

Service Robots in the Restaurants: A Systematic Literature Review Using TCCM Framework

Restoranlardaki Hizmet Robotları: TCCM Çerçevesinin Kullanıldığı Sistematik Bir Literatür İncelemesi

Kadir ÖZDEMİR*
Çağatan TAŞKIN**

ABSTRACT

This study aims to analyze academic literature on service robots in restaurants using the TCCM framework and bibliometric analysis based on the SPAR-4-SLR protocol. A systematic literature review utilized the WOS and SCOPUS databases. The performance analysis of the articles obtained after applying the exclusion and inclusion criteria was carried out using Bibliometrix R studio. According to the results, anthropomorphism theory, uncanny valley theory, TAM, role congruence theory, and UTAUT are the most frequently used theories in the reviewed studies. China, the USA, and Korea have the highest number of articles. However, the authors are primarily from a single country. According to the conceptual framework, the frequently used variables are classified as consumer characteristics, robot-related, and consumer perception-related. PROCESS Macro, Structural Equation Modeling, PLS/SEM, ANOVA, and ANCOVA are the most widely used analysis methods. The data in the reviewed studies were predominantly collected via a questionnaire with scenario analysis. This study offers insights to guide future research, identify promising areas for further investigation, and advance the emerging research field. Finally, this study will provide scholars, service providers, managers, and entrepreneurs with valuable theoretical and practical insights and guidelines.

KEYWORDS

Service Robots, Restaurants, TCCM Framework, Systematic Literature Review, Bibliometric Analysis

ÖZ

Bu çalışma, SPAR-4-SLR protokolüne dayalı TCCM (Teoriler-Bağlam-Karakteristikler-Metodoloji) çerçevesini ve bibliyometrik analiz yöntemini kullanarak restoranlardaki hizmet robotları hakkındaki akademik literatürü analiz etmeyi amaçlamaktadır. Sistematik literatür incelemesi için WOS ve SCOPUS veri tabanlarından yararlanılmıştır. Hariç tutma ve dahil etme kriterleri uygulandıktan sonra elde edilen makalelerin performans analizi Bibliometrix R uygulaması kullanılarak gerçekleştirilmiştir. Sonuçlara göre, antropomorfizm teorisi, tekinsiz vadi teorisi, TAM, rol uyumu teorisi ve UTAUT incelenen çalışmalarda en sık kullanılan teorilerdir. Çin, ABD ve Kore en fazla makaleye sahip ülkelerdir. Ancak, yazarlar çoğunlukla tek bir ülkedendir. İnceleme sonucu oluşturulan kavramsal çerçeveye göre, sıklıkla kullanılan değişkenler tüketici karakteristiği, robotla ilgili ve tüketici algısıyla ilgili değişkenler olarak sınıflandırılmıştır. PROCESS Macro, Yapısal Eşitlik Modellemesi, PLS/SEM, ANOVA ve ANCOVA en yaygın kullanılan analiz yöntemleridir. İncelenen çalışmalarda veriler ağırlıklı olarak senaryo analizli bir anket aracılığıyla toplanmıştır. Bu çalışma, gelecekteki araştırmalara rehberlik etmek, yapılacak çalışmalar için alanlar belirlemek ve geliştirmekte olan araştırma alanını ilerletmek için içgörüler sunmaktadır. Son olarak, bu çalışma akademisyenlere, hizmet sağlayıcılara, yöneticilere ve girişimcilere değerli teorik ve pratik bilgiler sağlamakta ve kılavuzluk etmektedir.

ANAHTAR KELİMELER

Hizmet Robotları, Restoranlar, TCCM Çerçevesi, Sistematik Literatür İncelemesi, Bibliyometrik Analiz

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* Arş. Gör. Dr., Bursa Teknik Üniversitesi, İnsan ve Toplum Bilimleri Fakültesi, kadir.ozdemir@btu.edu.tr, ORCID: 0000-0002-2034-4797

** Prof. Dr., Bursa Uludağ Üniversitesi, İktisadi ve İdari Bilimler Fakültesi, ctaskin@uludag.edu.tr, ORCID: 0000-0002-0655-5061

INTRODUCTION

The place of service robots in service encounters is becoming increasingly prominent (Kao & Huang, 2023). The global service robot market is predicted to grow 15.4% from 2023 to 2028, reaching \$84.8 billion in 2028 from \$41.5 billion in 2023. (Markets & Markets, 2024). Service robots are designed to deliver services, interact, and communicate with customers without human support (Shah et al., 2023). Service robots are supported by artificial intelligence that can serve people in different environments in many areas of their lives, unlike industrial robots used in production environments (Pransky, 1996; Fusté-Forné & Ivanov, 2021). In this regard, many service industries utilize service robots, such as restaurants, hotels (Akdim et al., 2021; Wirtz et al., 2021), banks and finance (Belanche et al., 2020), airports (Belanche et al., 2020; Wirtz et al., 2021), cleaning, construction, logistic-delivery, medical, health care, rescue, and security, education (Gonzalez-Aguirre et al., 2021) driving and housekeeping (Belanche et al., 2020).

Significantly, the utilization of robots in restaurants has been increasing recently (Seo & Lee, 2021). One of the most significant reasons for the accelerated utilization of robots in restaurants is COVID-19 (Shah et al., 2023). During the pandemic period, human employees were at substantial risk of contracting viral infections (Seo & Lee, 2021). In addition, research indicates that service robots offer critical benefits to restaurants, including cost reduction, a qualified workforce, high-quality service, increased time saving, productivity, and improved customer experience and engagement (Shah et al., 2023). Service robot usage in restaurants has had an impact on academic studies (Seo & Lee, 2021). In last years, there has been a growing number of academic research on this subject. However, the subject is still emerging and developing (Ivanov et al., 2019). The expected increase in the use of robots worldwide is one reason for the rise in academic research (Markets & Markets, 2024). Another reason for the increasing popularity of service robots is their potential to provide competitive advantages (Cha, 2020) and numerous benefits for service providers (Shah et al., 2023).

The initial research on robots in tourism and hospitality was carried out by Schraft and Wanner on an aircraft cleaning robot (Skywash) in 1993. Engineers conducted subsequent research for a considerable period. However, in recent years, especially after COVID-19, social scientists have conducted extensive and considerable research on robots (Ivanov et al., 2019; Shah et al., 2023). In this context, a systematic review of studies on robots in the social sciences is required to reveal the field's current state and provide insights for future research (Ivanov et al., 2019). There are some systematic reviews on service robots. These papers can be briefly summarized as follows:

