. J., Merigó, J. M., Valenzuela-Fernández, L., & Nicolás, C. (2018). Fifty years of the European journal of marketing: a bibliometric analysis. *European Journal of Marketing*, *52*(1/2), 439-468.

Mende, M., Scott, M. L., van Doorn, J., Grewal, D., & Shanks, I. (2019). Service robots rising: How humanoid robots influence service experiences and elicit compensatory consumer responses. *Journal of Marketing Research*, *56*(4), 535–556, SAGE Publications.

Mettler, T., Sprenger, M., & Winter, R. (2017). Service robots in hospitals: New perspectives on niche evolution and technology affordances. *European Journal of Information Systems*, *26*(5), 451–468, Palgrave Macmillan, Swiss Graduate School of Public Administration, University of Lausanne, Rue de la Mouline 28, Chavannes-près-Renens, 1022.

Nakanishi, J., Kuramoto, I., Baba, J., Ogawa, K., Yoshikawa, Y., & Ishiguro, H. (2019). Soliloquising social robot in a hotel room. *Proceedings of the 31st Australian Conference on Human-Computer-Interaction* (pp. 21–29).

Pan, S. (2021). Design of intelligent robot control system based on human–computer interaction. *International Journal of System Assurance Engineering and Management*, 1–10. doi:10.1007/s13198-021-01267-9.

Pereira, V., Hadjielias, E., Christofi, M., & Vrontis, D. (2021). A systematic literature review on the impact of artificial intelligence on workplace outcomes: A multi-process perspective. *Human Resource Management Review*, *33*(1), 100857.

Persson, O., Danell, R., & Schneider, J. W. (2009). How to use Bibexcel for various types of bibliometric analysis. *Celebrating Scholarly Communication Studies: A Festschrift for Olle Persson at His 60th Birthday*, *5*, 9–24.

Pinillos, R., Marcos, S., Feliz, R., Zalama, E., & Gómez-García-Bermejo, J. (2016). Long-term assessment of a service robot in a hotel environment. *Robotics and Autonomous Systems*, *79*, 40–57, Elsevier.

Pritchard, A. (1969). Statistical bibliography or bibliometrics. *Journal of Documentation*, *25*, 348.

Rafaeli, A., Altman, D., Gremler, D. D., Huang, M. -H., Grewal, D., Iyer, B., *et al.* (2017). The future of frontlinexries. *Journal of Service Research*, *20*(1), 91–99, Sage Publications Sage CA: Los Angeles, CA.

Shankar, V. (2018). How artificial intelligence (AI) is reshaping retailing. *Journal of Retailing*, *94*(4), vi–xi, Elsevier.

Shao, X., Jeong, E., Jang, S. S., & Xu, Y. (2020). Mr. Potato Head fights food waste: The effect of anthropomorphism in promoting ugly food. *International Journal of Hospitality Management*, *89*, 102521, Elsevier.

Shin, H., & Kang, J. (2020). Reducing perceived health risk to attract hotel customers in the COVID-19 pandemic era: Focused on technology innovation for social distancing and cleanliness. *International Journal of Hospitality Management*, *91*, 102664, Elsevier.

Sinha, N., Singh, P., Gupta, M., & Singh, P. (2020). Robotics at workplace: An integrated Twitter analytics–SEM based approach for behavioral intention to accept. *International Journal of Information Management*, *55*, 102210, Elsevier.

Song, M., Xing, X., Duan, Y., Cohen, J., & Mou, J. (2022). Will artificial intelligence replace human customer service? The impact of communication quality and privacy risks on adoption intention. *Journal of Retailing and Consumer Services*, *66*, 102900, Elsevier.

Suban, S. A., Madhan, K., & Shagirbasha, S. (2021). A bibliometric analysis of Halal and Islamic tourism. *International Hospitality Review*, *ahead-of-print*(ahead-of-print). doi:10.1108/IHR-05-2021-0038.

Tay, B. T. C., Low, S. C., Ko, K. H., & Park, T. (2016). Types of humor that robots can play. *Computers in Human Behavior*, *60*, 19–28, Elsevier.

Tung, V. W. S., & Law, R. (2017). The potential for tourism and hospitality experience research in human-robot interactions. *International Journal of Contemporary Hospitality Management*, *29*(10), 2498–2513, Emerald Group Publishing, School of Hotel and Tourism Management, Hong Kong Polytechnic University, Kowloon, Hong Kong.

Tussyadiah, I. (2020). A review of research into automation in tourism: Launching the annals of tourism research curated collection on artificial intelligence and robotics in tourism. *Annals of Tourism Research*, *81*, Elsevier, School of Hospitality and Tourism Management, University of Surrey, Guildford, GU2 7XH. doi: 10.1016/j.annals.2020.102883.

Tussyadiah, I., & Park, S. (2018). Information and communication technologies in tourism 2018. *Information and Communication Technologies in Tourism 2018*, January. doi: 10.1007/978-3-319-72923-7.

Tussyadiah, I. P., Zach, F. J., & Wang, J. (2020). Do travelers trust intelligent service robots? *Annals of Tourism Research*, *81*, Elsevier, School of Hospitality and Tourism Management, University of Surrey, Stag Hill Campus, Guildford, GU2 7XH. doi: 10.1016/j.annals.2020.102886.

Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*, *84*(2), 523–538, Akadémiai Kiadó, co-published with Springer Science+ Business Media BV.

Van Eck, N. J., & Waltman, L. (2014a). CitNetExplorer: a new software tool for analyzing and visualizing citation networks. *Journal of Informetrics*, *8*(4), 802–823, Elsevier.

van Eck, N. J., & Waltman, L. (2014b). Visualizing bibliometric networks. In Ding, Y., Rousseau, R., & Wolfram, D. (Eds.), *Measuring scholarly impact: methods and practice* (pp. 285–320). Cham: Springer International Publishing.

van Pinxteren, M. M. E., Wetzels, R. W. H., Rüger, J., Pluymaekers, M., & Wetzels, M. (2019). Trust in humanoid robots: Implications for services marketing. *Journal of Services Marketing*, *33*(4), 507–518, Emerald Group Holdings, Department of International Relationship Management, Zuyd Hogeschool, Maastricht.

Wan, L. C., Chan, E. K., & Luo, X. (2020). ROBOTS COME to RESCUE: How to reduce perceived risk of infectious disease in Covid19-stricken consumers? *Annals of Tourism Research*, *88*, 103069. doi:10.1016/j.annals.2020.103069.

Wang, Z., Tian, G., & Shao, X. (2020). Home service robot task planning using semantic knowledge and probabilistic inference. *Knowledge-Based Systems*, *204*, Elsevier B.V., School of Control Science and Engineering, Shandong University, 73 Jingshi Road, Jinan. doi: 10.1016/j.knosys.2020.106174.

Wang, Y., Cai, X., Xu, C., & Li, J. (2021). Rise of the machines: Examining the influence of professional service robots attributes on consumers' experience. *Journal of Hospitality and Tourism Technology*, *12*(4), 609–623, Emerald Group Holdings, College of Business Administration, Capital University of Economics and Business, Beijing.

Waytz, A., Heafner, J., & Epley, N. (2014). The mind in the machine: Anthropomorphism increases trust in an autonomous vehicle. *Journal of Experimental Social Psychology*, *52*, 113–117, Elsevier.

Westlund, J. M. K., Dickens, L., Jeong, S., Harris, P. L., DeSteno, D., & Breazeal, C. L. (2017). Children use non-verbal cues to learn new words from robots as well as people. *International Journal of Child-Computer Interaction*, *13*, 1–9, Elsevier.

Wirtz, J., & Zeithaml, V. (2018). Cost-effective service excellence. *Journal of the Academy of Marketing Science*, *46*(1), 59–80, Springer.

Wirtz, J., Patterson, P. G., Kunz, W. H., Gruber, T., Lu, V. N., Paluch, S., & Martins, A. (2018). Brave new world: Service robots in the frontline. *Journal of Service Management*, *29*(5), 907–931.

World Economic Forum (2017). Nearly half of current jobs could be automated by 2055, according to a new report. Available from: https://www.weforum.org/agenda/2017/02/nearly-half-of-jobs-could-be-automated-in-the-future-heres-what-the-researchers-are-saying

Xiao, L., & Kumar, V. (2021). Robotics for customer service: A useful complement or an ultimate substitute?. *Journal of Service Research*, *24*(1), 9–29, SAGE Publications Sage CA: Los Angeles, CA.

Yang, L. W., Aggarwal, P., & McGill, A. L. (2020). The 3 C's of anthropomorphism: Connection, comprehension, and competition. *Consumer Psychology Review*, *3*(1), 3–19, Wiley Online Library.

Yoganathan, V., Osburg, V.- S. ., H., Kunz, W., & Toporowski, W. (2021). Check-in at the Robo-desk: Effects of automated social presence on social cognition and service implications. *Tourism Management*, *85*, Elsevier, Executive and Professional Education, The University of Sheffield, Western Bank Villa, 300-302, Western, BankSheffield S10 2TN. doi: 10.1016/j.tourman.2021.104309.

Zhang, X., Balaji, M. S., & Jiang, Y. (2022). Robots at your service: Value facilitation and value co-creation in restaurants. *International Journal of Contemporary Hospitality Management*, *34*(5), 2004–2025. doi:10.1108/IJCHM-10-2021-1262.

Further reading

Bolton, R. N., McColl-Kennedy, J. R., Cheung, L., Gallan, A., Orsingher, C., Witell, L., & Zaki, M. (2018). Customer experience challenges: Bringing together digital, physical and social realms. *Journal of Service Management*, 29(5), 776–808, Emerald Group Holdings, Department of Marketing, W.P. Carey School of Business, Arizona State University, Tempe, AZ.

Singh, S., Dhir, S., Das, V. M., & Sharma, A. (2020). Bibliometric overview of the technological forecasting and social change journal: Analysis from 1970 to 2018. *Technological Forecasting and Social Change*, 154, 119963, Elsevier.

van Doorn, J., Mende, M., Noble, S. M., Hulland, J., Ostrom, A. L., Grewal, D., & Petersen, J. A. (2017). Domo arigato Mr. Roboto: Emergence of automated social presence in organizational frontlines and customers' service experiences. *Journal of Service Research*, 20(1), 43–58, SAGE Publications, University of Groningen, Groningen.

Corresponding author
Shameem Shagirbasha can be contacted at: shawaja@gmail.com