Lee (2021) conducted a systematic literature review on service robots, covering 1999–2020. The review analyzed 70 documents, including journal articles, books, and proceeding papers using the PRISMA protocol. Rosete et al. (2020) analyzed journal articles retrieved from the SCOPUS with the keywords "service robot" and "Henn-na." The study revealed the potential and constraints of robots in the hospitality sector. Ivanov (2019) reviewed 131 publications in the field of tourism published between 1993 and 2019, identified through WOS, SCOPUS, Academia.edu, ResearchGate, and Google Scholar, to highlight prominent themes. In their study, Shin (2022) analyzed 126 articles on robots in hospitality which are published in business management journals. Lu et al. (2020) systematically reviewed 20 business articles on the influence of robots on employees and customers. Liu et al. (2023) systematically reviewed 92 Web of Science studies on service failure and recovery of robots using the PRISMA protocol, identifying the field's current state and providing insights for future research. Mukherjee et al. (2023) carried out a systematic review of robots in tourism using the SPAR-4-SLR and the TMC (Theory, Methodology, Context) framework. The research analyzed 118 articles. Zhang et al. (2024) carried out a systematic review on human-like robots using the PRISMA protocol. They analyzed 118 articles in the SCOPUS database. Cheong et al. (2023) comprehensively review the literature on the use of robotics in the tourism sector. Through descriptive and content analyses, 121 articles in Science Direct, Scopus, and WOS databases were analyzed. In the study, the keywords 'robot', 'robotics', 'tourism', and 'hospitality' were searched. In a systematic literature review conducted by Cain et al. (2019), the status of robots in the hospitality sector was examined. The study considers the potential impact of advancements in robotics and artificial intelligence on the tourism sector.

Existing literature reveals no specific studies that address robots in the context of restaurants within the framework of TCCM. In the context of restaurants, Gonzalez et al. (2022) carried out a literature review, although their focus was on information and communication technologies rather than service robots. Thus, to fill this research gap, this study analyzed academic literature on service robots in restaurants utilizing the

TCCM framework and bibliometric analysis based on the SPAR-4-SLR, which is frequently used in systematic literature reviews, bibliometric analysis, and meta-analysis. This protocol can overcome the limitations of other protocols by facilitating a repeatable, consistent, and transparent examination (Paul et al., 2021). The articles were searched in the WOS and SCOPUS databases. These databases were selected for their superior functionality, comprehensive coverage of academic publications, and reputation for reliability, quality, and robustness (Cobelli & Blasioli, 2023; Zhang et al., 2024). After the inclusion and exclusion criteria, 115 research articles were obtained. These articles were analyzed in detail within the context of the TCCM framework and by using Bibliometrix software in R Studio. In this context, the forthcoming research questions will be discussed in this study to present the current state of the literature, fill gaps, and provide insights for future research:

RQ1: How is the performance of articles regarding service robots in restaurants?

RQ2: What are the crucial articles and authors contributing to relevant research areas?

RQ3: What are the theories, context, dependent and independent variables, mediators, moderators, and methods utilized in the relevant research area?

RQ4: What are the present and future research agendas?

This study is organized as follows: Service robots are defined in the first section, while the research methodology and used protocol are covered in detail in section 2. In section 3, analyses and findings are presented with the tables and figures. Finally, section 4 presents a discussion of the research results along with practical and theoretical implications, restrictions, and recommendations for forthcoming studies.

1. SERVICE ROBOTS IN THE RESTAURANTS

Service robots are computer-managed technology that can function autonomously without human guidance (Huang & Rust, 2018; Belanche et al., 2021). The rule-based service robots rely on past knowledge and constant sensor monitoring to detect and respond to the physical and temporal diversity in the service environment. They possess sufficient intelligence to carry out the necessary duties. Additionally, robots interact with customers through support and conversations (Wirtz et al., 2018). They can act independently, adapt to changing conditions, learn from previous customer interactions, and give the impression of a social presence (Belanche et al., 2020).

In the restaurant industry, service robot use has recently increased (Kao & Huang, 2023; Seo & Lee, 2021). The Covid-19 pandemic has substantially impacted this increase. Human employees were exposed to the enormous danger of viral infection during the pandemic. Thus, the danger of infection was decreased when service robots were used instead of human employees. Because service robots did not pose a risk of viral infection (Seo & Lee, 2020). Businesses have taken notice of this predicament, and many have decided to employ service robots as a preventative measure against losing customers (Hu, 2021).

In restaurants, robots can be used as front-line employees to welcome customers, as waiters (Belanche et al., 2020), and as chefs to cook food (Seo & Lee, 2021). For instance, Moley, the kitchen chef, can cook food according to the recipe given to him (Zhu & Chang, 2020). Service robots are being used at the Inomo restaurant in London. Inomo has robot waiters that interact with customers (Provenrobotics.ai, 2023). Robot chefs cook for customers at Spyce restaurant in Boston (Seo & Lee, 2021). Furthermore, robot chefs and robot waiters serve customers in a Chinese restaurant called Jingdong X Future in Tianjin, China (Zhu & Chang, 2020). Haidlao is a restaurant in China that employs cutting-edge technologies. The restaurant employs both robot waiters and robot chefs. The Robo Sushi restaurant in Germany represents a novel fusion of traditional sushi with robot technology. The preparation of sushi is conducted by robot chefs within the restaurant. (Provenrobotics.ai, 2023). Service robots have revolutionized how service providers engage with their customers. A new reality has emerged with robots in service delivery (Kao & Huang, 2023). So, service businesses that differentiate themselves through new technologies and proactively adapt to the changing environment can get a competitive edge over service robots that benefit people through social interaction (Cha, 2020).

2. METHODOLOGY

In this study, articles on service robots in restaurant were analyzed using the TCCM framework, and bibliometric analysis was performed, depending on the SPAR-4-SLR. The protocol is generally utilized in

systematic reviews and bibliometric analysis (Paul et al., 2021; Ahiadu et al., 2024). Thus, this research utilizes the SPAR-4-SLR which was improved to eliminate the restrictions of other protocols. This serves as the foundation for systematic review research and establishes exact planning, integration in execution, and transparency to permit replication. The protocol allows scholars to envision problems and uphold research integrity (Paul et al., 2021; Khan et al., 2024; Das et al., 2022; Ahiadu et al., 2024).

The stages of protocol and steps of methodology (Khan et al., 2024; Das et al., 2022; Sharma et al., Ahiadu et al., 2024; 2023; Paul et al., 2021) are shortly summarized in Table 1.

Table 1. Methodology

	Identification
Assembling	Domain: Service robots in restaurants Research Questions: RQ1: How is the performance of articles regarding service robots in restaurants? RQ2: What are the crucial articles and authors contributing to relevant research areas? RQ3: What are the theories, context, dependent and independent variables, mediators, moderators, and methods utilized in the relevant research area? RQ4: What are the current and future research agendas? Source Type: Peer-reviewed journal articles Source Quality: SCI-Expanded, SSCI, and ESCI
	Acquisition
	Database: Web of Science (WOS) and SCOPUS Search Period: 2019-2024 Search Keywords: “Robot” OR “Service Robot” AND “Restaurant” OR “Service Encounter” OR “Hospitality” Total Number of Articles Returned from the Research: 329
Arranging	Organization
	Organizing Codes: Article, authors, journals, publication years, countries, theories, variables, keywords, citations, methods Organizing Framework: TCCM
	Purification
	Article Type Excluded: Review articles, conceptual articles, and irrelevant articles duplicate = 214 Article Type Included: 115 journal articles
Assessing	Evaluation
	Analysis Method: Content analysis for TCCM framework and bibliometric analysis Agenda Proposal Method: Research questions and gaps utilizing the TCCM framework
	Reporting
	Reporting Conventions: Tables, figures, and keyword cluster Findings and Conclusion: Theoretical and managerial implications and future research direction Limitation: Database (WOS and SCOPUS)

Sources: Paul et al., (2021); Ahiadu et al., (2024); Sharma et al., (2023)

Many different software packages, such as VOSviewer, CiteSpace, and CiteSpace, can be used for bibliometric analysis (Moral-Munoz et al., 2020). In this study, bibliometric analyses were carried out utilizing Bibliometrix software in R Studio to analyze the performance of the selected articles. In addition, as Paul et al. (2021) suggest, the TCCM framework was utilized to identify current and future research agendas. This framework examines in detail the theories used in the studies (T), the contexts and the countries in which the studies were conducted (C), the characteristics/variables used in the studies (dependent, independent, moderator, mediator, control) (C), and the methodology of the studies (M) (Bhaiswar et al., 2022; Singh & Dhir, 2019; Roy Bhattacharjee et al., 2022).

The initial step in the systematic literature review was locating pertinent research articles (Bhaiswar et al., 2022). The articles were searched in the WOS and SCOPUS databases in the TITLE-ABSTRACT-KEYWORD-KEYWORDPLUS by using the Boolean operator ("keyword" OR/AND "keyword") (Saravanan, 2020). The keywords "Robot" OR "Service Robot" AND "Restaurant" OR "Hospitality" OR "Service Encounter" were used to search for articles. As a result of the searches, 121 articles were found in the WOS, and 295 were found in SCOPUS in the business areas. The articles obtained were merged using R Studio, as there may be duplicate articles in two different databases, and 87 duplicate articles were excluded. Thus, 329 articles were found. Finally, 329 articles were read in detail, and 214 articles contexts from retail stores (Rancati & Maggioni, 2023), hotels (Moliner-Tena et al., 2024), airports (Chen & VG, 2023), smart technologies (Leung, 2019), delivery robots (Lim et al., 2024), health care (Shanks et al., 2024), conceptual studies (McCartney & McCartney, 2020), studies investigating online customer reviews (Kim et al., 2022), and bibliometric studies (Yörük et al., 2023); literature review studies (Coelho & Farias, 2024) were excluded. In the end, 115 articles on service robots in the restaurant context were obtained for analysis.

3. ANALYSIS AND FINDINGS

The performance analysis of the studies and the results derived from the TCCM framework with content analysis are reported below.

3.1. Performance Analysis

Performance analysis, a significant part of bibliometric analysis, utilizes indicators such as journals, authors, publication years, countries, and citations (Donthu et al., 2021). As part of the performance analysis, this section presents a descriptive overview of the distribution of studies on service robots in restaurants by year, country, corresponding author, and journal. In addition, the most cited studies and the co-word analysis (word cloud) are briefly presented.

3.1.1. Publications Overview

The overview of the analyzed publications and the basic statistics on their citations are presented in Figure 1.

Figure 1. Publications Overview and Citation Statistics



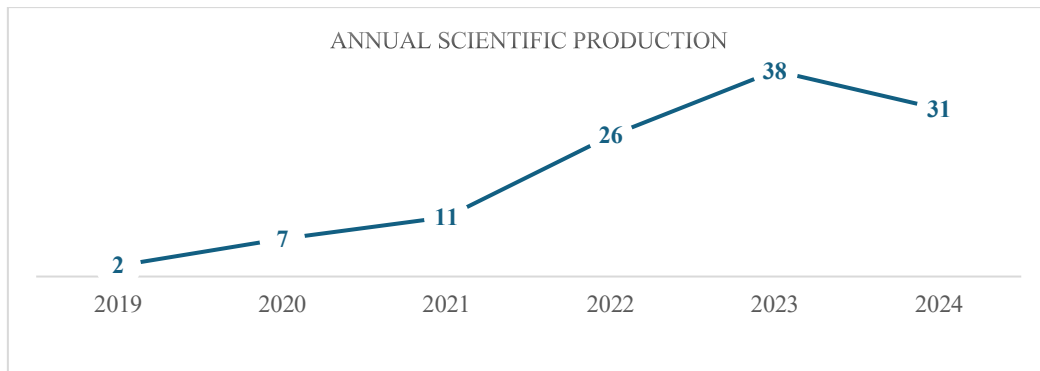
As demonstrated in Figure 1, a systematic review of articles published between 2019 and 2024 was conducted. The Bibliometrix R Studio was used to review and analyze 115 articles from 44 different sources (journals). The average age of the articles is 2.4 years.

The average number of citations per article is 24. A single author wrote ten articles, and the average number of authors per article is three. In addition, international collaboration and co-authorship is 22,61 percent. Most articles contain authors from the same country rather than articles where multiple countries are represented. International collaboration in this area is limited, with a rate of only 22,61 percent. The lack of collaboration can be seen as an impediment to developing and advancing the field.

3.1.2. Publications by Year

The annual scientific production of studies on robots in the restaurant context is shown in Figure 2.

Figure 2. Annual Scientific Production

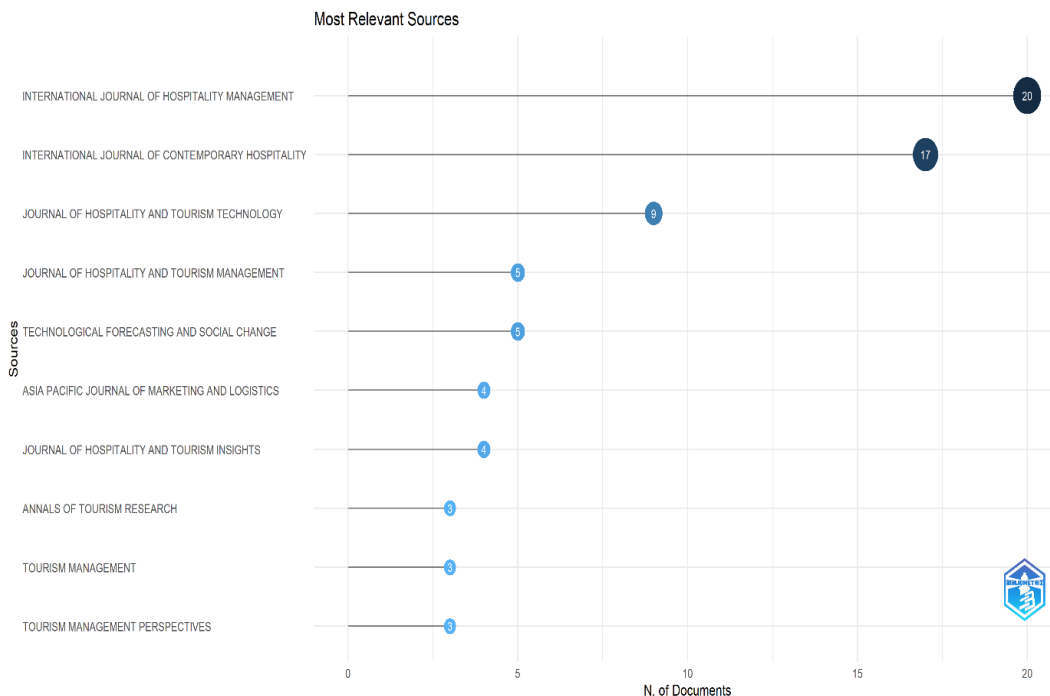


According to Figure 2, two of the studies included in the analysis were published in 2019, 7 in 2020, 11 in 2021, 26 in 2022, 38 in 2023, and 31 in 2024. The number of studies increases rapidly from year to year.

3.1.3. Publications by Journal

The list of journals with the most publications on robots in the restaurant context is shown in Figure 3.

Figure 3. List of Relevant Journals

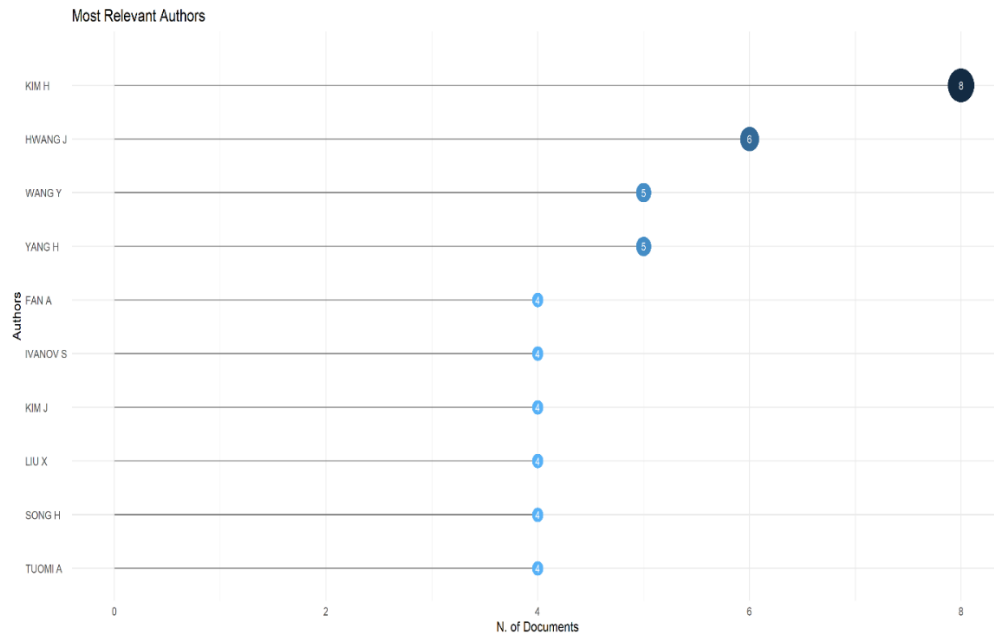


According to Figure 3, The most published journals are the International Journal of Hospitality Management (20), and the International Journal of Contemporary Hospitality (17). These journals are followed by the Journal of Hospitality and Tourism Technology (9), Journal of Hospitality and Tourism Management (5), and Technological Forecasting and Social Change (5).

3.1.4. Publications by Authors

The list of the relevant authors with the most publications is presented in Figure 4.

Figure 4. List of Relevant Authors

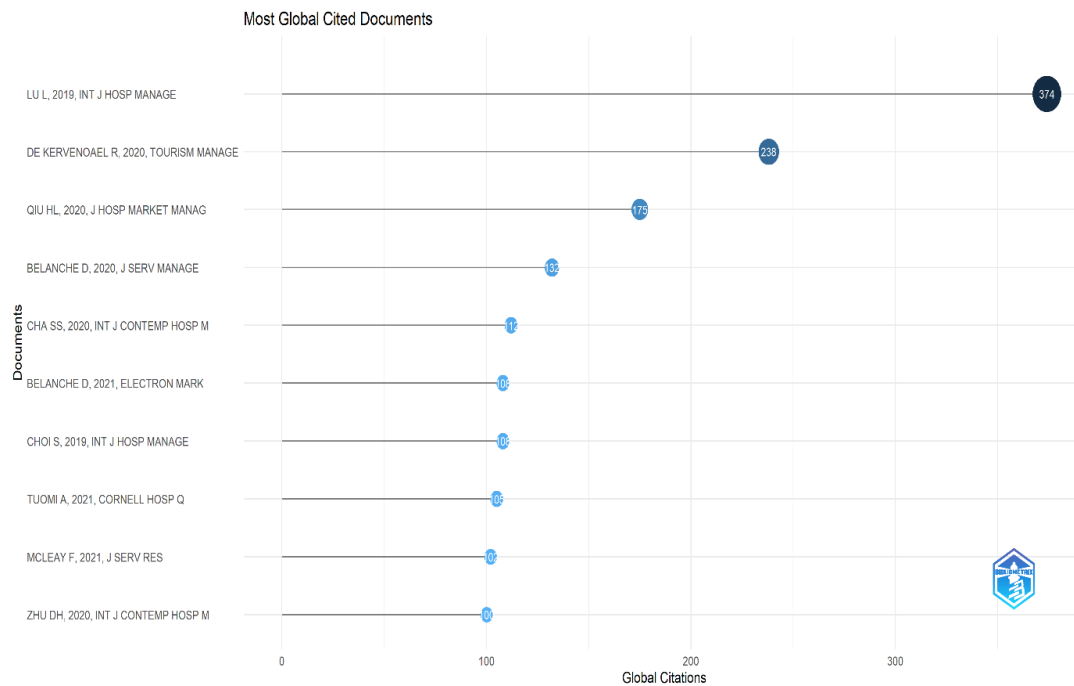


According to Figure 4, Kim H. (8) is the author with the most articles on service robots in restaurants. They are followed by Hwang J. (6), Wang Y. (5), Yang H. (5), Fan A. (4), Ivanov S. (4), Kim J. (4), Lu X. (4), Song H. (4), and Tuomi A. (4).

3.1.5. Most Cited Documents

The most cited studies in this research area are demonstrated in Figure 5.

Figure 5. Most Cited Documents



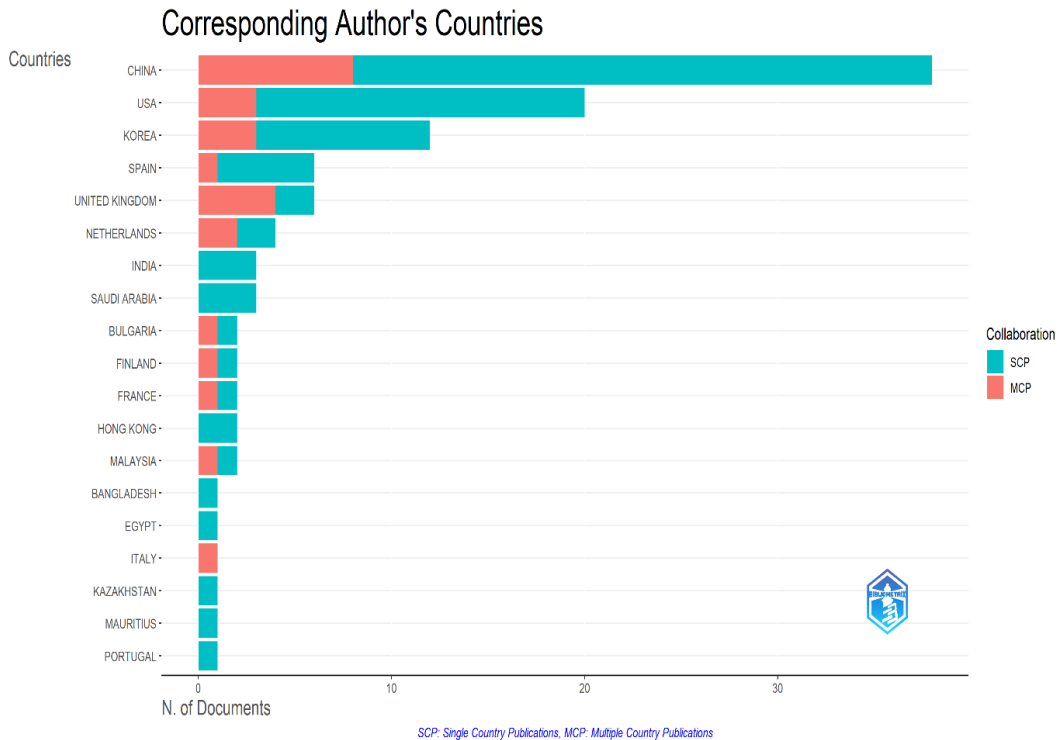
tendencies to robotic systems (Van Pinxteren et al., 2019). This tendency cultivates the perception that robots possess both human-like physical and mental attributes (Choi et al., 2021).

The theory of uncanny valley attempts to explain people's reactions when a robot resembles a human in physical appearance and functional characteristics (Mori, 1970; Misselhorn, 2009). According to the theory, the level of anthropomorphism of robots changes people's reactions to robots. According to Mori (1970), when the anthropomorphism of robots is up to a particular level, people perceive robots as cute and pleasant and have positive reactions to robots. However, as the anthropomorphism of robots increases (when it exceeds the threshold of the uncanny valley), people find robots more frightening, and threatening and perceive risk. This causes people to react more negatively to more human-like robots (Becker et al., 2023; Akdim et al., 2023; Lin, 2023). This phenomenon is called the 'Uncanny Valley Effect' (Lin, 2023). However, once the uncanny valley effect has been overcome, people positively respond to service robots. This can be achieved by adding more humanoid features to robots and by making robots almost completely human-like (Mara et al., 2022). Even many of the android robots, which are very similar to humans, cannot behave like humans in terms of functional characteristics. Mori (1970) pointed out that this situation would also frighten people. In other words, overcoming the uncanny valley depends on the human resemblance of robots going beyond the context of physical appearance or social function to behave like humans. If the service robots have these characteristics and can indeed act like humans, the increase of anthropomorphism may enable the uncanny valley to be overcome (Mara et al., 2022; Mende et al., 2023). The literature presents conflicting findings on anthropomorphism and the uncanny valley. Some studies suggest that human likeness enhances consumer comfort (Becker et al., 2023), while others indicate that increasing the human likeness of robots can provoke anxiety and fear (Mori, 1970). Therefore, the two theories about the anthropomorphism of robots are primarily utilized in the related papers.

3.2.2. Context

In the literature, the context part of the TCCM analysis is considered in terms of the context (e.g., hotel, airport, healthcare, education, restaurant) in which the studies were conducted and the countries of the responsible authors who carried out the studies (Bhaiswar et al., 2022). The context evaluation highlights the countries of the relevant authors because the study's research is conducted within the confines of the restaurant. In this regard, Figure 7 illustrates the related authors' nations for the reviewed articles.

Figure 7. Corresponding Author's Countries



As shown in Figure 7, most corresponding authors are from China, with 38 articles (e.g., Shan et al., 2024; Qiu et al., 2020; Li & Wang, 2022; Zhang et al., 2022). Of these 38 articles, 30 are from a single country, and 8 are multiple-country articles, meaning that authors other than the corresponding author are from different countries. China is followed by the USA (e.g., Chang & Kim, 2022; Wang & Papastathopoulos, 2023; Ma et al., 2022), Korea (e.g., Choi et al., 2023; Cha, 2020), Spain (e.g., Fusté-Forné, 2021; Belanche et al., 2021), the UK (e.g., Tuomi et al. 2021), and the Netherlands (e.g., Odekerken-Schröder et al., 2022). The corresponding author of 20 articles is from the USA, of which 17 are single-country articles, and 3 are multiple-country articles. The corresponding authors of 12 articles are from Korea, of which 9 are single-country articles, and 3 are multiple-country articles.

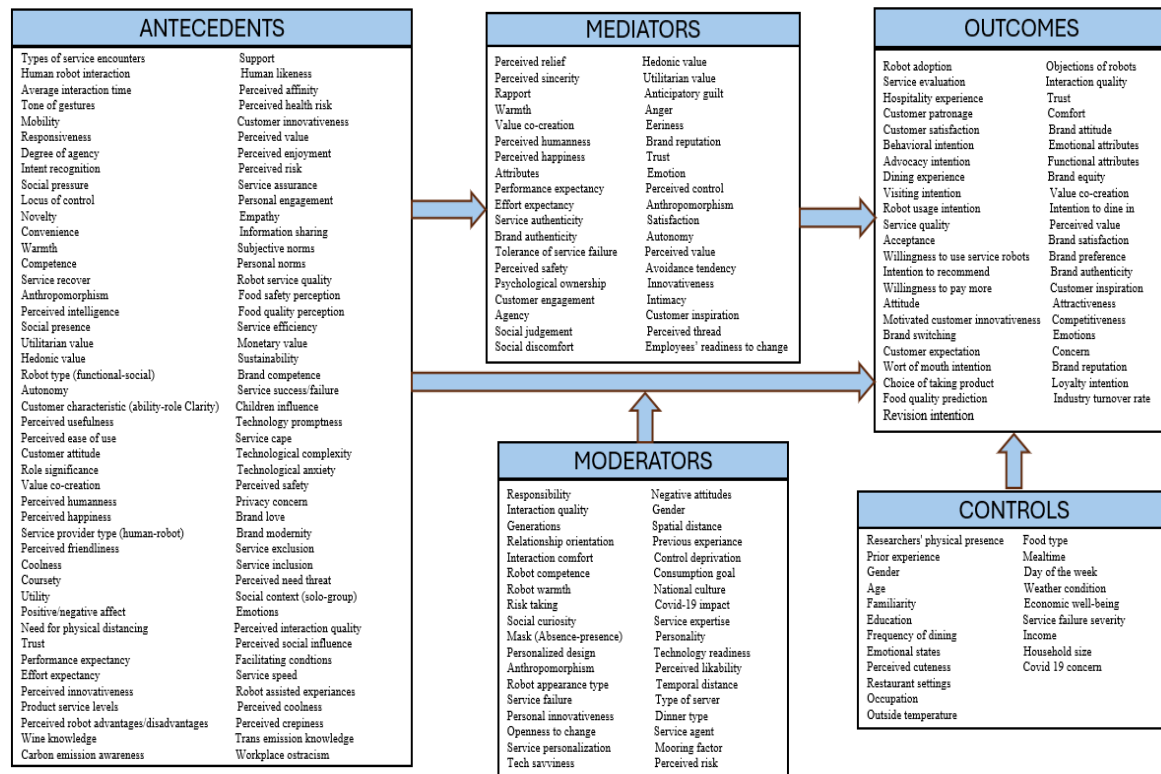
Analysis of the nations of the corresponding authors reveals that China, Korea, India, Malaysia, Saudi Arabia, and Turkey, which are part of the MSCI Emerging Market Index, have researched service robots in the restaurant sector. China and Korea hold a notable position regarding the number of publications, as they are two of the three countries with the greatest publication counts. It is also noteworthy that the countries of origin of the corresponding authors include developed nations such as the USA, Spain, the UK, and the Netherlands. Furthermore, corresponding authors from countries with low levels of economic development, including Bangladesh, Egypt, and Mauritius, have also contributed to service robotics through their research publications. Research on service robots relates to countries' economic development levels. Indeed, As Lucas (1988) asserted, technological advancement is a crucial determinant of national economic growth. Consequently, it is anticipated that research on service robots will proliferate in both developed and emerging nations. However, China and South Korea are particularly prominent, indeed the Australian Strategic Policy Institute (ASPI) (2023) reported that China is currently leading the United States in terms of technological advancement. The United States trails behind China in 37 out of the 44 technological developments assessed. Additionally, the same report indicated that South Korea has also made significant strides in technological advancement, outperforming numerous other countries.

It is somewhat unexpected that countries such as Singapore and Japan, where service robots are extensively utilized, are absent from the list. Additionally, there is a paucity of studies conducted within the context of European countries within the scope of our study. Furthermore, our study set lacks studies conducted in South America and Africa. In light of these findings, it is advised that future studies investigate the potential utilization of service robots in these countries. This may be attributed to the criteria employed for inclusion and exclusion. Nevertheless, the presence of corresponding authors from less developed countries can also be attributed to the utilization of scenario analysis in the papers as the methodology. Because in the scenario analysis method, the individuals whose data are collected do not need to use service robots. In this context, there may not be service robots in those countries. Individuals may participate in the relevant study by considering the utilization of a robot in the context of the scenarios created. In addition, robots may exist in these countries, and the corresponding authors may not be located in the country where the data was collected.

3.2.3. Characteristics

Following a systematic assessment of the literature on restaurant service robots, Figure 8 presents the current antecedents, outcomes, moderators, mediators, and control factors. Researchers have investigated several elements and how they relate to one another in the context of serving robots in restaurants, illustrated in the main framework below.

Figure 8. Existing Characteristics



Consumer characteristic variables (e.g., personal innovativeness, emotions, personal norms, social norms, utilitarian value, hedonic value), robot-related variables (e.g., human likeness, coolness, tone of gestures, mobility, responsiveness, anthropomorphism, service speed, robot type, degree of agency, warmth, competence), and consumer perception-related variables (e.g., perceived friendliness, perceived robot advantages, and disadvantages, perceived affinity, perceived value, perceived enjoyment, perceived engagement, perceived risk, perceived trust, perceived coolness) are the categories in the reviewed studies' antecedents. Consumer-characteristic variables are used as antecedents in shaping consumer opinions about service robots. It considers how personal, demographic, and other characteristics of consumers influence their e.g. attitudes (Li & Wang, 2022), intention to use, WOM, brand competence (Hwang et al., 2022), and willingness to pay (Chuah et al., 2022) towards service robots. The robot-related variables employed as antecedents were utilized to examine the extent to which both the physical appearance and behavioral characteristics of robots influence the overall assessment of customers. The robot-related variables affect e.g. robot adoption (Tuomi et al., 2021), service evaluation (Shan et al., 2024), perception of utilitarian and hedonic value (Odekerken-Schröder et al., 2022), customer satisfaction (Chang & Kim, 2022), attitudes, and behavioral intention (Li & Wang, 2022). Similarly, variables related to customer perceptions have been used to examine how customers' perceptions of service robots affect service evaluations. For instance, Li & Wang (2022) examined the influence of perceived usefulness and ease of use on attitude and intention. Söderlund (2021) investigated how perceived humanness and perceived happiness affect the overall service evaluation of customers. Hwang et al. (2022) explained the impact of perceived innovativeness on brand competence.

When we consider the mediating variables presented in Figure 8, we can classify these variables as customer-related and robot-related. Consumer-related variables included trust, emotions, attributes, perceived humanity, perceived happiness, perceived safety, perceived sincerity, social judgment, perceived value, innovativeness, hedonic value, utilitarian value, satisfaction, tolerance of service failure, and perceived control. Robot-related variables included agency, anger, eeriness, anthropomorphism, and autonomy.

Factors including customer acceptance, use intention, adaptability, preference, experience, service quality, behavioral intentions, behaviors, perception, recommendation intention, satisfaction, and willingness to pay are significant when examining outcomes. The output variables typically comprise either positive or negative customer responses. However, an analysis of the studies in focus reveals that positive customer responses are more frequently investigated as output variables than negative ones. For example, Figure (8)

shows that the variable indicating objections to robots was used as a negative customer response. In this regard, future studies should examine negative customer responses to robots in greater depth. Such responses may include dissatisfaction, discomfort, negative emotions, negative attitudes, and negative word-of-mouth (WOM). Analyzing negative responses and their underlying reasons, in contrast to positive responses, is crucial for ensuring customer satisfaction and preventing possible concerns. If potential adverse customer responses are not investigated and prevented, customers who have such responses can rapidly disseminate them to other customers. As Brunner et al. (2019) posit, customers tend to ascribe greater significance to negative information than to positive information. Moreover, negative information exerts a more pronounced influence on the decision-making process.

As illustrated in Figure 8, a variety of consumer-related variables were employed as moderator variables, including age, gender, openness to change, personal innovativeness, negative attitudes, experience, consumption goals, national culture, risk-taking, personality, previous experience, control deprivation, and technological readiness. Furthermore, robot-related variables, including competence, warmth, robot appearance type, anthropomorphism, service expertise, type of server, and service agent, are utilized as moderators. In addition to the customer-related and robot-related variables that have been previously discussed, future studies could also utilize potential moderator variables related to the business model of restaurants and restaurant settings. For example, restaurant types, including luxury, fine dining, casual, and quick-service formats, can be employed as moderating variables in different research and theoretical models. Similarly, Huang & Liu (2022) used dinner type (solo or group) as a moderator variable. Additionally, Hu (2021), utilized industry context (hedonic or utilitarian) as a moderator variable. Chang & Kim (2022) employed the relationship orientation of the restaurant (exchange or communal restaurant) as a moderator variable. The restaurant type classification used by Wang & Papastathopoulos (2023) can be employed as a moderator variable. Furthermore, economic, socio-demographic, and environmental factors may also be utilized as moderating variables. For instance, it is plausible that customers' usage intention, acceptance, and attitudes toward service robots may fluctuate by their income status. This phenomenon is also observed concerning the level of education and the social context in which the customer resides. In countries and settings with varying levels of development, consumer responses to robots may display significant differences.

Lastly, as control variables, the researchers employed demographic characteristics like gender, age, education, income, economic well-being, and occupation. Furthermore, they employed the following control variables: physical presence, previous experience, familiarity, emotional states, food kind, mealtime, restaurant settings, and COVID-19 concerns.

3.2.4. Methods

The methods utilized in the reviewed studies are summarized in Figure 9.

Figure 9. Analysis Techniques

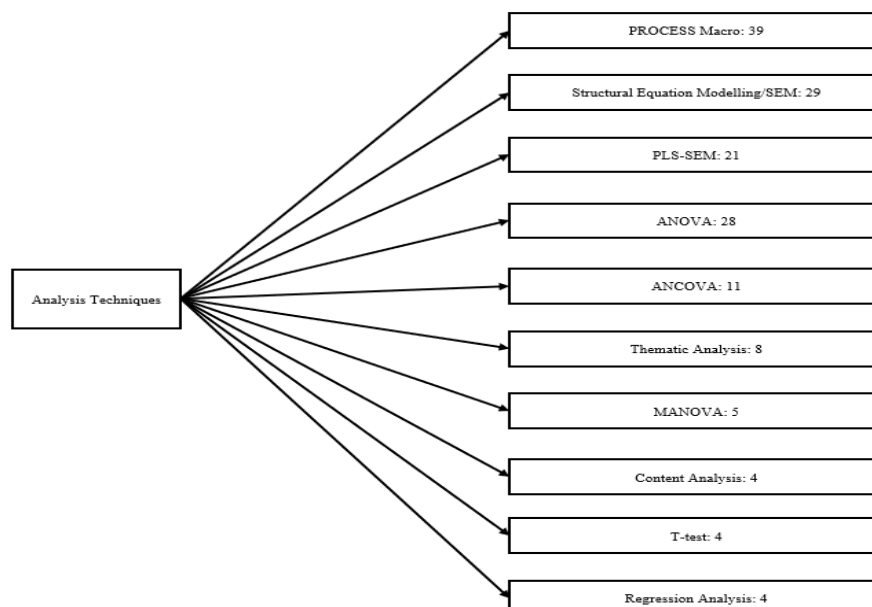


Figure 9 shows that 39 reviewed studies used the PROCESS Macro, while 29 studies used structural equation modeling, and 21 used PLS/SEM. The studies that employed the PROCESS Macro were mainly experimental and used ANOVA, ANCOVA, T-test, and MANOVA analyses. Additionally, four studies used regression analysis. However, as indicated, the reviewed studies were generally analyzed using quantitative methods. The number of studies using qualitative methods is limited. In this regard, thematic analysis was used in 8 studies and content analysis in 4 studies.

Regarding the method of analysis, the data collection methods and research designs of the reviewed studies were also examined. In this context, studies are generally analyzed using quantitative methods, 96 studies used questionnaires as a data collection method. In addition, data were collected utilizing in-depth interviews in 17 studies, observations in 4 studies, and focus group discussions in 3 studies. Also, most studies in the related field were experimental (47), while scenario analysis (55) was also commonly used. A limited number of studies employed a case study design. As some studies employ mixed methods that combine quantitative and qualitative approaches, the number of methods and reviewed studies varies.

4. CONCLUSION AND DISCUSSION

Our systematic literature review aims to contribute to the literature by synthesizing comprehensive and current information on robots in restaurants. The study analyzed articles from the WOS and SCOPUS databases, known for their high-impact factor journals and quality publications. After applying the inclusion and exclusion criteria, we analyzed 115 articles on the subject in detail using the TCCM framework and Bibliometrix software in R Studio. Also, the study's methodology was guided by the SPAR-4-SLR protocol. The bibliometric results enabled the identification of research trends, the countries with the most studies, the most productive journals, and the most productive authors. The review also identifies the theories, contexts, characteristics (variables), and methods utilized in existing studies employing the TCCM framework. This comprehensive analytical approach serves to enhance the theoretical framework and simultaneously offers a roadmap for future research, facilitating novel avenues for further study.

This study offers several theoretical and practical contributions for scholars, service providers, marketers, and entrepreneurs. According to the results, academic studies on robots in the restaurant industry are rapidly increasing, particularly after COVID-19. Figure 2 illustrates a notable increase in the number of articles published, particularly in 2022, 2023, and 2024 coinciding with the end of the pandemic period. Robots in restaurants have accelerated with the pandemic, and their use continues to increase daily (Ivanov et al., 2019; Shah et al., 2023). The growing popularity of the subject in the coming years and the proliferation of service robots in more restaurants indicate that academic studies will be increasing. In addition, the word cloud analysis indicated the most frequently used words in the reviewed articles. In this context, as shown in Figure 6, words such as satisfaction, acceptance, attitudes, hospitality, anthropomorphism, perception, intention, adoption, and consumer behavior were utilized. It is reasonable to assume that research on restaurant service robots primarily focuses on consumers' thoughts, intentions, attitudes, perceptions, ideas, and behaviors. Furthermore, Ivanov et al. (2019) and Markets & Markets (2024) support the conclusion that the related field is still emerging and developing. This is evidenced by frequently using words such as 'acceptance,' 'adoption,' and 'experience.'

The reviewed articles mainly employed anthropomorphism and uncanny valley theories. Given that the field is still emerging, it is critical to consider the human likeness of robots and the potential fear or anxiety this may elicit in consumers. Certain research demonstrates that human likeness increases customer comfort (Becker et al., 2023), whereas others imply that heightened human likeness in robots may elicit fear and anxiety (Mori, 1970). As indicated, the literature reveals contradictory results regarding anthropomorphism and the uncanny valley. Therefore, researchers have often employed these theories. Furthermore, it is noteworthy that robot-related variables such as human likeness, coolness, tone of gestures, mobility, responsiveness, anthropomorphism, service speed, robot type, degree of agency, warmth, and competence are frequently used as antecedents in the reviewed articles. The analysis of the effects of these variables also supports this trend and these conclusions. Furthermore, although less common than anthropomorphism and the uncanny valley, the TAM, the role congruity theory, and the UTAUT were relatively frequently used in the reviewed studies. Due to the paucity of theory used in the reviewed studies, there is a need for theory development to provide a more holistic explanation of consumer response to robots in restaurants.

Figure 1 shows that international collaboration in this area is limited, with a rate of only 23 percent. The lack of collaboration can be seen as an impediment to developing and advancing the field. Therefore, it is essential to increase international cooperation in future studies. In addition, Figure 9 demonstrates that PROCESS Macro was most frequently utilized in the data analysis of the reviewed studies. The reason for the frequent use of the PROCESS Macro is that many papers have conducted moderated mediation analyses (e.g., Choi et al., 2019; Chang & Kim, 2022; Shan et al., 2024). PROCESS Macro-analysis has been used extensively in moderation, mediation, and moderated mediation analysis in recent years. PROCESS Macro analysis is followed by SEM, PLS/SEM, ANOVA, and ANCOVA. As indicated, the reviewed studies were generally analyzed using quantitative methods. A limited number of studies have used qualitative methods. The number of studies analyzed by thematic and content analysis could be more precise. We can support this finding with data collection methods. Qualitative methods such as focus group discussions and in-depth interviews are limited. However, qualitative research methods with a robust exploratory aspect are essential for developing and emerging fields such as service robots in restaurants. Therefore, using qualitative research methods in future studies will contribute to the literature in generating novel insights. Using qualitative studies, it is possible to add new variables to the existing ones used in previous studies presented in Figure 8 and extend the conceptual framework.

Additionally, most of the studies used scenarios and collected participant data through scenario analysis. This shows that the data collected from customers who have experienced the service robot is limited. In this case, there may be doubts about the reliability of the results. One of the reasons for this phenomenon is that the field is relatively novel, and only a few restaurants have service robots. However, in future studies, collecting data from customers who experience dining in restaurants with service robots, rather than conducting scenario analyses, will increase the reliability of the results and make a substantial contribution to the literature.

5. IMPLICATIONS

In conclusion, identifying the theories and variables most used in previous studies has practical implications for service providers, marketers, and entrepreneurs. The variables highlighted in the reviewed studies are essential regarding customer characteristics, robot characteristics, and perceptions. The conceptual framework we have developed and the study we have conducted can guide scholars and practitioners in this regard. Service providers, marketers, and entrepreneurs can easily understand what issues to consider when deciding to use service robots in their restaurants, what has been researched in the literature, and which factors are more important and emphasized with the help of our study. Practitioners can identify how customers respond to service robots, how robots should be designed, and what types should be used. This gives practitioners an advantage in taking precautions and not making mistakes.

The extant literature on service robots in restaurants reveals a significant focus on the acceptance, adaptations, and usage. This provides practitioners with insights into the variables that enhance the acceptance, adoption, and use of robots. Nevertheless, the reviewed studies predominantly concentrate on specific variables, such as robot design and anthropomorphism. The objective is to ascertain the impact of these characteristics on the service outputs that have been identified. In this context, practitioners can gain insight into how the human-like characteristics and design of the service robots they will utilize in restaurant settings will be perceived and what outcomes they will engender. The variables that facilitate the adoption of robots in restaurants can be implemented by practitioners to enhance the consumer experience and improve employee acceptance. Future research in the restaurant sector will inform the effective utilization of robots in customer roles, ensuring that interactions are both satisfactory and efficient. Furthermore, it will address the economic aspects of robotic integration, including the potential for reduced costs and enhanced service delivery. The prospective research avenues delineated in this paper will facilitate the advancement of robots with augmented social aptitudes and user-friendly interfaces, thereby enabling them to cater to the heterogeneous expectations of customers.

6. FUTURE RESEARCH AND LIMITATIONS

The word cloud results can be supported by the independent and dependent variables shown in Figure 8 and used in the reviewed articles. A conceptual framework was designed based on the variables derived from previous studies (Figure 8). This framework should be extended in future studies by including novel factors. As evidenced by an analysis of the studies examined, the studies are primarily customer-oriented. The customer response to service robots has been the subject of considerable discussion and investigation. It is currently

believed that studies on employees and restaurant managers will prove both important and valuable, and will contribute new insights to the field. In this context, an area that requires further investigation is the compatibility of service robots with employees. It would be beneficial to ascertain whether employees are inclined to collaborate with service robots and whether they perceive such interactions as amenable. It would also be insightful to determine whether employees perceive robots as a potential threat and whether they believe that service robots impact their organizational commitment. What strategies should managers employ to foster a harmonious relationship between service robots and employees? Future studies may elucidate effective approaches to motivating employees about service robots and persuading them to collaborate with them. Indeed, there exists a paucity of studies on this subject (Mejia et al., 2024; Patwary et al., 2024). Nevertheless, this is a relatively small number of studies when compared to the research that has been conducted on customers.

Furthermore, a comparative analysis of restaurants that utilize service robots and those that do not can be conducted. What are the advantages of restaurants that employ service robots over those that do not? The impact of robots on customer perceptions has been examined, yet the role of these robots in enhancing restaurant operations requires further investigation. It would be beneficial to examine whether there is an increase in sales and customer numbers.

The number of studies that engage in cultural and cross-cultural comparative analysis is relatively limited. In this context, an investigation and comparison of customer responses in different cultural contexts to service robots in various settings would yield valuable insights. In addition, an examination of the most commonly used theories and characteristics reveals that robot appearance and anthropomorphism are the predominant factors. It would be beneficial to consider additional factors, beyond the appearance of service robots when examining their behavioral characteristics. This could include aspects such as their approach to customers, the way they smile, their movements, and their language style. Such studies could provide valuable insights. For example, the study by Choi et al. (2019) on the language style of robots is included in our study set. In their study, the language style of service robots was categorized as either literal or figurative. However, future studies would benefit from investigating additional factors, such as speech rate, intonation, facial expression and body language, grammatical structure, and word choice. Nevertheless, the ethical dimension of service robots (e.g. privacy concerns) is also under-researched within the study set. Mcleay et al. (2021) and Zhu & Zhang (2024) conducted examinations of service robots about ethical considerations and investigated customers' ethical perceptions. Xie and Lei (2022) and Rasheed et al. (2023) examined customer perceptions of privacy. Further research in this area may yield new information and insights. Customers may perceive privacy concerns or personality threats when interacting with robots. Therefore, further study of ethics, privacy, and threat issues in the context of robots is recommended, as this may provide important insights.

Like many studies, this study has limitations. The initial limitation is the WOS and SCOPUS databases. However, there are various studies on service robots in restaurants in databases such as Google Scholar, ABDC (Australian Business Deans Council), PUBMED, and EBSCO. The presence of high-impact factor journals in the WOS and SCOPUS databases and the publication of high-quality articles are why these databases are preferred. Another important reason is that the raw data obtained from these databases are suitable for bibliometric analysis and systematic literature reviews. A further limitation of the study is that the articles included in the analyses were searched in TITLE-ABSTRACT-KEYWORD-KEYWORDPLUS. More studies can be obtained by searching the relevant articles by selecting the phrase "all fields" when searching for related keywords. However, this is not the preferred method. Because the keywords of the studies in the context of the topic are usually mentioned in the title, abstract, and keywords. Therefore, systematic review articles published in reputable journals are usually searched for the keywords they use in the title, abstract, and keywords (e.g. Xu et al., 2023; Zhang et al., 2024; Mukherjee et al., 2023). Another limitation of the research is contextual. This study only focuses on service robots in restaurants. However, in-depth analyses can be carried out systematically in other areas such as hospitality, healthcare, education, and logistics, and the field's current state can be identified. The inclusion and exclusion criteria were applied to the articles obtained in the first phase of the study, and the articles were read in detail individually. These criteria excluded conceptual articles, articles examining online customer reviews, and meta-analysis articles. Especially in the hospitality and hotel management field, a significant number of studies examine online customer reviews. These articles can also be systematically analyzed in future studies, and their findings can be summarized. It is also substantial to note that this study only analyzed studies carried out between 2019 and 2024.

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